**Project Update: April 2022**

**Fieldwork campaign (from 21.02.2022 to 01.03.2022)**

- Temperature and hypoxic tolerance experiment: colonies of *Pocillopora capitata* were collected and incubated at 24°C (thermal stress during upwelling, low temperature), and at 28°C and 32°C under hypoxia and normoxia. Their respiration rates, colour of fragment, and polyp behavior were recorded as the coral response (Fig 1).

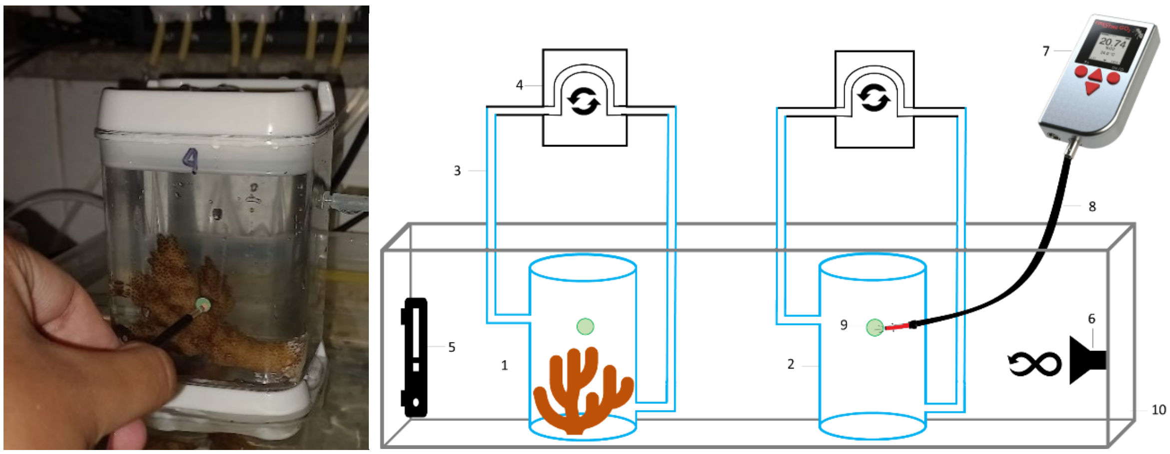
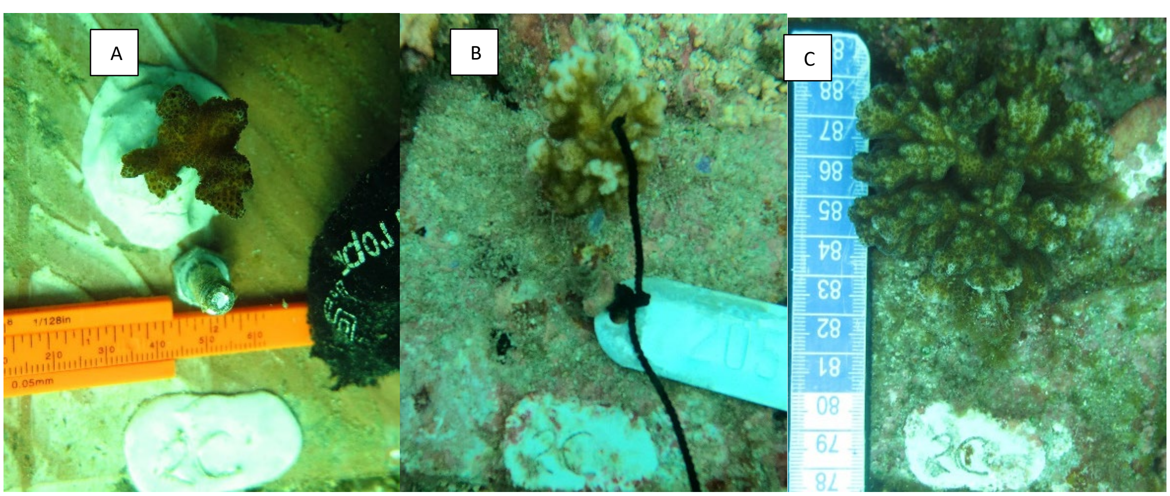



Fig 1. Left: photo of measurements of oxygen concentration for the incubation of coral fragment. Right: experimental setup to expose corals at different temperatures and oxygen conditions.

- Data collection of temperature, light, and salinity from sensors. Unfortunately, the salinity sensor deployed at Playa Blanca reef has technical problems. Hence was removed from the reef and send to technical support.

- Photographic record of experimental fragments to measure growth rates and health status (Fig 2,3).



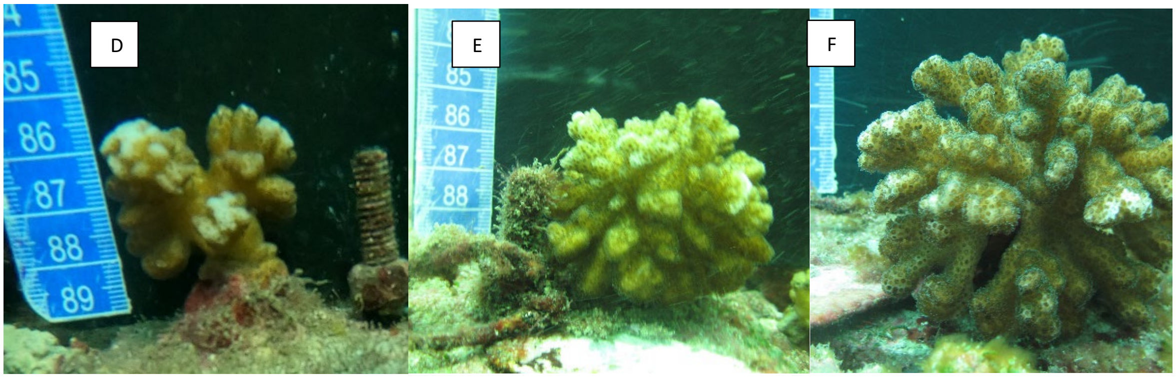



Fig 2. Photographic record of an experimental coral fragment (Colony ID: 2) from la Ventana Reef and maintained at the home reef (fragment ID: 2C). (A) April 2021, when fragment was seed (B, D) July 2021, (E) November 2021, (C, F) February 2022.

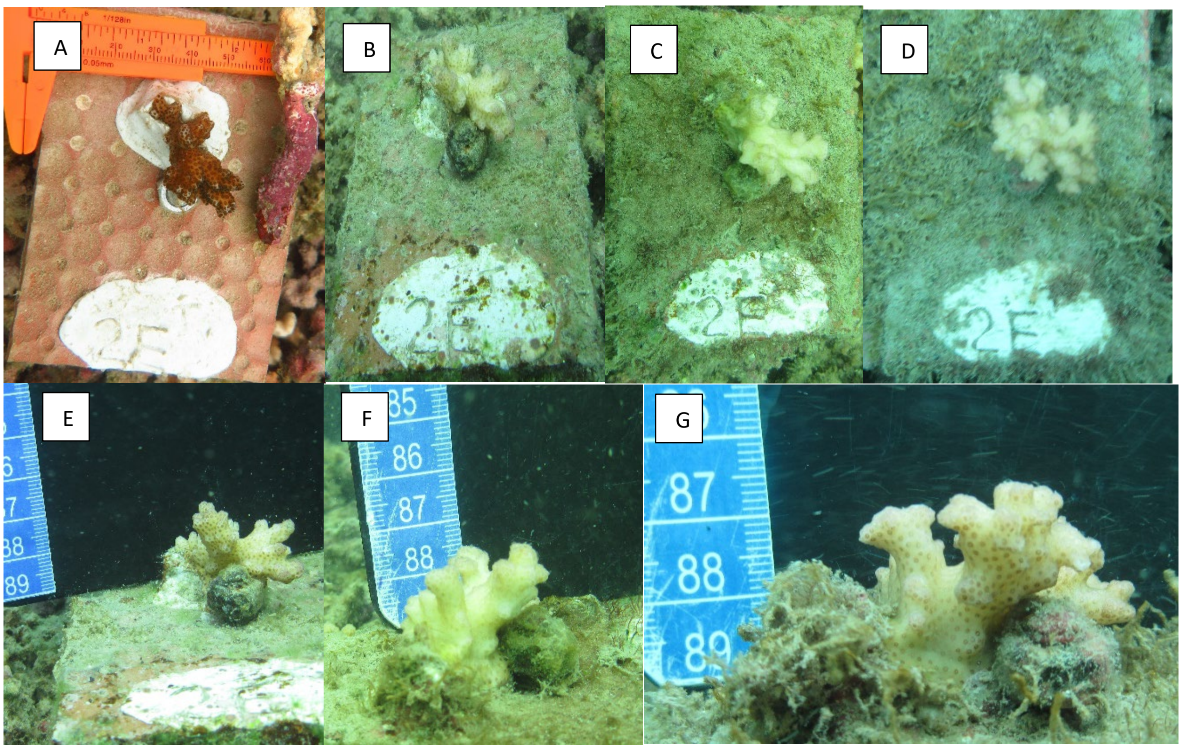



Fig 3. Photographic record of an experimental coral fragment (Colony ID 2) from la Ventana Reef and transplanted to Playa Blanca reef (fragment ID: 2E). (A) April 2021, when fragment was seed (B,E) July 2021, (C,F) November 2021, (D,G) February 2022.

**Data analysis**

- Data of temperature, salinity, and light were download from sensors and are under analysis.

- Coral growth rates at two reefs of Gorgona island:

Main result: there are significant differences in growth rates of fragments from la Ventana and Playa Blanca reefs. In general, coral fragments growth more at La

Ventana than Playa Blanca reef (either for those who maintain at the reef or the ones that were transplanted). During the warm season, corals from both reefs' growth similar, but the transplanted from Playa Blanca to La Ventana growth more. During the cool season, only the corals from La Ventana, and maintained there, growth more than corals from Playa Blanca reef of those transplanted to this reef. The effect of environmental parameters on the patters of coral growth rate at these reefs are under analysis.

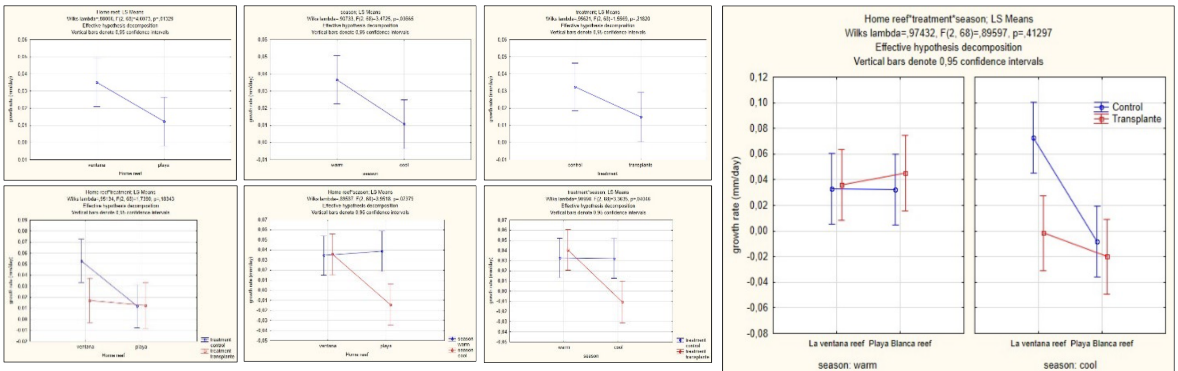


Fig. 4. Differences in growth rate of Pocillopora corals from two reefs at Gorgona Island.

- Data from the thermotolerance experiment (24°C, 28°C and 32°C) and changing oxygen concentration (hypoxia and normoxia) was analysed, data was submitted to a conference.

Main result:

1) Low oxygen conditions occur at Gorgona Island coral reefs (10 m depth, 3 mg $O_2$ $l^{-1}$, Fig 5A), but lower oxygen levels are reported at 30 m depth (<2.5 mg $O_2$ $l^{-1}$). We found that the hypoxic threshold for *Pocillopora capitata* is 2.9 mg $O_2$ $l^{-1}$ (Fig 5B) and lower oxygen conditions produce metabolic depression in corals. Also, the deepest distributions of *Pocillopora* corals are 20 m depth, hence oxygen conditions could be a bathymetric restriction for these corals.

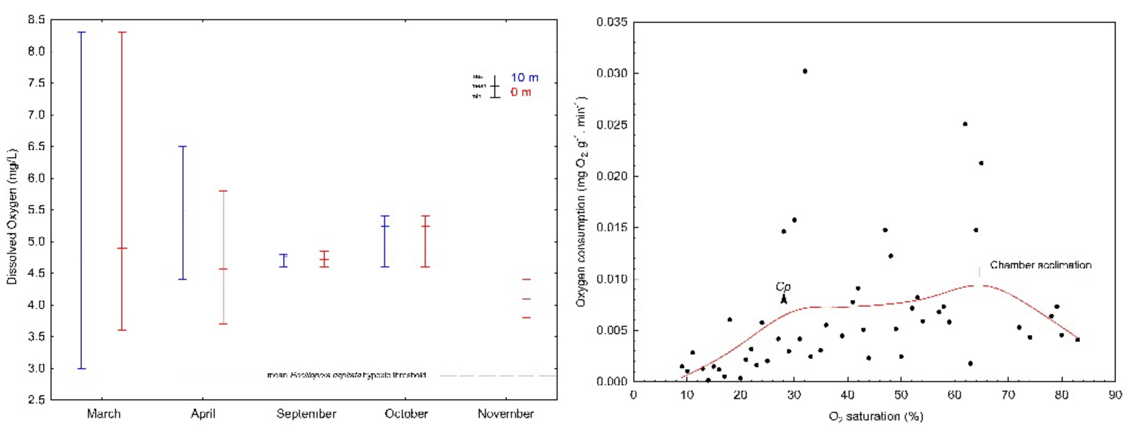


Fig 5. (A) Dissolved oxygen conditions at Gorgona Island coral reefs. (B) oxygen consumption profile of Pocillopora capitata over a gradient of oxygen saturation.

2) The respiration rate in *Pocillopora* corals increases as temperature increases, due to less solubility of oxygen at high temperature, and low respiration rate at low temperature because of a temperature dependence to start metabolic processes. As expected, respiration rate is significantly lower under hypoxia than in normoxia. Concerning the combined effects, the coral's respiration rate under hypoxic conditions at any temperature is like respiration at 24°C in normoxia (Fig 6).

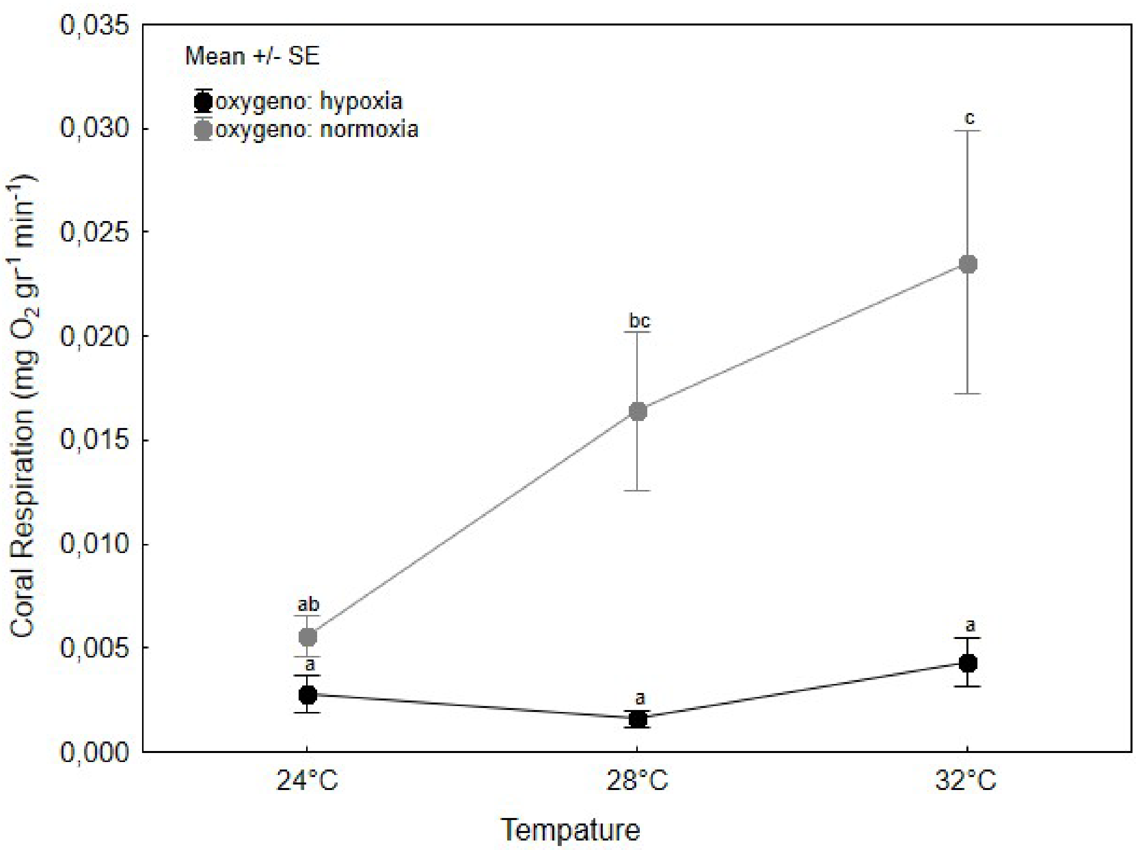



Fig. 6. Effects of changing temperature and dissolved oxygen conditions on Pocillopora respiration rate.

**Knowledge transference**

- A manuscript was written about the hypoxic threshold of *Pocillopora capitata*, which is under submission to Coral Reefs journal.

- An abstract was submitted for the Congreso Panamericano de arrecifes coralinos, to be held in September 25-30, 2022, at Veracruz Mexico.

Title: *Response of Pocillopora capitata to changes in temperature and oxygen conditions.*

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Abstract: Temperature and oxygen are key environmental factors that limit the occurrence of species in nature because organisms' metabolic processes are temperature-dependent, and oxygen is the terminal electron acceptor for aerobic energy production. Coral reefs of the Eastern Tropical Pacific experience abrupt changes in temperature due to upwelling and ENSO events, and low oxygen levels due to the presence of oxygen minimum zones or hypoxic inducing circumstances (high nutrient concentration, algal blooms). However, coral reefs at Gorgona Island seem to tolerate the harsh conditions of the region. To describe the response of corals to changes in temperature and oxygen conditions we let Pocillopora capitata coral fragments breathe over a gradient of $O_2$ saturation (100-1%, 5h) and at 24, 28, or 32°C (n= 7 for each trial), then the respiration rate at hypoxia (10-28% of $O_2$) and normoxia (50-80% of $O_2$) was compared at the given temperatures. These conditions were selected as common factors that corals deal with during upwelling or ENSO events and were extracted from a thermal and dissolved oxygen record (2005-2019) of reefs in Gorgona. The respiration rate ($\bar{x}$±SD mg $O_2$ $gr^{-1}$ $min^{-1}$) increases as temperature increases (0.004 ± 0.00 at 24°C, 0.010 ± 0.01 at 28°C, and 0.014 ± 0.02 at 32°C, p=0.01). As expected, respiration rate is significantly lower (p=0.00) under hypoxia (0.006 ± 0.007) than in normoxia (0.011 ± 0.001). Concerning the combined effects, the coral's respiration rate under hypoxic conditions at any temperature is like 24°C in normoxia. In no treatment was observed bleaching, however, occurs metabolic depression (50%) after short term exposure to hypoxia and/or atypical temperatures. It is important to investigate for how long corals can tolerate these harsh conditions and which physiological functions are affected by this low energy production (calcification, reproduction, photosynthesis), or if anaerobic processes are switched on to compensate for it and survive.

Palabras clave: metabolic depression, hypoxia, thermal tolerance.