# Supplementary Materials for

## Evaluation of the current understanding of the impact of climate change on coral physiology after three decades of experimental research

**This PDF file includes:**

Tables S1 to S7
Supplementary references for Table S1

Table S1: Summary of results derived from studies investigating the impact of ocean acidification on the physiology and algal and biochemical composition of tropical and temperate corals and anemones, together with the levels of $pCO_2$/pH and temperature used in the experiments.

Table S2: Two-way ANOVA tests analyzing direct and combined effects of ocean acidification and thermal-stress on maximum photochemical efficiency ($F_v/F_m$) at the end of the experiment.

Table S3: Statistical Student's t-tests in support of the differences found in the coral response to control condition over the experimental incubation.

Table S4: Two-way ANOVA tests analyzing direct and combined effects of ocean acidification and thermal-stress on photosynthesis, respiration and calcification rates, and the ratio of photosynthesis to respiration.

Table S5: Post hoc comparison using the Tukey HSD tests in support of the differences found in the coral response to the experimental treatments (heat-stress and ocean acidification).

Table S6: Results of the Principal Component Analysis (PCA) with the contribution of coral traits to principal component 1 (PC1) and 2 (PC2)

Table S7: Physicochemical conditions of the variation in temperature and pH over the course of the experiment for the four treatments.

## Table S1.

Summary of results derived from studies investigating the impact of ocean acidification on the physiology (i.e., calcification, photosynthesis, respiration, photochemical efficiency) and algal and biochemical composition (i.e., symbiont and Chl *a* density, cellular *Symbiodinium* pigmentation $C_i$, protein content, coral tissue biomass, lipid and carbohydrate content) of tropical and temperate (khaki shaded) corals and anemones (blue shaded), together with the levels of $pCO_2$/pH and temperature used in the experiments. Studies have documented no effect (0), significant positive (+) or negative (−) effects of low-pH for different functional or structural coral traits. Studies performed on juvenile corals/larvae were not considered in this summary. Numbers refer to the way of experimental manipulation of the seawater carbonate chemistry applied in the study ([1]Alkalinity/ Carbonate system manipulation,[2]changing DIC at constant total alkalinity by bubbling with $CO_2$, [3]*in situ* incubations at low pH sites); duration refers to the length of each study (min = minutes, h = hours, d = days, w = weeks, m = months, yr = years); letters refer to the technique used for measuring calcification rates ([A]Alkalinity anomaly, [B] Buoyant weight, [C] Linear Extension, [D] $^{45}Ca$ incorporation, [E]Cores, [F]Surface Area, [G]Cristal growth); symbols refer to different photosynthetic rates measured/calculated (* = Net photosynthesis, *[C] = net carbon production, # =gross photosynthesis); [T] = Transcriptomic analysis, CSD = Cell Specific Density, HL = High Light, HT = High Temperature, LEDR = Light Enhanced Dark Respiration, LL = Low Light, LT = Low Temperature, NA = Not Available, NG = Not Given.

<

| Study | Location | Genus species | Level | Duration | Temperature (°C) | Calcification | Photosynthesis | Respiration | Photochemical efficiency | Symbiont density | Chl*a* density | $C_i$ | Protein content | Coral tissue biomass | Lipid content | Carbohydrate content |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Agostini et al. 2013*** [2] | Japan | *Galaxea fascicularis* | 400 vs .750 ppm $CO_2$ | 5 d | 27 | NA | 0 * | 0 | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Anthony et al. 2008*** [2] | Heron Island, Australia | *Acropora intermedia* | 380 vs. 520–700 vs. 1000–1300 ppm $CO_2$ | 8 w | 25-26 | - [B] | - * | 0 | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Anthony et al. 2008*** [2] | Heron Island, Australia | *Porites lobata* | 380 vs. 520–700 vs. 1000–1300 ppm $CO_2$ | 8 w | 25-26 | - [B] | - * | 0 | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Baghdasarian et al. 2017*** [2] | Taiwan | *Seriatopora caliendrum* | 472 µatm vs. 907 µatm $CO_2$ | 12 d | 27.7 | NA | NA | NA | NA | 0 | NG | 0 | 0 | NA | NA | NA |
| ***Bedwell-Ivers et al. 2016*** [2] | Little Cayman Island | *Porites divaricata* | 500 µatm vs. 1000 µatm $CO_2$ | 28 d | Ambient | - [B]/0 [C] | -* | - | NA | 0 | 0 | NG | NA | NA | NA | NA |
| ***Bedwell-Ivers et al. 2016*** [2] | Little Cayman Island | *Aropora cervicornis* | 500 µatm vs. 1000 µatm $CO_2$ | 28 d | Ambient | 0 [BC] | 0* | 0 | NA | 0 | 0 | NG | NA | NA | NA | NA |
| ***Camp et al. 2016*** [1] | Little Cayman Island | *Acropora palmata* | Ambient vs. – pH 0.03 ± 0.02 units | 35 d | Ambient | - [A] | - # | 0 | NA | - | - | NG | NA | NA | NA | NA |
| ***Camp et al. 2016*** [1] | Little Cayman Island | *Porites astreoides* | Ambient vs. – pH 0.03 ± 0.02 units | 35 d | Ambient | - [A] | - # | 0 | NA | 0 | 0 | NG | NA | NA | NA | NA |
| ***Castillo et al. 2014*** [2] | USA | *Siderastrea siderea* | 324 vs. 477 vs. 604 vs. 2553 µatm | 95 d | 28.1 | parabolic [A] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Chauvin et al. 2011*** [1] | La Reunion Island | *Acropora muricata* | 1,440 – 340 µatm $CO_2$ | 2 h | 27 | - [A] | 0 * | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Comeau et al. 2012*** [1] | Moorea | *Porites rus* | 280 – 2000 µatm $CO_2$ | 15 d | 27.3 | - [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Comeau et al. 2012*** [1] | Moorea | *Porites rus* | 280 – 2000 µatm $CO_2$ | 5-7 d | 27.3 | - [A] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Comeau et al. 2013*** [2] | Moorea | *Porites rus* | 280 – 2100 µatm $CO_2$ (pH 8.1 to pH 7.4) | 2 w | 27 | - [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Comeau et al. 2013*** [2] | Moorea | *Acropora pulchra* | 280 – 2100 µatm $CO_2$ (pH 8.1 to pH 7.4) | 2 w | 27 | - [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Comeau et al. 2013*** [2] | Moorea | *Pocillopora damicornis* | 280 – 2100 µatm $CO_2$ (pH 8.1 to pH7.4) | 2 w | 27 | 0 [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Comeau et al. 2013*** [2] | Moorea | *Pavona cactus* | 280 – 2100 µatm $CO_2$ (pH 8.1 to pH7.4) | 2 w | 27 | - [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Comeau et al. 2014*** [2] | Moorea | *Acropora pulchra* | 400, 750 and 1100 µatm $CO_2$ | 20 d | 27.2 | - [B] | NA | NA | NA | NA | NA | NA | NA | +,- | NA | NA |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Comeau et al. 2014*** [2] | Moorea | *Porites rus* | 280 – 2000 µatm $CO_2$ | 2 w | 27 | - [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Comeau et al. 2014***[2] | Moorea | *Porites* spp. | 280 – 2000 µatm $CO_2$ | 2 w | 27 | 0 [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Comeau et al. 2014*** [2] | Moorea | *Psammocora profundacella* | 280 – 2000 µatm $CO_2$ | 2 w | 27 | - [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Comeau et al. 2014*** [2] | Moorea | *Porites irregularis* | 280 – 2000 µatm $CO_2$ | 2 w | 27 | - [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Comeau et al. 2014*** [2] | Moorea | *Porites verrucosa* | 280 – 2000 µatm $CO_2$ | 2 w | 27 | - [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Comeau et al. 2014*** [2] | Moorea | *Pocillopora damicornis* | 280 – 2000 µatm $CO_2$ | 2 w | 27 | 0 [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Comeau et al. 2014*** [2] | Moorea | *Acropora pulchra* | 280 – 2000 µatm $CO_2$ | 2 w | 27 | - [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Comeau et al. 2014*** [2] | Moorea | *Pavona cactus* | 280 – 2000 µatm $CO_2$ | 2 w | 27 | - [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Comeau et al. 2014*** [2] | Moorea, Hawaii, Japan | *Porites* spp. | 400 vs. 700 vs. 1000 ppm $CO_2$ | 2 w | 27 | 0 [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Comeau et al. 2014*** [2] | Moorea, Hawaii, Japan | *Pocillopora damicornis* | 400 vs. 700 vs. 1000 ppm $CO_2$ | 2 w | 27 | 0 [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Comeau et al. 2017*** [2] | Moorea | *Porites rus* | 280 – 2000 µatm $CO_2$ | 7–10 d | 27 | NA | 0* | 0 | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Comeau et al. 2017*** [2] | Moorea | *Porites* spp. | 280 – 2000 µatm $CO_2$ | 7–10 d | 27 | NA | 0* | 0 | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Comeau et al. 2017*** [2] | Moorea | *Psammocora profundacella* | 280 – 2000 µatm $CO_2$ | 7–10 d | 27 | NA | 0* | 0 | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Comeau et al. 2017*** [2] | Moorea | *Porites irregularis* | 280 – 2000 µatm $CO_2$ | 7–10 d | 27 | NA | -* | 0 | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Comeau et al. 2017*** [2] | Moorea | *Pocillopora verrucosa* | 280 – 2000 µatm $CO_2$ | 7–10 d | 27 | NA | 0* | 0 | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Comeau et al. 2017*** [2] | Moorea | *Pocillopora damicornis* | 280 – 2000 µatm $CO_2$ | 7–10 d | 27 | NA | 0* | 0 | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Comeau et al. 2017*** [2] | Moorea | *Acropora pulchra* | 280 – 2000 µatm $CO_2$ | 7–10 d | 27 | NA | 0* | 0 | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Comeau et al. 2017*** [2] | Moorea | *Pavona cactus* | 280 – 2000 µatm $CO_2$ | 7–10 d | 27 | NA | 0* | 0 | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Comeau et al. 2018*** [1,2] | Western Australia | *Acropora yongei* | pH 8.24 vs. pH 8.01 vs. pH 7.83 | 13 w | 20 | - [B] | +* | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Comeau et al. 2018*** [1,2] | Western Australia | *Pocillopora damicornis* | pH 8.24 vs. pH 8.01 vs. pH 7.83 | 8 w | 20 | 0 [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Cornwall et al. 2018*** [2] | Western Australia | *Goniapora* sp. | pH 8.05 vs. pH 7.65 | 100 d | 26.5 | 0 [B] | 0 [#] | 0 | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Comeau et al. 2019*** [2] | Western Australia | *Acropora yongei* | pH 8.05 vs. pH 7.65 | 27 w | 20.5 | - [B] | +* | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Comeau et a. 2019*** [2] | Western Australia | *Plesiastrea versipora* | pH 8.05 vs. pH 7.65 | 27 w | 20.5 | - [B] | +* | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Crawley et al. 2010*** [2] | Orpheus Island, Australia | *Acropora formosa* | Ambient vs. 600-790 vs. 1160-1500 ppm $CO_2$ | 4 d | 23 | NA | - * | + LED R 0 Dark | NA | 0 | NG | + | NA | NA | NA | NA |
| ***Davies et al. 2016***[2] | USA | *Siderastrea siderea* | 324 vs. 477 vs. 604 vs. 2553 µatm | 95 d | 28.1 | NA | NA | + [T] | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Diaz-Pulido et al. 2011*** [2] | Australia | *Acropora intermedia* | 400-1140 ppm $CO_2$ | 8 w | 24-25 | - [C] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Edmunds 2011*** [2] | Moorea | *Porites* spp. | 416 vs. 815 µatm $CO_2$ | 1 m | 25.5 | 0 [B] | NA | NA | NA | 0 | NA | NA | NA | 0 | NA | NA |
| ***Edmunds 2012*** [2] | Moorea | *Porites* spp. | 429 vs. 766 vs. 872 µatm $CO_2$ | 11 d | 28 | 0 [B] | NA | - | - | NA | NA | NA | NA | 0 | NA | NA |
| ***Edmunds et al. 2012*** [2] | Moorea | *Porites rus* | 416 vs. 815 µatm $CO_2$ | 1 m | 25.6 | - [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Edmunds et al. 2012*** [2] | Moorea | *Porites* spp. | 416 vs. 815 µatm $CO_2$ | 1 m | 25.6 | 0 [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Enochs et al. 2014*** [2] | Florida, USA | *Acropora cervicornis* | 500 – 900 µatm $CO_2$ | 28 d | 28 | - [B]/0 [C] | NA | NA | 0 | NA | NA | NA | NA | NA | NA | NA |
| ***Fabricius et al. 2011***[3] | Papa New Guinea | *Pocillopora damicornis* | pH 8.1 vs. pH 7.8 | 6 d | Ambient | - [C] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Fabricius et al. 2011*** [3] | Papa New Guinea | *Porites* spp. | pH 8.1 vs. pH 7.8 | NA | Ambient | 0 [E] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Fine & Tchernov 2007*** [2] | Mediterranean Sea | *Oculina patagonica* | pH 8.0-8.2 vs. pH 7.3-7.6 | 1 yr | Ambient (17-30°C) | - [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Fine & Tchernov 2007*** [2] | Mediterranean Sea | *Madracis pharencis* | pH 8.0-8.2 vs. pH 7.3-7.6 | 1 yr | Ambient (17-30°C) | - [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Godinot et al. 2011*** [2] | Red Sea | *Stylophora pistillata* | 8.1, 7.8 and 7.5 | 10 d | 26 | NA | 0 * | 0 | 0 | 0 | 0 | NG | 0 | NA | NA | NA |
| ***Hii et al. 2009*** [2] | Malaysia | *Porites cylindrica* | pH 8.2 vs. pH 7.9 | 15 d | 26 | - [A] | - *# | - | NA | - | NG | 0 | NA | NA | NA | NA |
| ***Hii et al. 2009*** [2] | Malaysia | *Galaxea fascicularis* | pH 8.2 vs. pH 7.9 | 15 d | 26 | + [A] | 0*/+ # | + | NA | - | NG | + | NA | NA | NA | NA |
| ***Hoadley et al. 2016*** [2] | USA | *Montipora hirsuta* | 400 vs. 800 µatm $CO_2$ | 18 d | 26.5 | NA | 0 * | NA | 0 | 0 | NG | 0 | NA | NA | NA | NA |
| ***Hoadley et al. 2016*** [2] | USA | *Pocillopora damicornis* | 400 vs. 800 µatm $CO_2$ | 18 d | 26.5 | NA | 0 * | NA | + at LT | 0 | NG | 0 | NA | NA | NA | NA |
| ***Hoadley et al. 2016*** [2] | USA | *Discosoma nummiforme* | 400 vs. 800 µatm $CO_2$ | 18 d | 26.5 | NA | 0 * | NA | + at HT | 0 | NG | 0 | NA | NA | NA | NA |
| ***Holcomb et al. 2010*** [2] | Woods Hole, Mass., USA | *Astrangia poculata* | ambient vs. 780 ppm | 6 m | 25.8 | - [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Holcomb et al. 2012*** [2] | Woods Hole, Mass., USA | *Astrangia poculata* | ambient vs. 790 ppm | 4 m | 24 | - [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Horwitz & Fine. 2014*** [2] | Red Sea | *Porites* sp. | pH 8.18 vs. pH 7.62 vs. pH 7.31 | 60 d | Ambient (21.6–24.3) | NA | NA | NA | NA | - | 0 | NA | NA | - | NA | NA |
| ***Horwitz & Fine. 2014*** [2] | Red Sea | *Favia favus* | pH 8.18 vs. pH 7.62 vs. pH 7.31 | 60 d | Ambient (21.6–24.3) | NA | NA | NA | NA | - | 0 | NA | NA | - | NA | NA |
| ***Horwitz & Fine. 2014*** [2] | Red Sea | *Acropora eurystoma* | pH 8.18 vs. pH 7.62 vs. pH 7.31 | 60 d | Ambient (21.6–24.3) | NA | NA | NA | NA | 0 | 0 | NA | NA | - | NA | NA |
| ***Horwitz & Fine. 2014*** [2] | Red Sea | *Stylophora pistillata* | pH 8.18 vs. pH 7.62 vs. pH 7.31 | 60 d | Ambient (21.6–24.3) | NA | NA | NA | NA | - | - | NA | NA | 0 | NA | NA |
| ***Houlbreque et al. 2012*** [2] | Red Sea | *Stylophora pistillata* | pH 8.1 vs. pH 7.8 vs. pH 7.5 | 5 w | 26 | 0 [D] | 0 * | 0 | 0 | 0 | 0 | NG | NA | NA | NA | NA |
| ***Iguchi et al. 2012*** [2] | Sesoko Island, Japan | *Porites australiensis* | pH 8.05 vs. pH 7.6 vs. pH 7.4 | 8 w | 27 | - [B] | NA | NA | - | 0 | NG | 0 | NA | NA | NA | NA |
| ***Jokiel et al. 2008*** [1] | Hawaii, USA | *Montipora capitata* | 186 vs. 440 µatm $CO_2$ | 10 m | Ambient | - [BC] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Jury et al. 2010*** [1] | Curaçao | *Madracis mirabilis* | pH 8.06 vs. pH 7.78 vs. pH 7.6 | 2 h | 27-28 | 0 [A] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Kaniewska et al. 2012*** [2] | Australia | *Acropora millepora* | pH 8.2 vs. pH 7.9 vs. pH 7.7 | 28 d | 26 | 0 [B] | - *# | - | NA | - | NG | NG | NA | NA | NA | NA |
| ***Kavousi et al. 2015*** [2] | Japan | *Acropora digitifera* | 400 vs 1000 µatm $CO_2$ | 26 | 28 | 0 [B] | NA | NA | 0 | 0 | NG | 0 | 0 | NA | NA | NA |
| ***Kavousi et al. 2015*** [2] | Japan | *Montipora digitata* | 400 vs 1000 µatm $CO_2$ | 26 | 28 | - [B] | NA | NA | - | 0 | NG | + | + | NA | NA | NA |
| ***Kavousi et al. 2015*** [2] | Japan | *Porites cylindrica* | 400 vs 1000 µatm $CO_2$ | 26 | 28 | - [B] | NA | NA | 0 | 0 | NG | - | 0 | NA | NA | NA |
| ***Krief et al. 2010*** [2] | Israel | *Porites sp.* | pH 8.09 vs. pH 7.49 vs. pH 7.19 | 6-14 m | 25 | NG [B]/- [F] | NA | NA | NA | - | NA | NA | + | NA | NA | NA |
| ***Krief et al. 2010*** [2] | Israel | *Stylophora pistillata* | pH 8.09 vs. pH 7.49 vs. pH 7.19 | 6-14 m | 25 | - [B] /- [F] | NA | NA | NA | - | NA | + | + | NA | NA | NA |
| ***Krueger et al. 2017*** [2] | Red Sea | *Stylophora pistillata* | pH 8.1 vs. pH 7.8 | 6 w | 26.2 | 0 [A] | + # | 0 | 0 | 0 | NG | - | 0 | NA | NA | 0 |
| ***Langdon & Atkinson 2005*** [1] | Hawaii, USA | *P. compressa*/*M. capitata* | 391 vs. 526 vs. 781 µatm $CO_2$ | 1.5 h | Ambient | - [A] | +*[C] | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Langdon & Atkinson 2005*** [1] | Hawaii, USA | *P. compressa*/*M. capitata* | 460 vs. 789 µatm $CO_2$ | 1.5 h | Ambient | | | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Langdon et al. 2018*** [2] | Florida, USA | *Acropora cervicornis* | 380 vs. 800 ppm $CO_2$ | 62 d | 26 | 0 [C] | NA | NA | 0 | NA | NA | NA | NA | NA | NA | NA |
| ***Langdon et al. 2018*** [2] | Florida, USA | *Orbicella faveolata* | 380 vs. 800 ppm $CO_2$ | 62 d | 26 | - [C] | NA | NA | - | NA | NA | NA | NA | NA | NA | NA |
| ***Leclercq et al. 2002*** [2] | Monaco | Coral community | 411 vs. 647 vs. 918 µatm $CO_2$ | 4-12 w | 26 | - [A] | 0 * | + | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Marubini & Atkinson 1999*** [1] | Hawaii, USA | *Porites compressa* | pH 8.0 vs. pH 7.2 | 5 w | NG | - [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Marubini et al. 2001*** [1] | Hawaii, USA | *Porites compressa* | 186 vs. 440 µatm $CO_2$ | 6 w | 26.2 | - [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Marubini et al. 2003*** [1] | Monaco | *Acropora verweyi* | pH 8.1 vs. pH 7.7 | 8 d | 26.5 | - [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Marubini et al. 2003*** [1] | Monaco | *Galaxea fascicularia* | pH 8.1 vs. pH 7.7 | 8 d | 26.5 | - [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Marubini et al. 2003*** [1] | Monaco | *Pavona cactus* | pH 8.1 vs. pH 7.7 | 8 d | 26.5 | - [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Marubini et al. 2003*** [1] | Monaco | *Turbinaria reniformis* | pH 8.1 vs. pH 7.7 | 8 d | 26.5 | - [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Marubini et al. 2008*** [1] | Monaco | *Stylophora pistillata* | pH 8.2 vs. pH 8.0 vs. pH 7.6 | 8 d | 26.5 | - [B] | 0 * | NA | NA | NA | 0 | NA | 0 | NA | NA | NA |
| ***Movilla et al. 2012*** [2] | Spain | *Cladocora caespitosa* | Ambient vs. 800 ppm | 92 d | 20 | - [B] | NA | NA | NA | 0 | NA | NA | NA | NA | NA | NA |
| ***Movilla et al. 2012*** [2] | Spain | *Oculina patagonica* | Ambient vs. 800 ppm | 92 d | 20 | - [B] | NA | NA | NA | 0 | NA | NA | NA | NA | NA | NA |
| ***Muehllehner & Edmunds 2008*** [1] | Moorea | *Pocillopora meandrina* | Ambient vs. pH 7.8 | 2 w | 27 | - [B] | NA | NA | 0 | NA | NA | NA | NA | NA | NA | NA |
| ***Muehllehner & Edmunds 2008*** [1] | Moorea | *Porites rus* | Ambient vs. pH 7.8 | 2 w | 27 | - [B] | NA | NA | 0 | NA | NA | NA | NA | NA | NA | NA |
| ***Noonan et al. 2015*** [2] | Orpheus Island, Australia | *Seriatopora hystrix* | pH 7.95 vs. pH 7.8 | 3 w | 28 | NA | + # | 0 | + | NA | + | NA | 0 | NA | NA | NA |
| ***Noonan et al. 2015*** [2] | Orpheus Island, Australia | *Acropora millepora* | pH 7.95 vs. pH 7.8 | 3 w | 28 | NA | 0 # | 0 | + | NA | 0 | NA | 0 | NA | NA | NA |
| ***Ogawa et al. 2013*** [2] | Heron Island, Australia | *Acropora aspera* | Ambient vs. +70 µatm $CO_2$ | 14 d | 29-30 | NA | NA | NA | 0 | 0 | NG | 0 | NA | NA | NA | NA |
| ***Ohde & Hossain 2004*** [1] | Japan | *Porites lutea* | pH 7.9 – pH 8.6 | 6 h | 25 | - [A] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Ohki et al. 2013*** [2] | Japan | *Acropora digitifera* | < 300 vs. 400 vs. 600 vs. 800 vs. 1000µatm | 6 w | 27.1 | - [B] | NA | NA | 0 | NA | NA | NA | NA | NA | NA | NA |
| ***Okazaki et al. 2013*** [1] | Florida,,USA | *Siderastrea radians* | Ambient vs. –pH 0.1-0.2 | Incubations of 90 min in situ at bimonthly intervals over a 2-yr period | Ambient | - [B] | 0 * | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Okazaki et al. 2013*** [1] | Florida,,USA | *Solenastrea hyades* | Ambient vs. –pH0.1-0.2 | Incubations of 90 min in situ at bimonthly intervals over a 2-yr period | Ambient | - [B] | 0 * | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Renegar & Riegl 2005*** [2] | Florida,,USA | *Acropora cervicornis* | Ambient vs. ~700 to 800 µatm $CO_2$ | 4 w | 25.3 | - [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Reynaud et al. 2003*** [2] | NG | *Stylophora pistillata* | 460 vs. 760 µatm $CO_2$ | 5 w | 25 | 0 [B] | - * | 0 | NA | + CSD | 0 | NA | 0 | NA | NA | NA |
| ***Ries et al. 2009*** [2] | North Carolina, USA | *Oculina arbuscula* | 409 – 2856 ppm $CO_2$ | 60 d | 25 | - [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Ries et al. 2010*** [2] | North Carolina, USA | *Oculina arbuscula* | 409 – 2856 ppm $CO_2$ | 60 d | 25 | - [BC] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Rodolfo-Metalpa et al. 2010*** [2] | Mediterranean Sea | *Cladocora caespitosa* | 400 vs. 700 µatm $CO_2$ | 1 yr | Ambient | 0 [B] | NG | NG | 0 | NA | NA | NA | NA | NA | NA | NA |
| ***Rodolfo-Metalpa et al. 2010*** [2] | Mediterranean Sea | *Cladocora caespitosa* | 400 vs 700 µatm $CO_2$ (summary) | 1 m | Ambient | 0 [A] | 0 *# | 0 | NA | 0 | 0 | NG | 0 | NA | NA | NA |
| ***Rodolfo-Metalpa et al. 2010*** [2] | Mediterranean Sea | *Cladocora caespitosa* | 400 vs 700 µatm $CO_2$ (winter) | 1 m | Ambient | 0 [A] | 0 *# | 0 | NA | + | + | NG | 0 | NA | NA | NA |
| ***Rodolfo-Metalpa et al. 2011*** [3] | Italy | *Cladocora caespitosa* | pH 8.1 – pH 7.3 | 3 m | Ambient | - [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Rodolfo-Metalpa et al. 2011*** [3] | Italy | *Cladocora caespitosa* | pH 8.1 – pH 7.4 | 3 m | Ambient | - [D] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Rodolfo-Metalpa et al. 2011*** [3] | Italy | *Balanophyllia europaea* | pH 8.1 – pH 7.3 | 3 m | Ambient | - [B] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Rodolfo-Metalpa et al. 2011*** [3] | Italy | *Balanophyllia europaea* | pH 8.1 – pH 7.4 | 3 m | Ambient | + [D] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Schoepf et al. 2013*** [2] | USA | *Acropora millepora* | 382 vs. 607 vs. 741 µatm $CO_2$ | 3.5 w | 26.5 | - [B] | NA | NA | NA | 0 | - | NG | 0 | 0 | + | - |
| ***Schoepf et al. 2013*** [2] | USA | *Montipora montasteriata* | 382 vs. 607 vs. 741 µatm $CO_2$ | 3.5 w | 26.5 | 0 [B] | NA | NA | NA | - | 0 | NG | 0 | 0 | 0 | 0 |
| ***Schoepf et al. 2013*** [2] | USA | *Pocillopora damicornis* | 382 vs. 607 vs. 741 µatm $CO_2$ | 3.5 w | 26.5 | 0 [B] | NA | NA | NA | 0 | 0 | NG | 0 | 0 | + | 0 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Schoepf et al. 2013*** [2] | USA | *Turbinaria reniformis* | 382 vs. 607 vs. 741 µatm $CO_2$ | 3.5 w | 26.5 | 0 [B] | NA | NA | NA | 0 | - | NG | 0 | 0 | 0 | 0 |
| ***Suggett et al. 2012*** [3] | Italy | *Anemonia viridis* | pH 8.2 to pH 7.6 | NA | 21 | NA | + [#] | + | 0 | + | NA | NA | NA | NA | NA | NA |
| ***Suggett et. al. 2013*** [2] | UK | *Acropora horrida* | 380 vs. 720 µatm $CO_2$ | 5-6 w | 26 | - [A] | + [#] | 0 | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Suggett et. al. 2013*** [2] | UK | *Porites cylindrica* | 380 vs. 720 µatm $CO_2$ | 5-6 w | 26 | - [A] | + [#] | 0 | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Takahashi et al. 2013*** [2] | Japan | *Acropora digifera* | 343 vs. 744 vs. 2142 µatm $CO_2$ | 5 w | 29 | 0 [AB] | 0 * | 0 | 0 | 0 | NA | NA | NA | NA | NA | NA |
| ***Towanda & Thuesen 2012*** [2] | USA | *Anthopleura elegantissima* | 370 vs. 420 vs. 2310 µatm $CO_2$ | 6 w | 12 | NA | + [#] | + | NA | + | 0 | NG | NG | NA | NA | NA |
| ***Tremblay et al. 2013*** [2] | Monaco | *Stylophora pistillata* | pH 8.1 vs. pH 7.2 | 6 m | 25 | NA | - [#] | 0 | NA | - | - | NA | - | NA | NA | NA |
| ***Venn et al. 2013*** [2] | Monaco | *Stylophora pistillata* | pH 8.0 to pH 7.2 | 2 m | 25 | - [FG] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***Wall et al. 2014*** [2] | Taiwan | *Seriatopora caliendrum* | 451 vs. 851 µatm $CO_2$ | 14 d | 27.7 | NA | 0 * | 0 | 0 | 0 | 0 | 0 | NA | NA | NA | NA |
| ***Wall et al. 2017*** [2] | Hawaii, USA | *Pocillopora acuta* LL (7.5 mol $m^{-2}$ $d^{-1}$) | 435 vs. 957 µatm $CO_2$ | 32 d | 25 | 0 [B] | NA | NA | NA | 0 | 0 | 0 | 0 | 0 | - | 0 |
| ***Wall et al. 2017*** [2] | Hawaii, USA | *Pocillopora acuta* HL (15.7 mol $m^{-2}$ $d^{-1}$) | 435 vs. 957 µatm $CO_2$ | 32 d | 25 | 0 [B] | NA | NA | NA | 0 | 0 | 0 | - | 0 | - | 0 |

>

**Table S2.** Two-way ANOVA tests analyzing direct and combined effects of ocean acidification (887 µatm) and thermal-stress (+2°C) on maximum photochemical efficiency ($F_v/F_m$) at the end of the experiment on the four coral species: *Pseudodiploria strigosa*, *Orbicella faveolata*, *Montastraea cavernosa* and *O. annularis sp.*; significant values ($P < 0.05$) are in bold.

| Species | Factor | df | F | *P* |
|---|---|---|---|---|
| *P. strigosa* | Temperature | 1 | 128.043 | **< 0.001** |
| | pH | 1 | 9.298 | **0.010** |
| | Temperature x pH | 1 | 7.207 | **0.020** |
| | Error | 12 | | |
| *O. faveolata* | Temperature | 1 | 72.638 | **< 0.001** |
| | pH | 1 | 0.368 | 0.555 |
| | Temperature x pH | 1 | 0.615 | 0.448 |
| | Error | 12 | | |
| *M. cavernosa* | Temperature | 1 | 53.218 | **< 0.001** |
| | pH | 1 | 0.060 | 0.810 |
| | Temperature x pH | 1 | 0.319 | 0.583 |
| | Error | 12 | | |
| *O. annularis* | Temperature | 1 | 17.547 | **0.001** |
| | pH | 1 | 0.242 | 0.632 |
| | Temperature x pH | 1 | 0.526 | 0.482 |
| | Error | 12 | | |

**Table S3. Welch t-test in support of the differences found in the coral response to control condition over the experimental incubation:** Results of independent Student's t-test for testing the effects of tank incubations (Day 0 vs. Day 10) on the variability of the structural (Chorophyll *a* [Chl*a*] and symbiont density, symbiont cell pigmentation [Ci]) and physiological (Gross photosynthesis [$P_{max}$], post-illumination respiration [$R_L$], ratio of photosynthesis to respiration [P:R] and calcification [$G_{max}$]) coral traits of *Pseudodiploria strigosa*, *Orbicella faveolata*, *Montastraea cavernosa* and *Orbicella annularis*. Significant values ($p < 0.05$) are in bold.

| Parameter | Species | Mean difference | SE | df | t-value | *p* |
|---|---|---|---|---|---|---|
| **Chl *a* density** | *P. strigosa* | 5.464 | 11.625 | 6 | 0.470 | 0.655 |
| **(mg Chl *a* $m^{-2}$)** | *O. faveolata* | -23.419 | 17.091 | 4.414 | -1.370 | 0.236 |
| | *M. cavernosa* | 10.103 | 25.317 | 6 | 0.399 | 0.704 |
| | *O. annularis* | -19.620 | 17.719 | 6 | -1.107 | 0.311 |
| **Symbiont density** | *P. strigosa* | -0.396 | 0.316 | 3.732 | -1.25 | 0.282 |
| **(x $10^6$ cells $cm^{-2}$)** | *O. faveolata* | -0.685 | 0.358 | 6 | -1.915 | 0.104 |
| | *M. cavernosa* | 0.0693 | 0.785 | 6 | 0.088 | 0.933 |
| | *O. annularis* | -1.319 | 0.670 | 6 | -1.969 | 0.97 |
| **Cellular Chl*a* concentration $C_i$** | *P. strigosa* | 0.260 | 0.448 | 5 | 0.579 | 0.588 |
| **(pg Chl *a* $cell^{-1}$)** | *O. faveolata* | 0.036 | 0.302 | 3.708 | 0.120 | 0.911 |
| | *M. cavernosa* | 0.291 | 0.316 | 6 | 0.921 | 0.392 |
| | *O. annularis* | 1.031 | 0.231 | 6 | 4.457 | **0.004** |

| | | | | | | |
|---|---|---|---|---|---|---|
| **$P_{max}$** | *P. strigosa* | -0.075 | 0.154 | 6 | -0.489 | 0.642 |
| **(µmol $O_2$ $cm^{-2}$ $h^{-1}$)** | *O. faveolata* | 0.471 | 0.203 | 6 | 2.321 | 0.059 |
| | *M. cavernosa* | -0.249 | 0.234 | 6 | -1.062 | 0.329 |
| | *O. annularis* | -0.229 | 0.218 | 6 | -1.049 | -1.049 |
| **$R_L$** | *P. strigosa* | 0.114 | 0.073 | 4.249 | 1.553 | 0.191 |
| **(µmol $O_2$ $cm^{-2}$ $h^{-1}$)** | *O. faveolata* | -0.327 | 0.173 | 6 | -1.895 | 0.107 |
| | *M. cavernosa* | 0.153 | 0.059 | 3.796 | 2.607 | 0.063 |
| | *O. annularis* | 0.001 | 0.082 | 6 | 0.009 | 0.993 |
| **P:R** | *P. strigosa* | 0.593 | 0.374 | 6 | 1.585 | 0.164 |
| | *O. faveolata* | -0.185 | 0.256 | 6 | -0.722 | 0.498 |
| | *M. cavernosa* | 0.058 | 0.333 | 6 | 0.173 | 0.869 |
| | *O. annularis* | -0.323 | 0.177 | 6 | -1.817 | 0.060 |
| **$G_{max}$** | *P. strigosa* | -0.062 | 0.047 | 5 | -1.306 | 0.248 |
| **(µmol $CaCO_3$ $cm^{-2}$ $h^{-1}$)** | *O. faveolata* | 0.045 | 0.111 | 6 | 0.400 | 0.703 |
| | *M. cavernosa* | 0.093 | 0.078 | 5 | 1.201 | 0.283 |
| | *O. annularis* | 0.150 | 0.055 | 5 | 2.729 | **0.021** |

**Table S4**. Two-way ANOVA tests analyzing direct and combined effects of ocean acidification (887 µatm) and thermal-stress (+2°C) on photosynthesis, respiration and calcification rates, and the ratio of photosynthesis to respiration of *Pseudodiploria strigosa*, *Orbicella faveolata*, *Montastraea cavernosa* and *O. annularis*; significant values ($p < 0.05$) are in bold.

| Parameter | Species | Factor | df | F | *p* |
|---|---|---|---|---|---|
| **Chl *a* density (mg Chl *a* $m^{-2}$)** | *P. strigosa* | Temperature | 1 | 60.027 | **< 0.001** |
| | | pH | 1 | 0.475 | 0.505 |
| | | Temperature x pH | 1 | 4.223 | 0.064 |
| | | Error | 11 | | |
| | *O. faveolata* | Temperature | 1 | 9.844 | **0.009** |
| | | pH | 1 | 1.930 | 0.192 |
| | | Temperature x pH | 1 | 3.832 | 0.076 |
| | | Error | 11 | | |
| | *M. cavernosa* | Temperature | 1 | 14.484 | **0.003** |
| | | pH | 1 | 0.520 | 0.485 |
| | | Temperature x pH | 1 | 0.201 | 0.662 |
| | | Error | 12 | | |

| | | | | | |
|---|---|---|---|---|---|
| | *O. annularis* | Temperature | 1 | 47.619 | **< 0.001** |
| | | pH | 1 | 9.390 | **0.011** |
| | | Temperature x pH | 1 | 1.520 | 0.243 |
| | | Error | 11 | | |
| **Symbiont density ($x\ 10^6$ cells $cm^{-2}$)** | *P. strigosa* | Temperature | 1 | 30.540 | **< 0.001** |
| | | pH | 1 | 4.068 | 0.069 |
| | | Temperature x pH | 1 | 4.035 | 0.070 |
| | | Error | 11 | | |
| | *O. faveolata* | Temperature | 1 | 12.775 | **0.004** |
| | | pH | 1 | 0.195 | 0.667 |
| | | Temperature x pH | 1 | 0.003 | 0.957 |
| | | Error | 12 | | |
| | *M. cavernosa* | Temperature | 1 | 1.442 | 0.253 |
| | | pH | 1 | 0.608 | 0.451 |

| | | | | | |
|---|---|---|---|---|---|
| | | Temperature x pH | 1 | 0.113 | 0.742 |
| | | Error | 12 | | |
| | *O. annularis* | Temperature | 1 | 15.813 | **0.002** |
| | | pH | 1 | 1.098 | 0.315 |
| | | Temperature x pH | 1 | 0.090 | 0.770 |
| | | Error | 12 | | |
| **Cellular Chl *a* concentration $C_i$ (pg Chl *a* cell$^{-1}$)** | *P. strigosa* | Temperature | 1 | 3.506 | 0.086 |
| | | pH | 1 | 0.270 | 0.613 |
| | | Temperature x pH | 1 | 1.450 | 0.252 |
| | | Error | 12 | | |
| | *O. faveolata* | Temperature | 1 | 0.028 | 0.870 |
| | | pH | 1 | 1.988 | 0.184 |
| | | Temperature x pH | 1 | 2.341 | 0.152 |
| | | Error | 12 | | |

| | | | | | |
|---|---|---|---|---|---|
| | *M. cavernosa* | Temperature | 1 | 23.454 | **< 0.001** |
| | | pH | 1 | 0.013 | 0.911 |
| | | Temperature x pH | 1 | 0.089 | 0.770 |
| | | Error | 12 | | |
| | *O. annularis* | Temperature | 1 | 1.068 | 0.324 |
| | | pH | 1 | 2.230 | 0.163 |
| | | Temperature x pH | 1 | 0.377 | 0.552 |
| | | Error | 12 | | |
| **$P_{max}$ ($\mu$mol $O_2$ $cm^{-2}$ $h^{-1}$)** | *P. strigosa* | Temperature | 1 | 171.138 | **< 0.001** |
| | | pH | 1 | 13.438 | **0.004** |
| | | Temperature x pH | 1 | 12.913 | **0.004** |
| | | Error | 11 | | |
| | *O. faveolata* | Temperature | 1 | 43.473 | **< 0.001** |
| | | pH | 1 | 0.005 | 0.944 |

| | | | | | |
|---|---|---|---|---|---|
| | | Temperature x pH | 1 | 1.229 | 0.289 |
| | | Error | 12 | | |
| | *M. cavernosa* | Temperature | 1 | 132.861 | **< 0.001** |
| | | pH | 1 | 0.155 | 0.701 |
| | | Temperature x pH | 1 | 0.002 | 0.968 |
| | | Error | 12 | | |
| | *O. annularis* | Temperature | 1 | 95.859 | **< 0.001** |
| | | pH | 1 | 0.615 | 0.448 |
| | | Temperature x pH | 1 | 0.590 | 0.457 |
| | | Error | 12 | | |
| **$R_L$ (µmol $O_2$ $cm^{-2}$ $h^{-1}$)** | *P. strigosa* | Temperature | 1 | 4.590 | 0.055 |
| | | pH | 1 | 2.750 | 0.125 |
| | | Temperature x pH | 1 | 1.321 | 0.275 |
| | | Error | 11 | | |

| | | | | | |
|---|---|---|---|---|---|
| | *O. faveolata* | Temperature | 1 | 2.754 | 0.123 |
| | | pH | 1 | 1.598 | 0.230 |
| | | Temperature x pH | 1 | 0.160 | 0.697 |
| | | Error | 12 | | |
| | *M. cavernosa* | Temperature | 1 | 52.715 | **< 0.001** |
| | | pH | 1 | 2.462 | 0.143 |
| | | Temperature x pH | 1 | 1.487 | 0.246 |
| | | Error | 12 | | |
| | *O. annularis* | Temperature | 1 | 36.620 | **< 0.001** |
| | | pH | 1 | 0.554 | 0.471 |
| | | Temperature x pH | 1 | 1.440 | 0.253 |
| | | Error | 12 | | |
| **P:R** | *P. strigosa* | Temperature | 1 | 160.078 | **< 0.001** |
| | | pH | 1 | 0.024 | 0.880 |

| | | | | |
|---|---|---|---|---|
| | Temperature x pH | 1 | 0.263 | 0.617 |
| | Error | 12 | | |
| *O. faveolata* | Temperature | 1 | 92.705 | **< 0.001** |
| | pH | 1 | 1.853 | 0.198 |
| | Temperature x pH | 1 | 0.785 | 0.393 |
| | Error | 12 | | |
| *M. cavernosa* | Temperature | 1 | 104.702 | **< 0.001** |
| | pH | 1 | 0.780 | 0.395 |
| | Temperature x pH | 1 | 0.060 | 0.811 |
| | Error | 12 | | |
| *O. annularis* | Temperature | 1 | 95.751 | **< 0.001** |
| | pH | 1 | 5.305 | **0.040** |
| | Temperature x pH | 1 | 0.207 | 0.657 |
| | Error | 12 | | |

| | | | | | |
|---|---|---|---|---|---|
| **$G_{max}$ (µmol $CaCO_3$ $cm^{-2}$ $h^{-1}$)** | *P. strigosa* | Temperature | 1 | 145.129 | **< 0.001** |
| | | pH | 1 | 5.209 | **0.043** |
| | | Temperature x pH | 1 | 0.088 | 0.773 |
| | | Error | 11 | | |
| | *O. faveolata* | Temperature | 1 | 14.188 | **0.003** |
| | | pH | 1 | 2.327 | 0.155 |
| | | Temperature x pH | 1 | 0.004 | 0.949 |
| | | Error | 11 | | |
| | *M. cavernosa* | Temperature | 1 | 47.196 | **< 0.001** |
| | | pH | 1 | 1.896 | 0.194 |
| | | Temperature x pH | 1 | 0.518 | 0.485 |
| | | Error | 12 | | |
| | *O. annularis* | Temperature | 1 | 49.905 | **< 0.001** |
| | | pH | 1 | 1.978 | 0.190 |

| | | | |
|---|---|---|---|
| Temperature x pH | 1 | 9.302 | **0.012** |
| Error | 10 | | |

**Table S5. Post hoc comparison using the Tukey HSD tests in support of the differences found in the coral response to the experimental treatments (heat-stress and ocean acidification).** Analyses were focused on the variability shown by the following coral traits of *Pseudodiploria strigosa*, *Orbicella faveolata*, *Montastraea cavernosa* and *Orbicella annularis:* A) structural: Chorophyll *a* [Chl*a*] and symbiont density, symbiont cell pigmentation [Ci]; and B) physiological: Gross photosynthesis [$P_{max}$], light-enhanced respiration [$R_L$], ratio of photosynthesis to respiration [P:R] and calcification [$G_{max}$]. Experimental treatments: CT-COA – ambient temperature-ambient pH; CT-OA – ambient temperature-low pH; HT-COA – high temperature-ambient pH; HT-OA – high temperature-low pH. Significant values ($p < 0.05$) are indicated in bold.

| Parameter | Species | Comparison | Mean difference | SE | *p* | 95 % CI Lower Bound | 95 % CI Upper Bound |
|---|---|---|---|---|---|---|---|
| **Chl *a* density** | *P. strigosa* | CT-COA – CT-OA | -27.130 | 12.075 | 0.166 | -62.979 | 8.720 |
| **(mg Chl *a* $m^{-2}$)** | | CT-COA – HT-COA | 25.107 | 12.075 | 0.214 | -10.742 | 60.957 |
| | | CT-COA – HT-OA | 31.130 | 12.075 | 0.097 | -4.719 | 66.980 |
| | | CT-OA – HT-COA | 52.237 | 12.075 | **0.005** | 16.388 | 88.087 |
| | | CT-OA – HT-OA | 58.260 | 12.075 | **0.002** | 22.411 | 94.110 |
| | | HT-COA – HT-OA | 6.023 | 12.075 | 0.958 | -29.827 | 41.873 |
| | *O. faveolata* | CT-COA – CT-OA | 13.622 | 20.614 | 0.91 | -47.579 | 74.823 |
| | | CT-COA – HT-COA | 53.820 | 20.614 | 0.092 | -7.381 | 115.021 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | CT-COA – HT-OA | 47.817 | 20.614 | 0.148 | -13.384 | 109.018 |
| | | CT-OA – HT-COA | 40.197 | 20.614 | 0.259 | -21.004 | 101.398 |
| | | CT-OA – HT-OA | 34.195 | 20.614 | 0.385 | -27.007 | 95.396 |
| | | HT-COA – HT-OA | -6.003 | 20.614 | 0.991 | -67.204 | 55.198 |
| | *M. cavernosa* | CT-COA – CT-OA | 12.451 | 15.054 | 0.841 | -32.244 | 57.146 |
| | | CT-COA – HT-COA | 45.290 | 15.054 | **0.047** | 0.595 | 89.985 |
| | | CT-COA – HT-OA | 48.186 | 15.054 | **0.033** | 3.490 | 92.880 |
| | | CT-OA – HT-COA | 32.839 | 15.054 | 0.184 | -11.856 | 77.534 |
| | | CT-OA – HT-OA | 35.735 | 15.054 | 0.136 | -8.961 | 80.429 |
| | | HT-COA – HT-OA | 2.895 | 15.054 | 0.997 | -41.800 | 47.590 |
| | *O. annularis* | CT-COA – CT-OA | 20.801 | 13.623 | 0.453 | -19.646 | 61.247 |
| | | CT-COA – HT-COA | 50.807 | 13.623 | **0.013** | 10.360 | 91.254 |
| | | CT-COA – HT-OA | 65.133 | 13.623 | **0.002** | 24.686 | 105.579 |
| | | CT-OA – HT-COA | 30.007 | 13.623 | 0.178 | -10.440 | 70.453 |
| | | CT-OA – HT-OA | 44.332 | 13.623 | **0.03** | 3.885 | 84.779 |
| | | HT-COA – HT-OA | 14.326 | 13.623 | 0.724 | -26.121 | 54.772 |
| **Symbiont density** | *P. strigosa* | CT-COA – CT-OA | -0.593 | 0.231 | 0.099 | -1.278 | 0.093 |
| **(x $10^6$ cells $cm^{-2}$)** | | CT-COA – HT-COA | 0.692 | 0.231 | **0.048** | 0.006 | 1.377 |
| | | CT-COA – HT-OA | 0.690 | 0.231 | **0.048** | 0.004 | 1.376 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | CT-OA – HT-COA | 1.284 | 0.231 | **<0.001** | 0.598 | 1.970 |
| | CT-OA – HT-OA | 1.283 | 0.231 | **<0.001** | 0.597 | 1.968 |
| | HT-COA – HT-OA | -0.001 | 0.231 | 1 | -0.687 | 0.684 |
| *O. faveolata* | CT-COA – CT-OA | -0.207 | 0.589 | 0.984 | -1.956 | 1.542 |
| | CT-COA – HT-COA | 1.466 | 0.589 | 0.113 | -0.283 | 3.215 |
| | CT-COA – HT-OA | 1.305 | 0.589 | 0.174 | -0.444 | 3.054 |
| | CT-OA – HT-COA | 1.673 | 0.589 | 0.062 | -0.076 | 3.422 |
| | CT-OA – HT-OA | 1.512 | 0.589 | 0.099 | -0.237 | 3.261 |
| | HT-COA – HT-OA | -0.161 | 0.589 | 0.993 | -1.910 | 1.588 |
| *M. cavernosa* | CT-COA – CT-OA | 0.330 | 0.419 | 0.858 | -0.913 | 1.573 |
| | CT-COA – HT-COA | 0.455 | 0.419 | 0.704 | -0.788 | 1.698 |
| | CT-COA – HT-OA | 0.586 | 0.419 | 0.522 | -0.657 | 1.829 |
| | CT-OA – HT-COA | 0.125 | 0.419 | 0.99 | -1.118 | 1.368 |
| | CT-OA – HT-OA | 0.256 | 0.419 | 0.927 | -0.987 | 1.499 |
| | HT-COA – HT-OA | 0.131 | 0.419 | 0.989 | -1.112 | 1.374 |
| *O. annularis* | CT-COA – CT-OA | 0.590 | 0.619 | 0.778 | -1.249 | 2.429 |
| | CT-COA – HT-COA | 1.873 | 0.619 | **0.046** | 0.034 | 3.712 |
| | CT-COA – HT-OA | 2.200 | 0.619 | **0.018** | 0.362 | 4.040 |
| | CT-OA – HT-COA | 1.283 | 0.619 | 0.217 | -0.556 | 3.122 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | CT-OA – HT-OA | 1.611 | 0.619 | 0.094 | -0.228 | 3.450 |
| | | HT-COA – HT-OA | 0.328 | 0.619 | 0.95 | -1.511 | 2.167 |
| **Cellular Chl *a* concentration, $C_i$ (pg Chl *a* cell$^{-1}$)** | *P. strigosa* | CT-COA – CT-OA | -0.322 | 0.666 | 0.961 | -2.299 | 1.654 |
| | | CT-COA – HT-COA | 0.315 | 0.666 | 0.964 | -1.662 | 2.291 |
| | | CT-COA – HT-OA | 1.126 | 0.666 | 0.369 | -0.850 | 3.103 |
| | | CT-OA – HT-COA | 0.637 | 0.666 | 0.776 | -1.340 | 2.613 |
| | | CT-OA – HT-OA | 1.448 | 0.666 | 0.185 | -0.528 | 3.425 |
| | | HT-COA – HT-OA | 0.812 | 0.666 | 0.627 | -1.165 | 2.788 |
| | *O. faveolata* | CT-COA – CT-OA | 0.706 | 0.340 | 0.215 | -0.302 | 1.715 |
| | | CT-COA – HT-COA | 0.408 | 0.340 | 0.638 | -0.601 | 1.416 |
| | | CT-COA – HT-OA | 0.379 | 0.340 | 0.687 | -0.629 | 1.387 |
| | | CT-OA – HT-COA | -0.298 | 0.340 | 0.816 | -1.307 | 0.710 |
| | | CT-OA – HT-OA | -0.327 | 0.340 | 0.772 | -1.336 | 0.681 |
| | | HT-COA – HT-OA | -0.029 | 0.340 | 1 | -1.037 | 0.980 |
| | *M. cavernosa* | CT-COA – CT-OA | 0.071 | 0.543 | 0.999 | -1.542 | 1.684 |
| | | CT-COA – HT-COA | 1.975 | 0.543 | **0.016** | 0.362 | 3.588 |
| | | CT-COA – HT-OA | 1.817 | 0.543 | **0.026** | 0.204 | 3.430 |
| | | CT-OA – HT-COA | 1.904 | 0.543 | **0.02** | 0.291 | 3.517 |
| | | CT-OA – HT-OA | 1.746 | 0.543 | **0.033** | 0.133 | 3.359 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | HT-COA – HT-OA | -0.158 | 0.543 | 0.991 | -1.771 | 1.454 |
| | *O. annularis* | CT-COA – CT-OA | 0.240 | 0.370 | 0.914 | -0.875 | 1.354 |
| | | CT-COA – HT-COA | 0.114 | 0.400 | 0.991 | -1.090 | 1.318 |
| | | CT-COA – HT-OA | 0.689 | 0.370 | 0.299 | -0.426 | 1.804 |
| | | CT-OA – HT-COA | -0.125 | 0.400 | 0.989 | -1.329 | 1.079 |
| | | CT-OA – HT-OA | 0.449 | 0.370 | 0.632 | -0.666 | 1.564 |
| | | HT-COA – HT-OA | 0.575 | 0.400 | 0.505 | -0.630 | 1.779 |
| **$P_{max}$** | *P. strigosa* | CT-COA – CT-OA | -0.384 | 0.189 | 0.23 | -0.945 | 0.177 |
| **(µmol $O_2$ $cm^{-2}$ $h^{-1}$)** | | CT-COA – HT-COA | 0.789 | 0.189 | **0.006** | 0.227 | 1.350 |
| | | CT-COA – HT-OA | 0.783 | 0.189 | **0.006** | 0.221 | 1.344 |
| | | CT-OA – HT-COA | 1.173 | 0.189 | **<0.001** | 0.611 | 1.734 |
| | | CT-OA – HT-OA | 1.167 | 0.189 | **<0.001** | 0.605 | 1.728 |
| | | HT-COA – HT-OA | -0.006 | 0.189 | 1 | -0.567 | 0.555 |
| | *O. faveolata* | CT-COA – CT-OA | -0.182 | 0.218 | 0.837 | -0.829 | 0.465 |
| | | CT-COA – HT-COA | 0.845 | 0.218 | **0.01** | 0.198 | 1.492 |
| | | CT-COA – HT-OA | 1.005 | 0.218 | **0.003** | 0.358 | 1.652 |
| | | CT-OA – HT-COA | 1.027 | 0.218 | **0.002** | 0.380 | 1.674 |
| | | CT-OA – HT-OA | 1.187 | 0.218 | **<0.001** | 0.540 | 1.834 |
| | | HT-COA – HT-OA | 0.160 | 0.218 | 0.882 | -0.487 | 0.807 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | *M. cavernosa* | CT-COA – CT-OA | 0.038 | 0.124 | 0.989 | -0.329 | 0.405 |
| | | CT-COA – HT-COA | 1.011 | 0.124 | **<0.001** | 0.644 | 1.378 |
| | | CT-COA – HT-OA | 1.042 | 0.124 | **<0.001** | 0.675 | 1.409 |
| | | CT-OA – HT-COA | 0.973 | 0.124 | **<0.001** | 0.606 | 1.340 |
| | | CT-OA – HT-OA | 1.004 | 0.124 | **<0.001** | 0.637 | 1.371 |
| | | HT-COA – HT-OA | 0.031 | 0.124 | 0.994 | -0.336 | 0.398 |
| | *O. annularis* | CT-COA – CT-OA | 0.003 | 0.217 | 1 | -0.640 | 0.645 |
| | | CT-COA – HT-COA | 1.382 | 0.217 | **<0.001** | 0.739 | 2.024 |
| | | CT-COA – HT-OA | 1.619 | 0.217 | **<0.001** | 0.976 | 2.262 |
| | | CT-OA – HT-COA | 1.379 | 0.217 | **<0.001** | 0.736 | 2.022 |
| | | CT-OA – HT-OA | 1.617 | 0.217 | **<0.001** | 0.974 | 2.260 |
| | | HT-COA – HT-OA | -0.238 | 0.217 | 0.697 | -0.881 | 0.405 |
| **$R_L$** ($\mu$**mol $O_2$ cm$^{-2}$ h$^{-1}$**) | *P. strigosa* | CT-COA – CT-OA | 0.160 | 0.135 | 0.649 | -0.241 | 0.561 |
| | | CT-COA – HT-COA | -0.090 | 0.135 | 0.908 | -0.491 | 0.311 |
| | | CT-COA – HT-OA | -0.044 | 0.135 | 0.988 | -0.445 | 0.357 |
| | | CT-OA – HT-COA | -0.250 | 0.135 | 0.3 | -0.651 | 0.152 |
| | | CT-OA – HT-OA | -0.204 | 0.135 | 0.464 | -0.605 | 0.198 |
| | | HT-COA – HT-OA | 0.046 | 0.135 | 0.986 | -0.355 | 0.447 |
| | *O. faveolata* | CT-COA – CT-OA | 0.101 | 0.086 | 0.652 | -0.154 | 0.356 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | CT-COA – HT-COA | -0.077 | 0.086 | 0.81 | -0.331 | 0.178 |
| | | CT-COA – HT-OA | -0.024 | 0.086 | 0.992 | -0.279 | 0.231 |
| | | CT-OA – HT-COA | -0.178 | 0.086 | 0.218 | -0.432 | 0.077 |
| | | CT-OA – HT-OA | -0.125 | 0.086 | 0.491 | -0.380 | 0.130 |
| | | HT-COA – HT-OA | 0.053 | 0.086 | 0.926 | -0.202 | 0.307 |
| | *M. cavernosa* | CT-COA – CT-OA | 0.012 | 0.047 | 0.994 | -0.127 | 0.150 |
| | | CT-COA – HT-COA | -0.279 | 0.047 | **<0.001** | -0.417 | -0.141 |
| | | CT-COA – HT-OA | -0.187 | 0.047 | **0.008** | -0.325 | -0.049 |
| | | CT-OA – HT-COA | -0.291 | 0.047 | **<0.001** | -0.429 | -0.152 |
| | | CT-OA – HT-OA | -0.199 | 0.047 | **0.005** | -0.337 | -0.061 |
| | | HT-COA – HT-OA | 0.092 | 0.047 | 0.251 | -0.046 | 0.230 |
| | *O. annularis* | CT-COA – CT-OA | 0.105 | 0.076 | 0.537 | -0.121 | 0.330 |
| | | CT-COA – HT-COA | -0.261 | 0.076 | **0.022** | -0.486 | -0.035 |
| | | CT-COA – HT-OA | -0.285 | 0.076 | **0.013** | -0.511 | -0.060 |
| | | CT-OA – HT-COA | -0.365 | 0.076 | **0.002** | -0.591 | -0.140 |
| | | CT-OA – HT-OA | -0.390 | 0.076 | **0.001** | -0.615 | -0.164 |
| | | HT-COA – HT-OA | -0.025 | 0.076 | 0.988 | -0.250 | 0.201 |
| **P:R** | *P. strigosa* | CT-COA – CT-OA | -0.098 | 0.207 | 0.964 | -0.711 | 0.516 |
| | | CT-COA – HT-COA | 1.775 | 0.207 | **<0.001** | 1.161 | 2.389 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | CT-COA – HT-OA | 1.828 | 0.207 | **<0.001** | 1.214 | 2.441 |
| | CT-OA – HT-COA | 1.873 | 0.207 | **<0.001** | 1.259 | 2.486 |
| | CT-OA – HT-OA | 1.925 | 0.207 | **<0.001** | 1.311 | 2.539 |
| | HT-COA – HT-OA | 0.053 | 0.207 | 0.994 | -0.561 | 0.666 |
| *O. faveolata* | CT-COA – CT-OA | 0.073 | 0.216 | 0.986 | -0.567 | 0.712 |
| | CT-COA – HT-COA | 1.333 | 0.216 | **<0.001** | 0.693 | 1.972 |
| | CT-COA – HT-OA | 1.675 | 0.216 | **<0.001** | 1.035 | 2.315 |
| | CT-OA – HT-COA | 1.26 | 0.216 | **<0.001** | 0.620 | 1.900 |
| | CT-OA – HT-OA | 1.603 | 0.216 | **<0.001** | 0.963 | 2.242 |
| | HT-COA – HT-OA | 0.343 | 0.216 | 0.42 | -0.297 | 0.982 |
| *M. cavernosa* | CT-COA – CT-OA | 0.108 | 0.238 | 0.968 | -0.600 | 0.815 |
| | CT-COA – HT-COA | 1.683 | 0.238 | **<0.001** | 0.975 | 2.390 |
| | CT-COA – HT-OA | 1.873 | 0.238 | **<0.001** | 1.165 | 2.580 |
| | CT-OA – HT-COA | 1.575 | 0.238 | **<0.001** | 0.868 | 2.282 |
| | CT-OA – HT-OA | 1.765 | 0.238 | **<0.001** | 1.058 | 2.472 |
| | HT-COA – HT-OA | 0.190 | 0.238 | 0.854 | -0.517 | 0.897 |
| *O. annularis* | CT-COA – CT-OA | 0.315 | 0.241 | 0.576 | -0.401 | 1.031 |
| | CT-COA – HT-COA | 1.590 | 0.241 | **<0.001** | 0.875 | 2.306 |
| | CT-COA – HT-OA | 2.060 | 0.241 | **<0.001** | 1.345 | 2.776 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | CT-OA – HT-COA | 1.275 | 0.241 | **<0.001** | 0.560 | 1.991 |
| | | CT-OA – HT-OA | 1.745 | 0.241 | **<0.001** | 1.030 | 2.461 |
| | | HT-COA – HT-OA | 0.470 | 0.241 | 0.259 | -0.246 | 1.186 |
| **$G_{max}$** | *P. strigosa* | CT-COA – CT-OA | 0.0784 | 0.045 | 0.342 | -0.056 | 0.213 |
| **(µmol $CaCO_3$ $cm^{-2}$ $h^{-1}$)** | | CT-COA – HT-COA | 0.375 | 0.041 | **<0.001** | 0.251 | 0.499 |
| | | CT-COA – HT-OA | 0.436 | 0.041 | **<0.001** | 0.311 | 0.560 |
| | | CT-OA – HT-COA | 0.297 | 0.045 | **<0.001** | 0.163 | 0.431 |
| | | CT-OA – HT-OA | 0.357 | 0.045 | **<0.001** | 0.223 | 0.491 |
| | | HT-COA – HT-OA | 0.060 | 0.041 | 0.49 | -0.064 | 0.185 |
| | *O. faveolata* | CT-COA – CT-OA | 0.088 | 0.089 | 0.755 | -0.179 | 0.356 |
| | | CT-COA – HT-COA | 0.224 | 0.082 | 0.08 | -0.023 | 0.472 |
| | | CT-COA – HT-OA | 0.320 | 0.082 | **0.011** | 0.073 | 0.568 |
| | | CT-OA – HT-COA | 0.136 | 0.089 | 0.455 | -0.132 | 0.403 |
| | | CT-OA – HT-OA | 0.232 | 0.089 | 0.096 | -0.035 | 0.499 |
| | | HT-COA – HT-OA | 0.096 | 0.082 | 0.656 | -0.151 | 0.344 |
| | *M. cavernosa* | CT-COA – CT-OA | -0.036 | 0.078 | 0.965 | -0.268 | 0.195 |
| | | CT-COA – HT-COA | 0.419 | 0.078 | **<0.001** | 0.187 | 0.650 |
| | | CT-COA – HT-OA | 0.303 | 0.078 | **0.01** | 0.071 | 0.535 |
| | | CT-OA – HT-COA | 0.455 | 0.078 | **<0.001** | 0.223 | 0.686 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | CT-OA – HT-OA | 0.339 | 0.078 | **0.005** | 0.108 | 0.571 |
| | HT-COA – HT-OA | -0.116 | 0.078 | 0.477 | -0.347 | 0.116 |
| *O. annularis* | CT-COA – CT-OA | -0.017 | 0.089 | 0.997 | -0.284 | 0.249 |
| | CT-COA – HT-COA | 0.208 | 0.089 | 0.145 | -0.058 | 0.475 |
| | CT-COA – HT-OA | 0.439 | 0.089 | **0.002** | 0.173 | 0.706 |
| | CT-OA – HT-COA | 0.225 | 0.082 | 0.077 | -0.021 | 0.472 |
| | CT-OA – HT-OA | 0.457 | 0.082 | **<0.001** | 0.210 | 0.703 |
| | HT-COA – HT-OA | 0.231 | 0.082 | 0.069 | -0.016 | 0.478 |

**Table S6.** Results of the Principal Component Analysis (PCA) with the contribution of coral traits to principal component 1 (PC1) and 2 (PC2)

| **Coral Trait** | PC1 | PC2 |
|---|---|---|
| Symbiont density | -0.4171 | -0.214 |
| Chla density | -0.4203 | 0.1276 |
| Symbionts Ci | -0.3069 | 0.4833 |
| Calcification rate ($G_{max}$) | 0.0974 | 0.8115 |
| Respiration rate ($R_L$) | -0.4151 | 0.1246 |
| Photosynthesis rate ($P_{max}$) | -0.4647 | -0.0391 |
| P/R ratio | -0.3967 | -0.1694 |

**Table S7.** Physicochemical conditions of the variation in temperature and pH over the course of the experiment for the four treatments. Temperature (°C) and pH (on the NBS scale) at each experimental condition (CT-COA – Ambient temperature-ambient pH; CT-OA – Ambient temperature-low pH; HT-COA – high temperature-ambient pH; HT-OA – High temperature-low pH) represent averages of daily temperature and pH (*n* = 13) ± SE. Mean (± SE; *n* = 8) seawater carbonate chemistry ($pCO_2$, $HCO_3^-$, $CO_3^{2-}$ and $\Omega_{arag}$) for the various experimental treatments were derived from measurements of pH and Total alkalinity (TA) of water samples using the software CO2SYS[71].

| Treatment | Temperature (°C) | $pH_{NBS}$ | TA (µlmol $kg^{-1}$) | $pCO_2$ (µatm) | $HCO_3^-$ (µlmol $kg^{-1}$) | $CO_3^{2}$ (µlmol $kg^{-1}$) | $\Omega_{arag}$ |
|---|---|---|---|---|---|---|---|
| CT-COA | 29.96 ± 0.023 | 8.10 ± 0.00417 | 2320.34 ± 9.75 | 448.07 ± 8.59 | 1789.07 ± 10.62 | 217.01 ± 2.06 | 3.53 ± 0.03 |
| CT-OA | 29.91 ± 0.038 | 7.90 ± 0.00021 | 2288.04 ± 14.42 | 886.65 ± 5.57 | 1943.42 ± 12.46 | 140.80 ± 1.00 | 2.29 ± 0.02 |
| HT-COA | 31.94 ± 0.035 | 8.16 ± 0.00380 | 2277.85 ± 13.29 | 386.63 ± 8.82 | 1653.63 ± 13.65 | 253.67 ± 2.96 | 4.18 ± 0.05 |
| HT–OA | 31.91 ± 0.042 | 7.90 ± 0.00012 | 2277.12 ± 14.68 | 883.61 ± 5.25 | 1913.74 ± 12.50 | 148.4 ± 1.07 | 2.44 ± 0.02 |

**References Table S1:**

S. Agostini, H. Fujimura, T. Higuchi, I. Yuyama, B. E. Casareto, Y. Suzuki, Y. Nakano, The effects of thermal and high-$CO_2$ stresses on the metabolism and surrounding microenvironment of the coral *Galaxea fascicularis*. *Comptes Rendus Biologies,* **336**, 384-391 (2013).

K. R. Anthony, D. I. Kline, G. Diaz-Pulido, S. Dove, O. Hoegh-Guldberg. Ocean acidification causes bleaching and productivity loss in coral reef builders. *Proceedings of the National Academy of Sciences of the United States of America,* **105**, 17442-17446 (2008).

G. Baghdasarian, A. Osberg, D. Mihora, H. M. Putnam, R. D. Gates, P. J. Edmunds Effects of temperature and $pCO_2$ on population regulation of *Symbiodinium* spp. in a tropical reef coral. *Biological Bulletin,* **232**, 123-139 (2017).

H. E. Bedwell-Ivers, M. S. Koch, K. E. Peach, L. Joles, E. Dutra, C. Manfrino, The role of *in hospite* zooxanthellae photophysiology and reef chemistry on elevated $pCO_2$ effects in two branching Caribbean corals: *Acropora cervicornis* and *Porites divaricata*. *ICES Journal of Marine Science,* **74**, 1103-1112 (2016).

E. F. Camp, D. J. Smith, C. Evenhuis, I. Enochs, D. Manzello, S. Woodcock, D. J. Suggett Acclimatization to high-variance habitats does not enhance physiological tolerance of two key Caribbean corals to future temperature and pH. *Proceedings: Biological sciences, The Royal Society,* **283**, (2016)

K. D. Castillo, J. B. Ries, J. F. Bruno, I. T. Westfield The reef-building coral *Siderastrea siderea* exhibits parabolic responses to ocean acidification and warming. *Proceedings: Biological sciences, The Royal Society,* **281**, (2014)

A. Chauvin, V. Denis, P. Cuet, Is the response of coral calcification to seawater acidification related to nutrient loading? *Coral Reefs,* **30**, 911-923 (2011).

S. Comeau, R. C. Carpenter, P. J. Edmunds, Coral reef calcifiers buffer their response to ocean acidification using both bicarbonate and carbonate. *Proceedings: Biological sciences, The Royal Society,* **280**, 20122374 (2012).

S. Comeau, R. C. Carpenter, P. J. Edmunds, Effects of irradiance on the response of the coral *Acropora pulchra* and the calcifying alga *Hydrolithon reinboldii* to temperature elevation and ocean acidification. *Journal of Experimental Marine Biology and Ecology,* **453**, 28-35 (2014a).

S. Comeau, R. C. Carpenter, P. J. Edmunds, Effects of $pCO_2$ on photosynthesis and respiration of tropical scleractinian corals and calcified algae. *ICES Journal of Marine Science,* **74**, 1092-1102 (2017).

S. Comeau, R. C. Carpenter, Y. Nojiri, H. M. Putnam, K. Sakai, P. J. Edmunds, Pacific-wide contrast highlights resistance of reef calcifiers to ocean acidification. *Proceedings of the Royal Society B: Biological Sciences,* **281**, 20141339-20141339 (2014b).

S. Comeau, C. E. Cornwall, T. M. DeCarlo, E. Krieger, M. T. McCulloch, Similar controls on calcification under ocean acidification across unrelated coral reef taxa. *Global Change Biology,* **24**, 4857-4868 (2018).

S. Comeau, C. E. Cornwall, C. A. Pupier, T. M. DeCarlo, C. Alessi, R. Trehern, M. T. McCulloch, Flow-driven micro-scale pH variability affects the physiology of corals and coralline algae under ocean acidification. *Scientific Reports,* **9**, (2019).

S. Comeau, P. J. Edmunds, N. B. Spindel, R. C. Carpenter, The responses of eight coral reef calcifiers to increasing partial pressure of $CO_2$ do not exhibit a tipping point. *Limnology and Oceanography,* **58**, 388-398 (2013).

S. Comeau, P. J. Edmunds, N. B. Spindel, R. C. Carpenter, Fast coral reef calcifiers are more sensitive to ocean acidification in short-term laboratory incubations. *Limnology and Oceanography,* **59**, 1081-1091 (2014c).

C. E. Cornwall, S. Comeau, T. M. DeCarlo, B. Moore, Q. D'Alexis, M. T. McCulloch, Resistance of corals and coralline algae to ocean acidification: physiological control of calcification under natural pH variability. *Proceedings of the Royal Society B: Biological Sciences,* **285**, 20181168 (2018).

A. Crawley, D. I. Kline, S. Dunn, K. R. N. Anthony, S. Dove, The effect of ocean acidification on symbiont photorespiration and productivity in *Acropora formosa*. *Global Change Biology,* **16**, 851-863 (2010).

S. W. Davies, A. Marchetti, J.B. Ries, K. D. Castillo, Thermal and $pCO_2$ stress elicit divergent transcriptomic responses in a resilient coral. *Frontiers in Marine Science,* **3**, 112 (2016).
G. Diaz-Pulido, M. Gouezo, B. Tilbrook, S. Dove, K. R. Anthony, High $CO_2$ enhances the competitive strength of seaweeds over corals. *Ecol Lett,* **14**, 156-162 (2011).
P. J. Edmunds, Zooplanktivory ameliorates the effects of ocean acidification on the reef coral *Porites* spp. *Limnology and Oceanography,* **56**, 2402-2410 (2011).
P. J. Edmunds, Effect of $pCO_2$ on the growth, respiration, and photophysiology of massive *Porites* spp. in Moorea, French Polynesia. *Marine Biology,* **159**, 2149-2160 (2012).
P. J. Edmunds, D. Brown, V. Moriarty, Interactive effects of ocean acidification and temperature on two scleractinian corals from Moorea, French Polynesia. *Global Change Biology,* **18**, 2173-2183 (2012).
I. C. Enochs, D. P. Manzello, R. Carlton, S. Schopmeyer, R. Hooidonk, D. Lirman, Effects of light and elevated $pCO_2$ on the growth and photochemical efficiency of *Acropora cervicornis*. *Coral Reefs*, **33**(2), 477-485 (2014).
K. E. Fabricius, C. Langdon, S. Uthicke *et al.,* Losers and winners in coral reefs acclimatized to elevated carbon dioxide concentrations. *Nature Climate Change,* **1**, 165-169 (2011).
M. Fine, D. Tchernov, Scleractinian coral species survive and recover from decalcification. *Science,* **315**, 1811-1811 (2007).
C. Godinot, F. Houlbreque, R. Grover, C. Ferrier-Pages, Coral uptake of inorganic phosphorus and nitrogen negatively affected by simultaneous changes in temperature and pH. *PLoS ONE,* **6**, e25024 (2011).
Y.-S. Hii, A. M. Ambok Bolong, T.-T. Yang, H.-C. Liew, Effect of elevated carbon dioxide on two scleractinian corals: *Porites cylindrica* (Dana, 1846) and *Galaxea fascicularis* (Linnaeus, 1767). *Journal of Marine Biology,* **2009**, 215196 (2009).
K. D. Hoadley, D. T. Pettay, D. Dodge, M. E. Warner, Contrasting physiological plasticity in response to environmental stress within different cnidarians and their respective symbionts. *Coral Reefs,* **35**, 529-542 (2016).
M. Holcomb, A. L. Cohen, D. C. McCorkle, An investigation of the calcification response of the scleractinian coral *Astrangia poculata* to elevated $pCO_2$ and the effects of nutrients, zooxanthellae and gender. *Biogeosciences,* **9**, 29-39 (2012).
M. Holcomb, D. C. McCorkle, A. L. Cohen, Long-term effects of nutrient and $CO_2$ enrichment on the temperate coral *Astrangia poculata* (Ellis and Solander, 1786). *Journal of Experimental Marine Biology and Ecology,* **386**, 27-33 (2010).
R. Horwitz, M. Fine, High $CO_2$ detrimentally affects tissue regeneration of Red Sea corals. *Coral Reefs*, **33**, 819–829 (2014).
F. Houlbrèque, R. Rodolfo-Metalpa, R. Jeffree *et al.,* Effects of increased $pCO_2$ on zinc uptake and calcification in the tropical coral *Stylophora pistillata*. *Coral Reefs,* **31**, 101-109 (2012).
A. Iguchi, S. Ozaki, T. Nakamura *et al.,* Effects of acidified seawater on coral calcification and symbiotic algae on the massive coral *Porites australiensis*. *Mar Environ Res,* **73**, 32-36 (2012).
P. L. Jokiel, K. S. Rodgers, I. B. Kuffner, A. J. Andersson, G. Cox, F. T. Meckenzie, Ocean acidification and calcifying reef organisms: a mesocosm investigation. *Coral Reefs,* **27**, 473-483 (2008).
C. P. Jury, R. F. Whitehead, A. M. Szmant, Effects of variations in carbonate chemistry on the calcification rates of *Madracis auretenra* (= *Madracis mirabilis* sensu Wells, 1973): bicarbonate concentrations best predict calcification rates. *Global Change Biology,* **16**, 1632-1644 (2010).

P. Kaniewska, P. R. Campbell, D. Kline, M. Rodriguez-Lanetty, D. J. Miller, S. Dove, O. Hoegh-Guldberg, Major cellular and physiological impacts of ocean acidification on a reef building coral. *PLoS ONE,* **7**, e34659 (2012).

J. Kavousi, J. D. Reimer, Y. Tanaka, T. Nakamura, Colony-specific investigations reveal highly variable responses among individual corals to ocean acidification and warming. *Marine Environmental Research,* **109**, 9-20 (2015).

S. Krief, E. J. Hendy, M. Fine, R. Yam, A. Meibom, G. L. Foster, A. Shemesh, Physiological and isotopic responses of scleractinian corals to ocean acidification. *Geochimica et Cosmochimica Acta,* **74**, 4988-5001 (2010).

T. Krueger, N. Horwitz, J. Bodin, M.-E. Giovani, S. Escrig, A. Meibom, M. Fine, Common reef-building coral in the Northern Red Sea resistant to elevated temperature and acidication. *R Soc Open Sci,* **4**, 170038 (2017).

C. Langdon, M. Aktinson, Effect of elevated $pCO_2$ on photosynthesis and calcification of corals and interactions with seasonal change in temperature/irradiance and nutrient enrichment. *Journal of Geophysical Research,* **110**, C09S07 (2005).

C. Langdon, R. Albright, A. Baker, P. Jones, Two threatened Caribbean coral species have contrasting responses to combined temperature and acidification stress. *Limnology and Oceanography,* **63**, 2450-2464 (2018).

N. Leclercq, J. P. Gattuso, J. Jaubert, Primary production, respiration, and calcification of a coral reef mesocosm under increased $CO_2$ partial pressure. *Limnology and Oceanography,* **47**, 558-564 (2002).

F. Marubini, M. J. Atkinson, Effects of lowered pH and elevated nitrate on coral calcification. *Marine Ecology Progress Series,* **188**, 117-121 (1999).

F. Marubini, H. Barnett, C. Langdon, M. J. Atkinson, Dependence of calcification on light and carbonate ion concentration for the hermatypic coral *Porites compressa*. *Marine Ecology Progress Series,* **220**, 153-162 (2001).

F. Marubini, C. Ferrier-Pagès, P. Furla, D. Allemand, Coral calcification responds to seawater acidification: a working hypothesis towards a physiological mechanism. *Coral Reefs,* **27**, 491-499 (2008).

F. Marubini, C. Ferrier-Pagès, J. P. Cuif, Suppression of skeletal growth in scleractinian corals by decreasing ambient carbonate-ion concentration: a cross-family comparison. *Proceedings of the Royal Society of London. Series B: Biological Sciences,* **270**, 179-184 (2003).

R. Z. B. Mason, Decline in symbiont densities of tropical and subtropical scleractinian corals under ocean acidification. Coral Reefs **37,** 945-953 (2018).

J. Movilla, E. Calvo, C. Pelejero, R. Coma, E. Serrano, P. Fernández-Vallejo, M. Ribes, Calcification reduction and recovery in native and non-native Mediterranean corals in response to ocean acidification. *Journal of Experimental Marine Biology and Ecology,* **438**, 144-153 (2012).

N. Muehllehner, P. E. Edmunds, Effects of ocean acidification and increased temperature on skeletal growth of two scleractinian corals, *Pocillopora meandrina* and *Porites rus*. In: *11th International Coral Reef Symposium.*, (Ft. Lauderdale, Florida, 2008) pp 57-61

S. H. C. Noonan, K. E. Fabricius, Ocean acidification affects productivity but not the severity of thermal bleaching in some tropical corals. *ICES Journal of Marine Science: Journal du Conseil*, fsv127, (2015).

D. Ogawa, T. Bobeszko, T. Ainsworth, W. Leggat, The combined effects of temperature and $CO_2$ lead to altered gene expression in *Acropora aspera*. *Coral Reefs,* **32**, 895-907 (2013).

S. Ohde, M. M. M. Hossain, Effect of $CaCO_3$ (aragonite) saturation state of seawater on calcification of *Porites* coral. *Geochemical Journal,* **38**, 613-621 (2004).
S. Ohki, T. Irie, M. Inoue *et al.,* Symbiosis increases coral tolerance to ocean acidification. *Biogeosciences Discussions,* **10**, 7013-7030 (2013).
R. R. Okazaki, P. K. Swart, C. Langdon, Stress-tolerant corals of Florida Bay are vulnerable to ocean acidification. *Coral Reefs,* **32**, 671-683 (2013).
D. A. Renegar, B. Riegl, Effect of nutrient enrichment and elevated $CO_2$ partial pressure on growth rate of Atlantic scleractinian coral *Acropora cervicornis*. *Marine Ecology Progress Series,* **293**, 69-76 (2005).
S. Reynaud, N. Leclercq, S. Romaine-Lioud, C. Ferrier-Pagès, J. Jaubert, J. P. Gattuso, Interacting effects of $CO_2$ partial pressure and temperature on photosynthesis and calcification in a scleractinian coral. *Global Change Biology,* **9**, 1660-1668 (2003).
J. B. Ries, A. L. Cohen, D. C. McCorkle, Marine calcifiers exhibit mixed responses to $CO_2$-induced ocean acidification. *Geology,* **37**, 1131-1134 (2009).
J. B. Ries, A. L. Cohen, D. C. McCorkle, A nonlinear calcification response to $CO_2$-induced ocean acidification by the coral *Oculina arbuscula*. *Coral Reefs,* **29**, 661-674 (2010).
R. Rodolfo-Metalpa, F. Houlbrèque, É. Tambutté *et al.,* Coral and mollusc resistance to ocean acidification adversely affected by warming. *Nature Climate Change,* **1**, 308-312 (2011).
R. Rodolfo-Metalpa, S. Martin, C. Ferrier-Pagès, J. P. Gattuso, Response of the temperate coral *Cladocora caespitosa* to mid- and long-term exposure to $pCO_2$ and temperature levels projected for the year 2100 AD. *Biogeosciences,* **7**, 289-300 (2010).
V. Schoepf, A. G. Grottoli, M. E. Warner *et al.,* Coral energy reserves and calcification in a high-$CO_2$ world at two temperatures. *PLoS ONE,* **8**, e75049 (2013).
D. J. Suggett, L. F. Dong, T. Lawson, E. Lawrenz, L. Torres, D. J. Smith, Light availability determines susceptibility of reef building corals to ocean acidification. *Coral Reefs,* **32**, 327-337 (2013).
D. J. Suggett, J. M. Hall-Spencer, R. Rodolfo-Metalpa *et al.,* Sea anemones may thrive in a high $CO_2$ world. *Global Change Biology,* **18**, 3015-3025 (2012).
A. Takahashi, H. Kurihara, Ocean acidification does not affect the physiology of the tropical coral *Acropora digitifera* during a 5-week experiment. *Coral Reefs,* **32**, 305-314 (2013).
T. Towanda, E. V. Thuesen, Prolonged exposure to elevated $CO_2$ promotes growth of the algal symbiont *Symbiodinium muscatinei* in the intertidal sea anemone *Anthopleura elegantissima*. *Biol Open,* **1**, 615-621 (2012).
P. Tremblay, M. Fine, J. F. Maguer, R. Grover, C. Ferrier-Pagès, Photosynthate translocation increases in response to low seawater pH in a coral–dinoflagellate symbiosis. *Biogeosciences,* **10**, 3997-4007 (2013).
A. A. Venn, E. Tambutté, M. Holcomb, J. Laurent, D. Allemand, S. Tambutté, Impact of seawater acidification on pH at the tissue–skeleton interface and calcification in reef corals. *Proceedings of the National Academy of Sciences,* **110**, 1634-1639 (2013).
C. B. Wall, T. Y. Fan, P. J. Edmunds, Ocean acidification has no effect on thermal bleaching in the coral *Seriatopora caliendrum*. *Coral Reefs,* **33**, 119-130 (2014).

C. B. Wall, R. A. B. Mason, W. R. Ellis, R. Cunning, R. D. Gates, Elevated $pCO_2$ affects tissue biomass composition, but not calcification, in a reef coral under two light regimes. *Royal Society Open Science,* 4, 170683 (2017).