QCL WATER SCIENCE

University of Amsterdam

Growth and Survival of Five Coral Species and their Potential for Coral Reef Restoration in the Colombian Caribbean

Context

As observed in the rest of the world, coral reefs in the Colombian Caribbean are severely threatened by increasingly acute and chronic natural disturbances, and a wide range of anthropogenic stressors.

One of the main factors is ocean acidification (OA). OA is mainly caused by increased dissolved carbon dioxide (CO_2) levels in the ocean due to rising atmospheric CO_2, making the ocean more acidic. Some biogeographical regions or parts of the ocean are naturally more acidic than others (e.g., deep-sea hydrothermal vents) and OA has already occurred in the past to some degree. However, this phenomenon is happening faster now than in the last 20 million years.

Experimental Setup

The experimental setup consisted in deploying the AquapHOx® Logger in underwater coral nurseries (Fig. 1) in three different locations in Colombia. The areas chosen (Santa Marta, Islas del Rosario, and Providencia) to test pH levels are located in three environmentally different areas in Caribbean Colombia.

Figure 1. The AquapHOx logger deployed in a "table nursery" in Santa Marta

Environmental variables included cold-water upwellings, different nutrient concentrations, variable levels of turbidity and sedimentation.

Coral nurseries were populated with five different coral species (*Acropora cervicornis, Acropora palmata, Montastrea cavernosa, Colpophyllia natans* and *Pseudodiploria strigosa*).

The choice of the species is dictated by their importance in building the 3D structure of coral reefs, especially *A. cervicornis* and A. palmata which are also listed as Critically Endangered on the IUCN Red List (2008).

Results

Figure 2. pH values in Santa Marta ranged from a minimum of 8.03 (first day) to a maximum of 8.23 (third day), oscillating in between. The graph also highlighted a daily trend, with raising pH levels between 12:00 and 4:00 pm and decreasing overnight

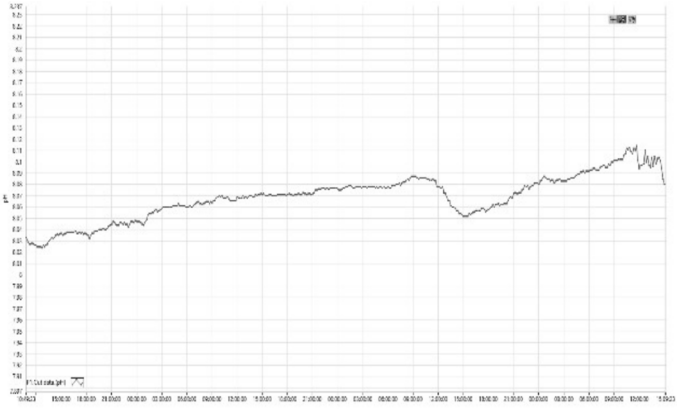

Figure 3. pH levels at Rosario Islands were not following any visible daily trend. Rather, they slowly increased (from 8.03 to 8.08) for two days consequently and suddenly decrease from 8.08 to 8.05 in three hours (12:00/3:00 pm), only to start increasing again. The minimum value was 8.02 and the maximum reached 8.11

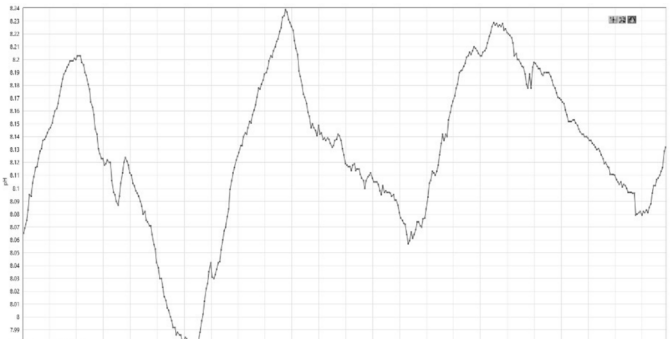

Figure 4. pH profile in Providencia showed the greatest difference between day and night within the three locations, shifting from 7.97 to 8.23. This is translated into a decrease in the acidity of nearly 100% in less than just 12 hours (6:00 am/6:00 pm on the second day)

Conclusions

Today, the ocean's average pH is around 8.1. It has already decreased by 0.1 since the beginning of the Industrial Revolution and is projected to drop further by 0.3/0.4 by the end of the century if CO_2 emissions are not reduced. The biological impacts of this increased acidification will drastically affect many marine organisms including corals, reducing their ability to produce their skeletons, recovering from disturbances, compromising fertilization and affecting larval settlement.

The data retrieved from the AquapHOx® Logger showed interesting outcomes, highlighting the differences between the three areas: Providencia with its ocean settings, the archipelago of Islas del Rosario close to the coast and affected by the runoffs or river Magdalena and the Inca Inca Bay in Santa Marta, with pure coastal settings. The outcomes clearly highlight the existence of some trends in Santa Marta and Providencia, while for Islas del Rosario more data is definitely needed to establish the possible existence of a pattern.

The similar trends from Santa Marta and Providencia could be because of underwater currents (e.g., the Caribbean Current) which provide significant and constant water flow. The possible explanation for the irregular pattern in Islas del Rosario could be because of the different sediment/nutrient load produced by the discharges of the river Magdalena which flows south-westward. Additionally, the experiment took place during the rainy season (April to November), which could lead to an increase in the carrying capacity of the river.

Lastly, with these new insights, we are just scratching the surface, underlining how important should be to monitor the pH levels constantly due to the frequency with which they change and how these rapid changes could potentially affect coral growth rates.

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