The widely distributed soft coral *Xenia umbellata* exhibits high resistance against phosphate enrichment and temperature increase

- Supplementary Material -

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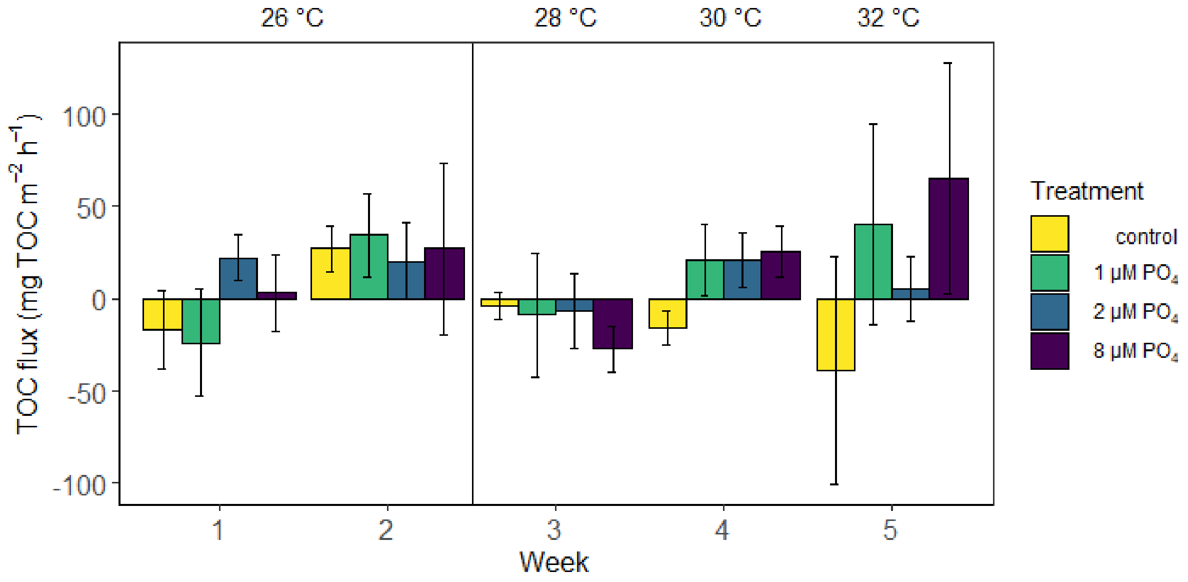

Figure S1. TOC fluxes of *Xenia umbellata* colonies under experimental conditions: only temperature increase without PO_4 addition (control), 1 µM PO_4 + temperature increased from week 3 onwards (1 µM PO_4), 2 µM PO_4 + temperature increased (2 µM PO_4), and 8 µM PO_4 + temperature increased (8 µM PO_4). Error bars represent standard errors. The vertical line indicates the start of the temperature treatment and the average temperature for all tanks for the different time points is given on top of the graph.

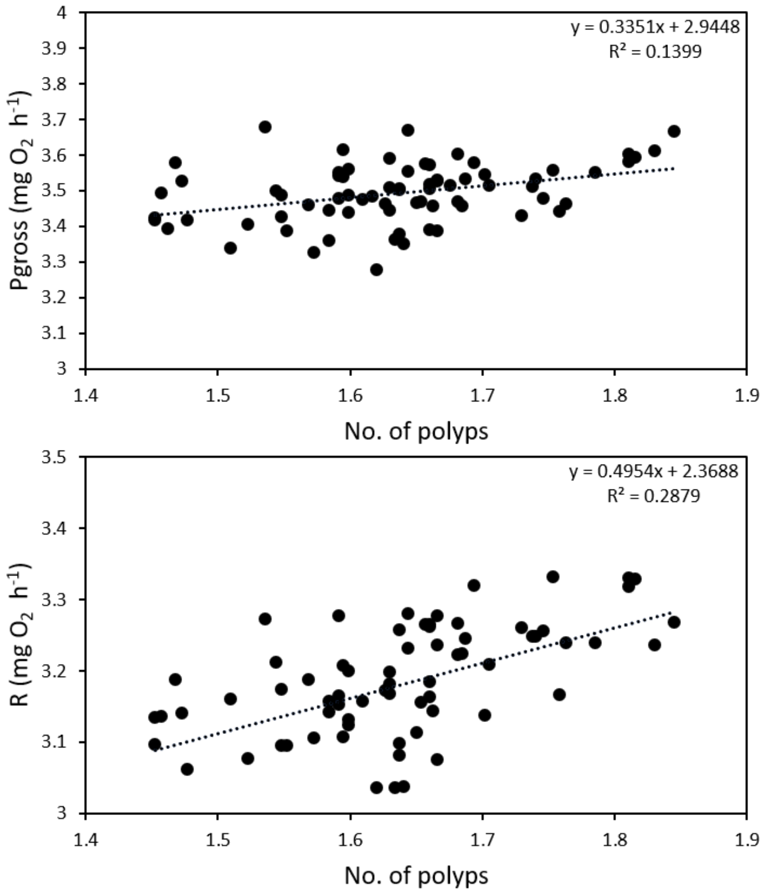

Figure S2. Correlation of log-transformed oxygen fluxes and number of polyps in *Xenia umbellata* colonies including all treatments.

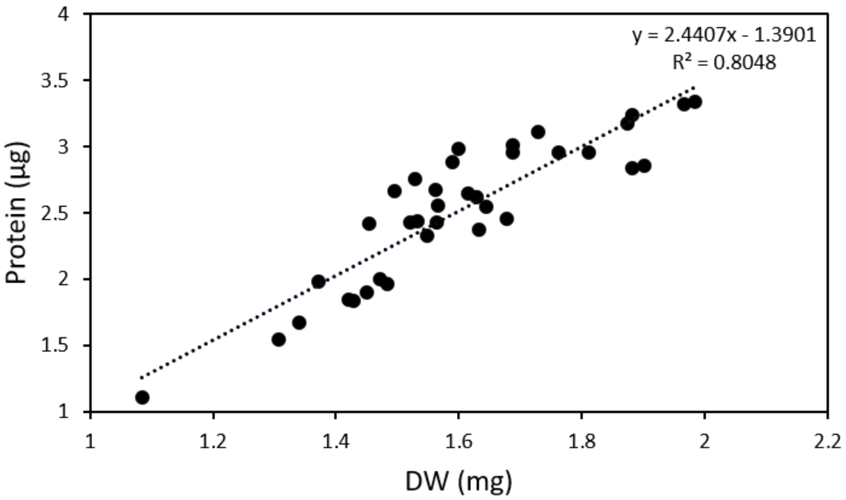

Figure S3. Correlation of log-transformed protein content and dry weight in *Xenia umbellata* colonies including all treatments.

Table S1. Experimental studies on effects of phosphate enrichment (PO_4) and temperature increase (Temp.) on hard corals in comparison to the present study. Only parameters similar to the ones measured in the present study were summarized. N = nitrogen source, P = phosphate source, P_{gross} = gross photosynthesis, P_{net} = net photosynthesis, R = dark respiration, P/R = photosynthesis to respiration ratio

Study	**Duration**	**Treatment**	**Coral species**	**Parameter**	**Effect**
EUTROPHICATION EXPERIMENTS					
Ferrier-Pagès et al. 2000 [1]	9 weeks	2 µM PO_4	*Stylophora pistillata*	growth	Decrease (- 60 %)
				P_{gross}	Increase (+ 100 %)
				R	Increase (+ 59 %)
				P/R	Increase (+ 47)
Koop et al. 2001 [2]	406 days	20 µM Ammonium and/or 4µM PO_4	*Stylophora pistillata*	P_{gross}	P: decrease (- 19 %) N+P: decrease (- 14 %)
				R	n.s.
Stambler et al. 1991 [3]	28 days	0.5 and 2 µM PO_4	*Pocillopora damicornis*	Protein	n.s.
Tanaka et al. 2017 [4]	2 months	Nitrate: 1.4-1.9 µM PO_4: 0.1 µM	*Montipora digitata*	Symbiont C content	N: n.s. N+P: Increase (+ 48 %)
				Symbiont N content	N: Increase (NA) N+P: Increase (NA)
				Host C + N content	n.s.
				Host and Symbiont δ13C	N: Decrease (Host: - 6 %, Symbiont: - 5 %) N+P: n.s.
Hoegh-Guldberg et al. 2004 [5]	406 days	20 µM Ammonium and/or 4µM PO_3^{2+}	*Heliofungia actiniformis*	Host δ15N	P: Decrease (- 68 %) N+P: Decrease (- 47 %)
				Symbiont δ15N	P: n.s. N+P: Decrease (- 55 %)
				δ13C	n.s.
			Pocillopora damicornis	Host δ15N	P: n.s. N+P: Decrease (- 55 %)
				Symbiont δ15N	P: n.s. N+P: Decrease (- 73 %)
				δ13C	n.s.
Silbiger et al. 2018 [6]	6 weeks	medium (3.6 µmol l^{-1} DIN + 1.08 µmol l^{-1} PO_4); high (7.61 µmol l^{-1} DIN + 2.6 µmol l^{-1} PO4)	*Porites compressa and Montipora caiptata*	R	Medium: Increase (+ 7 %) High: Increase (+ 51 %)
TEMPERATURE EXPERIMENTS					
Krueger et al. 2017 [7]	6 weeks	1-2 °C	*Stylophora pistillata*	P_{net}	Increase (+ 44 %)
				Protein	n.s.
Schlöder and D'Croz 2004 [8]	30 days	1 °C	*Pocillopora damicornis*	Protein	n.s.
			Porites lobata	Protein	n.s.
Gibbin et al. 2018 [9]	7 days	2.5 °C	*Pocillopora damicornis*	P_{gross}	n.s.
				R	n.s.
				Protein	n.s.
				δ13C	Warm-acclimated: increase in coral gastrodermis (14 %)
				δ15N	Warm-acclimated: decrease in coral gastrodermis (- 81 %)

Grover et al. 2011 [10]	10 days	3 °C and 7°C	*Stylophora pistillata*	Protein	3/7 °C: n.s.
				P_{gross}	3 °C: n.s. 7 °C: -200 %
				R	3/7 °C: n.s.
Rodrigues and Grottoli 2006 [11]	1 month	3 °C	*Montipora capitata*	δ13C (host)	n.s.
				δ13C (symbiont)	decrease (- 2 ‰)
				δ15N	n.s.
			Porites compressa	δ13C	n.s.
				δ15N	n.s.
Rodrigues and Grottoli 2007 [12]	1 month	3 °C	*Montipora capitata*	Protein	n.s.
				P_{gross}	Decrease (- 67 %)
				R	Decrease (- 45 %)
			Porites compressa	Protein	Decrease (- 36 %)
				P_{gross}	n.s.
				R	n.s.
Nyström et al. 2001 [13]	24 h	4 °C	*Porites cylindrica*	P_{gross}	Decrease (- 50 %)
				R	Decrease (- 57 %)
Bahr et al. 2018 [14]	1 day	4 °C	*Montipora capitata*	P_{net}	n.s.
				R	n.s.
				P/R	Decresase (- 23 %)
			Pocillopora damicornis	P_{net}	n.s.
				R	Increase (+ 40 %)
				P/R	Decrease (- 32 %)
			Leptastrea purpurea	P_{net}	Decrease (- 27 %)
				R	n.s.
				P/R	Decrease (- 39 %)
Hoadley et al. 2015 [15]	24 days	5 °C	*Acropora millepora*	Protein	Decrease (- 31 %)
				Fv/Fm	Decrease (- 14 %)
				P/R	n.s.
				R	n.s.
			Pocillopora damicornis	Protein	n.s.
				Fv/Fm	Decrease (- 10 %)
				P/R	n.s.
				R	Increased (+ 47 %)
			Montipora monasteriata	Protein	Decrease (- 28 %)
				Fv/Fm	Decrease (- 15 %)
				P/R	n.s.
				R	Increased (+ 62 %)
			Turbinaria reniformis	Protein	Increase (+ 83 %)
				Fv/Fm	n.s.
				P/R	n.s.
				R	Increased (+ 31 %)
Petrou et al. 2018 [16]	12 days	5 °C	*Acropora millepora*	Fv/Fm	Significant decrease from day 9 onwards (- 35 %)
Béraud et al. 2013 [17]	7 days	5 °C	*Turbinaria reniformis*	Protein	n.s.
				P_{gross}	- 100 %
				R	+ 64 %
				δ13C	n.s.
				δ15N	n.s.
Courtial et al. 2017 [18]	5 weeks	5 °C	*Pocillopora damicornis*	Protein	Decrease (- 60 %)
				P_{net}	n.s.
				R	n.s.
			Turbinaria reniformis	Protein	n.s.
				P_{net}	n.s.
				R	n.s.

Ferrier-Pagès et al. 2010 [19]	5 days	5 °C	*Stylophora pistillata*	Fv/Fm	Decrease (- 18 %)
				P_{gross}	Decrease (- 60 %)
				R	Decrease (- 33 %)
			Turbinaria reniformis	Fv/Fm	Decrease (- 11 %)
				P_{gross}	Decrease (- 75 %)
				R	Decrease (- 66 %)
			Galaxea fascicularis	Fv/Fm	Decrease (- 33 %)
				P_{gross}	Decrease (- 51 %)
				R	Decrease (- 33 %)
Baker et al. 2018 [20]	10 days	5 °C	*Orbicella faveolata (shallow samples)*	% C content	Host: Decrease (- 15 %) Symbiont: n.s.
				δ15N (host)	n.s.
				δ15N (symbiont)	Increase (+ 32 %)
				δ13C (host)	n.s.
				δ13C (symbiont)	Increase (+ 14 %)
Hoogenboom et al. 2012 [21]	10-13 days	6 °C	*Stylophora pistillata*	P_{gross} (unfed)	Decrease (- 47 %)
				P_{gross} (fed)	n.s.
				R	n.s.
			Turbinaria reniformis	P_{gross} (unfed)	Decrease (- 39 %)
				P_{gross} (fed)	n.s.
				R	n.s.
Grottoli et al. 2017 [22]	37 days	6 °C	*Stylophora pistillata*	Protein	n.s.
				δ13C (host)	Increase (+ 2 ‰)
			Pocillopora damicornis	Protein	n.s.
				δ13C (host)	n.s.
			Favia favus	Protein	Decrease (- 48 %)
				δ13C (host)	Increase (+ 2 ‰)
COMBINED EXPERIMENTS					
Hall et al. 2018 [23]	30 days	5 °C Nutrients: nitrate+nitrite (1µM)+PO_4 (0.0625 µM)	*Stylophora pistillata*	Fv/Fm	Temp.: decrease (NA) Nutrients: n.s. Comb.: n.s.
				P_{net}	Temp.: n.s. Nutrients: decrease (- 34 %) Comb.: n.s.
				R	n.s.
				Protein	Temp.: n.s. Nutrients: decrease (- 24 %) Comb.: n.s.
Ezzat et al. 2016 [24]	4 weeks eutrophication, 10 days warming	DIP: 2µM Temp.: 5 °C	*Pocillopora damicornis*	R	DIP: - 50 % Temp.: + 25 % Comb.: + 44 %
				P_{gross}	DIP: n.s. Temp.: - 50 % Comb.: - 50 %
Present study	5 weeks, Temp.: 3 weeks	PO_4: 1,2,8 µM Temp.: 6 °C	*Xenia umbellata*	P_{gross}	n.s.
				R	n.s.
				P/R	n.s.
				Protein	Temp.: decrease (- 62 %)
				δ13C	Temp.: Decrease (- 6.9 %)
				δ15N	Temp.: Decrease (- 10 %)

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