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Supplement of

Ocean-related global change alters lipid biomarker production in common marine phytoplankton

Rong Bi et al.

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Table S1. Measured dissolved inorganic carbon (DIC) and total alkalinity (TA), calculated $p\text{CO}_2$, and pH (mean \pm SE) in the cultures of *Phaeodactylum tricornutum*, *Rhodomonas* sp. and *Emiliania huxleyi* on the sampling days at steady state. Triplicates were set for each treatment.

Species		Treatment		DIC ($\mu\text{mol kg}^{-1}$)	TA ($\mu\text{mol kg}^{-1}$)	$p\text{CO}_2$ (μatm)	pH	
<i>P. tricornutum</i> ^a	12°C	Low CO ₂	N:P = 10:1	2476 \pm 12	2505 \pm 7.0	1479 \pm 97	7.788 \pm 0.008	
			N:P = 24:1	2425 \pm 16	2551 \pm 0.7	728 \pm 78	8.057 \pm 0.017	
			N:P = 63:1	2404 \pm 18	2533 \pm 5.6	714 \pm 72	7.996 \pm 0.004	
		High CO ₂	N:P = 10:1	2634 \pm 17	2502 \pm 0.4	4032 \pm 353	7.510 \pm 0.016	
			N:P = 24:1	2628 \pm 28	2534 \pm 1.4	3300 \pm 558	7.557 \pm 0.044	
			N:P = 63:1	2629 \pm 5.2	2520 \pm 3.3	3542 \pm 159	7.417 \pm 0.010	
		18°C	Low CO ₂	N:P = 10:1	2392 \pm 11	2462 \pm 0.5	1289 \pm 103	7.856 \pm 0.025
				N:P = 24:1	2273 \pm 9.7	2535 \pm 7.4	435 \pm 21	8.230 \pm 0.029
				N:P = 63:1	2421 \pm 22	2512 \pm 2.3	1167 \pm 160	7.902 \pm 0.019
	High CO ₂		N:P = 10:1	2564 \pm 8.2	2466 \pm 3.9	4045 \pm 204	7.381 \pm 0.019	
			N:P = 24:1	2594 \pm 8.1	2545 \pm 2.1	3059 \pm 128	7.584 \pm 0.025	
			N:P = 63:1	2551 \pm 23	2540 \pm 2.4	2401 \pm 346	7.598 \pm 0.013	
	24°C	Low CO ₂	N:P = 10:1	2350 \pm 15	2464 \pm 1.8	1217 \pm 110	8.033 \pm 0.035	
			N:P = 24:1	2280 \pm 32	2494 \pm 1.1	704 \pm 103	8.233 \pm 0.043	
			N:P = 63:1	2330 \pm 10	2470 \pm 0.6	1015 \pm 59	8.067 \pm 0.009	
High CO ₂		N:P = 10:1	2521 \pm 2.5	2480 \pm 0.4	3473 \pm 86	7.449 \pm 0.025		
		N:P = 24:1	2514 \pm 0.04	2503 \pm 0.8	2865 \pm 20	7.483 \pm 0.054		
		N:P = 63:1	2557 \pm 14	2497 \pm 3.5	3928 \pm 335	7.381 \pm 0.018		
<i>Rhodomonas</i> sp. ^a	12°C	Low CO ₂	N:P = 10:1	2181 \pm 6.5	2289 \pm 0.2	725 \pm 20	8.016 \pm 0.009	
			N:P = 24:1	2238 \pm 16	2345 \pm 2.6	745 \pm 100	8.072 \pm 0.017	
			N:P = 63:1	2255 \pm 14	2317 \pm 1.7	1012 \pm 111	7.940 \pm 0.005	
		High CO ₂	N:P = 10:1	2368 \pm 7.3	2298 \pm 2.0	2726 \pm 138	7.456 \pm 0.003	
			N:P = 24:1	2418 \pm 2.7	2349 \pm 5.0	2724 \pm 58	7.506 \pm 0.017	

<i>E. huxleyi</i> ^b	18°C	Low CO ₂	N:P = 63:1	2420 ± 14	2313 ± 2.0	3420 ± 315	7.333 ± 0.005
			N:P = 10:1	2211 ± 15	2287 ± 0.3	1138 ± 136	7.958 ± 0.019
			N:P = 24:1	2255 ± 8.0	2342 ± 2.1	1073 ± 70	7.979 ± 0.017
		High CO ₂	N:P = 63:1	2209 ± 7.7	2311 ± 1.5	945 ± 61	7.970 ± 0.021
			N:P = 10:1	2387	2285 ± 2.3	4028	7.399 ± 0.013
			N:P = 24:1	2423 ± 17	2347 ± 1.7	3489 ± 414	7.472 ± 0.014
	24°C	Low CO ₂	N:P = 63:1	2388 ± 2.5	2310 ± 1.1	3486 ± 74	7.448 ± 0.012
			N:P = 10:1	2188 ± 7.4	2302 ± 0.5	1083 ± 56	7.939 ± 0.010
			N:P = 24:1	2201 ± 17	2306 ± 3.2	1160 ± 109	7.927 ± 0.016
		High CO ₂	N:P = 63:1	2189 ± 12	2288 ± 4.6	1210 ± 126	7.920 ± 0.009
			N:P = 10:1	2383 ± 15	2297 ± 1.3	4395 ± 347	7.372 ± 0.011
			N:P = 24:1	2398 ± 8.4	2318 ± 5.1	4259 ± 95	7.372 ± 0.010
	12°C	Low pCO ₂	N:P = 63:1	2408 ± 3.4	2306 ± 2.2	4814 ± 138	7.789 ± 0.183
			N:P = 10:1	1302 ± 54	1269 ± 57	1509 ± 35	7.803 ± 0.007
			N:P = 24:1	1328 ± 18	1292 ± 27	1564 ± 149	7.710 ± 0.039
		High pCO ₂	N:P = 63:1	1374 ± 25	1349 ± 24	1412 ± 21	7.832 ± 0.004
			N:P = 10:1	1956 ± 46	1962 ± 50	1357 ± 14	7.504 ± 0.034
			N:P = 24:1	2042 ± 17	2053 ± 17	1357 ± 76	7.466 ± 0.001
	18°C	Low pCO ₂	N:P = 63:1	1829 ± 22	1801 ± 49	1041 ± 191	7.494 ± 0.014
			N:P = 10:1	763 ± 15	793 ± 4	552 ± 118	8.032 ± 0.044
			N:P = 24:1	885 ± 6	922 ± 12	567 ± 84	7.906 ± 0.015
		High pCO ₂	N:P = 63:1	1065 ± 3	1108 ± 8	633 ± 44	8.072 ± 0.001
			N:P = 10:1	1415 ± 154	1454 ± 121	1113 ± 489	7.704 ± 0.077
			N:P = 24:1	1278 ± 13	1196 ± 18	2944 ± 330	7.581 ± 0.079
24°C	Low pCO ₂	N:P = 63:1	1613 ± 35	1620 ± 32	1507 ± 332	7.705 ± 0.010	
		N:P = 10:1	785 ± 13	808 ± 10	845 ± 256	8.105 ± 0.007	

	N:P = 24:1	809 ± 10	682 ± 11	-	8.042 ± 0.017
	N:P = 63:1	1243 ± 16	1231 ± 10	1734 ± 163	7.980 ± 0.039
High $p\text{CO}_2$	N:P = 10:1	1266 ± 22	1240 ± 20	2079 ± 406	7.625 ± 0.004
	N:P = 24:1	1596 ± 63	1691 ± 36	1163 ± 190	7.608 ± 0.007
	N:P = 63:1	1616 ± 27	1550 ± 34	3295 ± 171	7.553 ± 0.029

^a Data for *Phaeodactylum tricornutum* and *Rhodomonas* sp. are modified after Bi et al. (2017). ^b Data for *Emiliana huxleyi* are from Bi et al. (2018).

Table S2. Results of Akaike information criterion corrected (AICc) in the generalized linear mixed models (GLMMs) testing for the effects of temperature, N:P supply ratios and $p\text{CO}_2$ on carbon-normalized and per-cell contents of brassicasterol/epi-brassicasterol (brassi./epi-brassi./POC and brassi./epi-brassi./cell; $\mu\text{g mg C}^{-1}$ and pg cell^{-1}) in *Phaeodactylum tricornutum*, *Rhodomonas* sp. and *Emiliana huxleyi*, and carbon-normalized and per-cell contents of C_{37} - C_{39} total alkenones (alkenones/POC and alkenones/cell), per-cell contents of C_{37} alkenones ($\text{C}_{37}/\text{Cell}$), C_{38} alkenones ($\text{C}_{38}/\text{Cell}$), C_{38} ethyl ketones ($\text{C}_{38} \text{ Et}/\text{Cell}$) and C_{38} methyl ketones ($\text{C}_{38} \text{ Me}/\text{Cell}$), $\text{C}_{37}/\text{C}_{38}$ alkenone ratios, and $\text{C}_{38} \text{ Et}/\text{C}_{38} \text{ Me}$ ($\text{C}_{38} \text{ Et}/\text{Me}$) in *E. huxleyi*.

Species	Response variable	Effect builder	AICc
<i>P. tricornutum</i>	Brassi./epi-brassi./POC	Main, two way and three way	271
		Main, two way	248
		Main	207
	Brassi./epi-brassi./cell	Main, two way and three way	63
		Main, two way	39
		Main	-21
<i>Rhodomonas</i> sp.	Brassi./epi-brassi./POC	Main, two way and three way	197
		Main, two way	194
		Main	191
	Brassi./epi-brassi./cell	Main, two way and three way	94
		Main, two way	66
		Main	5
<i>E. huxleyi</i>	Brassi./epi-brassi./POC	Main, two way and three way	272
		Main, two way	248
		Main	200
	Brassi./epi-brassi./cell	Main, two way and three way	116
		Main, two way	89
		Main	31
	Alkenones/POC	Main, two way and three way	575

		Main, two way	558
		Main	534
Alkenones/Cell		Main, two way and three way	109
		Main, two way	82
		Main	26
C ₃₇ /Cell		Main, two way and three way	105
		Main, two way	77
		Main	22
C ₃₈ /Cell		Main, two way and three way	115
		Main, two way	88
		Main	32
C ₃₈ Et/Cell		Main, two way and three way	125
		Main, two way	98
		Main	42
C ₃₈ Me/Cell		Main, two way and three way	100
		Main, two way	73
		Main	15
C ₃₇ /C ₃₈ alkenone ratios		Main, two way and three way	79
		Main, two way	50
		Main	-13
C ₃₈ Et/Me		Main, two way and three way	83
		Main, two way	55
		Main	-5

The selected models are shown in bold.

Table S3. Brassicasterol/epi-brassicasterol contents (each $\mu\text{g mg C}^{-1}$ and pg cell^{-1} ; mean \pm SE) in *Phaeodactylum tricornutum*, *Rhodomonas* sp. and *Emiliania huxleyi* as a function of temperature, N:P supply ratios and $p\text{CO}_2$. Triplicates were set for each treatment.

Treatment			<i>P. tricornutum</i>		<i>Rhodomonas</i> sp.		<i>E. huxleyi</i>	
			$\mu\text{g mg C}^{-1}$	pg cell^{-1}	$\mu\text{g mg C}^{-1}$	pg cell^{-1}	$\mu\text{g mg C}^{-1}$	pg cell^{-1}
12 °C	Low $p\text{CO}_2$	N:P = 10:1	8.00 \pm 1.59	0.06 \pm 0.01	4.02 \pm 0.18	0.37 \pm 0.02	6.08 \pm 0.69	0.11 \pm 0.01
		N:P = 24:1	8.34 \pm 0.10	0.05 \pm 0.002	4.49 \pm 0.42	0.48 \pm 0.11	6.24 \pm 0.44	0.11 \pm 0.01
		N:P = 63:1	6.33 \pm 0.30	0.06 \pm 0.01	4.31 \pm 0.34	0.50 \pm 0.10	3.99 \pm 1.66	0.08 \pm 0.04
	High $p\text{CO}_2$	N:P = 10:1	6.51 \pm 0.29	0.05 \pm 0.002	3.96 \pm 0.28	0.50 \pm 0.12	5.46 \pm 0.55	0.08 \pm 0.01
		N:P = 24:1	6.40 \pm 0.18	0.06 \pm 0.003	4.30 \pm 0.04	0.29 \pm 0.06	5.28 \pm 0.51	0.11 \pm 0.01
		N:P = 63:1	6.36 \pm 0.78	0.08 \pm 0.02	3.64 \pm 0.52	0.51 \pm 0.18	4.77 \pm 0.38	0.11 \pm 0.01
18 °C	Low $p\text{CO}_2$	N:P = 10:1	8.53 \pm 0.11	0.08 \pm 0.002	4.47 \pm 0.80	0.41 \pm 0.06	5.73 \pm 0.16	0.04 \pm 0.001
		N:P = 24:1	7.43 \pm 0.94	0.05 \pm 0.01	4.91 \pm 0.13	0.32 \pm 0.03	7.19 \pm 0.21	0.08 \pm 0.01
		N:P = 63:1	7.42 \pm 0.82	0.11 \pm 0.02	4.01 \pm 0.23	0.48 \pm 0.05	4.85 \pm 0.44	0.15 \pm 0.03
	High $p\text{CO}_2$	N:P = 10:1	9.29 \pm 0.44	0.08 \pm 0.003	4.95 \pm 0.12	0.51 \pm 0.10	6.33 \pm 0.70	0.04 \pm 0.01
		N:P = 24:1	8.26 \pm 0.52	0.08 \pm 0.01	1.91 \pm 0.34	0.32 \pm 0.16	7.70 \pm 0.92	0.14 \pm 0.01
		N:P = 63:1	7.35 \pm 0.64	0.10 \pm 0.01	4.61 \pm 0.69	0.59 \pm 0.17	4.17 \pm 0.35	0.13 \pm 0.05
24 °C	Low $p\text{CO}_2$	N:P = 10:1	6.31 \pm 0.75	0.05 \pm 0.01	3.36 \pm 0.16	0.25 \pm 0.04	7.54 \pm 0.24	0.06 \pm 0.003
		N:P = 24:1	6.36 \pm 0.91	0.07 \pm 0.02	9.56 \pm 0.55	0.29 \pm 0.03	7.15 \pm 0.56	0.07 \pm 0.002
		N:P = 63:1	7.47 \pm 0.44	0.13 \pm 0.01	4.79 \pm 0.40	0.54 \pm 0.16	4.25 \pm 0.43	0.09 \pm 0.01
	High $p\text{CO}_2$	N:P = 10:1	7.66 \pm 0.17	0.07 \pm 0.01	4.44 \pm 0.44	0.38 \pm 0.03	6.83 \pm 0.46	0.05 \pm 0.003
		N:P = 24:1	8.88 \pm 2.10	0.11 \pm 0.004	4.10 \pm 0.39	0.32 \pm 0.06	7.85 \pm 0.31	0.19 \pm 0.02
		N:P = 63:1	7.90 \pm 0.40	0.09 \pm 0.01	2.94 \pm 0.08	0.42 \pm 0.03	4.03 \pm 0.30	0.12 \pm 0.02

Table S4. Alkenone contents (each $\mu\text{g mg C}^{-1}$ and pg cell^{-1} ; mean \pm SE) in *Emiliania huxleyi* as a function of temperature, N:P supply ratios and $p\text{CO}_2$. Triplicates were set for each treatment.

Treatment			C _{37:4} Me		C _{37:3} Me		C _{37:2} Me		C _{38:3} Et		C _{38:3} Me	
			$\mu\text{g mg C}^{-1}$	pg cell^{-1}	$\mu\text{g mg C}^{-1}$	pg cell^{-1}	$\mu\text{g mg C}^{-1}$	pg cell^{-1}	$\mu\text{g mg C}^{-1}$	pg cell^{-1}	$\mu\text{g mg C}^{-1}$	pg cell^{-1}
12 °C	Low $p\text{CO}_2$	N:P = 10:1	5.10 \pm 0.61	0.09 \pm 0.01	52.6 \pm 9.17	0.91 \pm 0.12	13.3 \pm 2.63	0.23 \pm 0.03	22.5 \pm 3.95	0.39 \pm 0.05	16.2 \pm 3.21	0.28 \pm 0.04
		N:P = 24:1	4.90 \pm 0.38	0.09 \pm 0.01	43.3 \pm 3.67	0.79 \pm 0.09	10.5 \pm 0.83	0.19 \pm 0.02	21.1 \pm 1.95	0.39 \pm 0.05	13.6 \pm 1.47	0.25 \pm 0.03
		N:P = 63:1	7.17 \pm 1.22	0.15 \pm 0.05	56.9 \pm 3.28	0.80 \pm 0.42	18.7 \pm 0.31	0.26 \pm 0.13	24.3 \pm 2.20	0.51 \pm 0.15	19.3 \pm 1.28	0.40 \pm 0.11
	High $p\text{CO}_2$	N:P = 10:1	5.38 \pm 0.25	0.08 \pm 0.01	40.9 \pm 7.59	0.61 \pm 0.11	11.0 \pm 3.32	0.16 \pm 0.05	18.0 \pm 3.28	0.27 \pm 0.05	16.5 \pm 3.34	0.25 \pm 0.05
		N:P = 24:1	4.05 \pm 0.19	0.09 \pm 0.01	39.5 \pm 1.67	0.86 \pm 0.07	11.3 \pm 0.46	0.24 \pm 0.02	18.8 \pm 1.04	0.41 \pm 0.03	14.3 \pm 0.68	0.31 \pm 0.03
		N:P = 63:1	6.15 \pm 0.63	0.14 \pm 0.02	49.7 \pm 6.17	1.13 \pm 0.16	19.8 \pm 4.47	0.45 \pm 0.11	18.4 \pm 1.79	0.42 \pm 0.05	18.1 \pm 2.35	0.41 \pm 0.05
18 °C	Low $p\text{CO}_2$	N:P = 10:1	1.01 \pm 0.06	0.01 \pm 0.001	41.1 \pm 8.74	0.29 \pm 0.08	25.3 \pm 6.89	0.18 \pm 0.06	10.7 \pm 2.25	0.08 \pm 0.02	13.2 \pm 3.02	0.09 \pm 0.03
		N:P = 24:1	0.90 \pm 0.07	0.01 \pm 0.002	39.0 \pm 3.39	0.45 \pm 0.09	25.5 \pm 2.14	0.30 \pm 0.06	14.3 \pm 1.07	0.17 \pm 0.03	10.8 \pm 0.88	0.13 \pm 0.02
		N:P = 63:1	1.10 \pm 0.15	0.03 \pm 0.01	36.9 \pm 8.36	1.15 \pm 0.38	22.8 \pm 9.16	0.72 \pm 0.30	10.4 \pm 2.95	0.33 \pm 0.12	9.72 \pm 2.41	0.31 \pm 0.10
	High $p\text{CO}_2$	N:P = 10:1	1.58 \pm 0.34	0.01 \pm 0.00	51.8 \pm 2.14	0.35 \pm 0.07	27.3 \pm 2.51	0.19 \pm 0.06	14.1 \pm 0.43	0.10 \pm 0.02	16.4 \pm 0.58	0.11 \pm 0.03
		N:P = 24:1	0.72 \pm 0.16	0.01 \pm 0.002	28.7 \pm 2.65	0.51 \pm 0.04	14.7 \pm 1.55	0.26 \pm 0.01	14.4 \pm 0.90	0.25 \pm 0.01	8.06 \pm 0.70	0.14 \pm 0.01
		N:P = 63:1	0.97 \pm 0.09	0.03 \pm 0.01	38.0 \pm 11.2	0.93 \pm 0.10	30.8 \pm 13.3	0.69 \pm 0.21	11.4 \pm 3.37	0.28 \pm 0.03	10.8 \pm 3.34	0.26 \pm 0.03
24 °C	Low $p\text{CO}_2$	N:P = 10:1	0 \pm 0	0 \pm 0	18.7 \pm 1.22	0.15 \pm 0.01	78.3 \pm 9.84	0.62 \pm 0.09	3.90 \pm 0.24	0.03 \pm 0.003	3.91 \pm 0.21	0.03 \pm 0.003
		N:P = 24:1	0 \pm 0	0 \pm 0	17.4 \pm 2.55	0.16 \pm 0.01	60.6 \pm 19.4	0.56 \pm 0.15	5.50 \pm 0.78	0.05 \pm 0.004	2.51 \pm 0.39	0.02 \pm 0.002
		N:P = 63:1	0 \pm 0	0 \pm 0	12.8 \pm 3.66	0.26 \pm 0.05	41.7 \pm 13.8	0.85 \pm 0.17	3.05 \pm 1.02	0.06 \pm 0.02	1.69 \pm 0.48	0.03 \pm 0.01
	High $p\text{CO}_2$	N:P = 10:1	0 \pm 0	0 \pm 0	20.2 \pm 5.41	0.15 \pm 0.03	47.8 \pm 13.0	0.69 \pm 0.31	3.26 \pm 0.50	0.04 \pm 0.01	3.01 \pm 0.39	0.03 \pm 0.01
		N:P = 24:1	0 \pm 0	0 \pm 0	15.7 \pm 1.41	0.37 \pm 0.05	76.1 \pm 9.40	1.82 \pm 0.31	5.36 \pm 0.38	0.13 \pm 0.01	2.65 \pm 0.31	0.06 \pm 0.01
		N:P = 63:1	0 \pm 0	0 \pm 0	20.2 \pm 3.18	0.56 \pm 0.04	53.0 \pm 1.03	1.96 \pm 0.21	5.32 \pm 0.90	0.15 \pm 0.01	2.91 \pm 0.46	0.08 \pm 0.01
Mean per-cell content												
			C _{37:4} Me		C _{37:3} Me		C _{37:2} Me		C _{38:3} Et		C _{38:3} Me	
All treatment			0 – 0.15		0.15 – 1.15		0.16 – 1.96		0.03 – 0.51		0.02 – 0.41	

Table S4. Continued.

Treatment			C _{38:2} Et		C _{38:2} Me		C _{39:3} Et*		C _{39:2} Et*	
			$\mu\text{g mg C}^{-1}$	pg cell ⁻¹	$\mu\text{g mg C}^{-1}$	pg cell ⁻¹	$\mu\text{g mg C}^{-1}$	pg cell ⁻¹	$\mu\text{g mg C}^{-1}$	pg cell ⁻¹
12 °C	Low <i>p</i> CO ₂	N:P = 10:1	13.4 ± 2.85	0.23 ± 0.04	4.08 ± 1.01	0.07 ± 0.01	3.81 ± 0.82	0.07 ± 0.01	2.29 ± 0.53	0.04 ± 0.01
		N:P = 24:1	10.9 ± 0.63	0.20 ± 0.02	3.27 ± 0.50	0.06 ± 0.01	3.29 ± 0.33	0.06 ± 0.01	1.88 ± 0.19	0.03 ± 0.005
		N:P = 63:1	16.3 ± 0.43	0.33 ± 0.06	5.71 ± 0.01	0.12 ± 0.02	4.50 ± 0.21	0.09 ± 0.02	3.28 ± 0.05	0.07 ± 0.01
	High <i>p</i> CO ₂	N:P = 10:1	10.6 ± 3.72	0.16 ± 0.05	4.10 ± 1.28	0.06 ± 0.02	3.84 ± 0.96	0.06 ± 0.01	2.37 ± 0.78	0.04 ± 0.01
		N:P = 24:1	12.1 ± 0.30	0.27 ± 0.03	3.81 ± 0.12	0.08 ± 0.01	3.60 ± 0.19	0.08 ± 0.01	2.33 ± 0.07	0.05 ± 0.01
		N:P = 63:1	16.4 ± 4.37	0.37 ± 0.10	6.42 ± 1.34	0.15 ± 0.03	3.77 ± 0.64	0.09 ± 0.01	3.37 ± 0.86	0.08 ± 0.02
18 °C	Low <i>p</i> CO ₂	N:P = 10:1	16.5 ± 4.73	0.12 ± 0.04	7.89 ± 2.21	0.06 ± 0.02	1.95 ± 0.49	0.01 ± 0.004	3.06 ± 0.93	0.02 ± 0.01
		N:P = 24:1	20.3 ± 1.70	0.23 ± 0.05	6.66 ± 0.47	0.08 ± 0.01	2.03 ± 0.19	0.02 ± 0.005	3.08 ± 0.27	0.04 ± 0.01
		N:P = 63:1	15.0 ± 6.30	0.48 ± 0.21	5.85 ± 2.29	0.19 ± 0.08	1.50 ± 0.42	0.05 ± 0.02	2.48 ± 1.01	0.08 ± 0.03
	High <i>p</i> CO ₂	N:P = 10:1	18.1 ± 2.53	0.13 ± 0.05	8.85 ± 1.18	0.06 ± 0.02	2.54 ± 0.27	0.02 ± 0.01	3.49 ± 0.63	0.03 ± 0.01
		N:P = 24:1	13.5 ± 1.64	0.24 ± 0.02	3.94 ± 0.37	0.07 ± 0.003	1.99 ± 0.09	0.04 ± 0.001	2.07 ± 0.23	0.04 ± 0.003
		N:P = 63:1	21.5 ± 9.85	0.47 ± 0.16	8.24 ± 3.62	0.18 ± 0.06	1.75 ± 0.59	0.04 ± 0.01	3.68 ± 1.66	0.08 ± 0.03
24 °C	Low <i>p</i> CO ₂	N:P = 10:1	40.2 ± 5.94	0.32 ± 0.05	15.0 ± 1.88	0.12 ± 0.02	0.25 ± 0.13	0.002 ± 0.001	4.49 ± 0.63	0.04 ± 0.01
		N:P = 24:1	41.3 ± 14.1	0.38 ± 0.11	7.14 ± 2.07	0.07 ± 0.02	0.23 ± 0.11	0.002 ± 0.001	2.87 ± 0.83	0.03 ± 0.01
		N:P = 63:1	23.3 ± 8.87	0.46 ± 0.12	4.87 ± 1.71	0.10 ± 0.02	0 ± 0	0 ± 0	1.68 ± 0.68	0.03 ± 0.01
	High <i>p</i> CO ₂	N:P = 10:1	25.3 ± 8.55	0.39 ± 0.19	9.00 ± 2.73	0.12 ± 0.05	0.17 ± 0.17	0.002 ± 0.001	2.75 ± 0.88	0.04 ± 0.02
		N:P = 24:1	51.0 ± 5.79	1.22 ± 0.19	9.59 ± 1.15	0.23 ± 0.04	0 ± 0	0 ± 0	4.21 ± 0.48	0.10 ± 0.02
		N:P = 63:1	41.2 ± 11.7	1.10 ± 0.12	8.84 ± 2.21	0.24 ± 0.03	0.11 ± 0.11	0.002 ± 0.002	3.24 ± 0.91	0.09 ± 0.01
Mean per-cell content										
			C _{38:2} Et		C _{38:2} Me		C _{39:3} Et*		C _{39:2} Et*	
All treatment			0.12 - 1.22		0.06 - 0.24		0 - 0.09		0.02 - 0.10	

* Tentatively identified due to low molecular ion abundance.

Table S4. Continued.

Treatment			Total alkenones		C ₃₇ /C ₃₈	C ₃₈ Et/Me	U ₃₇ ^{K'}
			μg mg C ⁻¹	pg cell ⁻¹			
12 °C	Low pCO ₂	N:P = 10:1	133.2 ± 24.8	2.29 ± 0.31	1.27 ± 0.02	1.79 ± 0.04	0.20 ± 0.003
		N:P = 24:1	112.7 ± 9.69	2.06 ± 0.24	1.20 ± 0.01	1.92 ± 0.08	0.20 ± 0.004
		N:P = 63:1	156.2 ± 7.51	3.24 ± 0.80	1.34 ± 0.08	1.55 ± 0.07	0.24 ± 0.01
	High pCO ₂	N:P = 10:1	112.8 ± 24.0	1.68 ± 0.34	1.20 ± 0.09	1.37 ± 0.05	0.20 ± 0.03
		N:P = 24:1	109.9 ± 4.17	2.38 ± 0.22	1.12 ± 0.01	1.71 ± 0.03	0.22 ± 0.004
		N:P = 63:1	142.1 ± 21.4	3.24 ± 0.53	1.29 ± 0.04	1.41 ± 0.05	0.28 ± 0.03
18 °C	Low pCO ₂	N:P = 10:1	120.7 ± 29.3	0.85 ± 0.25	1.41 ± 0.04	1.28 ± 0.02	0.37 ± 0.02
		N:P = 24:1	122.6 ± 10.1	1.42 ± 0.28	1.26 ± 0.01	1.98 ± 0.04	0.40 ± 0.005
		N:P = 63:1	105.7 ± 32.1	3.33 ± 1.22	1.58 ± 0.15	1.53 ± 0.17	0.34 ± 0.08
	High pCO ₂	N:P = 10:1	144.1 ± 7.07	0.99 ± 0.27	1.42 ± 0.10	1.28 ± 0.03	0.35 ± 0.03
		N:P = 24:1	88.1 ± 6.21	1.55 ± 0.04	1.10 ± 0.05	2.34 ± 0.17	0.34 ± 0.02
		N:P = 63:1	127.0 ± 47.0	2.96 ± 0.60	1.41 ± 0.09	1.65 ± 0.10	0.41 ± 0.06
24 °C	Low pCO ₂	N:P = 10:1	164.7 ± 20.0	1.30 ± 0.19	1.55 ± 0.03	2.31 ± 0.12	0.80 ± 0.01
		N:P = 24:1	137.6 ± 39.2	1.27 ± 0.30	1.40 ± 0.04	4.72 ± 0.37	0.76 ± 0.04
		N:P = 63:1	89.1 ± 29.9	1.80 ± 0.38	1.73 ± 0.10	3.90 ± 0.21	0.76 ± 0.02
	High pCO ₂	N:P = 10:1	138.3 ± 35.9	0.85 ± 0.14	1.52 ± 0.09	2.54 ± 0.22	0.79 ± 0.04
		N:P = 24:1	164.6 ± 18.8	3.93 ± 0.63	1.34 ± 0.01	4.62 ± 0.09	0.83 ± 0.01
		N:P = 63:1	117.2 ± 3.17	4.19 ± 0.39	1.60 ± 0.03	3.89 ± 0.19	0.77 ± 0.02
			% of total alkenones				
			C ₃₇ Me	C ₃₈ Et	C ₃₈ Me	C ₃₉ Et	
All treatments			48 – 65%	18 – 35%	6.6 – 19%	0 – 5.9%	

Table S5. Dimension 1 (Dim1) and Dim 2 loadings for each variable in PCA (Fig. 3) testing the responses of carbon-normalized contents of the major sterol component (brassicasterol/epi-brassicasterol), C₃₇-C₃₉ total alkenones and total fatty acids (TFAs) ($\mu\text{g mg C}^{-1}$) in *Phaeodactylum tricornutum*, *Rhodomonas* sp. and *Emiliana huxleyi* to changes in temperature, N:P molar ratios and $p\text{CO}_2$.

Variables	Dim 1	Dim 2
% of variance	26.4	17.7
Temperature	-0.320	0.493
$p\text{CO}_2$	0.185	0.151
N:P supply ratio	0.668	0.559
Brassicasterol/epi-brassicasterol (<i>P. tricornutum</i>)	-0.024	-0.420
Brassicasterol/epi-brassicasterol (<i>Rhodomonas</i> sp.)	-0.402	0.393
Brassicasterol/epi-brassicasterol (<i>E. huxleyi</i>)	-0.833	-0.040
Alkenones (<i>E. huxleyi</i>)	-0.292	0.317
TFAs (<i>P. tricornutum</i>)	0.608	0.426
TFAs (<i>Rhodomonas</i> sp.)	0.819	-0.104
TFAs (<i>E. huxleyi</i>)	0.279	-0.753

Fig. S1

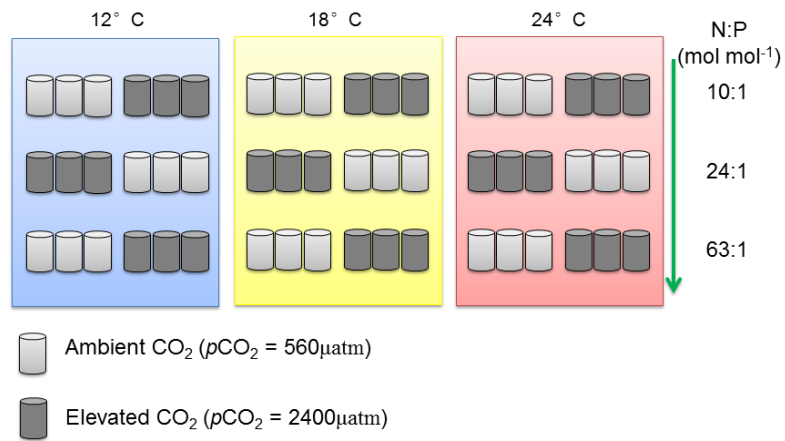


Fig. S1. Experimental setup. The three phytoplankton species were grown semi-continuously under a full-factorial combination of three temperatures (12, 18 and 24 °C), three N:P supply ratios (molar ratios 10:1, 24:1 and 63:1) and two $p\text{CO}_2$ levels (560 and 2400 μatm). Triplicates were set for each treatment.