

Supplementary Information

Coral Reproduction in a Changing Climate

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I. Coral Spawning Timing

Table S1: Timing of spawning per treatment

	High Temperature				Low Temperature			
	High UVR		Low UVR		High UVR		Low UVR	
	High PAR	Low PAR	High PAR	Low PAR	High PAR	Low PAR	High PAR	Low PAR
Number of spawning days								
Mean	2.60	3.48	2.75	2.48	4.08	4.46	2.64	3.04
Std Error	0.31	0.27	0.30	0.21	0.36	0.24	0.20	0.28
First month of spawning (6=June, 7=July, 8=August)								
Mean ^a	6.23	6.12	6.20	6.21	6.37	6.52	6.88	6.75
Std Error	0.09	0.07	0.10	0.10	0.10	0.12	0.12	0.09
Time of spawn: June								
Mean	17:20	17:16	17:00	16:51	18:08	18:16	18:08	18:11
Std Error	00:06	00:05	00:05	00:06	00:05	00:04	00:07	00:07
Time of spawn: July								
Mean	17:07	17:23	17:22	17:22	18:34	18:43	18:35	18:37
Std Error	00:05	00:05	00:05	00:06	00:04	00:03	00:06	00:08

^aMean values calculated only for the purpose of this table. Months were analyzed as categorical variables.

Table S2: Summary of a factorial ANOVA on the timing of spawning. Effects on the number of days that each individual spawned

	Number of spawning days				
	df	SS	F	p-value	
Temperature	1, 188	26.26	13.91	3×10^{-4}	***
UVR	1, 188	42.33	22.42	4×10^{-6}	***
PAR	1, 188	6.21	3.29	0.071	
Temperature x UVR	1, 188	12.48	6.61	0.011	*
Temperature x PAR	1, 188	0.08	0.04	n.s.	
UVR x PAR	1, 188	3.82	2.02	0.156	
Temperature x UVR x PAR	1, 188	4.21	2.23	0.137	

Table S3: Summary of two-way ordinal regression for cumulative link models on the timing of spawning. Effects on the first month of spawning

Difference in first month of spawning					
	df	χ^2	p-value	adj. p-value [#]	
Factors: Temperature and UVR					
Temperature	1	38.214	6×10^{-10}	2×10^{-9}	****
UVR	1	6.788	0.009	0.028	*
Temperature x UVR	1	3.817	0.051	0.152	
Factors: Temperature and PAR					
Temperature	1	36.923	1×10^{-9}	4×10^{-9}	****
PAR	1	0.052	0.819	1	
Temperature x PAR	1	0.318	0.572	1	
Factors: UVR and PAR					
UVR	1	5.469	0.019	0.058	
PAR	1	0.024	0.876	1	
UVR x PAR	1	0.064	0.800	1	

Bonferroni correction for three repetitions given the two-way ordinal regressions was run three times with different combinations of fixed factors.

Table S4: Summary of factorial ANOVA on the timing of spawning. Effects on the time of day that each individual started spawning.

Time of first spawn					
	df	SS	F	p-value	
Temperature	1, 385	137.11	602.48	$< 2 \times 10^{-16}$	****
UVR	1, 385	0.72	3.16	0.076	
PAR	1, 385	0.37	1.61	0.206	
month	1, 385	7.04	30.92	5×10^{-8}	****
Temperature x UVR	1, 385	0.00	0.01	n.s.	
Temperature x PAR	1, 385	0.01	0.03	n.s.	
UVR x PAR	1, 385	0.52	2.30	0.130	
Temperature x month	1, 385	1.75	7.69	0.006	**
UVR x month	1, 385	1.84	8.07	0.005	**
PAR x month	1, 385	0.41	1.79	0.182	
Temperature x UVR x PAR	1, 385	0.06	0.28	n.s.	
Temperature x UVR x month	1, 385	1.16	5.08	0.025	
Temperature x PAR x month	1, 385	0.34	1.48	0.225	
UVR x PAR x month	1, 385	0.08	0.34	n.s.	
Temperature x UVR x PAR x month	1, 385	0.02	0.106	n.s.	

II. Fertilisation Success

Table S5: Fertilisation success per treatment

	High Temperature				Low Temperature			
	High UVR		Low UVR		High UVR		Low UVR	
	High	Low	High	Low	High	Low	High	Low
	PAR	PAR	PAR	PAR	PAR	PAR	PAR	PAR
Percent Fertilization								
Mean	95.44	62.70	74.53	85.90	79.58	97.99	98.11	84.55
Std Error	1.58	11.98	19.67	2.51	8.43	1.15	1.89	12.28

Table S6: Summary of factorial ANOVA on fertilisation success. ANOVA performed on logit-transformed data.

Percent Fertilisation Success					
	df	SS	F	p-value	
Temperature	1, 52	0.79	4.81	0.033	*
UVR	1, 52	0.006	0.04	n.s.	
PAR	1, 52	0.11	0.68	n.s.	
Temperature x UVR	1, 52	0.02	0.14	n.s.	
Temperature x PAR	1, 52	0.82	5.04	0.029	*
UVR x PAR	1, 52	0.03	0.20	n.s.	
Temperature x UVR x PAR	1, 52	1.13	6.92	0.011	*

III. Sperm and Egg Physiology

Table S7: Sperm physiology per treatment

	High Temperature				Low Temperature			
	High UVR		Low UVR		High UVR		Low UVR	
	High	Low	High	Low	High	Low	High	Low
	PAR	PAR	PAR	PAR	PAR	PAR	PAR	PAR
Percent Sperm motility								
Mean ^a	59.64	72.09	68.75	92.60	60.70	72.29	58.54	70.46
Std Error	7.89	4.40	12.65	0.80	8.41	3.59	7.19	4.64
Percent High Mitochondrial Membrane Potential								
Mean	64.76	61.61	78.39	71.56	57.16	44.65	44.41	60.86
Std Error	8.85	3.56	0.84	0.68	6.95	6.49	5.91	8.27

Table S8: Summary of factorial ANOVA on sperm physiology. Effects on sperm motility

Sperm Motility				
	df	SS	F	p-value
Temperature	1, 37	216.9	0.94	n.s.
UVR	1, 37	93.8	0.41	n.s.
PAR	1, 37	1841.1	8.00	0.008
Temperature x UVR	1, 37	624.3	2.71	0.108
Temperature x PAR	1, 37	46.7	0.20	n.s.
UVR x PAR	1, 37	31.4	0.14	n.s.
Temperature x UVR x PAR	1, 37	63.2	0.27	n.s.

Table S9: Summary of factorial ANOVA on sperm physiology. Effects on the sperm mitochondrial membrane potential, with high mitochondrial membrane potential indicative of healthy cells and low mitochondrial membrane potential indicative of early stages of apoptosis

Sperm High Mitochondrial Membrane Potential				
	df	SS	F	p-value
Temperature	1, 37	2080	7.24	0.011
UVR	1, 37	348	1.21	0.278
PAR	1, 37	18	0.06	n.s.
Temperature x UVR	1, 37	172	0.60	n.s.
Temperature x PAR	1, 37	53	0.19	n.s.
UVR x PAR	1, 37	949	3.30	0.077
Temperature x UVR x PAR	1, 37	549	1.91	0.175

Table S10: Egg size per treatment

	High Temperature				Low Temperature			
	High UVR		Low UVR		High UVR		Low UVR	
	High PAR	Low PAR	High PAR	Low PAR	High PAR	Low PAR	High PAR	Low PAR
Egg Volume: June (mm³)								
Mean	0.00123	0.00151	0.00135	0.00148	0.00168	0.00176	0.00157	0.00171
Std Error	0.00009	0.00005	0.00004	0.00005	0.00009	0.00009	0.00003	0.00010
Egg Volume: July (mm³)								
Mean	0.00159	0.00153	0.00152	0.00152	0.00174	0.00181	0.00172	0.00176
Std Error	0.00003	0.00005	0.00004	0.00006	0.00007	0.00005	0.00005	0.00004
Egg Volume: August (mm³)								
Mean	0.00164	0.00160	0.00134	0.00161	0.00174	0.00179	0.00170	0.00173
Std Error	0.00005	0.00006	0.00006	0.00009	0.00006	0.00008	0.00009	0.00007

Table S11: Summary of factorial ANOVA analysis testing for the effects of temperature, PAR, UVR, and spawning month on the average egg volume.

	Egg volume				
	df	SS	F	p	
Temperature (T°)	1, 175	2×10^{-6}	68.86	3×10^{-14}	***
UVR	1, 175	9×10^{-8}	2.99	0.085	
PAR	1, 175	2×10^{-7}	6.37	0.012	*
Spawn. month	2, 175	3×10^{-7}	5.23	0.006	**
T° x UVR	1, 175	6×10^{-10}	0.02	n.s.	
T° x PAR	1, 175	5×10^{-10}	0.02	n.s.	
UVR x PAR	1, 175	6×10^{-9}	0.21	n.s.	
T° x spawn. month	2, 175	6×10^{-8}	1.00	0.369	
UVR x spawn. month	2, 175	4×10^{-8}	0.60	n.s.	
PAR x spawn. month	2, 175	9×10^{-8}	1.59	0.208	
T° x UVR x PAR	1, 175	3×10^{-8}	0.86	n.s.	
T° x UVR x spawn. month	2, 175	4×10^{-8}	0.67	n.s.	
T° x PAR x spawn. month	2, 175	6×10^{-8}	1.01	0.365	
UVR x PAR x spawn. month	2, 175	7×10^{-8}	1.23	0.296	
T° x UVR x PAR x spawn. month	2, 175	1×10^{-7}	1.79	0.169	

IV. Other Physiology Characteristics

Table S12: Other physiology per treatment

	High Temperature				Low Temperature			
	High UVR		Low UVR		High UVR		Low UVR	
	High PAR	Low PAR	High PAR	Low PAR	High PAR	Low PAR	High PAR	Low PAR
Daily Growth								
Mean ^a	45.93	39.25	49.84	48.82	68.00	64.54	54.25	46.73
Std Error	4.01	4.38	4.63	4.87	6.73	6.81	3.81	5.76
Percent Loss in Pigmentation								
Mean	17.44	11.10	22.35	19.33	6.62	2.18	12.47	3.39
Std Error	1.91	1.48	1.90	1.79	1.62	1.12	2.13	1.09

Table S13: Summary of factorial ANOVA on physiology. Effects on growth. ANOVA conducted on square-root-transformed data to fulfill normality assumptions

Growth					
	df	SS	F	p-value	
Temperature	1, 186	0.033	11.23	0.001	***
UVR	1, 186	0.003	1.00	0.318	
PAR	1, 186	0.007	2.47	0.118	
Temperature x UVR	1, 186	0.026	8.60	0.004	**
Temperature x PAR	1, 186	0.0003	0.09	n.s.	
UVR x PAR	1, 186	0.00002	0.01	n.s.	
Temperature x UVR x PAR	1, 186	0.003	0.85	n.s.	

Table S14: Summary of factorial ANOVA on physiology. Effects on discoloration

Percent Loss of Pigmentation					
	df	SS	F	p-value	
Temperature	1, 191	6461	93.92	$< 2 \times 10^{-16}$	***
UVR	1, 191	1267	18.41	3×10^{-5}	***
PAR	1, 191	1617	23.50	3×10^{-6}	***
Temperature x UVR	1, 191	117	1.70	0.194	
Temperature x PAR	1, 191	53	0.77	n.s.	
UVR x PAR	1, 191	5	0.07	n.s.	
Temperature x UVR x PAR	1, 191	197	2.87	0.092	