Unlocking how corals have acclimatised to thrive within the temperate waters of Sydney Harbour

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Certificate of Original Authorship

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been appropriately acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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Table of Contents

List of Figures

Chapter 1

Chapter 2

(open circles), observed SST (Fairlight) (blue squares), and bars of degree heating weeks (DHWs) from June 2015 (winter)-June 2017. SST data were obtained from the MODIS (MODerate Resolution Imaging Spectroradiometer) platform and DHWs (50-km) data from the National Environmental Satellite Data and Information Service (NESDIS) of the U.S. National Oceanic and Atmospheric Administration (NOAA). Alert level bars correspond to satellite bleaching alert levels based on current 50-km Hotspot data.

Figure 3. Maximum quantum yield of PSII (F_v/F_m, dashed lines) expressed as means ± SEM of healthy (*in situ*), bleached (*ex situ*) and bleached (*in situ*) colonies of *P. versipora*. *In situ* measurements are of eight colonies in total, four colonies from each harbour site and *ex situ* measurements are of eight coral fragments maintained in aquaria. Three technical replicates were performed on each colony/fragment. ANOVA with Tukey's post hoc tests were used for statistical analysis with numbers indicating significant differences ($p < 0.05$).
Symbiodiniaceae cell density (cells/cm^2 surface area, solid lines) of *C. mcneilli P. versipora* (bleached) and *P. versipora* (healthy) expressed as means ± SEM (*P. versipora* n = 8, *C. mcneilli* n = 4, *C. mcneilli* was sampled from Fairlight only). Measurements were taken in February (pre-bleaching), April (during bleaching), June and August (recovery period) 2016. Image of bleached (April) and non-bleached (July, recovery) colony of *P. versipora* at Middle Head (depth 4 m).

Figure 4. Venn diagram of the core microbiomes of healthy *P. versipora* and *C. mcneilli* colonies pre-bleaching. The number of OTUs for each species core and the overall shared core are shown. Only core taxa with >1% abundance are shown. Each OTU is presented to genus level where possible. UC: Unclassified. *Escherichia/Shigella* is unclassified (UC) at species level.

Figure 5. Metabolic comparisons of photosynthesis and respiration (P: R) and calcification

(G) rates (μmol cm^{-2} h^{-1}) (± SEM) over the experimental period (December- August) for A) *P. versipora* and B) *C. mcneilli.* Dashed lines connect metabolic shifts through time. The bleaching timepoint is indicated with a red data point and recovery with a blue data point. All other timepoints are pre-bleaching.

Chapter 3

Figure. 1. Overview of sampling locations within Sydney Harbour (top panel) and Botany Bay (bottom panel) represented by letters a-c. Inserts show specific sampling sites within locations.

Figure. 2: (A) Satellite-derived SST and SST anomaly data from January 2008 – June 2017 for Sydney Harbour (MODIS; MODerate Resolution Imaging Spectroradiometer). The grey box indicates the period of this study. (B) *In situ* SSTs for Botany Bay (black), Fairlight (light green) and Middle Head (dark grey) and overlayed satellite-derived data from the MODIS (red) platform for the period June 2015 – June 2017. Microbial sampling times are indicated with black arrows.

Figure. 3. Principal coordinates analysis (PCO) biplot (based on a Bray-Curtis similarity matrix) of 16S rRNA gene sequences obtained from *P. versipora* and *C. mcneilli* over the two-

year study period. Black lines show vectors (Spearman's correlations of variables with PCO axis) representative of dominant ASVs driving the difference between the two species (explaining > 2% of the dissimilarity between the two groups as determined by SIMPER). Numbers on the vector lines refer to taxa identification (classified to genus level where possible).

Figure. 4. CAP Analysis for (a) *P. versipora* and (b) *C. mcneilli* with season and year. Black lines show vectors (Spearman's correlations of variables with PCO axis) representative of

dominant ASVs (> 3 correlation value) driving the differences between Season*Year. Only the top 9 most abundant bacteria genera were showed on the plot.

Figure. 5. Distance-based redundancy analysis (db-RDA) [based on Bray Curtis resemblance distance matrix and principal coordinates analysis (PCoA)] for *P. versipora* (top) and *C. mcneilli* (bottom) with season and year. Correlations between environmental variables and the first two RDA axis are represented by the lengths of the vectors (environmental-factor vectors) and the % correlation explained by the model is on axis 1 and axis 2. For both coral species the Capscale model is significant (P-value = 0.001; f = 21.482 for *P. versipora* and P-value = 0.02; f = 21.48 for *C. mcneilli*).

Chapter 4

Figure 1. Thermal stress temperature treatment over 11 days showing control (black line) and treatment (red line). Dashed line shows measurement days (days 1, 5, 9 and 12).

Figure 2. Metabolic comparisons of photosynthesis and respiration (P: R) and calcification (G) rates (μmol cm^{-2} h^{-1}) (± SE) over the 11-day heat stress experiment for A) *P. versipora* and B) *C. mcneilli.* Dashed lines connect metabolic shifts through time for control (black) and temperature treatment (red) corals.

Figure 3. Pie chart showing proportions of functional primary metabolite groups and bar chart of the number of compounds identified as contributing to the major KEGG pathways for P. *versipora* (A) and *C. mcneilli* (B).

Figure 4. PLS-DA scores plot from comparison of the metabolite profiles of control and treatment groups for *P. versipora* (left) and *C. mcneilli* (right).

Figure 5. Heat map of all compounds ($p < 0.05$) for *P. versipora*. Rows are metabolites and columns are biological replicate samples of the six treatments (T0 control and heat treatment, T2 control and heat treatment and Tend Control and heat treatment groups) as ordered by

hierarchical clustering of metabolites based on Pearson's correlation of their expression across samples.

Figure 6. Heat map of all compounds ($p < 0.05$) for *C. mcneilli*. Rows are metabolites and columns are biological replicate samples of the six treatments (T0 control and heat treatment, T2 control and heat treatment and Tend Control and heat treatment groups) as ordered by hierarchical clustering of metabolites based on Pearson's correlation of their expression across samples.

List of Tables

Chapter 2

Chapter 3

List of Supplementary Figures

Figure S2.7. August (recovery) dominant OTU mean proportion comparison for *P. versipora* (green) and *C. mcneilli* (purple). PERMANOVA; $p = 0.004$, t = 1.584 (significantly different).

Figure S3.1: All environmental parameters for Middle Head, Fairlight and Botany Bay from June 2015- June 2017. All are an average of n = 3.

Figure S3.2. Bacterial community composition (relative frequency %) at the taxonomic level of Phylum for *P. versipora* from June 2015- June 2017. (A) represents 2015, (B) represents 2016 and (C) represents 2017. Most abundant 10 taxon shown with a relative abundance >5%. UC: Unclassified. Numbers under bars are sample replicates for each season.

Figure S3.3. Bacterial community composition (relative frequency %) at the taxonomic level of Phylum for *C. mcneilli* from June 2015- June 2017. (A) represents 2015, (B) represents 2016 and (C) represents 2017. Most abundant 10 taxon shown with a relative abundance >5%. UC: Unclassified. Numbers under bars are sample replicates for each season.

Figure S3.4. Box plot of Shannon diversity index (H') for *P. versipora* and *C. mcneilli* across all seasons and years (based on ANOVA analysis). The solid line is the median and the boxes show the 25 and 75% percentiles; the error bars are the 5 and 95% percentiles and the dots correspond to outliers.

Figure S4.1. Symbiodiniaceae cell density (cells/cm^2 surface area) of a) *P. versipora* and b) *C. mcneilli* for control and temperature treatment, expressed as means ± SEM (*P. versipora* n = 8, *C. mcneilli* n = 8). Measurements were taken on days 1, 4, 8 and 11.

Figure S4.2. Relationship between gross photosynthesis and Symbiodiniaceae density over the experimental period (Day 1, 4, 8 and 11) for *P. versipora* (left panel) and *C. mcneilli* (right panel). For all days, control corals are represented with black dots.

Figure S4.3. Gross photosynthesis per symbiont cell density over the heat stress experiment for control and heat treatment colonies *P. versipora* (A) and *C. mcneilli* (B).

Figure S4.4. Physiological parameters for *P. versipora* (a, c, e, g) and *C. mcneilli* (b, d, g, h) showing F_v/F_m (a, b), the oxygen flux between photosynthesis (light) and respiration (dark, grey shading) (c, d), calcification (light) (e, f) and the photosynthesis to respiration ratio (P: R) (g, h) over 11-days of temperature stress for control (white bars) and temperature treatment (red bars). Letters indicate significant differences at $\alpha = 0.05$ across days and species while * indicate significant differences between treatment and control. Averages (± SE) shown (n = 4).

List of Supplementary Tables

Table S2.1. Physio-chemical *in situ* parameters measured in February, April, June and August at Fairlight (FL) and Middle Head (MH) (bi-monthly average ± SEM) and tank conditions measured in December, January and February (pre-bleaching), June and August (recovery) (average of n = 4 tanks ± SEM). Total alkalinity and pH were used with temperature and salinity to calculate pCO_2 and aragonite saturation state. Light (µmol photons m^{-2} s^{-1}) was calculated based on the diffuse attenuation coefficient model at 7 m for Sydney Harbour data and is represented as an average of n=4 tanks ± SE for the tank experiment. Nutrient values are n=3 ± SD.

Table S2.2. Raw data measurements for the experimental period (December-August) for the corals *P. versipora* and *C. mcneilli.* Measurements include net photosynthesis (P_G), respiration (R), calcification (G) and *Symbiodiniaceae* density ± SE. ANOVA with Tukey's post-hoc and Kruskal-Wallis tests with pairwise comparisons and Bonferroni correction were used for statistical analysis across timepoints and species. (4) Indicates significant difference from T_4, (3) indicates significant difference from T_3, * indicates significant difference from all ($p < 0.05$).

Table S3.1. List of bacterial taxa, level of classification and number of ASVs represented by these taxa which were removed from the analysis as they were present in the negative controls (>5% relative abundance)

Table S3.2. Between species univariate STAMP analysis results showing the ASVs that were most significantly different between species *P. versipora* (PV) and *C. mcneilli* (Cosc). P-values were calculated using the Kruskal-Wallis test with Storey's False Discovery Rate (FDR) multiple test correction method and a *P-value* < 0.05. Data represents 32 out of 188 significant

features identified between the coral species. A 10% prevalence filter was applied to the data (10% of the value of the ASV should contain at least 2 counts).

Table S3.3. PERMANOVA comparisons for *P. versipora* and *C. mcneilli* between seasons (each season across years were pooled). Significance is indicated by * (P-value < 0.05).

Table S3.4. PERMANOVA comparisons for *P. versipora* between seasons and years. Significance is indicated by * (P-value < 0.05).

Table S3.5. PERMANOVA comparisons for *C. mcneilli* between seasons and years. Significance is indicated by * (P-value < 0.05).

Table S3.6. Univariate STAMP analysis showing *P. versipora* associated ASVs (and assigned taxonomy) with significant differential abundance over time. Season represents the season*year at which ASVs were most abundant. P-values were calculated using the Kruskal-Wallis test with Storey's False Discovery Rate (FDR) multiple test correction method and a *p*value < 0.05. Data represents 15 out of 99 significant features identified between the coral species. A 10% prevalence filter was applied to the data (10% of the value of the ASV should contain at least 2 counts).

Table S3.7. Univariate STAMP analysis showing *C. mcneilli* associated ASVs (and assigned taxonomy) with significant differential abundance over time. Season represents the season*year at which ASVs were most abundant. P-values were calculated using the Kruskal-Wallis test with Storey's False Discovery Rate (FDR) multiple test correction method and a *P*value < 0.05. Data represents 15 out of 39 significant features identified between the coral species. A 10% prevalence filter was applied to the data (10% of the value of the ASV should contain at least 2 counts).

Table S3.8. DistLM marginal tests showing significant environmental variables used in the dbRDA models for *P. versipora* and *C. mcneilli*. Significance is indicated by * (P-value < 0.05).

Table S4.1. Summary of ANOVA and Kruskal-Wallis test comparisons for control and treatment variables P_G, R, G_L and the P:R ratio for each measurement day (1, 4, 8 and 11) and each species. MS: mean square, df: degrees of freedom, F: F-statistic, P value: * for P < 0.05, ** for P < 0.01.

Table S4.2. Within species across time (days 1, 5, 9 and 12) ANOVA and Kruskal-Wallis test comparisons for physiological variables P_G, R, G_L and the P:R ratio. Results are shown for temperature treatment corals only. df: degrees of freedom, F: F-statistic, P value: * for P < 0.05, ** for P < 0.01.

Table S4.3. Summary of Tukey Post-hoc pairwise comparisons across time (days 1, 5, 9 and 12) for both coral species and for physiological variables P_G, R, G_L and the P:R ratio. Results are shown for temperature treatment corals only. Only P values are displayed. P value: * for P < 0.05, ** for P < 0.01.

Table S4.4. Summary of ANOVA species comparisons for temperature treatment corals at each timepoint (days 1, 5, 9 and 12) for physiological variables P_G, R, G_L and the P:R ratio. df: degrees of freedom, F: F-statistic, P value: * for P < 0.05, ** for P < 0.01.

Table S4.5. Summary of ANOVA and Kruskal-Wallis tests for F_v/F_m values comparing control and treatment corals on each day for each species. df: degrees of freedom, F: F-statistic, P value: * for P < 0.05, ** for P < 0.01.

Table S4.6. Summary of Tukey Post-hoc pairwise comparisons for F_v/F_m values across time (days 1, 4, 8 and 11) for both coral species. Results are shown for temperature treatment corals

only. Only P values are displayed. P value: * for $P < 0.05$, ** for $P < 0.01$. All values are significant unless specified (NS).

Table S4.7. OPLS regression results for each OPLS model tested. Six models were used to investigate the relationship between primary metabolite and lipid profiling data and physiological responses.

Table S4.8 Metabolic profile for *P. versipora* (>70% match to the NIST database) under ambient conditions.

Table S4.9 Metabolic profile for *C. mcneilli* (>70% match to the NIST database) under ambient conditions.

Thesis Summary

Whilst corals are under immense anthropogenic pressure from increasingly altered environments, growing evidence suggests that some coral populations have evolved to thrive within present day marginal environments. Marginal coral populations are therefore significant to understand the adaptive and acclimative capacities required to tolerate future climates. Genetic shifts within the coral microbiome are being increasingly recognised for their importance to holobiont functioning under extremes, and is considered in this thesis in terms of symbiont (Symbiodiniaceae) and bacterial diversity in response to variable environmental conditions. Promising new "omics" approaches are allowing us to create species-specific metabolite profiles and further uncover the complex mechanisms of cell metabolism under environmental stress. When coupled to measurements of coral physiological variables (photosynthesis, respiration and calcification), the molecular regulation of corals under various environmental conditions can be elucidated.

This thesis focuses on two coral species, *Plesiastrea versipora* and *Coscinaraea mcneilli* surviving under highly variable environmental conditions in Sydney Harbour. Specifically, coral heat stress tolerance was investigated during the 2016 El Niño event, which lead to the first report of coral bleaching in Sydney Harbour, showing that these high-latitude corals bleach in a similar way to tropical corals. Sampling for microbial diversity analysis was conducted ahead of coral bleaching in February, during coral bleaching in April and during coral recovery in August. Parallel measurements of coral metabolic rates (photosynthesis, respiration and calcification) were made in aquaria. Only *P. versipora* showed a bleaching response and a switch towards a heterotrophic nutrient acquisition mode during bleaching highlighting the different bleaching susceptibilities of these two-coral species. Microbial community composition showed clear species-specific associations and shifts in diversity and abundance of key bacterial taxa in response to the thermal anomaly event and over a 2-year study with

seasonal environmental change. Metabolite profiling conducted using GC-MS showed overall between species similarity with lipid compounds dominating the metabolome of both coral species. Under acute heat stress, increases in fatty acid metabolism significantly correlate to holobiont photosynthesis, suggesting a predictive capacity of metabolomic analysis in determining coral performance under heat stress.

The systematic approach implemented in this thesis highlights some of the potential mechanisms of coral persistence in marginal environments. This is relevant as high-latitude regions such as Sydney have been proposed as coral refuge environments with climate change. This research will also open up a new level of biodiversity complexity quantification that is used to designate Sydney Harbour's high conservation value.