

**Limits to the thermal tolerance of corals adapted to a highly fluctuating,
naturally extreme temperature environment**

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Supplemental Materials

Supplemental Table S1. Results from one-way ANOVAs to test for significant differences in tank conditions between intertidal and subtidal tanks within each temperature (temp.) treatment. df=degrees of freedom, SS=sum of squares, TA = total alkalinity, Ω_{arag} = saturation state for aragonite.

Variable	Temp.	df	SS	F-statistic	P-value
Day Temp.	Ambient	1	0.0036	0.0046	0.9467
	Ambient +2°C	1	0.2728	0.8392	0.3705
	Ambient +3°C	1	0.1473	0.1592	0.6941
Night Temp.	Ambient	1	0.0006	0.0012	0.9726
	Ambient +2°C	1	0.2426	0.4478	0.5110
	Ambient +3°C	1	0.0277	0.0241	0.8782
$T_{\text{Heating}} - T_{\text{Control}}$	Ambient	n/a	n/a	n/a	n/a
	Ambient +2°C	1	0.0006	0.0012	0.9728
	Ambient +3°C	1	0.0024	0.0034	0.9541
pH _T	Ambient	1	0.0000	0.0059	0.9424
	Ambient +2°C	1	0.0001	0.0678	0.8074
	Ambient +3°C	1	0.0002	0.5294	0.5072
pCO ₂	Ambient	1	1.3067	0.0004	0.9855
	Ambient +2°C	1	118.1041	0.0834	0.7871
	Ambient +3°C	1	113.7962	0.2112	0.6697
TA	Ambient	1	10.1140	0.0613	0.8166
	Ambient +2°C	1	0.2166	0.0020	0.9664
	Ambient +3°C	1	8.8088	0.0708	0.8033
Ω_{arag}	Ambient	1	0.0000	0.0000	1.0000
	Ambient +2°C	1	0.0017	0.0250	0.8820
	Ambient +3°C	1	0.0014	0.0375	0.8559
Ammonium	Ambient	1	0.0012	0.1370	0.7301
	Ambient +2°C	1	0.0005	0.0232	0.8862
	Ambient +3°C	1	0.0039	3.3611	0.1407
Nitrate	Ambient	1	0.0013	1.2535	0.3256
	Ambient +2°C	1	0.0000	0.0628	0.8145
	Ambient +3°C	1	0.0036	1.0627	0.3609
Phosphate	Ambient	1	0.0000	0.0672	0.8082
	Ambient +2°C	1	0.0000	0.0240	0.8843
	Ambient +3°C	1	0.0001	0.0723	0.8014

Supplemental Table S2. Results from two generalized linear mixed model analyses to test for the effects of time, temperature (=Temp.), and environment (=Env.) on Fv/Fm and Qm of *Acropora aspera*. P-values ≤ 0.05 are highlighted in bold. Num df = numerator degrees of freedom, den df = denominator degrees of freedom.

Effect	Num df	Den df	F-statistic	P-value
Fv/Fm				
Temp.	2	44	370.39	<0.0001
Time	9	480	189.50	<0.0001
Temp. x Time	18	480	63.41	<0.0001
Env.	1	22	34.45	<0.0001
Temp. x Env.	2	44	5.41	0.0079
Env. x Time	9	480	7.80	<0.0001
Temp. x Env. x Time	18	480	6.51	<0.0001
Qm				
Temp.	2	44	22.05	<0.0001
Time	9	477	57.17	<0.0001
Temp. x Time	18	477	18.96	<0.0001
Env.	1	22	3.18	0.0882
Temp. x Env.	2	44	0.33	0.7224
Env. x Time	9	477	4.61	<0.0001
Temp. x Env. x Time	18	477	5.45	<0.0001

Supplemental Table S3. Results from two generalized linear mixed model analyses to test for the effects of time, temperature (=Temp.), and environment (=Env.) on Fv/Fm and Qm of *Dipsastraea* sp. *P*-values ≤ 0.05 are highlighted in bold. Num df = numerator degrees of freedom, den df = denominator degrees of freedom.

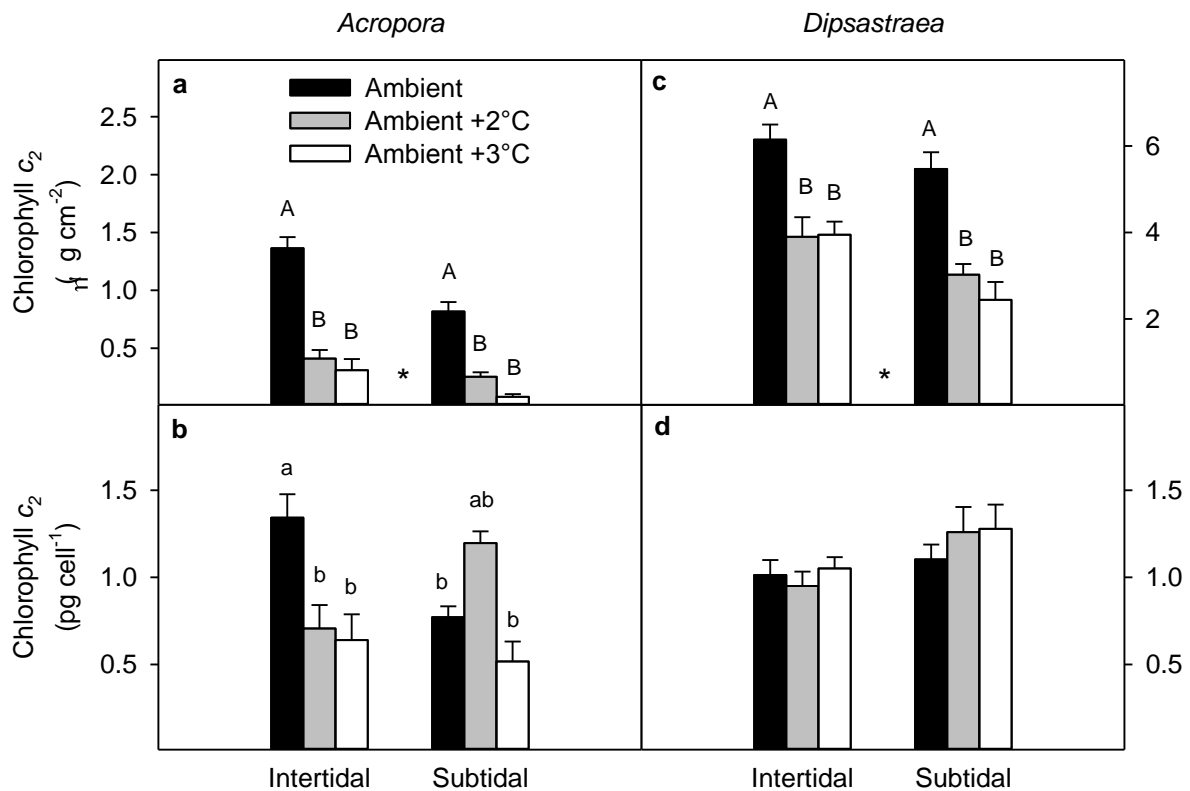
Effect	Num df	Den df	<i>F</i> -statistic	<i>P</i> -value
Fv/Fm				
Temp.	2	36	45.16	< 0.0001
Time	9	485	176.94	< 0.0001
Temp. x Time	18	485	44.36	< 0.0001
Env.	1	18	5.88	0.0260
Temp. x Env.	2	36	3.10	0.0573
Env. x Time	9	485	6.97	< 0.0001
Temp. x Env. x Time	18	485	4.82	< 0.0001
Qm				
Temp.	2	36	21.23	< 0.0001
Time	9	485	23.06	< 0.0001
Temp. x Time	18	485	2.55	0.0005
Env.	1	18	1.64	0.2172
Temp. x Env.	2	36	9.00	0.0007
Env. x Time	9	485	3.26	0.0007
Temp. x Env. x Time	18	485	0.96	0.5091

Supplemental Table S4. Results from generalized linear mixed models to test for the effects of temperature (=Temp.) and environment (=Env.) on chlorophyll *a* per area, chlorophyll *a* per cell, symbiont density (=Dens.) and tissue biomass (=Biom.) of *Acropora aspera* and *Dipsastraea* sp. Post hoc Tukey tests were used when main effects (but no interaction terms) were significant. *P*-values ≤ 0.05 are highlighted in bold. Num df = numerator degrees of freedom, den df = denominator degrees of freedom. NB=ambient control, BL=ambient +2°C, BH=ambient+3°C. IT=Intertidal, ST=subtidal.

Factor	Effect	Num df	Den df	<i>F</i> -statistic	<i>P</i> -value	Tukey
<i>Acropora aspera</i>						
Chl <i>a</i> area ⁻¹	Temp.	2	13	55.22	<0.0001	
	Env.	1	22	2.45	0.1317	
	Temp. x Env.	2	13	6.07	0.0137	
Chl <i>a</i> cell ⁻¹	Temp.	2	13	9.26	0.0032	
	Env.	1	22	1.10	0.3055	
	Temp. x Env.	2	13	4.60	0.0308	
Dens.	Temp.	2	13	44.95	<0.0001	NB > BL=BH
	Env.	1	22	4.36	0.0486	IT > ST
	Temp. x Env.	2	13	1.23	0.3233	
Biom.	Temp.	2	13	2.40	0.1294	
	Env.	1	22	0.52	0.4778	
	Temp. x Env.	2	13	2.44	0.1264	
<i>Dipsastraea</i> sp.						
Chl <i>a</i> area ⁻¹	Temp.	2	36	110.72	<0.0001	NB > BL=BH
	Env.	1	18	9.64	0.0061	IT > ST
	Temp. x Env.	2	36	0.19	0.8297	
Chl <i>a</i> cell ⁻¹	Temp.	2	36	5.72	0.0069	NB=BH > BH=BL
	Env.	1	18	0.04	0.8392	
	Temp. x Env.	2	36	0.17	0.8481	
Dens.	Temp.	2	36	65.42	<0.0001	NB > BL=BH
	Env.	1	18	9.17	0.0072	IT > ST
	Temp. x Env.	2	36	0.78	0.4667	
Biom.	Temp.	2	36	0.47	0.6275	
	Env.	1	18	7.42	0.0139	IT > ST
	Temp. x Env.	2	36	0.26	0.7736	

Supplemental Table S5. Results from generalized linear mixed models to test for the effects of temperature (=Temp.) and environment (=Env.) on chlorophyll c_2 per area and chlorophyll c_2 per cell of *Acropora aspera* and *Dipsastraea* sp. Post hoc Tukey tests were used when main effects (but no interaction terms) were significant. *P*-values ≤ 0.05 are highlighted in bold. Num df = numerator degrees of freedom, den df = denominator degrees of freedom. NB=ambient control, BL=ambient+2°C, BH=ambient+3°C. IT=Intertidal, ST=subtidal.

Factor	Effect	Num df	Den df	<i>F</i> -statistic	<i>P</i> -value	Tukey
<i>Acropora aspera</i>						
Chl c_2 area ⁻¹	Temp.	2	13	39.22	<0.0001	NB > BL=BH
	Env.	1	21	16.27	0.0006	IT > ST
	Temp. x Env.	2	13	3.46	0.0625	
Chl c_2 cell ⁻¹	Temp.	2	13	10.78	0.0017	
	Env.	1	21	2.50	0.1288	
	Temp. x Env.	2	13	6.81	0.0095	
<i>Dipsastraea</i> sp.						
Chl c_2 area ⁻¹	Temp.	2	35	52.96	<0.0001	NB > BL=BH
	Env.	1	18	5.89	0.0259	IT > ST
	Temp. x Env.	2	35	1.30	0.2858	
Chl c_2 cell ⁻¹	Temp.	2	35	0.78	0.4681	
	Env.	1	18	3.82	0.0664	
	Temp. x Env.	2	35	0.74	0.4850	



Supplemental Figure S1. Chlorophyll c_2 normalized to (a, c) surface area and (b, d) symbiont cells of intertidal and subtidal *Acropora aspera* and *Dipsastraea* sp. Mean \pm SE are shown. Asterisks indicate significant effects of environment, whereas upper case letters indicate significant temperature effects. Lower case letters indicate results from Tukey-adjusted multiple pairwise comparisons when there was a significant interaction between environment and temperature. Statistical results in Table S5. Note the different scales for the two corals in panels a and c.