

Combined effects of macroalgal presence and elevated temperature on the early life-history stages of a common Caribbean coral

Kevin Olsen^{1,2}, Raphael Ritson-Williams^{2,3}, Valerie J. Paul², Cliff Ross^{1,*}

¹Department of Biology, University of North Florida, 1 UNF Drive, Jacksonville, FL 32224, USA

²Smithsonian Marine Station, 701 Seaway Drive, Ft. Pierce, FL 34949, USA

³Present address: Department of Biology, University of Hawaii at Manoa, 2540 Campus Road, Dean Hall R2, Honolulu, HI 96822, USA

*Corresponding author: cliff.ross@unf.edu

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Supplement. Additional figures and tables

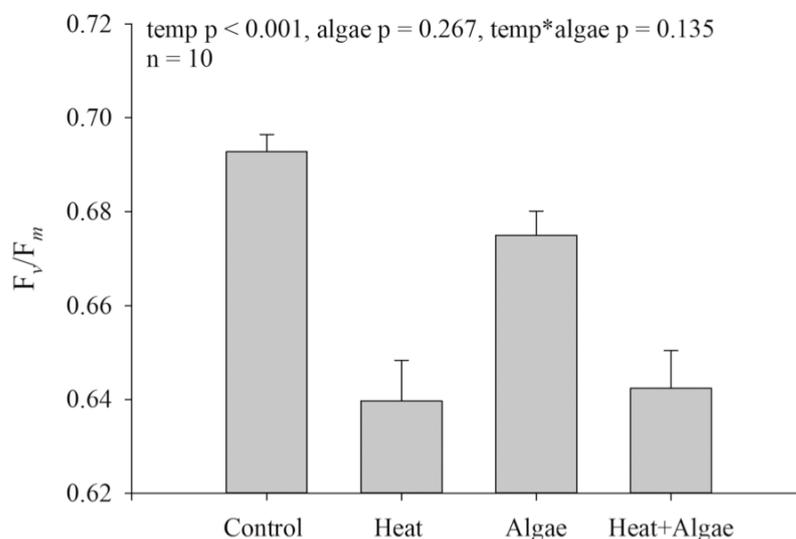


Fig. S1. Treatment effects following 48 h of exposure on the maximum quantum yield (F_v/F_m) of *in hospite* zooxanthellae within larvae from *Porites astreoides* (see Table S1). Bars represent mean + 1SE

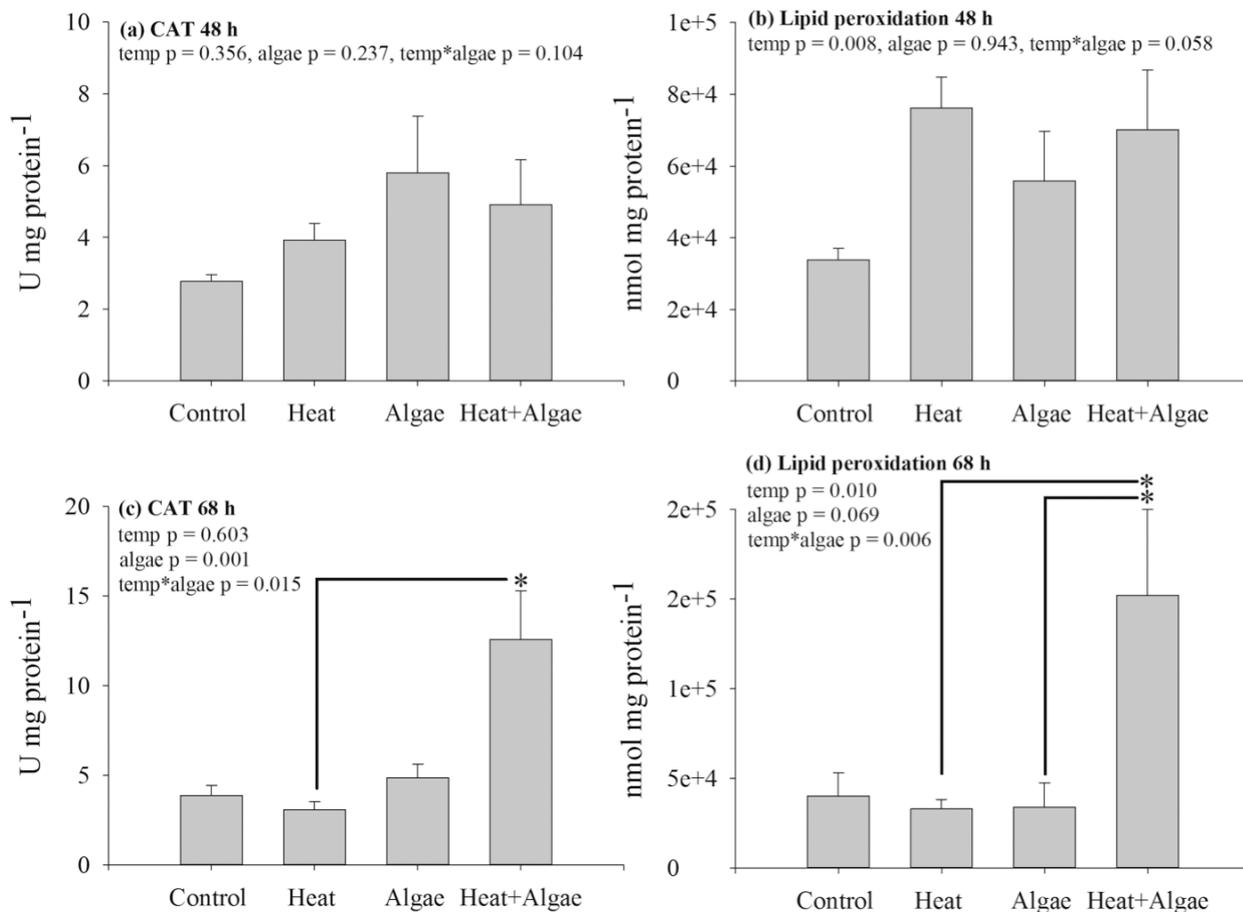


Fig. S2. Biomarkers of oxidative stress in larvae of *Porites astreoides*. (a) Activity of the enzyme catalase (CAT) following 48 h of exposure to treatments (n = 10 for Control and Heat+Algae treatments, n = 9 for Heat+Algae treatments), (b) lipid peroxidation following 48 h of exposure (n = 6 for Control treatment, n = 4 Heat and Heat+Algae treatments, and n = 5 for Algae treatment), (c) CAT activity following 68 h of exposure (n = 8 for Control, Algae, and Heat+Algae treatments, n = 10 for Heat treatment), and (d) lipid peroxidation following 68 h of treatment (n = 7 for Control and Algae treatments, n = 6 for Heat and Heat+Algae treatments) (see Tables S1 & S2). Lines indicate a significant difference between treatments based on a post-hoc student's *t*-test and a corrected significance level of 0.0125. Bars represent mean + 1SE.

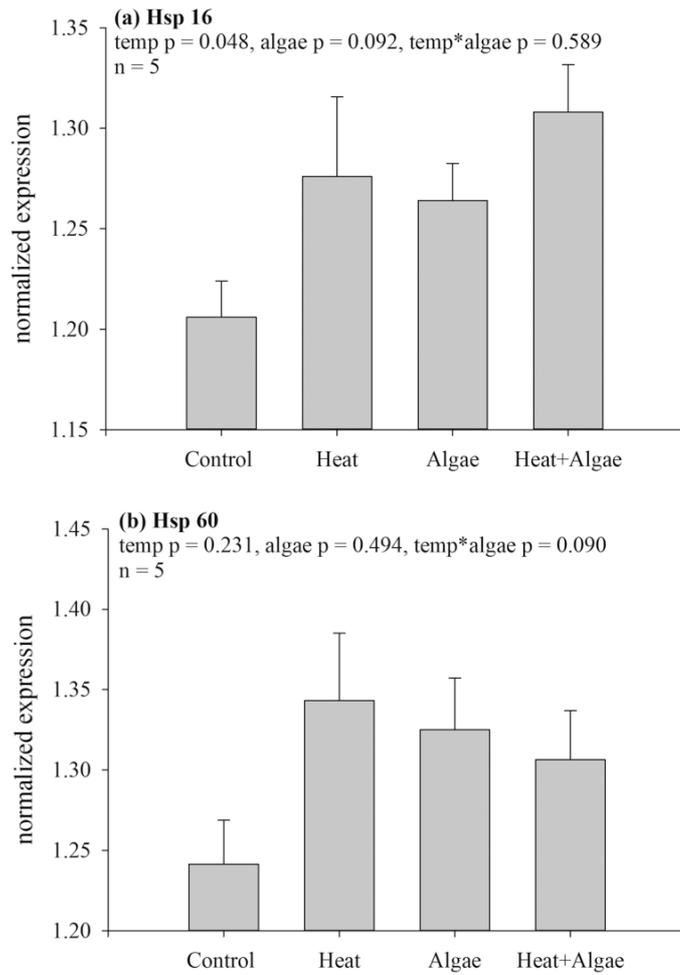


Fig. S3. Normalized heat shock protein (Hsp) transcriptional expression in larvae from *Porites astreoides* following 16 h of exposure to treatment: (a) Hsp 16, (b) Hsp 60 (see Table S1). Bars represent mean + 1SE

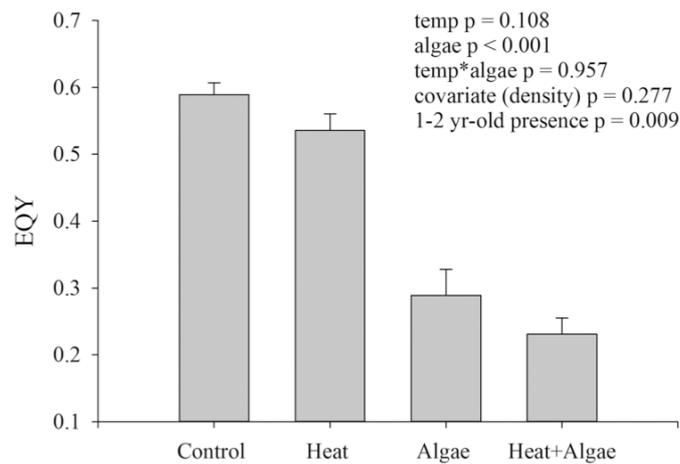


Fig. S4. Treatment effects on the effective quantum yield (EQY) of *in hospite* zooxanthellae within 6 week-old *P. astreoides* following 7 d of exposure (n = 10 for Control, Algae, and Heat+Algae treatments, n = 9 for Heat treatment) (see Table S1). Bars represent mean + 1SE

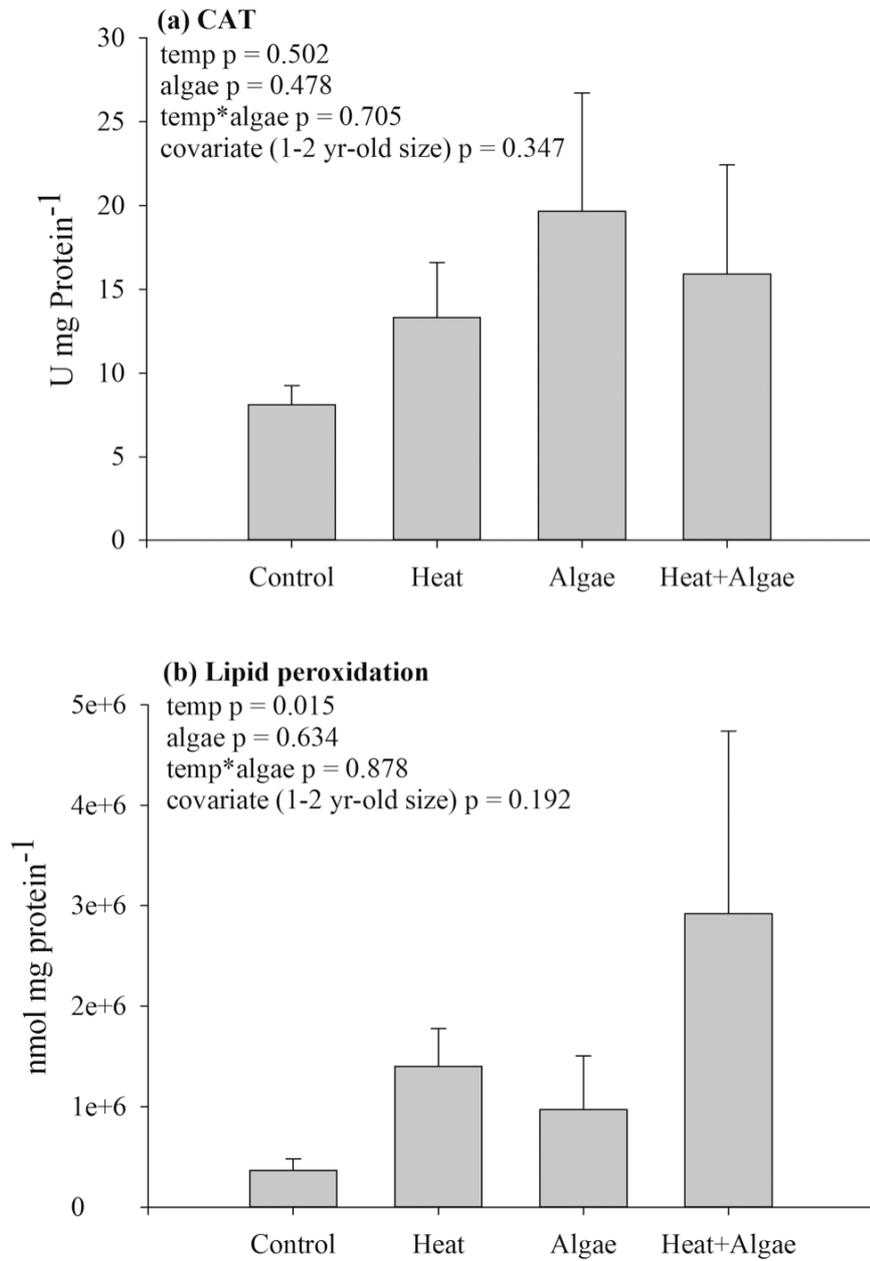


Fig. S5. Oxidative stress biomarkers in 6 week-old *P. astreoides* following 7 d of exposure: (a) activity of the enzyme catalase (CAT) (n = 6 for Control and Algae treatments, n = 4 for Heat and Heat+Algae treatments), and (b) lipid peroxidation (n = 6 for Control treatment, n = 4 for Heat and Heat+Algae treatments, and n = 5 for Algae treatment) (see Table S1). Bars represent mean + 1SE

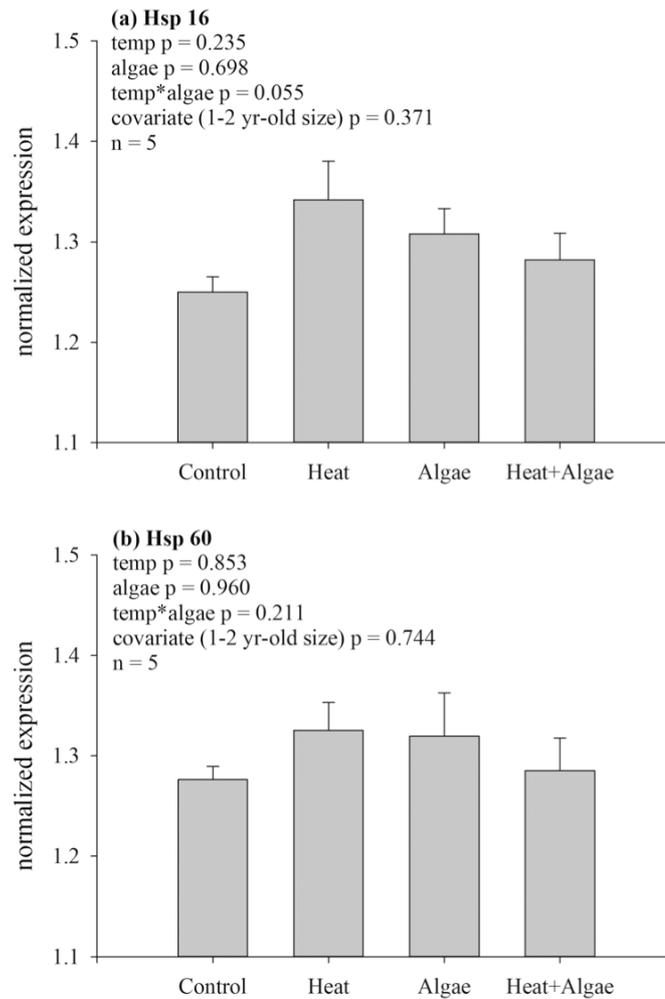


Fig. S6. Normalized heat shock protein transcriptional expression in 6 week-old *P. astreoides* following 7 d of exposure to treatments: (a) Hsp 16, (b) Hsp 60. Bars represent mean + 1SE

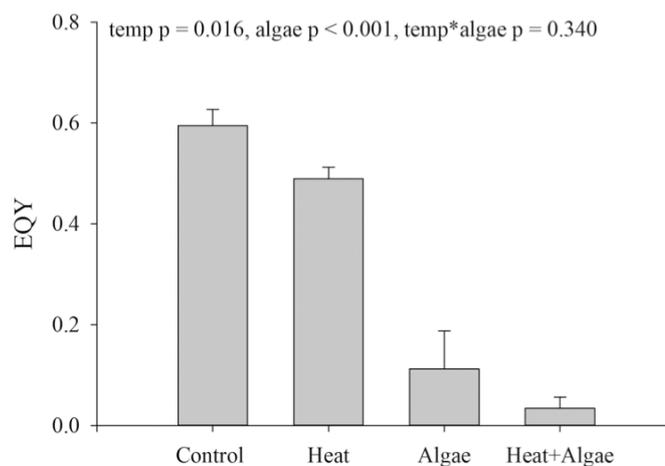


Fig. S7. Treatment effects on the effective quantum yield (EQY) of *in hospite* zooxanthellae within 1-2 year-old *P. astreoides* following 7 d of exposure (n = 7 for Control, Algae, and Heat+Algae treatments, n = 6 for Heat treatment) (see Table S1). Bars represent mean + 1SE

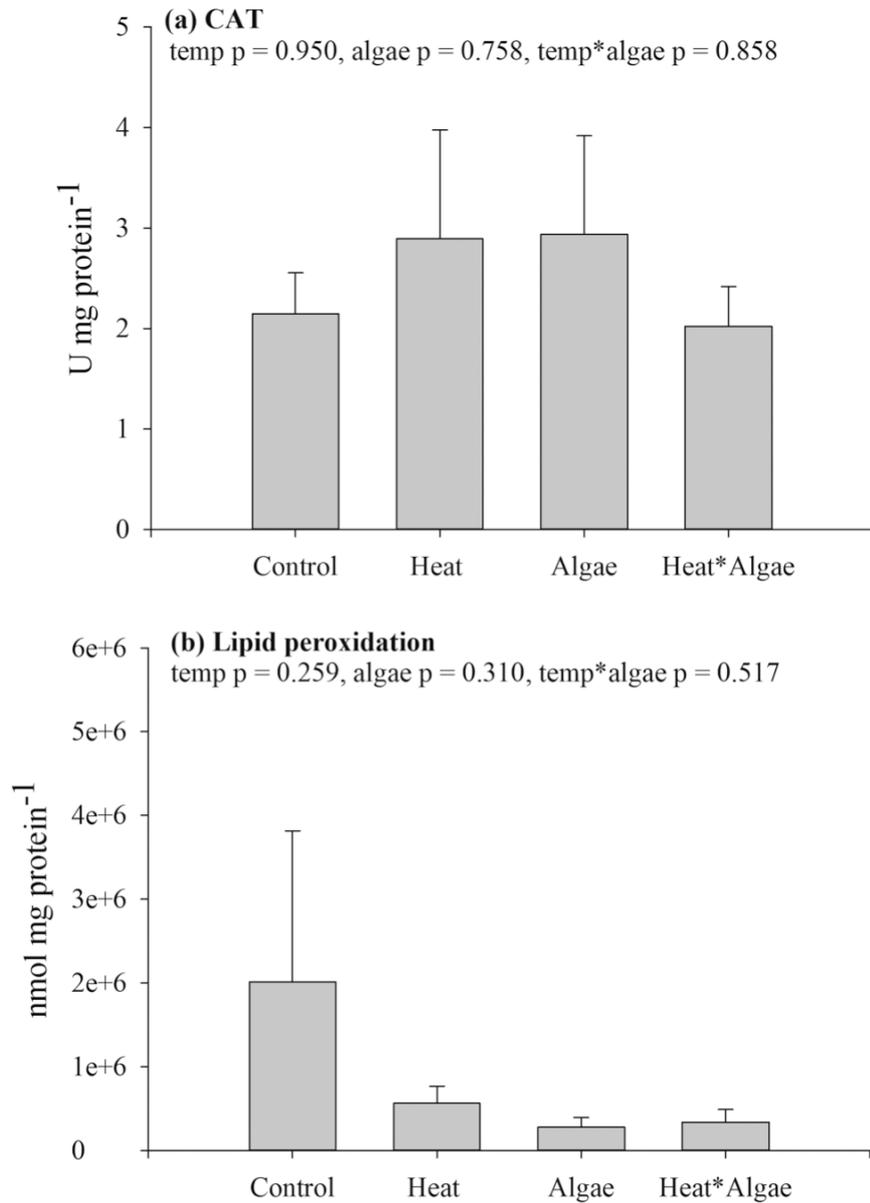


Fig. S8. Biomarkers of oxidative stress in 1-2 year-old *P. astreoides* following 7 d of exposure: (a) activity of the enzyme catalase (CAT) (n = 6 for Control and Algae treatments, n = 4 for Heat and Heat+Algae treatments), and (b) lipid peroxidation (n = 6 for Control treatment, n = 4 for Heat and Heat+Algae treatments, and n = 5 for Algae treatment). Bars represent mean + 1SE

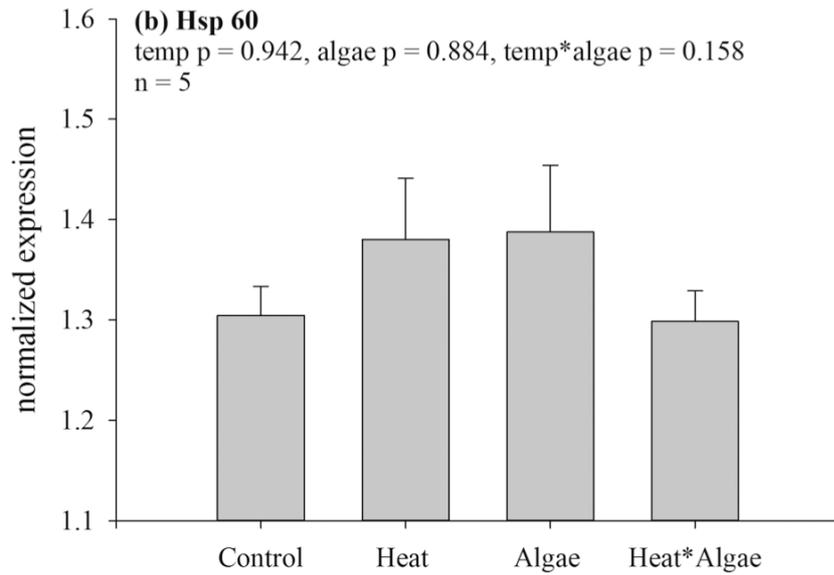
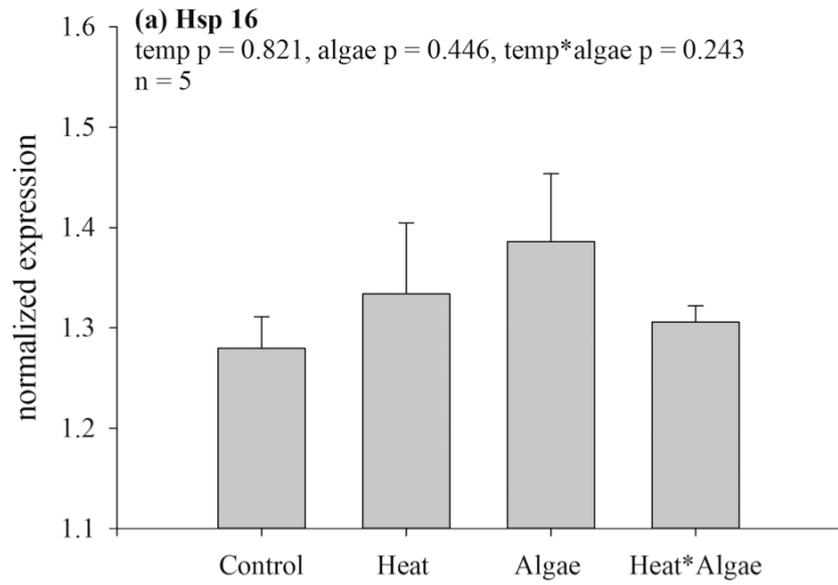


Fig. S9. Normalized heat shock protein transcriptional expression in 1-2 year-old *P. astreoides* following 7 d of exposure to treatments: (a) Hsp 16, (b) Hsp 60. Bars represent mean + 1SE

Table S1. Summary of between-subjects effects for experiments on *Porites astreoides*. Results from 2-way ANOVA, significant differences at $p < 0.05$ in **bold**. F_v/F_m : maximum quantum yield, CAT: catalase, Hsp: heat shock protein, n/a: not applicable

Life-history stage	Dependent variable	temp	algae	temp*algae	Block/covariate (density)	Covariate (1–2 yr-old size)	1–2 yr-old presence/absence	
Larvae	% survival	$F_{(1,36)}=1.089$ $p=0.304$	$F_{(1,36)}=110.009$ $p<0.001$	$F_{(1,36)}=5.419$ $p=0.026$	n/a	n/a	n/a	
	% settlement	$F_{(1,36)}=0.684$ $p=0.414$	$F_{(1,36)}=10.646$ $p=0.002$	$F_{(1,36)}=0.709$ $p=0.405$	n/a	n/a	n/a	
	% post-settlement survival	$F_{(1,33)}=0.020$ $p=0.905$	$F_{(1,33)}=5.640$ $p=0.041$	$F_{(1,33)}=0.270$ $p=0.620$	$F_{(9,33)}=1.510$ $p=0.273$	n/a	n/a	
	F_v/F_m	$F_{(1,36)}=40.914$ $p<0.001$	$F_{(1,36)}=1.270$ $p=0.267$	$F_{(1,36)}=2.341$ $p=0.135$	n/a	n/a	n/a	
	CAT activity (48 h)	$F_{(1,34)}=0.877$ $p=0.356$	$F_{(1,34)}=1.445$ $p=0.237$	$F_{(1,34)}=2.782$ $p=0.104$	n/a	n/a	n/a	
	CAT activity (68 h)	$F_{(1,30)}=0.277$ $p=0.603$	$F_{(1,30)}=14.241$ $p=0.001$	$F_{(1,30)}=6.679$ $p=0.015$	n/a	n/a	n/a	
	Lipid peroxidation (48 h)	$F_{(1,15)}=7.951$ $p=0.008$	$F_{(1,15)}=0.005$ $p=0.943$	$F_{(1,15)}=3.861$ $p=0.058$	n/a	n/a	n/a	
	Lipid peroxidation (68 h)	$F_{(1,22)}=7.695$ $p=0.010$	$F_{(1,22)}=1.3566$ $p=0.069$	$F_{(1,22)}=8.740$ $p=0.006$	n/a	n/a	n/a	
	18S ribosomal RNA	$F_{(1,16)}=0.182$ $p=0.675$	$F_{(1,16)}=0.018$ $p=0.894$	$F_{(1,16)}=0.046$ $p=0.832$	n/a	n/a	n/a	
	Normalized Hsp 16	$F_{(1,16)}=4.573$ $p=0.048$	$F_{(1,16)}=3.222$ $p=0.092$	$F_{(1,16)}=0.305$ $p=0.589$	n/a	n/a	n/a	
	Normalized Hsp 60	$F_{(1,16)}=1.550$ $p=0.231$	$F_{(1,16)}=0.489$ $p=0.494$	$F_{(1,16)}=3.252$ $p=0.090$	n/a	n/a	n/a	
	6 wk-olds	% survival	$F_{(1,33)}=1.816$ $p=0.187$	$F_{(1,33)}=64.276$ $p<0.001$	$F_{(1,33)}=0.485$ $p=0.491$	$F_{(1,33)}=0.015$ $p=0.902$	n/a	$F_{(1,33)}=0.127$ $p=0.724$
		Effective quantum yield (EQY)	$F_{(1,33)}=2.732$ $p=0.108$	$F_{(1,33)}=149.551$ $p<0.001$	$F_{(1,33)}=0.003$ $p=0.957$	$F_{(1,33)}=1.222$ $p=0.277$	n/a	$F_{(1,33)}=7.616$ $p=0.009$
CAT activity		$F_{(1,15)}=0.473$ $p=0.502$	$F_{(1,15)}=0.529$ $p=0.478$	$F_{(1,15)}=0.149$ $p=0.705$	n/a	$F_{(1,15)}=0.941$ $p=0.347$	n/a	
Lipid peroxidation		$F_{(1,14)}=7.732$ $p=0.015$	$F_{(1,14)}=0.237$ $p=0.634$	$F_{(1,14)}=0.025$ $p=0.878$	n/a	$F_{(1,14)}=1.881$ $p=0.192$	n/a	
18S ribosomal RNA		$F_{(1,15)}=0.001$ $p=0.973$	$F_{(1,15)}=1.204$ $p=0.290$	$F_{(1,15)}=0.610$ $p=0.447$	n/a	$F_{(1,15)}=0.720$ $p=0.410$	n/a	
Normalized Hsp 16		$F_{(1,15)}=1.532$ $p=0.235$	$F_{(1,15)}=0.157$ $p=0.698$	$F_{(1,15)}=4.330$ $p=0.055$	n/a	$F_{(1,15)}=0.852$ $p=0.371$	n/a	
Normalized Hsp 60		$F_{(1,15)}=0.035$ $p=0.853$	$F_{(1,15)}=0.003$ $p=0.960$	$F_{(1,15)}=1.710$ $p=0.211$	n/a	$F_{(1,15)}=0.111$ $p=0.744$	n/a	
1–2 yr-olds	% survival	$F_{(1,23)}=2.472$ $p=0.130$	$F_{(1,23)}=37.203$ $p<0.001$	$F_{(1,23)}=0.352$ $p=0.559$	n/a	n/a	n/a	
	Effective quantum yield (EQY)	$F_{(1,23)}=6.814$ $p=0.016$	$F_{(1,23)}=55.628$ $p<0.001$	$F_{(1,23)}=0.951$ $p=0.340$	n/a	n/a	n/a	
	CAT activity	$F_{(1,16)}=0.004$ $p=0.950$	$F_{(1,16)}=0.097$ $p=0.758$	$F_{(1,16)}=0.033$ $p=0.858$	n/a	n/a	n/a	
	Lipid peroxidation	$F_{(1,15)}=1.344$ $p=0.259$	$F_{(1,15)}=1.082$ $p=0.310$	$F_{(1,15)}=0.435$ $p=0.517$	n/a	n/a	n/a	
	18S ribosomal RNA	$F_{(1,16)}=0.086$ $p=0.773$	$F_{(1,16)}=1.628$ $p=0.220$	$F_{(1,16)}=0.001$ $p=0.976$	n/a	n/a	n/a	
	Normalized Hsp 16	$F_{(1,16)}=0.053$ $p=0.821$	$F_{(1,16)}=0.611$ $p=0.446$	$F_{(1,16)}=1.468$ $p=0.243$	n/a	n/a	n/a	
	Normalized Hsp 60	$F_{(1,16)}=0.005$ $p=0.942$	$F_{(1,16)}=0.022$ $p=0.884$	$F_{(1,16)}=2.192$ $p=0.158$	n/a	n/a	n/a	

Table S2. Results of post-hoc *t*-tests for dependent variables with a significant interaction term (temp*algae $p < 0.05$, see Table S1). Significance (*) based on Bonferonni's correction ($0.05/4 = 0.0125$). CAT: catalase

Dependent variable	<i>t</i> -test	Degrees of freedom, p-value
Larval survival	Control vs. Heat	df=18, p=0.018
	Control vs. Algae	df=18, p<0.001*
	Heat vs. Heat+Algae	df=18, p<0.001*
	Algae vs. Heat+Algae	df=18, p=0.409
Larval lipid peroxidation 68 h	Control vs. Heat	df=16, p=0.900
	Control vs. Algae	df=13, p=0.535
	Heat vs. Heat+Algae	df=15, p<0.001*
	Algae vs. Heat+Algae	df=12, p=0.001*
Larval CAT 68 h	Control vs. Heat	df=16, p=0.145
	Control vs. Algae	df=14, p=0.409
	Heat vs. Heat+Algae	df=16, p<0.001*
	Algae vs. Heat+Algae	df=14, p=0.055

Table S3. Mean temperatures (\pm SE) of treatments used across coral life-history stages

Life-history stage	Treatment	Mean temperature (°C)
Larvae	Control	27.48 (0.11)
	Heat	31.02 (0.12)
	Algae	27.52 (0.10)
	Heat+Algae	31.21 (0.12)
6 wk-olds and 1–2 yr-olds	Control	29.47 (0.07)
	Heat	32.49 (0.10)
	Algae	29.49 (0.07)
	Heat+Algae	32.75 (0.09)