

Supplementary Material

Supplementary figures



Fig. S1. Example photographs of diseased or dead colonies of *Platygyra daedalea* in Saada Reef. Based on the poor condition of the colonies of this species, samples were not collected at Saada Reef (southern PAG) for an experimental CBASS run.

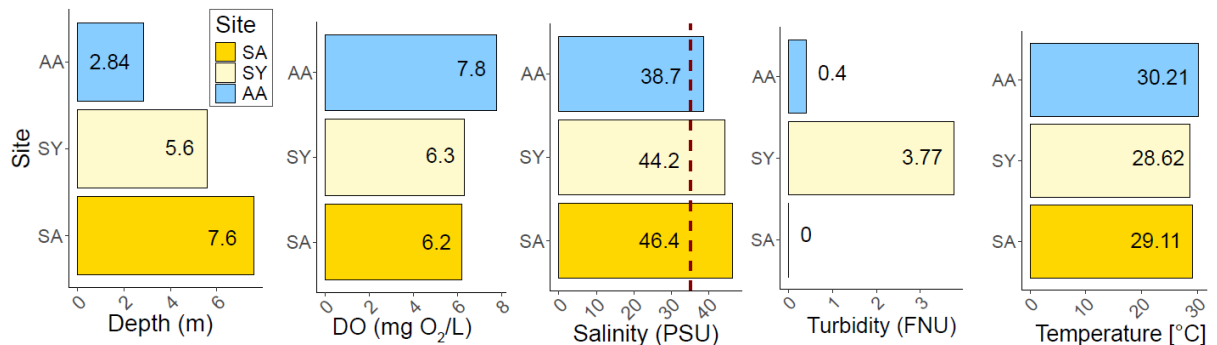


Fig. S2. Environmental parameters of sampling sites on the day of collection. Sampling depth (m), dissolved oxygen (DO; mg O₂/L), salinity (PSU), turbidity (FNU), and water temperature (°C) from sites Saada Reef (SA), Saadiyat Reef (SY) in the southern PAG, and Al Aqah (AA) in the GO. Values represent CTD logging profile averages. The red dashed line on the salinity graph represents 35 PSU, the common seawater salinity level as a reference.

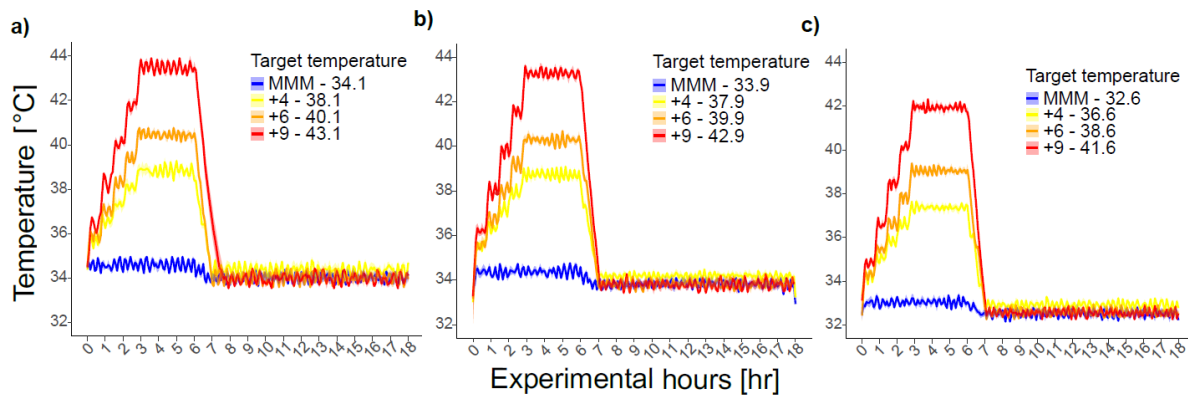


Fig. S3. Thermal profiles during CBASS runs based on HOBO temperature loggers. Shown are temperature averages across experiments for coral species (*Cyphastrea microphthalma*, *Platygyra daedalea*, and *Porites harrisoni* for (a) Saada Reef (SA), (b) Saadiyat Reef (SY) in the southern PAG, and (c) Al Aqah (AA) in the GO. The respective heat-hold target temperatures for the different sites are shown in the upper right. Standard error indicated with polygon in lighter color.

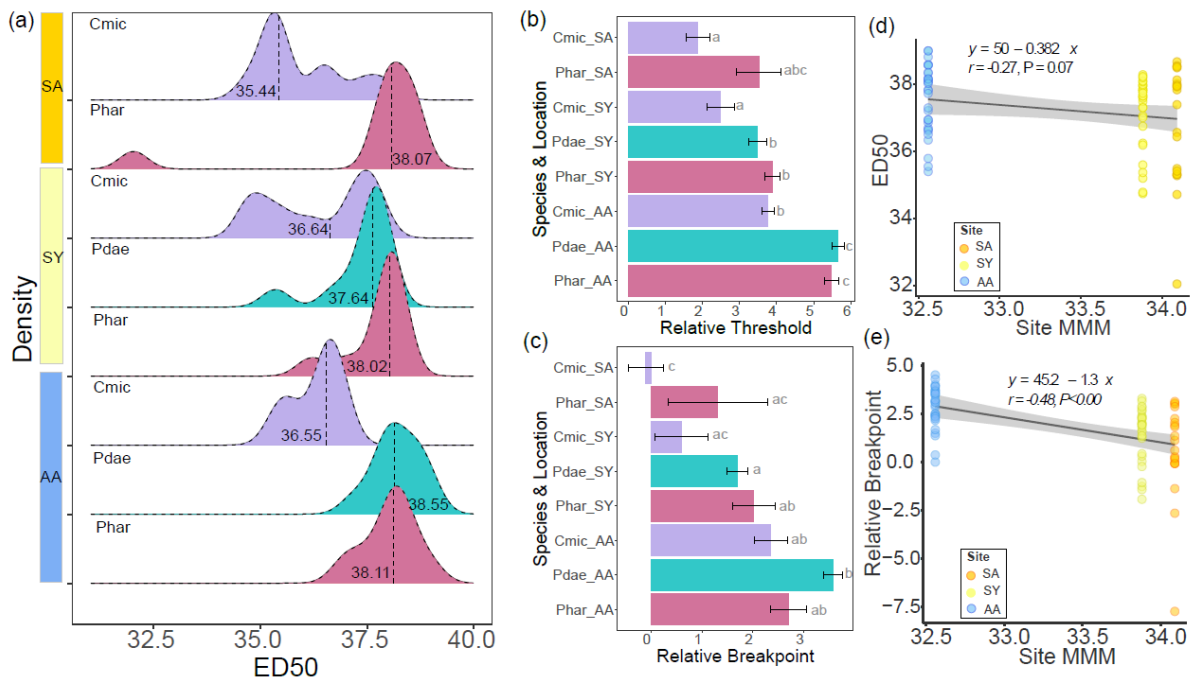


Fig. S4. Thermal tolerance response for Timepoint 2 (post-recovery phase). Distribution of (a) absolute thermal threshold (ED50), (b) relative thermal threshold (ED50-MMM), (c) relative breakpoint temperature (ED5-MMM), linear regression of Site MMM versus (d) absolute thermal threshold and (e) relative breakpoint temperature (°C). $n = 10$ colonies per coral species (Cmic, *Cyphastrea microphthalma*; Phar, *Porites harrisoni*; Pdae, *Platygyra daedalea*) per site (SA: Saada Reef, SY: Saadiyat Reef, both in the southern PAG; AA: Al Aqah in the GO). Pearson's correlation coefficient, r . Different letters indicating significant differences ($P \leq 0.05$) between each group (species-site).

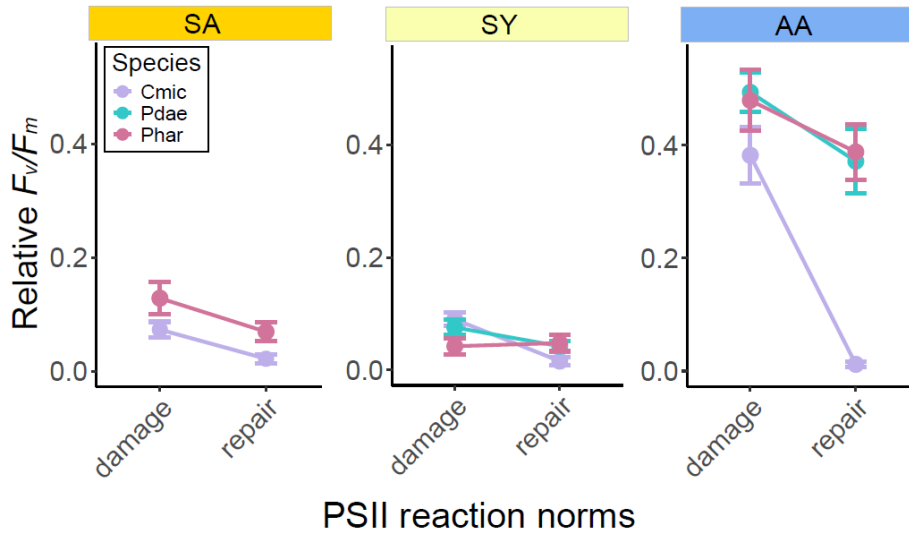


Fig. S5. Reaction norms of Photosystem II (PSII). Photosynthetic efficiency (F_v/F_m) of $+6^\circ\text{C}$ in proportion to the baseline temperature (MMM) at timepoint 1 (damage) and 2 (repair). $n = 10$ colonies per coral species (Cmic, *Cyphastrea microphthalma*; Phar, *Porites harrisoni*; Pdae, *Platygyra daedalea*) per site (SA: Saada Reef, SY: Saadiyat Reef, both in the southern PAG; AA: Al Aqah in the GO).

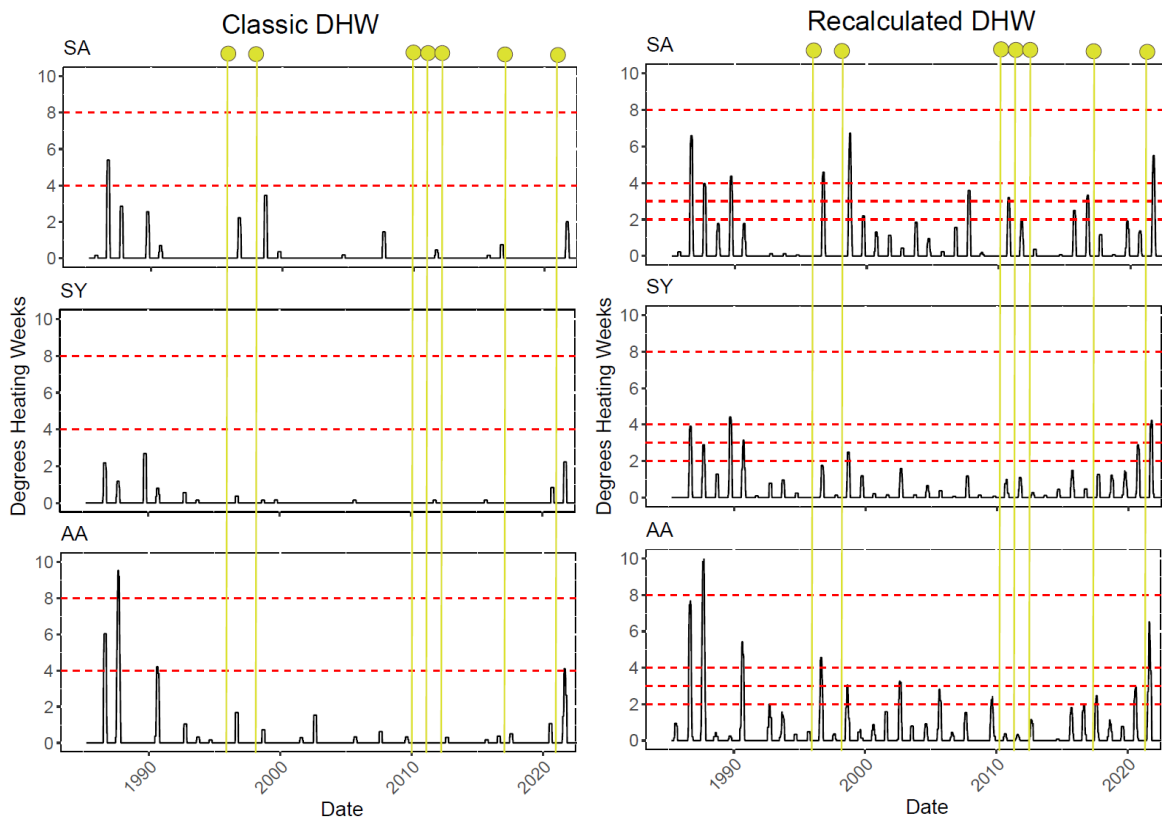


Fig. S6. Degree heating weeks (DHW) since 1985 and coral bleaching across collection sites using the conventional and a more sensitive calculation. For the conventional DHW, DHWs were extracted from NOAA CoastWatch ERDDAP, while the recalculated DHWs were determined using a more sensitive calculation according to (Whitaker & DeCarlo, 2024). This more sensitive calculation considers a thermal anomaly threshold of 0.4°C rather than 1°C and summing across a rolling week window of 11 rather than 12. Collection sites presented are Saada Reef (SA), Saadiyat Reef (SY) in

the southern PAG and Al Aqah (AA) in the GO. Dashed horizontal red lines represent DHW of 4 and 8, which have been indicated previously to be a predictor of bleaching and severe bleaching, respectively (Kayanne, 2017; Liu et al., 2003; Skirving et al., 2020). Additional horizontal dashed red lines are added at DHW 2 and 3 to indicate the lower bleaching thresholds that have been suggested for the recalculated DHW (Whitaker & DeCarlo, 2024). Reports of severe mass bleaching events in the PAG during 1996, 1998, 2010-2012, 2017 and 2021 have been denoted with yellow circles and vertical lines (J. A. Burt, 2024).

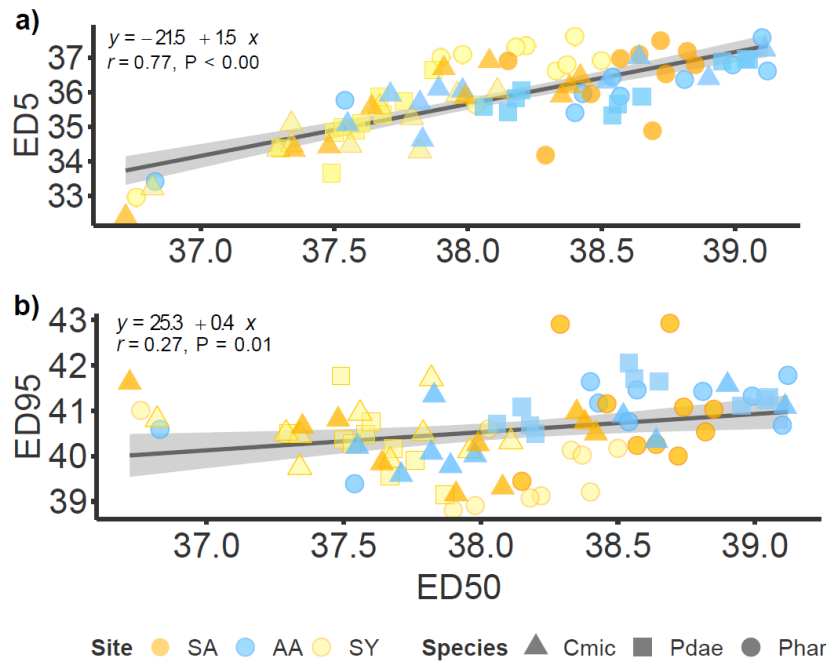


Fig. S7. Linear regressions between different dose-response curve ED values. Thermal threshold (ED50) versus (a) breakpoint temperature (ED5) and, (b) ED95 (thermal limit). Data points include coral species *Cyphastrea microphthalmia* (Cmic), *Platygyra daedalea* (Pdae), and *Porites harrisoni* (Phar) across Saada Reef (SA), Saadiyat Reef (SY) in the southern PAG, and Al Aqah (AA) in the GO. Pearson's correlation coefficient, r .

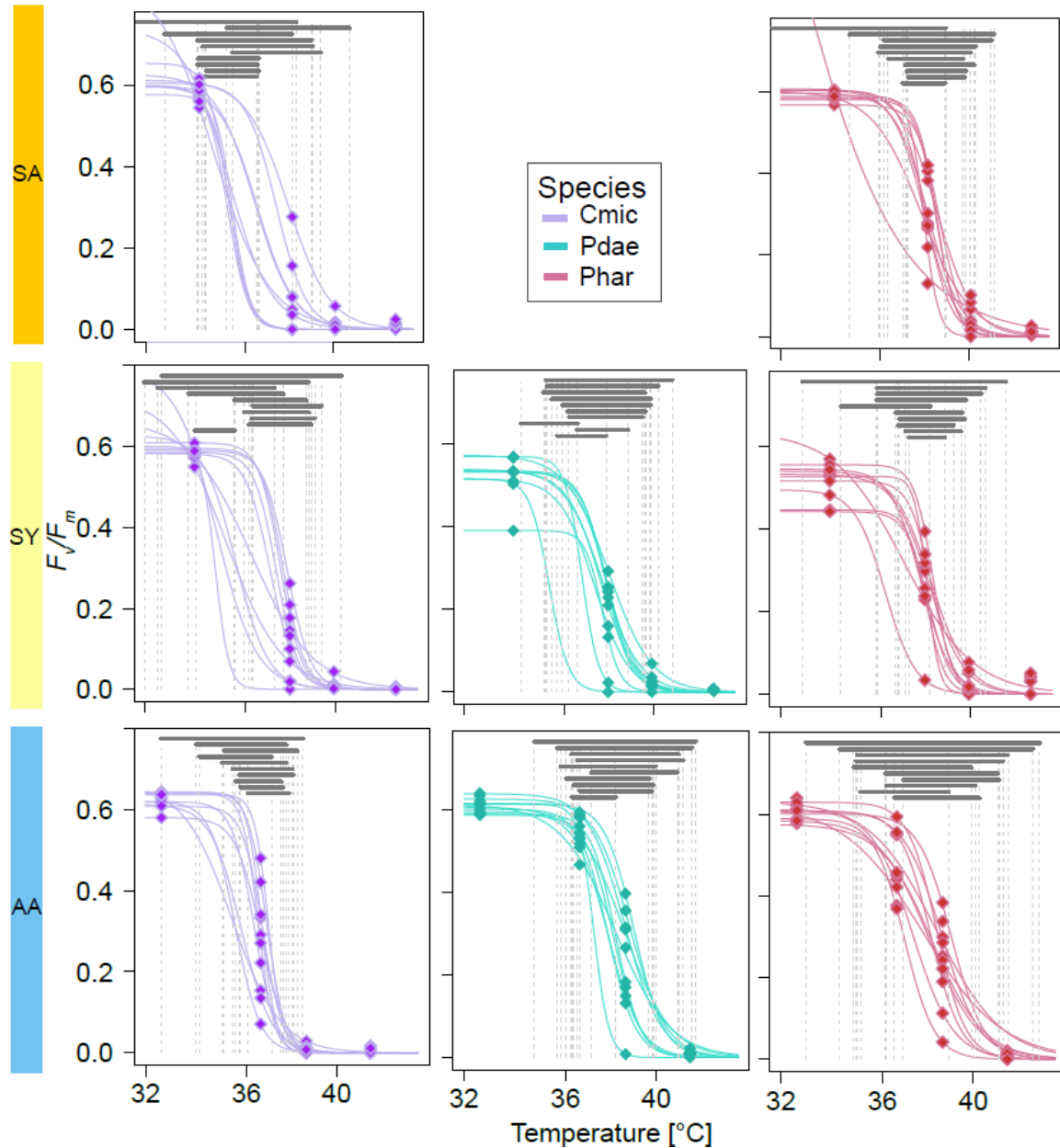


Fig. S8. Colony-level dose-response curves modelled for Fv/Fm over temperature at timepoint 2. Coral species indicated as purple, pink, and turquoise curves for *Cyphastrea microphthalmia*, *Porites harrisoni* and *Platygyra daedalea*, respectively, for each site (SA: Saada Reef, SY: Saadiyat Reef (SY) in the southern PAG; AA: Al Aqah in the GO). Data points show the Fv/Fm values at the four CBASS temperature treatments of baseline (MMM), +4°C, +6°C and +9°C ($n = 10$). Dashed grey vertical lines represent the ED5 and ED95 values and the horizontal bars along the top of the plot indicate the decline width (DW; ED95-ED5) ordered from widest to narrowest DW. Note, those curves which extend past the boundaries of the plot/scale result in decline width bars outside of range.

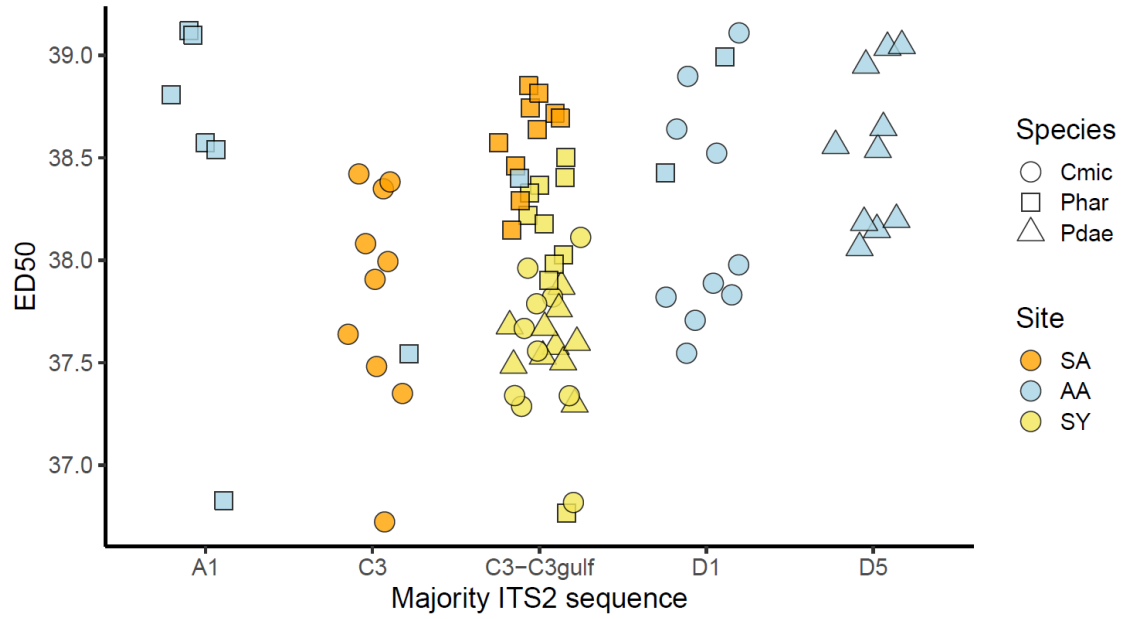


Fig. S9. Relative abundance (%) of majority ITS2 type profile sequences for all assayed colonies plotted against their thermal tolerance threshold (ED50). Phar, *Porites harrisoni*; Cmic, *Cyphastrea microphthalma*; Pdae, *Platygyra daedalea*. Colored by site; Saada Reef (SA) = orange, Saadiyatt Reef (SY) = yellow, Al Aqah (AA) = blue.

Supplementary Tables

Table S1. ITS2 type profiles of all colonies ranked by ED50. Relative abundance (%) of dominant ITS2 type profiles for each coral colony. Sample ID denotes site_species_colony. Sites: SA, Saada Reef; SY, Saadiyat Reef; AA, Al Aqah. Coral species: Phar, Pdae, Cmic, for *Porites harrisoni*, *Platygyra daedalea* and *Cyphastrea microphthalma*, respectively.

Sample	ITS2 type profile	Rel. Abund.	ITS2 type profile majority seq	ED50 [°C]
AA_Pharc_02	A1	1.0000	A1	39.12
AA_Cmic_03	D1-D6-D4-D2.2-D5-D2-D17bg	0.9185	D1	39.11
AA_Pharc_05	A1	0.9990	A1	39.1
AA_Pdae_08	D5-D5a-D5f-D4	0.8796	D5	39.05
AA_Pdae_06	D5/D5a-D4-D4a-D2	0.9167	D5	39.04
AA_Pharc_07	D1/D4/D4c-D1h	0.9950	D1	38.99
AA_Pdae_10	D5-D5a-D5f-D4	0.8927	D5	38.95
AA_Cmic_05	D1-D6-D4-D2.2-D5-D2-D17bg	0.9576	D1	38.9
SA_Pharc_04	C3-C3cc-C3gulf-C3abk	0.9492	C3-C3gulf	38.85
SA_Pharc_08	C3-C3gulf-C3by-C3c-C3cc-C3abp	0.9429	C3-C3gulf	38.82
AA_Pharc_03	A1	0.9991	A1	38.81
SA_Pharc_05	C3-C3cc-C3gulf-C3abk	0.9833	C3-C3gulf	38.74
SA_Pharc_03	C3-C3cc-C3gulf-C3abk	0.9792	C3-C3gulf	38.72
SA_Pharc_01	C3-C3cc-C3gulf-C3abk	0.9491	C3-C3gulf	38.69
AA_Pdae_09	D5-D5a-D5f-D4	0.8866	D5	38.65
SA_Pharc_02	C3-C3cc-C3gulf-C3abk	0.9483	C3-C3gulf	38.64
AA_Cmic_04	D1-D6-D4-D2.2-D5-D2-D17bg	0.9609	D1	38.64
AA_Pharc_09	A1	0.9999	A1	38.57
SA_Pharc_06	C3-C3cc-C3gulf-C3abk	0.9770	C3-C3gulf	38.57
AA_Pdae_01	D5/D5a-D4-D4a-D2	0.8385	D5	38.56

AA_Pharm_01	A1	0.9146	A1	38.54
AA_Pdae_05	D5/D5a-D4-D4a-D2	0.8470	D5	38.54
AA_Cmic_08	D1-D6-D4-D2.2-D5-D2-D17bg	0.9400	D1	38.52
SY_Pharm_08	C3-C3gulf-C3cd-C3dz	0.8737	C3-C3gulf	38.5
SA_Pharm_07	C3-C3gulf-C3by-C3c-C3cc-C3abp	0.9157	C3-C3gulf	38.46
AA_Pharm_04	D1/D4/D4c-D1h	0.9995	D1	38.43
SA_Cmic_10	C3-C3l-C3hg-C3abl-C3qh-C3gm	0.8125	C3	38.42
SY_Pharm_05	C3-C3gulf-C3cc	0.9425	C3-C3gulf	38.4
AA_Pharm_08	C3yd/C3yc-C3-C3gulf	0.9395	C3-C3gulf	38.4
SA_Cmic_05	C3-C3l-C3hg-C3abl-C3qh-C3gm	0.5280	C3	38.38
SY_Pharm_10	C3/C3c-C3gulf	0.9413	C3-C3gulf	38.37
SA_Cmic_03	C3-C3l-C3hg-C3abl-C3qh-C3gm	0.8372	C3	38.35
SY_Pharm_06	C3-C3gulf-C3cc	0.9629	C3-C3gulf	38.33
SA_Pharm_09	C3-C3gulf-C3by-C3c-C3cc-C3abp	0.8833	C3-C3gulf	38.29
SY_Pharm_03	C3/C3c-C3gulf	0.9603	C3-C3gulf	38.22
AA_Pdae_07	D5/D1-D4-D5a	0.6784	D5	38.2
SY_Pharm_09	C3/C3c-C3gulf	0.9277	C3-C3gulf	38.18
AA_Pdae_02	D5/D5a-D4-D4a-D4b	0.8640	D5	38.18
AA_Pdae_03	D5/D5a-D4-D4a-D2	0.9176	D5	38.15
SA_Pharm_10	C3-C3gulf-C3cc	0.8420	C3-C3gulf	38.15
SY_Cmic_02	C3-C3gulf-C3c-C3am-C3jd	0.7970	C3-C3gulf	38.11
SA_Cmic_09	C3-C3l-C3hg-C3abl-C3qh-C3gm	0.8403	C3	38.08
AA_Pdae_04	D5/D5a-D4-D4a-D2	0.9436	D5	38.06
SY_Pharm_02	C3/C3c-C3gulf	0.9415	C3-C3gulf	38.03
SA_Cmic_07	C3-C3l-C3hg-C3abl-C3qh-C3gm	0.8185	C3	37.99
AA_Cmic_09	D1/D17a-D4-D17-D1g	0.9779	D1	37.98
SY_Pharm_01	C3-C3gulf-C3cc	0.9546	C3-C3gulf	37.98

SY_Cmic_07	C3-C3gulf-C3c-C3am-C3jd	0.8427	C3-C3gulf	37.96
SA_Cmic_08	C3-C3l-C3hg-C3abl-C3qh-C3gm	0.8418	C3	37.91
SY_Pharc_07	C3-C3gulf-C3cc	0.9433	C3-C3gulf	37.9
AA_Cmic_07	D1/D17a-D4-D17-D1g	0.9793	D1	37.89
SY_Pdae_10	C3-C3gulf-C3d-C3i-C115c-C115b-C3ak-C3ai-C18a	0.8882	C3-C3gulf	37.87
AA_Cmic_02	D1/D17a-D4-D17-D1g	0.9840	D1	37.83
AA_Cmic_06	D1/D17a-D4-D17-D1g	0.9947	D1	37.82
SY_Cmic_03	C3-C3gulf-C3c-C3am-C3jd	0.8543	C3-C3gulf	37.82
SY_Cmic_04	C3-C3gulf-C3c-C3am-C3jd	0.7453	C3-C3gulf	37.79
SY_Pdae_09	C3-C3gulf-C3d-C3i-C3ak-C115c-C3ai-C115b	0.9294	C3-C3gulf	37.76
AA_Cmic_01	D1/D17a-D4-D17-D1g	0.8365	D1	37.71
SY_Pdae_07	C3-C3gulf-C3d-C3i-C115c-C115b-C3ak-C3ai-C18a	0.9012	C3-C3gulf	37.68
SY_Cmic_10	C3-C3gulf-C3c-C3aj-C3am	0.7085	C3-C3gulf	37.67
SY_Pdae_05	C3-C3d-C3gulf-C3i-C115c-C3ai-C3ak	0.8437	C3-C3gulf	37.67
SA_Cmic_06	C3-C3l-C3hg-C3abl-C3qh-C3gm	0.8279	C3	37.64
SY_Pdae_06	C3-C3gulf-C3d-C3i-C115c-C115b-C3ak	0.8507	C3-C3gulf	37.6
SY_Pdae_03	C3-C3gulf-C3d-C3i-C115c-C115b-C3ak-C3ai-C18a	0.9088	C3-C3gulf	37.58
SY_Cmic_09	C3-C3gulf-C3c-C3aj-C3am	0.8488	C3-C3gulf	37.56
AA_Cmic_10	D1/D17a-D4-D17-D1g	0.9653	D1	37.55
AA_Pharc_10	C3-C1qs	0.9719	C3	37.54
SY_Pdae_04	C3-C3gulf-C3d-C3i-C115c-C115b-C3ak-C3ai-C18a	0.9006	C3-C3gulf	37.53
SY_Pdae_02	C3-C3gulf-C3d-C3i-C115c-C115b-C3ak-C3ai-C18a	0.8296	C3-C3gulf	37.5
SY_Pdae_01	C3-C3gulf-C3d-C3i-C115c-C115b-C3ak-C3ai-C18a	0.4628	C3-C3gulf	37.49

SA_Cmic_01	C3-C3l-C3hg-C3abl-C3qh-C3gm	0.8083	C3	37.48
SA_Cmic_04	C3-C3l-C3hg-C3abl-C3qh-C3gm	0.7500	C3	37.35
SY_Cmic_01	C3-C3gulf-C3c-C3aj-C3am	0.8223	C3-C3gulf	37.34
SY_Cmic_05	C3-C3gulf-C3c-C3am-C3ja	0.7563	C3-C3gulf	37.34
SY_Pdae_08	C3-C3gulf-C3d-C3i-C115c-C115b-C3ak-C3ai-C18a	0.9027	C3-C3gulf	37.3
SY_Cmic_08	C3-C3gulf-C3c-C3aj-C3am	0.8093	C3-C3gulf	37.29
AA_Pharm_06	A1	0.7244	A1	36.83
SY_Cmic_06	C3-C3gulf-C3c-C3am-C3jd	0.7573	C3-C3gulf	36.82
SY_Pharm_04	C3/C3c-C3gulf	0.9523	C3-C3gulf	36.76
SA_Cmic_02	C3-C3l-C3hg-C3abl-C3qh-C3gm	0.6500	C3	36.72

Table S2. Pearson's Product correlation (*r*) statistical results. Dose-response curve derivatives (for timepoint 1) include the absolute (ED50) and relative thermal tolerance threshold (Rel.ED50 = ED50-MMM), relative breakpoint temperature (Rel.ED5 = ED5-MMM), decline width (DW = ED95-ED5) and decline width range (DWR = maximum DW - minimum DW). Climate metrics include local maximum monthly mean temperature at a site (MMM), degrees heating weeks ≥ 4 (DHW4), sea surface temperature anomaly frequency standard deviation (SSTA_Freq_stdev), and thermal stress anomaly frequency (TSA_Freq_stdev). Correlations combine 10 colonies for all 3 three coral species per site. Thus, $n = 30$ for Saadiyat Reef and Al Aqah, and $n = 20$ for Saada Reef (as only 2 species assayed). For DWR, the range is for each species per site, $n = 3$ or $n = 2$, respectively. Lower and upper confidence intervals of 95%.

Comparison Group	Correlation	P-value	Lower CI	Upper CI
Rel.ED50vsMMM	-0.85	2.20E-16	-0.9	-0.77
DWRvsMMM	0.78	0.02354	0.16	0.96
Rel.ED50vsDHW4	0.78	2.20E-16	0.67	0.85
DWRvsSSTA_Freq_stdev	0.77	0.02299	0.16	0.96
Rel.ED5vsMMM	-0.6	4.32E-09	-0.72	-0.44
Rel.ED50vsSSTA_Freq_stdev	-0.58	2.07E-08	-0.71	-0.41
Rel.ED5vsDHW4	0.54	2.14E-07	0.37	0.68
ED50vsDHW4	0.49	4.67E-06	0.3	0.64
DWRvsDHW4	-0.43	0.2889	-0.87	0.39
Rel.ED5vsSSTA_Freq_stdev	-0.41	1.44E-04	-0.58	-0.21
ED50vsMMM	-0.33	2.09E-03	-0.52	-0.13
DWRvsTSA_Freq_stdev	0.25	0.55	-0.55	0.81
Rel.ED50vsTSA_Freq_stdev	0.2	0.0714	-0.02	0.4
Rel.ED5vsTSA_Freq_stdev	0.13	0.2347	-0.09	0.34
DWvsDHW4	0.05	0.64	-0.17	0.27
DWvsMMM	-0.05	6.60E-01	-0.27	0.17
DWvsSSTA_Freq_stdev	0.03	0.8224	-0.24	0.2
DWvsSSTA_Freq_stdev	0.03	0.82	0.16	0.96

Supplementary data

[DataS1](#) - Raw dark-acclimated photosynthetic efficiency values (PAM).

[DataS2](#) - SymPortal ITS2 type abundance data

[DataS3](#) - ED results

[DataS4](#) - Statistical results