Supplement of Biogeosciences, 15, 1029–1045, 2018
https://doi.org/10.5194/bg-15-1029-2018-supplement

Biogeosciences Open Access EGU

Supplement of

Simultaneous shifts in elemental stoichiometry and fatty acids of *Emiliania huxleyi* in response to environmental changes

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Table S1. Measured dissolved inorganic carbon (DIC) and total alkalinity (TA), and calculated pCO_2 (mean ± SE) at the end of the experiments in the cultures of *Emiliania huxleyi*. N:P: N:P supply ratios. Outliers in the data of pCO_2 were excluded in the table.

Treatment			DIC ($\mu mol\ kg^{-1}$)	TA ($\mu mol\ kg^{-1}$)	pCO_2 (μatm)
12 °C	Low pCO_2	N:P = 10:1	1302 ± 54	1269 ± 57	1509 ± 35
		N:P = 24:1	1328 ± 18	1292 ± 27	1564 ± 149
		N:P = 63:1	1374 ± 25	1349 ± 24	1412 ± 21
	High pCO_2	N:P = 10:1	1956 ± 46	1962 ± 50	1357 ± 14
		N:P = 24:1	2042 ± 17	2053 ± 17	1357 ± 76
		N:P = 63:1	1829 ± 22	1801 ± 49	1041 ± 191
18 °C	Low pCO_2	N:P = 10:1	763 ± 15	793 ± 4	552 ± 118
		N:P = 24:1	885 ± 6	922 ± 12	567 ± 84
		N:P = 63:1	1065 ± 3	1108 ± 8	633 ± 44
	High pCO_2	N:P = 10:1	1415 ± 154	1454 ± 121	1113 ± 489
		N:P = 24:1	1278 ± 13	1196 ± 18	2944 ± 330
		N:P = 63:1	1613 ± 35	1620 ± 32	1507 ± 332
24 °C	Low pCO_2	N:P = 10:1	785 ± 13	808 ± 10	845 ± 256
		N:P = 24:1	809 ± 10	682 ± 11	-
		N:P = 63:1	1243 ± 16	1231 ± 10	1734 ± 163
	High pCO_2	N:P = 10:1	1266 ± 22	1240 ± 20	2079 ± 406
		N:P = 24:1	1596 ± 63	1691 ± 36	1163 ± 190
		N:P = 63:1	1616 ± 27	1550 ± 34	3295 ± 171

Table S2. Results of Akaike information criterion corrected (AICc) in GLMMs for the observed maximal growth rate (μ_{max}), elemental stoichiometry and fatty acid proportions and contents in response to temperature, N:P supply ratios and pCO_2 in *Emiliania huxleyi*. The selected models are shown in bold, the results of which are shown in Table 1. POC: particulate organic carbon; PON: particulate organic nitrogen; POP: particulate organic phosphorus; PIC: particulate inorganic carbon; TFAs: total fatty acids; SFA: saturated fatty acid; MUFA: monounsaturated fatty acid; PUFA: polyunsaturated fatty acid; DHA: docosahexaenoic acid. Effect builder of main: models containing first order effects of the three factors; effect builder of main, two way: models containing first order effects and second order interactions of the three factors; effect builder of main, two way and three way: models containing first order effects, second and third order interactions of the three factors.

Variable	Effect builder	AICc
μ_{max}	Main, two way and three way	23.856
	Main, two way	18.473
	Main	**5.471**
POC (pg cell^{-1})	Main, two way and three way	336.081
	Main, two way	**333.586**
	Main	339.852
POC (μg ml^{-1})	Main, two way and three way	304.408
	Main, two way	280.234
	Main	**235.488**
POC production (pg cell^{-1} d^{-1})	Main, two way and three way	88.022
	Main, two way	59.365
	Main	**5.219**
PON (pg cell^{-1})	Main, two way and three way	125.664
	Main, two way	**123.586**
	Main	125.405
POP (pg cell^{-1})	Main, two way and three way	-139.184
	Main, two way	**-140.161**

	Main	-136.986
PIC (pg cell^{-1})	Main, two way and three way	285.804
	Main, two way	**284.025**
	Main	299.364
PIC (μg ml^{-1})	Main, two way and three way	300.200
	Main, two way	276.029
	Main	**231.545**
PIC production (pg cell^{-1} d^{-1})	Main, two way and three way	92.222
	Main, two way	64.188
	Main	**9.065**
POC:PON (mol mol^{-1})	Main, two way and three way	220.755
	Main, two way	218.755
	Main	**213.130**
POC:POP (mmol mol^{-1})	Main, two way and three way	613.955
	Main, two way	611.731
	Main	**606.395**
PON:POP (mol mol^{-1})	Main, two way and three way	362.508
	Main, two way	359.671
	Main	**356.018**
PIC:POC	Main, two way and three way	56.147
	Main, two way	26.690
	Main	**-36.148**
SFA proportion (% of TFAs)	Main, two way and three way	304.845
	Main, two way	**302.115**
	Main	304.984
MUFA proportion (% of TFAs)	Main, two way and three way	300.697
	Main, two way	278.543
	Main	**264.319**
PUFA proportion (% of TFAs)	Main, two way and three way	359.132
	Main, two way	336.555
	Main	**318.057**
DHA proportion (% of TFAs)	Main, two way and three way	304.197
	Main, two way	**301.625**
	Main	310.200
TFA content (μg mg^{-1} C^{-1})	Main, two way and three way	554.949
	Main, two way	536.499
	Main	**512.664**
SFA content (μg mg^{-1} C^{-1})	Main, two way and three way	437.382
	Main, two way	416.262
	Main	**393.592**
MUFA content (μg mg^{-1} C^{-1})	Main, two way and three way	421.162
	Main, two way	400.009

	Main	**374.298**
PUFA content (μg mg^{-1} C^{-1})	Main, two way and three way	485.817
	Main, two way	465.876
	Main	**432.787**
DHA content (μg mg^{-1} C^{-1})	Main, two way and three way	449.256
	Main, two way	428.583
	Main	**391.542**

Table S3. The nature (synergism or antagonism) and magnitude (the difference between observed combined effect and predicted additive effect) of the observed interactive effects of warming, N and P deficiency (-N and -P), and enhanced pCO_2 (HCO_2) on cellular contents of particulate organic carbon (POC), particulate organic nitrogen (PON), particulate organic phosphorus (POP) and particulate inorganic carbon (PIC), and proportions of saturated fatty acids (SFAs), and docosahexaenoic acid (DHA) in *Emiliania huxleyi*. TFAs: total fatty acids.

		Interaction		
Variable	Treatment	Nature	Magnitude ± SE	*n*
POC (pg cell^{-1})	Warming × -N	Synergism	19.056 ± 0.392	12
	Warming × -P	Synergism	39.644 ± 2.854	12
PON (pg cell^{-1})	Warming × -N	Synergism	0.948 ± 0.039	12
	Warming × -P	Synergism	3.586 ± 0.327	12
POP (pg cell^{-1})	Warming × -N	Synergism	0.154 ± 0.004	12
	Warming × -P	Synergism	0.237 ± 0.019	12
	Warming × HCO_2	Synergism	0.315 ± 0.023	18
PIC (pg cell^{-1})	Warming × -N	Antagonism	-2.010 ± 0.524	12
	Warming × -P	Synergism	9.511 ± 2.264	12
	Warming × HCO_2	Synergism	17.640 ± 1.495	18
SFAs (% of TFAs)	-N × HCO_2	Synergism	28.746 ± 1.070	9
	-P × HCO_2	Synergism	24.096 ± 0.840	9
DHA (% of TFAs)	Warming × -N	Synergism	4.622 ± 0.873	12
	Warming × -P	Synergism	4.316 ± 0.671	12
	Warming × HCO_2	Synergism	5.013 ±0.912	18

Table S4. Fatty acid profiles of *Emiliania huxleyi* under three temperatures (12, 18 and 24 °C), three N:P supply ratios (molar ratios 10:1, 24:1 and 63:1) and two pCO_2 levels (560 and 2400 μatm). Data are expressed as fatty acid contents (μg mg C^{-1}) and percentages of total fatty acids (% of TFAs) (mean ± SE). SFAs, saturated fatty acids; MUFAs, monounsaturated fatty acids; PUFAs, polyunsaturated fatty acids; TFAs, total fatty acids.

	12 °C											
	Low pCO_2						High pCO_2					
	N:P = 10:1		N:P = 24:1		N:P = 63:1		N:P = 10:1		N:P = 24:1		N:P = 63:1	
	Content	%	Content	%	Content	%	Content	%	Content	%	Content	%
14:0	31 ±1	19 ±1	26 ±4	20 ±0	23 ±3	16 ±1	22 ±0	17 ±1	24 ±1	20 ±2	12 ±0	15 ±0
16:0	11 ±0	7 ±0	10 ±2	7 ±0	9 ±2	6 ±0	11 ±2	8 ±0	9 ±2	8 ±1	4 ±0	5 ±0
16:1n-7	1 ±0	1 ±0	1 ±0	1 ±0	2 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0
18:0	3 ±0	2 ±0	4 ±1	3 ±0	6 ±2	4 ±1	6 ±2	4 ±1	4 ±2	3 ±1	2 ±0	2 ±0
18:1n-9	33 ±1	20 ±0	27 ±4	20 ±0	25 ±3	17 ±1	23 ±1	18 ±1	22 ±2	19 ±0	11 ±0	13 ±0
18:1n-7	6 ±0	3 ±0	5 ±1	4 ±0	7 ±1	5 ±0	5 ±0	4 ±0	5 ±0	4 ±0	4 ±0	4 ±0
18:2n-6	9 ±0	5 ±0	7 ±1	6 ±0	5 ±1	4 ±0	5 ±0	4 ±0	5 ±1	5 ±0	2 ±0	3 ±0
18:3n-6	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0
18:3n-3	11 ±1	7 ±0	8 ±1	6 ±0	10 ±2	7 ±0	9 ±1	7 ±0	7 ±1	6 ±0	6 ±0	7 ±0
18:4n-3	7 ±0	4 ±0	5 ±1	4 ±0	6 ±1	4 ±0	6 ±1	4 ±0	5 ±1	4 ±0	4 ±0	5 ±0
20:2n-6	1 ±0	0 ±0	0 ±0	0 ±0	1 ±0	1 ±0	1 ±0	0 ±0	0 ±0	0 ±0	1 ±0	1 ±0
20:3n-6	0 ±0	0 ±0	1 ±0	0 ±0	1 ±0	1 ±0	0 ±0	0 ±0	1 ±1	1 ±0	0 ±0	0 ±0
22:0	1 ±0	1 ±0	1 ±0	1 ±0	2 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	0 ±0	1 ±0

20:5n-3	2 ±0	1 ±0	1 ±0	1 ±0	2 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0
23:0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	1 ±1	1 ±0	0 ±0	0 ±0	0 ±0	0 ±0
24:0	1 ±0	0 ±0	0 ±0	0 ±0	1 ±0	0 ±0	1 ±0	1 ±0	0 ±0	0 ±0	0 ±0	0 ±0
22:5n-3, 24:1n-9	1 ±0	1 ±0	1 ±0	1 ±0	2 ±1	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0
22:6n-3	29 ±2	18 ±1	23 ±4	17 ±1	33 ±7	22 ±2	26 ±3	20 ±1	20 ±3	17 ±1	22 ±1	27 ±0
Unidentified	14 ±1	9 ±0	10 ±2	7 ±0	12 ±3	8 ±1	10 ±1	7 ±0	9 ±1	7 ±0	10 ±0	12 ±0
∑SFAs[a]	47 ±0	29 ±1	43 ±7	32 ±1	41 ±6	28 ±1	41 ±5	32 ±1	38 ±5	32 ±1	20 ±1	24 ±1
∑MUFAs[b]	41 ±1	26 ±0	35 ±5	26 ±0	35 ±4	25 ±1	30 ±1	23 ±1	30 ±4	25 ±1	16 ±0	20 ±0
∑PUFAs[c]	59 ±4	37 ±1	47 ±8	35 ±1	58 ±11	39 ±1	49 ±5	38 ±1	41 ±5	35 ±1	36 ±1	44 ±1
∑TFAs[d]	162 ±5		134 ±22		146 ±24		130 ±12		118 ±14		82 ±2	

[a] also includes 20:0 present at < 0.5% of TFAs in all treatments. [b] also includes 14:1, 20:1n-9 and 22:1n-9 present at < 0.5% of TFAs in all treatments. [c] also includes 16:3n-4, 20:4n-6, 20:3n-3, 20:4n-3, 22:2n-6 present at < 0.5% of TFAs in all treatments. [d] also includes the unidentified FA component.

79 Table S4. Continued.

	18 °C											
	Low pCO_2						High pCO_2					
	N:P = 10:1		N:P = 24:1		N:P = 63:1		N:P = 10:1		N:P = 24:1		N:P = 63:1	
	Content	%	Content	%	Content	%	Content	%	Content	%	Content	%
14:0	27 ±2	18 ±1	17 ±0	17 ±0	21 ±0	15 ±1	32 ±3	18 ±1	20 ±3	18 ±1	16 ±0	16 ±0
16:0	9 ±0	6 ±0	5 ±0	5±0	7 ±0	5 ±0	12 ±1	7 ±0	8 ±2	7 ±0	6 ±0	6 ±0
16:1n-7	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0
18:0	2 ±0	2 ±0	1 ±0	1 ±0	2 ±0	2 ±0	3 ±0	2 ±0	3 ±1	3 ±0	2 ±0	2 ±0
18:1n-9	23 ±1	15 ±0	12 ±0	13 ±0	16 ±0	11 ±0	31 ±2	17 ±1	17 ±3	16 ±1	15 ±0	15 ±0
18:1n-7	6 ±0	4 ±0	3 ±0	3 ±0	6 ±0	4 ±0	6 ±0	4 ±0	4 ±1	4 ±0	4 ±0	4 ±0
18:2n-6	4 ±0	3 ±0	3 ±0	3 ±0	3 ±0	2 ±0	5 ±0	3 ±0	4 ±1	4 ±0	3 ±0	2 ±0
18:3n-6	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0
18:3n-3	10 ±0	7 ±0	8 ±0	8 ±0	10 ±0	7 ±0	12 ±0	7 ±0	7 ±1	6 ±0	8 ±0	8 ±0
18:4n-3	10 ±0	7 ±0	8 ±0	8 ±0	10 ±0	7 ±0	10 ±1	6 ±0	7 ±1	6 ±0	6 ±0	6 ±0
20:2n-6	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	1 ±0	1 ±0
20:3n-6	0 ±0	0 ±0	0 ±0	0 ±0	1 ±0	0 ±0	0 ±0	0 ±0	1 ±0	1 ±0	0 ±0	0 ±0
22:0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0
20:5n-3	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0
23:0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0
24:0	1 ±0	0 ±0	1 ±0	1 ±0	0 ±0	0 ±0	1 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0
22:5n-3, 24:1n-9	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	2 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0
22:6n-3	40 ±2	26 ±1	25 ±1	26 ±0	40 ±3	29 ±1	42 ±1	25 ±1	25 ±5	23 ±2	27 ±1	26 ±1
Unidentified	13 ±1	9 ±0	11 ±0	11 ±0	16 ±1	12 ±0	13 ±0	8 ±0	9 ±2	8 ±0	10 ±0	10 ±0

∑SFAs[a]	41 ±2	27 ±1	24 ±1	25 ±0	32 ±0	23 ±1	49 ±4	28 ±1	33 ±5	29 ±1	26 ±1	25 ±1
∑MUFAs[b]	32 ±1	21 ±0	17 ±0	18 ±0	25 ±1	18 ±0	40 ±2	23 ±0	24 ±4	22 ±1	22 ±0	22 ±0
∑PUFAs[c]	67 ±2	44 ±1	45 ±1	47 ±0	67 ±4	48 ±1	73 ±0	42 ±2	46 ±9	41 ±2	45 ±1	44 ±1
∑TFAs[d]	153 ±6		97 ±3		140 ±5		176 ±7		112 ±19		103 ±0	

100 Table S4. Continued.

	24 °C											
	Low pCO_2						High pCO_2					
	N:P = 10:1		N:P = 24:1		N:P = 63:1		N:P = 10:1		N:P = 24:1		N:P = 63:1	
	Content	%	Content	%	Content	%	Content	%	Content	%	Content	%
14:0	17 ±0	17 ±0	15 ±0	18 ±1	23 ±3	18 ±1	18 ±0	19 ±1	7 ±2	16 ±1	12 ±1	14 ±0
16:0	7 ±0	7 ±0	6 ±1	7 ±0	10 ±1	8 ±1	8 ±0	8 ±1	4 ±1	10 ±1	7 ±1	8 ±0
16:1n-7	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0
18:0	2 ±0	2 ±0	2 ±1	3 ±1	4 ±1	3 ±1	2 ±0	2 ±1	3 ±0	7 ±1	3 ±1	4 ±1
18:1n-9	11 ±0	11 ±0	7 ±0	8 ±0	11 ±1	8 ±0	12 ±0	13 ±0	5 ±1	11 ±1	8 ±0	10 ±0
18:1n-7	4 ±0	3 ±0	3 ±0	3 ±0	8 ±1	7 ±0	4 ±0	4 ±0	2 ±1	5 ±0	7 ±0	8 ±0
18:2n-6	3 ±0	3 ±0	4 ±0	5 ±0	5 ±0	4 ±0	3 ±0	3 ±0	2 ±1	4 ±0	3 ±0	4 ±0
18:3n-6	0 ±0	0 ±0	1 ±0	1 ±0	1 ±0	0 ±0	0 ±0	0 ±0	1 ±0	2 ±1	0 ±0	0 ±0
18:3n-3	6 ±0	6 ±0	4 ±0	6 ±0	6 ±1	5 ±0	5 ±0	5 ±0	2 ±1	4 ±0	4 ±0	5 ±0
18:4n-3	10 ±1	10 ±1	10 ±1	12 ±0	11 ±1	9 ±0	8 ±1	9 ±0	4 ±1	8 ±1	7 ±1	8 ±0
20:2n-6	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0
20:3n-6	0 ±0	0 ±0	1 ±0	1 ±0	1 ±0	1 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0
22:0	1 ±0	1 ±0	0 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	2 ±1	1 ±0	1 ±0
20:5n-3	1 ±0	1 ±0	0 ±0	0 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	2 ±0	0 ±0	1 ±0
23:0	0 ±0	0 ±0	1 ±0	1 ±0	0 ±0	0 ±0	0 ±0	1 ±0	1 ±0	2 ±1	0 ±0	0 ±0
24:0	0 ±0	0 ±0	1 ±0	1 ±0	1 ±0	1 ±0	0 ±0	0 ±0	1 ±0	2 ±1	1 ±0	1 ±0
22:5n-3, 24:1n-9	1 ±0	1 ±0	0 ±0	1 ±0	1 ±0	1 ±0	1 ±0	1 ±0	0 ±0	0 ±0	1 ±0	1 ±0
22:6n-3	30 ±1	30 ±0	21 ±2	26 ±1	31 ±4	25 ±1	23 ±4	25 ±2	8 ±3	17 ±3	21 ±1	25 ±1
Unidentified	6 ±0	6 ±0	4 ±0	5 ±0	9 ±1	7 ±0	5 ±1	5 ±0	2 ±1	4 ±0	6 ±0	7 ±0

∑SFAs[a]	27 ±1	27 ±0	25 ±2	30 ±1	39 ±3	31 ±2	30 ±0	32 ±2	16 ±2	39 ±4	24 ±2	29 ±1
∑MUFAs[b]	16 ±0	16 ±0	11 ±1	13 ±0	21 ±2	17 ±0	17 ±1	19 ±0	8 ±2	18 ±1	17 ±1	21 ±1
∑PUFAs[c]	51 ±1	51 ±0	42 ±4	51 ±1	56 ±7	45 ±1	41 ±5	44 ±2	17 ±5	39 ±3	36 ±2	43 ±0
∑TFAs[d]	100 ±1		81 ±7		125 ±12		93 ±6		42 ±9		82 ±5	

Table S5. Results of the selected GLMMs testing for the effects of temperature, N:P supply ratios and pCO_2 on population yield and production of particulate organic carbon (POC) and particulate inorganic carbon (PIC), and fatty acid contents in *Emiliania huxleyi*. Significant *p* values are shown in bold. T: temperature; N:P: N:P supply ratio; TFA: total fatty acid; MUFA: monounsaturated fatty acid; PUFA: polyunsaturated fatty acid; DHA: docosahexaenoic acid.

Variable	Factor	Coefficienct ± SE	*t*	*p*
POC population yield (μg ml^{-1})	Intercept	13.456 ± 1.007	13.360	**<0.001**
	T	-0.096 ± 0.047	-2.045	**0.046**
	pCO_2	<0.001 ± <0.001	-0.361	0.719
	N:P	-0.035 ± 0.010	-3.436	**0.001**
POC production (pg $cell^{-1}$ d^{-1})	Intercept	-0.261 ± 0.101	-2.587	**0.013**
	T	0.023 ± 0.005	4.895	**<0.001**
	pCO_2	<0.001 ± <0.001	1.631	0.109
	N:P	0.007 ± 0.001	6.899	**<0.001**
PIC population yield (μg ml^{-1})	Intercept	6.922 ± 0.968	7.149	**<0.001**
	T	0.201 ± 0.045	4.442	**<0.001**
	pCO_2	-0.002 ± <0.001	-8.955	**<0.001**
	N:P	-0.034 ± 0.010	-3.404	**0.001**
PIC production (pg $cell^{-1}$ d^{-1})	Intercept	-0.689 ± 0.105	-6.581	**<0.001**
	T	0.047 ± 0.005	9.589	**<0.001**
	pCO_2	<0.001 ± <0.001	-5.294	**<0.001**
	N:P	0.007 ± 0.001	6.339	**<0.001**
TFA content (μg mg^{-1} C^{-1})	Intercept	202.099 ± 17.745	11.389	**<0.001**
	T	-3.444 ± 0.827	-4.164	**<0.001**
	pCO_2	-0.014 ± 0.004	-3.038	**0.004**
	N:P	-0.188 ± 0.182	-1.033	0.307
SFA content (μg mg^{-1} C^{-1})	Intercept	58.540 ± 5.265	11.119	**<0.001**
	T	-0.978 ± 0.245	-3.986	**<0.001**
	pCO_2	-0.003 ± 0.001	-2.240	**0.030**
	N:P	-0.118 ± 0.054	-2.182	**0.034**
MUFA content (μg mg^{-1} C^{-1})	Intercept	53.910 ± 4.324	12.468	**<0.001**
	T	-1.361 ± 0.202	-6.755	**<0.001**
	pCO_2	-0.002 ± 0.001	-1.882	0.066
	N:P	-0.074 ± 0.044	-1.675	0.100
PUFA content (μg mg^{-1} C^{-1})	Intercept	71.361 ± 7.854	9.086	**<0.001**

	T	-0.664 ± 0.366	-1.813	0.076
	pCO_2	-0.007 ± 0.002	-3.626	**0.001**
	N:P	-0.024 ± 0.081	-0.292	0.772
DHA content (µg mg^{-1} C^{-1})	Intercept	36.201 ± 5.156	7.021	**<0.001**
	T	-0.248 ± 0.240	-1.031	0.308
	pCO_2	-0.004 ± 0.001	-3.034	**0.004**
	N:P	0.021 ± 0.053	0.392	0.697

Table S6. The changes in cellular elemental contents (as pg $cell^{-1}$), population yield and production of particulate organic carbon (POC) and particulate inorganic carbon (PIC) (as μg ml^{-1} and pg $cell^{-1}$ d^{-1}, respectively), elemental molar ratios, and the proportions and contents of major fatty acid groups and docosahexaenoic acid (DHA) (as % of total fatty acids and μg mg C^{-1}, respectively) in response to warming, N and P deficiency and enhanced pCO_2 in *Emiliania huxleyi*. Here, only significant changes are shown based on GLMM results in Table 1 and Table S5. Red and blue arrows indicate a mean percent increase and decrease in a given response, respectively. SFAs, saturated fatty acids; MUFAs, monounsaturated fatty acids; PUFAs, polyunsaturated fatty acids.

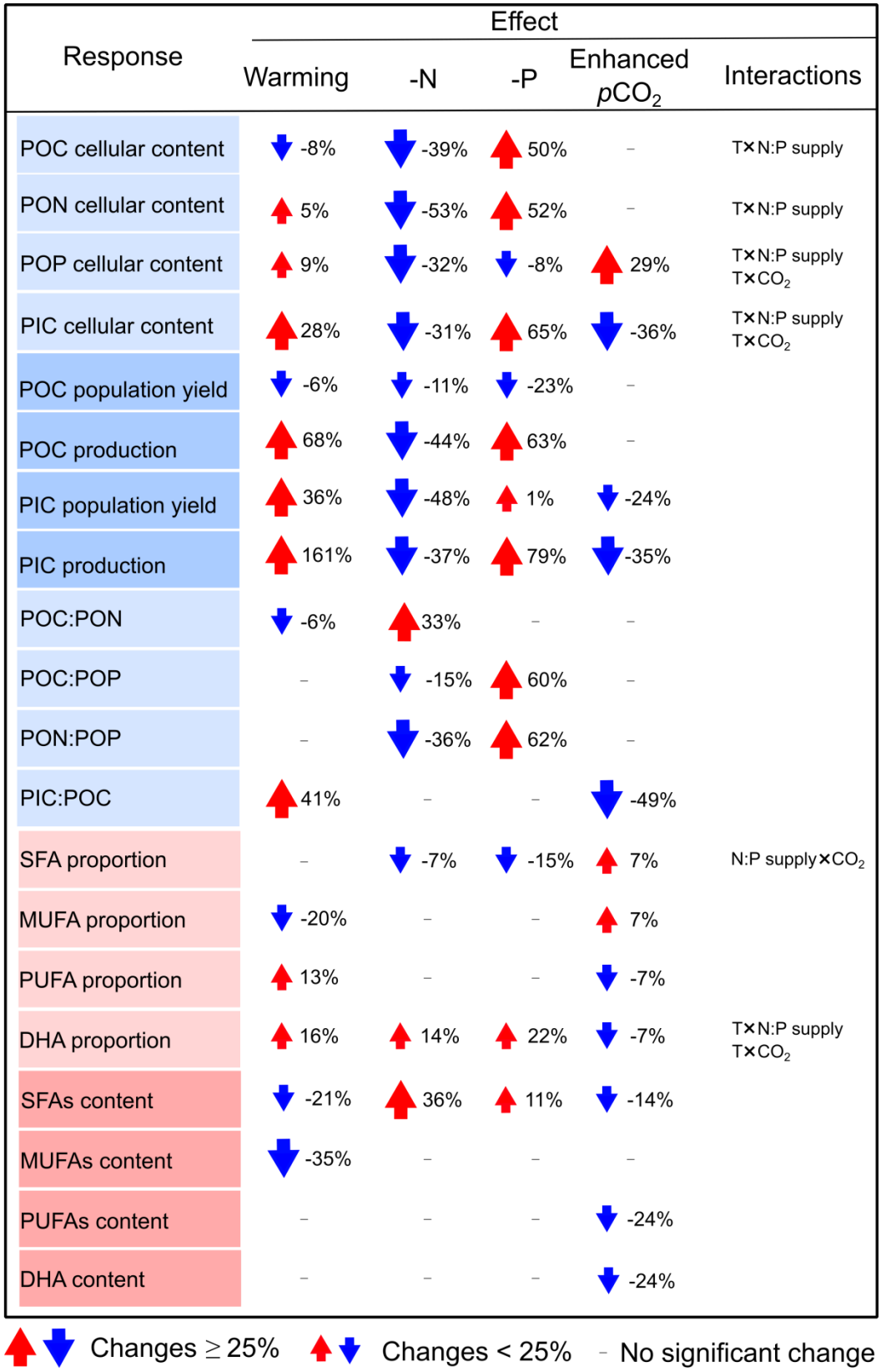
Response
Effect
Warming
-N
-P
Enhanced pCO_2
Interactions
POC cellular content
-8%
-39%
50%
–
T×N:P supply
PON cellular content
5%
-53%
52%
–
T×N:P supply
POP cellular content
9%
-32%
-8%
29%
T×N:P supply
T×CO_2
PIC cellular content
28%
-31%
65%
-36%
T×N:P supply
T×CO_2
POC population yield
-6%
-11%
-23%
–
POC production
68%
-44%
63%
–
PIC population yield
36%
-48%
1%
-24%
PIC production
161%
-37%
79%
-35%
POC:PON
-6%
33%
–
–
POC:POP
–
-15%
60%
–
PON:POP
–
-36%
62%
–
PIC:POC
41%
–
–
-49%
SFA proportion
–
-7%
-15%
7%
N:P supply×CO_2
MUFA proportion
-20%
–
–
7%
PUFA proportion
13%
–
–
-7%
DHA proportion
16%
14%
22%
-7%
T×N:P supply
T×CO_2
SFAs content
-21%
36%
11%
-14%
MUFAs content
-35%
–
–
–
PUFAs content
–
–
–
-24%
DHA content
–
–
–
-24%
Changes ≥ 25%
Changes < 25%
– No significant change

Fig. S1

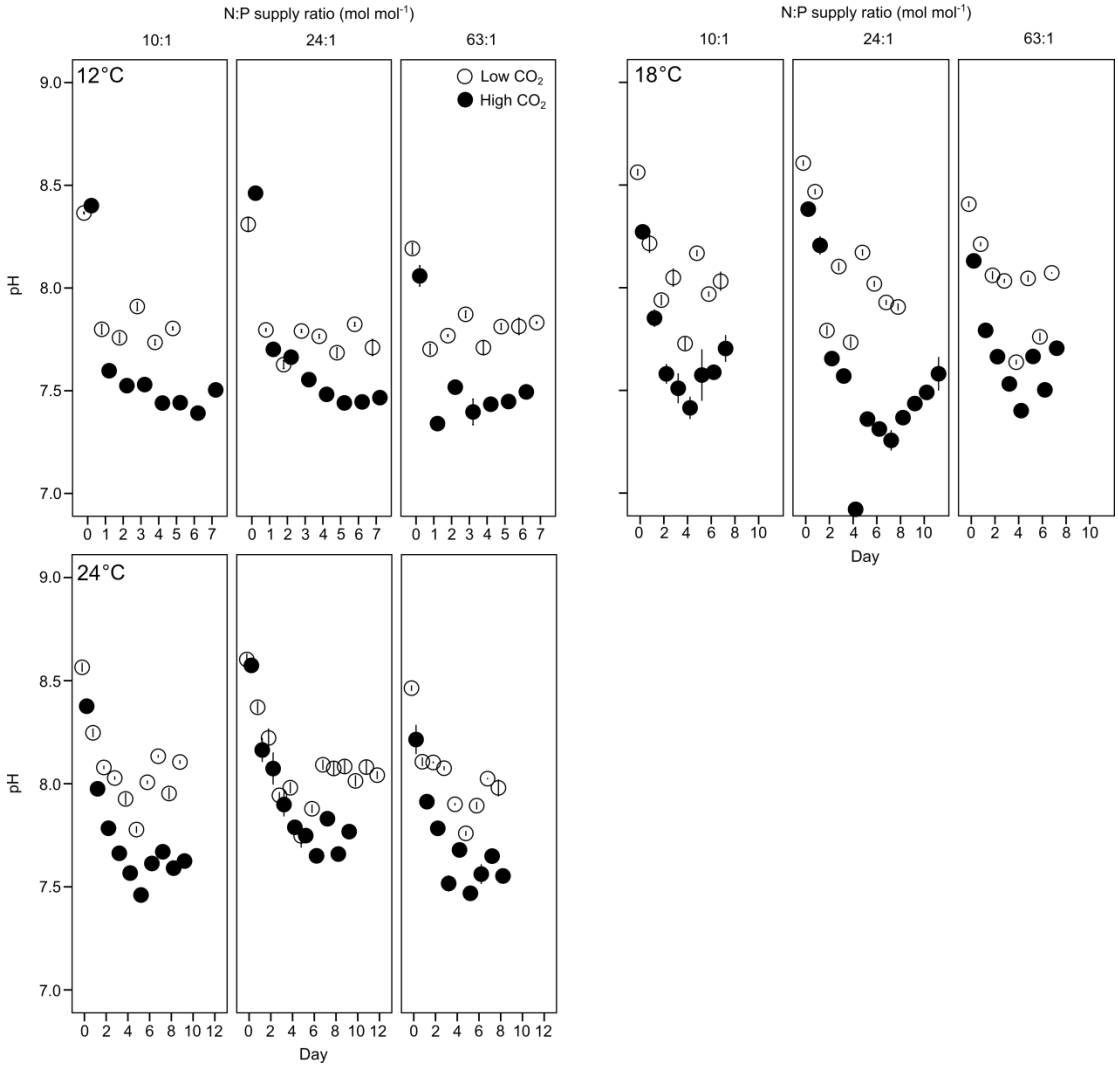

Fig. S1 Time course of pH (mean ± SE) under three temperature, three N:P supply ratios and two target pCO_2 levels (low CO_2: 560 μatm; high CO_2: 2400 μatm) in the semi-continuous cultures of *Emiliania huxleyi*.

Fig. S2

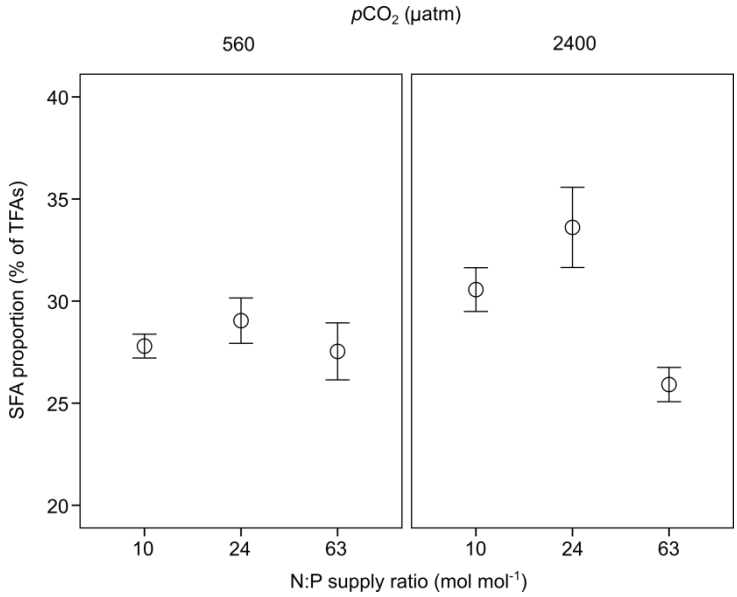

Fig. S2 Responses of the proportion of saturated fatty acids (SFAs) (mean ± SE) to N:P supply ratios and pCO_2 in *Emiliania huxleyi*.

Fig. S3

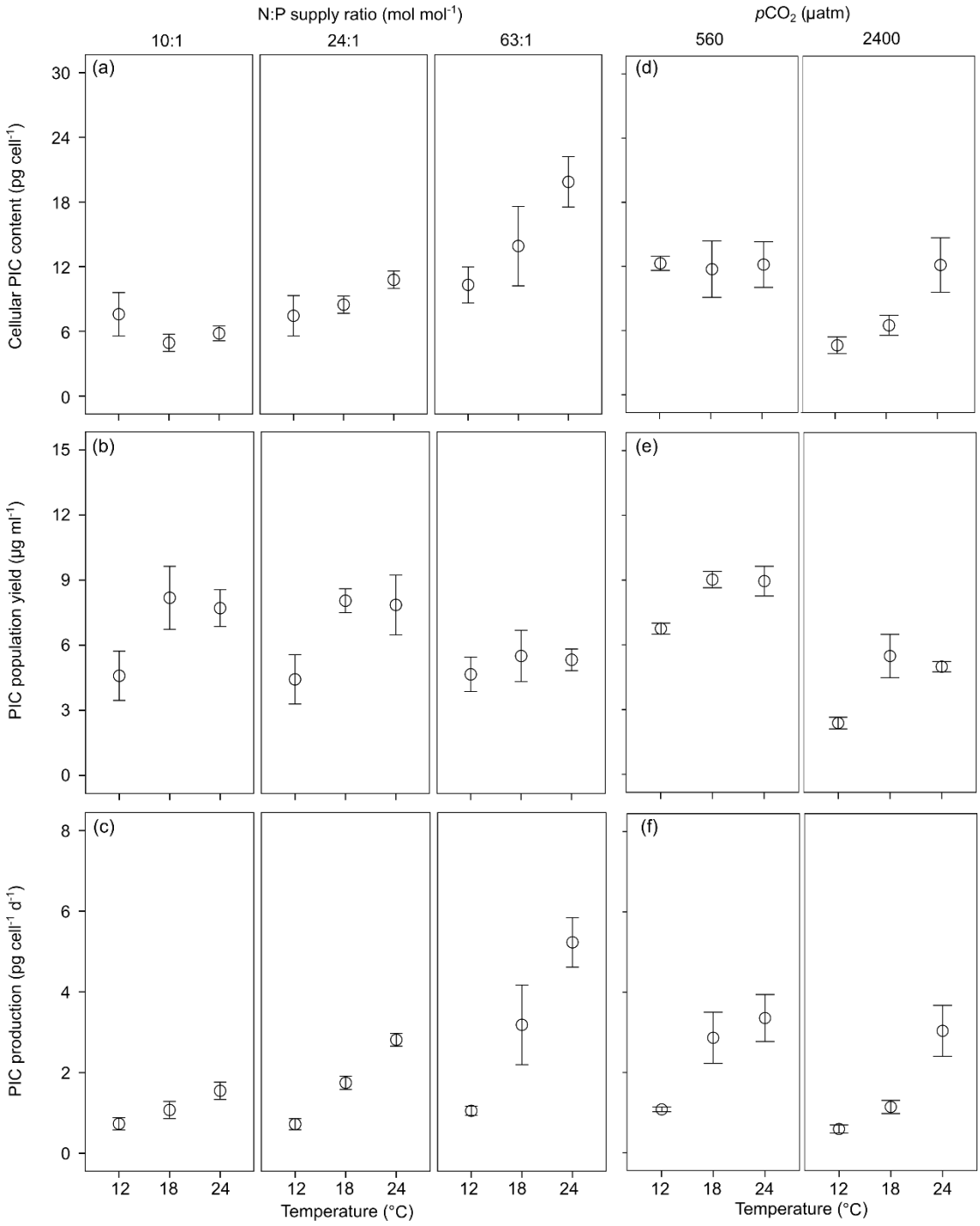

Fig. S3 Responses of (a, d) cellular contents of particulate inorganic carbon (PIC), (b, e) PIC population yield (µg ml^{-1}) and (c, f) PIC production (pg $cell^{-1}$ d^{-1}) (mean ± SE) to temperature, N:P supply ratios and pCO_2 in *Emiliania huxleyi*. For cellular PIC content, the selected model contains the first order effects and second order interactions of the three environmental factors, while those for PIC population yield and production contain only the first order effects. The results of AICc are shown in Table S2.

Fig. S4

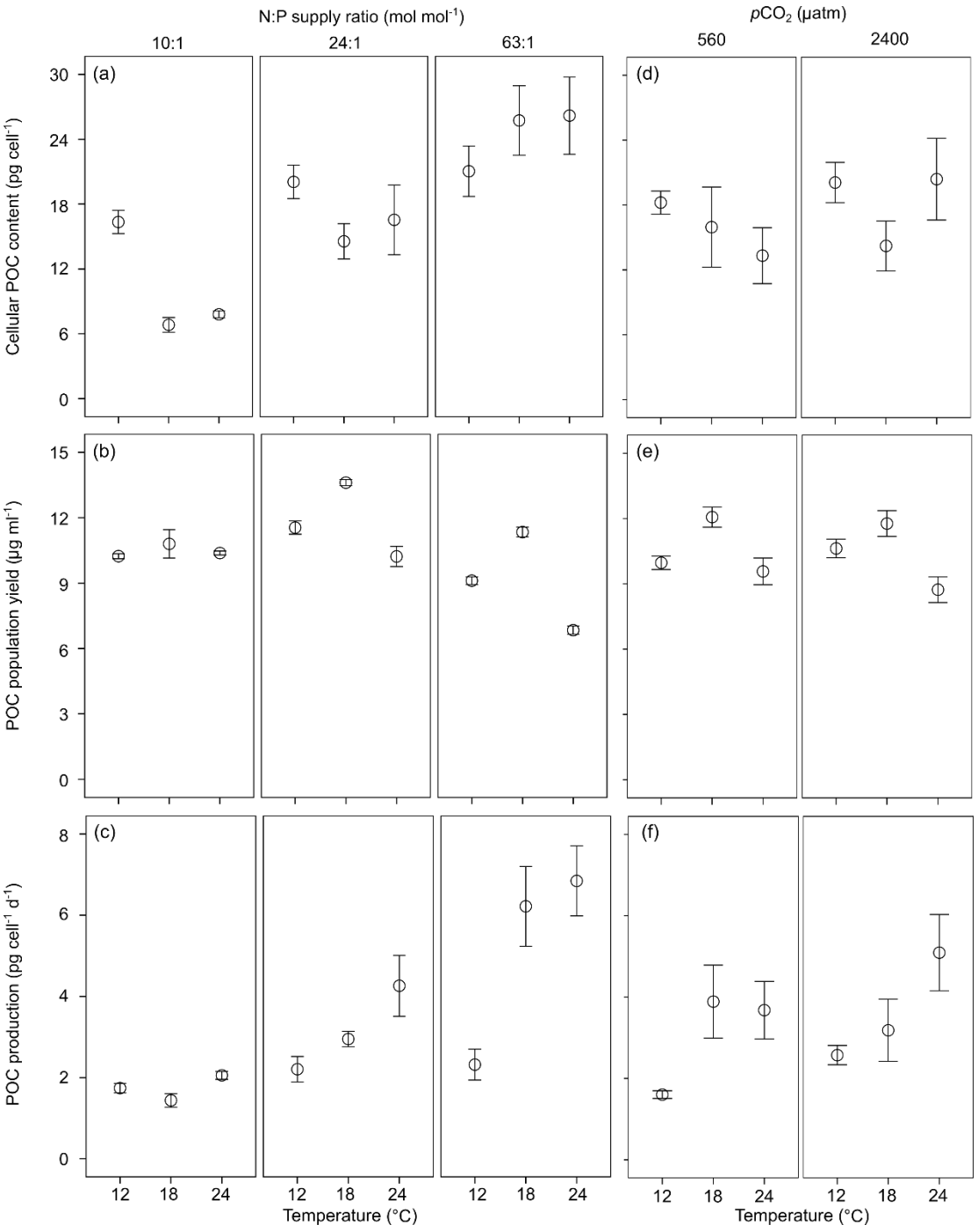

Fig. S4 Responses of (a, d) cellular contents of particulate organic carbon (POC), (b, e) POC population yield and (c, f) POC production (mean ± SE) to temperature, N:P supply ratios and pCO_2 in *Emiliania huxleyi*. For cellular POC content, the selected model contains the first order effects and second order interactions of the three environmental factors, while those for POC population yield and production contain only the first order effects. The results of AICc are shown in Table S2.