

Supplementary Table 1: Carbonate system parameters (calculated from the start and end values of DIC and TA) of the four individual experiments with corresponding experimental conditions. Values are expressed as the mean with corresponding standard deviation ($\pm 1SD$).

Experiment 1: North Sea water, salinity = 34, light = 180 $\mu\text{mol photons m}^{-2} \text{ s}^{-1}$, light:dark = 14 : 10 h, replicates = 3									
Seawater Sr/Ca = 8.42 \pm 0.30, Mg/Ca = 5.29 \pm 0.15									
Species	T °C	pCO ₂ μatm	pH total scale	Ω	DIC $\mu\text{mol kg}^{-1}$	TA $\mu\text{mol kg}^{-1}$	CO ₂	HCO ₃ ⁻ $\mu\text{mol kg}^{-1}$	CO ₃ ²⁻
<i>C. braarudii</i>	10	417 \pm 15	8.04 \pm 0.03	3.29 \pm 0.38	2139 \pm 19	2322 \pm 9	18 \pm 1	1984 \pm 33	137 \pm 16
<i>C. braarudii</i>	15	320 \pm 17	8.15 \pm 0.02	5.00 \pm 0.18	2107 \pm 8	2393 \pm 5	12 \pm 1	1887 \pm 15	208 \pm 8
<i>C. braarudii</i>	18	501 \pm 30	7.99 \pm 0.02	4.12 \pm 0.17	2182 \pm 8	2408 \pm 7	17 \pm 1	1993 \pm 13	172 \pm 7
<i>C. quadriperforatus</i>	15	308 \pm 2	8.17 \pm 0.01	5.33 \pm 0.03	2149 \pm 2	2453 \pm 2	12 \pm 1	1915 \pm 2	222 \pm 1
<i>C. quadriperforatus</i>	18	451 \pm 45	8.04 \pm 0.03	4.66 \pm 0.24	2221 \pm 8	2478 \pm 7	16 \pm 2	2012 \pm 17	194 \pm 10
<i>C. quadriperforatus</i>	20	316 \pm 46	8.15 \pm 0.03	4.10 \pm 0.23	2115 \pm 7	2351 \pm 17	14 \pm 1	1930 \pm 10	171 \pm 9
<i>E. huxleyi</i>	10	276 \pm 6	8.21 \pm 0.01	4.75 \pm 0.26	2151 \pm 13	2425 \pm 6	12 \pm 1	1941 \pm 19	198 \pm 7
<i>E. huxleyi</i>	15	306 \pm 5	8.17 \pm 0.01	5.30 \pm 0.05	2133 \pm 3	2436 \pm 1	12 \pm 1	1901 \pm 5	221 \pm 2
<i>E. huxleyi</i>	20	400 \pm 41	8.07 \pm 0.03	5.15 \pm 0.27	2126 \pm 5	2415 \pm 12	13 \pm 1	1899 \pm 15	214 \pm 11
<i>E. huxleyi</i>	25	427 \pm 30	8.05 \pm 0.03	5.97 \pm 0.31	2140 \pm 10	2470 \pm 14	12 \pm 1	1882 \pm 20	246 \pm 13
Experiment 2: North Sea water, salinity = 34, light = 130 $\mu\text{mol photons m}^{-2} \text{ s}^{-1}$, light:dark = 14 : 10 h, replicates = 2									
Seawater Sr/Ca = 8.42 \pm 0.30, Mg/Ca = 5.29 \pm 0.15									
Species	T °C	pCO ₂ μatm	pH total scale	Ω	DIC $\mu\text{mol kg}^{-1}$	TA $\mu\text{mol kg}^{-1}$	CO ₂	HCO ₃ ⁻ $\mu\text{mol kg}^{-1}$	CO ₃ ²⁻
<i>E. huxleyi</i>	10	193 \pm 3	8.35 \pm 0.01	6.36 \pm 0.07	2150 \pm 1	2520 \pm 3	9 \pm 1	1876 \pm 4	265 \pm 3
<i>E. huxleyi</i>	10	467 \pm 9	7.99 \pm 0.01	2.99 \pm 0.06	2148 \pm 1	2311 \pm 3	21 \pm 1	2002 \pm 2	125 \pm 2
<i>E. huxleyi</i>	10	699 \pm 5	7.82 \pm 0.01	2.05 \pm 0.01	2143 \pm 1	2240 \pm 1	31 \pm 1	2027 \pm 1	85 \pm 1
<i>E. huxleyi</i>	10	898 \pm 24	7.72 \pm 0.01	1.60 \pm 0.04	2138 \pm 1	2199 \pm 2	39 \pm 1	2032 \pm 2	67 \pm 2
<i>E. huxleyi</i>	10	1238 \pm 23	7.58 \pm 0.01	1.16 \pm 0.02	2131 \pm 1	2150 \pm 2	54 \pm 1	2028 \pm 1	48 \pm 1

<i>E. huxleyi</i>	20	175 ± 1	8.39 ± 0.01	9.76 ± 0.01	2139 ± 1	2689 ± 1	6 ± 1	1728 ± 1	405 ± 1
<i>E. huxleyi</i>	20	365 ± 4	8.11 ± 0.01	5.60 ± 0.05	2135 ± 1	2449 ± 3	12 ± 1	1891 ± 1	232 ± 2
<i>E. huxleyi</i>	20	690 ± 12	7.85 ± 0.01	3.24 ± 0.04	2135 ± 1	2305 ± 3	22 ± 1	1978 ± 2	135 ± 2
<i>E. huxleyi</i>	20	812 ± 20	7.78 ± 0.01	2.76 ± 0.05	2118 ± 3	2257 ± 1	26 ± 1	1978 ± 5	114 ± 2
<i>E. huxleyi</i>	20	1106 ± 12	7.65 ± 0.01	2.08 ± 0.01	2128 ± 2	2217 ± 1	36 ± 1	2006 ± 2	86 ± 1

Experiment 3: North Sea water, salinity = 34, light = 130 $\mu\text{mol photons m}^{-2} \text{ s}^{-1}$, light:dark = 16 : 08 h, replicates = 3

Seawater Sr/Ca = 8.42 ± 0.30, Mg/Ca = 5.29 ± 0.15

Species	T °C	pCO ₂ μatm	pH total scale	Ω	DIC $\mu\text{mol kg}^{-1}$	TA $\mu\text{mol kg}^{-1}$	CO ₂	HCO ₃ ⁻ $\mu\text{mol kg}^{-1}$	CO ₃ ²⁻
<i>C. braarudii</i>	17	524 ± 27	7.95 ± 0.02	3.33 ± 0.12	2056 ± 7	2242 ± 6	18 ± 1	1899 ± 11	139 ± 6
<i>C. braarudii</i>	17	1151 ± 130	7.61 ± 0.05	1.57 ± 0.21	2046 ± 21	2105 ± 29	41 ± 5	1939 ± 19	66 ± 8
<i>C. braarudii</i>	17	1799 ± 257	7.42 ± 0.06	1.00 ± 0.10	2037 ± 28	2038 ± 16	63 ± 9	1931 ± 25	42 ± 5
<i>C. braarudii</i>	17	2311 ± 122	7.31 ± 0.02	0.80 ± 0.01	2052 ± 18	2021 ± 12	81 ± 4	1938 ± 15	33 ± 1
<i>C. braarudii</i>	17	3508 ± 172	7.12 ± 0.02	0.50 ± 0.01	2034 ± 8	1943 ± 3	123 ± 6	1890 ± 4	21 ± 1

Experiment 4: Artificial sea water, salinity = 35, light = 150 $\mu\text{mol photons m}^{-2} \text{ s}^{-1}$, light:dark = 16 : 08 h, replicates = 1

Seawater Sr/Ca = 9.66 ± 0.21, Mg/Ca = 5.43 ± 0.13

Species	T °C	pCO ₂ μatm	pH free scale	Ω	DIC $\mu\text{mol kg}^{-1}$	TA $\mu\text{mol kg}^{-1}$	CO ₂	HCO ₃ ⁻ $\mu\text{mol kg}^{-1}$	CO ₃ ²⁻
<i>G. oceanica</i>	20	25	8.90	14.83	1421	2340	1	800	620
<i>G. oceanica</i>	20	59	8.66	11.64	1581	2296	2	1092	487
<i>G. oceanica</i>	20	108	8.48	9.35	1719	2288	4	1324	391
<i>G. oceanica</i>	20	280	8.17	5.88	1942	2291	9	1687	246
<i>G. oceanica</i>	20	413	8.04	4.58	2014	2280	13	1809	192
<i>G. oceanica</i>	20	574	7.91	3.63	2065	2268	19	1895	152
<i>G. oceanica</i>	20	764	7.81	2.95	2122	2278	25	1974	123

<i>G. oceanica</i>	20	940	7.73	2.57	2182	2309	30	2044	108
<i>G. oceanica</i>	20	1216	7.63	2.06	2209	2296	39	2083	86
<i>G. oceanica</i>	20	1476	7.55	1.77	2246	2307	48	2125	74
<i>G. oceanica</i>	20	1781	7.48	1.50	2268	2303	58	2148	63
<i>G. oceanica</i>	20	2104	7.41	1.30	2301	2314	68	2179	55
<i>G. oceanica</i>	25	26	8.85	14.72	1335	2262	1	723	611
<i>G. oceanica</i>	25	58	8.65	13.25	1583	2385	2	1031	550
<i>G. oceanica</i>	25	288	8.15	6.50	1883	2267	8	1605	270
<i>G. oceanica</i>	25	318	8.23	6.15	1905	2267	9	1640	255
<i>G. oceanica</i>	25	447	8.11	5.10	1996	2290	13	1772	212
<i>G. oceanica</i>	25	612	8.00	4.11	2049	2279	17	1861	171
<i>G. oceanica</i>	25	771	7.91	3.52	2103	2293	22	1934	146
<i>G. oceanica</i>	25	980	7.71	2.88	2118	2264	28	1970	120
<i>G. oceanica</i>	25	1284	7.60	2.29	2139	2242	36	2007	95
<i>G. oceanica</i>	25	1731	7.48	1.79	2188	2248	49	2064	74
<i>G. oceanica</i>	25	2067	7.41	1.52	2193	2227	59	2071	63
<i>G. oceanica</i>	25	3517	7.15	0.78	2067	2018	100	1935	32

Supplementary Table 2: Physiological parameters of the four individual experiments with corresponding experimental conditions. Values are expressed as the mean with corresponding standard deviation ($\pm 1SD$).

Experiment 1: North Sea water, salinity = 34, light = 180 $\mu\text{mol photons m}^{-2} \text{ s}^{-1}$, light:dark = 14 : 10 h, replicates = 3									
Seawater Sr/Ca = 8.42 \pm 0.30, Mg/Ca = 5.29 \pm 0.15									
Species	T °C	pCO ₂ μatm	growth rate d^{-1}	POC _{prod} $\text{pgC cell}^{-1}\text{day}^{-1}$	PIC _{prod} $\text{pgC cell}^{-1}\text{day}^{-1}$	TPN _{prod} $\text{pgN cell}^{-1}\text{day}^{-1}$	Chla _{prod} $\text{pgChla cell}^{-1}\text{day}^{-1}$	PIC:POC mol/mol	POC:TPN
<i>C. braarudii</i>	10	417 \pm 15	0.38 \pm 0.01	149 \pm 8	75 \pm 1	18.8 \pm 1.1	2.33 \pm 0.22	0.50 \pm 0.03	9.27 \pm 0.37
<i>C. braarudii</i>	15	320 \pm 17	0.52 \pm 0.01	155 \pm 6	120 \pm 10	16.0 \pm 0.1	4.07 \pm 0.42	0.78 \pm 0.09	11.25 \pm 0.45
<i>C. braarudii</i>	18	501 \pm 30	0.56 \pm 0.01	205 \pm 5	137 \pm 6	20.2 \pm 0.3	5.43 \pm 0.22	0.67 \pm 0.04	11.84 \pm 0.14
<i>C. quadriperforatus</i>	15	308 \pm 2	0.51 \pm 0.01	28.6 \pm 2.4	40.9 \pm 0.7	7.84 \pm 1.44	0.91 \pm 0.37	1.43 \pm 0.12	4.31 \pm 0.52
<i>C. quadriperforatus</i>	18	451 \pm 45	0.54 \pm 0.01	44.9 \pm 7.2	54.4 \pm 6.1	5.10 \pm 0.53	0.44 \pm 0.12	1.23 \pm 0.24	10.25 \pm 1.21
<i>C. quadriperforatus</i>	20	316 \pm 46	0.64 \pm 0.01	55.8 \pm 1.1	72.8 \pm 1.1	5.92 \pm 0.06	1.16 \pm 0.06	1.31 \pm 0.01	10.99 \pm 0.13
<i>E. huxleyi</i>	10	276 \pm 6	0.53 \pm 0.01	12.2 \pm 0.52	5.81 \pm 0.17	2.21 \pm 0.13	0.59 \pm 0.02	0.48 \pm 0.01	6.43 \pm 0.09
<i>E. huxleyi</i>	15	306 \pm 5	1.03 \pm 0.01	8.21 \pm 0.06	6.27 \pm 0.16	1.42 \pm 0.09	0.27 \pm 0.01	0.76 \pm 0.01	6.76 \pm 0.47
<i>E. huxleyi</i>	20	400 \pm 41	1.24 \pm 0.01	5.56 \pm 0.04	5.05 \pm 0.04	0.96 \pm 0.01	0.22 \pm 0.01	0.91 \pm 0.01	6.75 \pm 0.07
<i>E. huxleyi</i>	25	427 \pm 30	1.34 \pm 0.01	7.31 \pm 0.16	7.72 \pm 0.19	1.11 \pm 0.06	0.27 \pm 0.01	1.06 \pm 0.01	7.66 \pm 0.42
Experiment 2: North Sea water, salinity = 34, light = 130 $\mu\text{mol photons m}^{-2} \text{ s}^{-1}$, light:dark = 14 : 10 h, replicates = 2									
Seawater Sr/Ca = 8.42 \pm 0.30, Mg/Ca = 5.29 \pm 0.15									
Species	T °C	pCO ₂ μatm	growth rate d^{-1}	POC _{prod} $\text{pgC cell}^{-1}\text{day}^{-1}$	PIC _{prod} $\text{pgC cell}^{-1}\text{day}^{-1}$	TPN _{prod} $\text{pgN cell}^{-1}\text{day}^{-1}$	Chla _{prod} $\text{pgChla cell}^{-1}\text{day}^{-1}$	PIC:POC mol/mol	POC:TPN
<i>E. huxleyi</i>	10	193 \pm 3	0.64 \pm 0.01	5.78 \pm 0.53	8.10 \pm 0.70	0.87 \pm 0.06	0.07 \pm 0.01	1.40 \pm 0.01	7.81 \pm 1.27
<i>E. huxleyi</i>	10	467 \pm 9	0.65 \pm 0.01	5.48 \pm 0.07	8.21 \pm 0.25	0.79 \pm 0.03	0.07 \pm 0.01	1.50 \pm 0.03	8.09 \pm 0.36
<i>E. huxleyi</i>	10	699 \pm 5	0.63 \pm 0.01	5.33 \pm 0.65	7.72 \pm 0.04	0.79 \pm 0.06	0.07 \pm 0.01	1.46 \pm 0.17	7.90 \pm 0.40
<i>E. huxleyi</i>	10	898 \pm 24	0.62 \pm 0.01	5.13 \pm 0.02	6.68 \pm 0.54	0.73 \pm 0.01	0.06 \pm 0.01	1.30 \pm 0.10	8.17 \pm 0.06
<i>E. huxleyi</i>	10	1238 \pm 23	0.57 \pm 0.01	5.11 \pm 0.09	5.70 \pm 0.77	0.69 \pm 0.02	0.06 \pm 0.01	1.12 \pm 0.17	8.59 \pm 0.44

<i>E. huxleyi</i>	20	175 ± 1	1.34 ± 0.01	8.03 ± 1.21	7.50 ± 0.71	1.26 ± 0.13	0.10 ± 0.01	1.02 ± 0.14	6.85 ± 0.45
<i>E. huxleyi</i>	20	365 ± 4	1.41 ± 0.01	7.74 ± 0.56	6.70 ± 1.18	1.27 ± 0.04	0.13 ± 0.01	0.87 ± 0.22	7.11 ± 0.27
<i>E. huxleyi</i>	20	690 ± 12	1.35 ± 0.01	7.61 ± 0.30	6.08 ± 0.18	1.32 ± 0.12	0.13 ± 0.01	0.80 ± 0.06	6.74 ± 0.33
<i>E. huxleyi</i>	20	812 ± 20	1.31 ± 0.02	7.42 ± 0.22	5.02 ± 0.42	1.47 ± 0.24	0.12 ± 0.01	0.70 ± 0.05	5.80 ± 1.04
<i>E. huxleyi</i>	20	1106 ± 12	1.19 ± 0.03	8.14 ± 0.11	3.82 ± 0.29	1.55 ± 0.09	0.10 ± 0.01	0.47 ± 0.04	6.13 ± 0.29

Experiment 3: North Sea water, salinity = 34, light = 130 $\mu\text{mol photons m}^{-2} \text{s}^{-1}$, light:dark = 16 : 08 h, replicates = 3

Seawater Sr/Ca = 8.42 ± 0.30, Mg/Ca = 5.29 ± 0.15

Species	T °C	pCO ₂ μatm	growth rate d ⁻¹	POC _{prod} pgC cell ⁻¹ day ⁻¹	PIC _{prod}	TPN _{prod} pgN cell ⁻¹ day ⁻¹	Chla _{prod} pgChla cell ⁻¹ day ⁻¹	PIC:POC mol/mol	POC:TPN
<i>C. braarudii</i>	17	524 ± 27	0.63 ± 0.06	215 ± 14	335 ± 24	24.5 ± 1.8	-	1.60 ± 0.17	8.33 ± 0.46
<i>C. braarudii</i>	17	1151 ± 130	0.57 ± 0.06	289 ± 94	346 ± 115	25.8 ± 9.2	-	1.37 ± 0.70	7.80 ± 0.78
<i>C. braarudii</i>	17	1799 ± 257	0.43 ± 0.06	140 ± 6	82 ± 39	5.6 ± 2.8	-	0.57 ± 0.31	9.40 ± 0.20
<i>C. braarudii</i>	17	2311 ± 122	0.13 ± 0.06	89 ± 17	22 ± 16	1.5 ± 1.4	-	0.27 ± 0.29	7.10 ± 0.70
<i>C. braarudii</i>	17	3508 ± 172	0.13 ± 0.06	90 ± 54	17 ± 11	1.3 ± 0.8	-	0.20 ± 0.01	7.67 ± 0.57

Experiment 4: Artificial sea water, salinity = 35, light = 150 $\mu\text{mol photons m}^{-2} \text{s}^{-1}$, light:dark = 16 : 08 h, replicates = 1

Seawater Sr/Ca = 9.66 ± 0.22, Mg/Ca = 5.43 ± 0.14

Species	T °C	pCO ₂ μatm	growth rate d ⁻¹	POC _{prod} pgC cell ⁻¹ day ⁻¹	PIC _{prod}	TPN _{prod} pgN cell ⁻¹ day ⁻¹	Chla _{prod} pgChla cell ⁻¹ day ⁻¹	PIC:POC mol/mol	POC:TPN
<i>G. oceanica</i>	20	25	0.29	5.6	6.6	1.24	0.06	1.18	5.23
<i>G. oceanica</i>	20	59	0.54	6.2	13.4	0.53	0.12	2.17	13.65
<i>G. oceanica</i>	20	108	0.82	12.2	24.6	0.94	0.23	2.02	15.16
<i>G. oceanica</i>	20	280	1.00	14.3	26.0	1.14	0.24	1.81	14.68
<i>G. oceanica</i>	20	413	1.06	12.2	21.0	0.97	0.23	1.73	14.70
<i>G. oceanica</i>	20	574	1.05	12.7	20.3	1.01	0.23	1.59	14.74
<i>G. oceanica</i>	20	764	0.88	16.7	19.7	1.18	0.22	1.18	16.46

<i>G. oceanica</i>	20	940	0.79	13.7	15.9	1.18	0.16	1.16	13.63
<i>G. oceanica</i>	20	1216	0.58	9.0	9.0	1.54	0.08	1.00	6.76
<i>G. oceanica</i>	20	1476	0.51	8.2	8.1	1.41	0.08	0.99	6.77
<i>G. oceanica</i>	20	1781	0.44	7.1	6.0	1.20	0.05	0.84	6.95
<i>G. oceanica</i>	20	2104	0.36	7.6	7.8	0.76	0.06	1.02	11.65
<i>G. oceanica</i>	25	26	0.21	1.5	1.7	0.39	0.02	1.11	4.54
<i>G. oceanica</i>	25	58	0.47	4.0	7.5	0.91	0.06	1.85	5.19
<i>G. oceanica</i>	25	288	1.13	14.3	28.0	2.34	0.30	1.96	7.14
<i>G. oceanica</i>	25	318	1.13	-	-	-	-	-	-
<i>G. oceanica</i>	25	447	1.10	-	-	-	-	-	-
<i>G. oceanica</i>	25	612	1.11	-	-	-	-	-	-
<i>G. oceanica</i>	25	771	1.07	-	-	-	-	-	-
<i>G. oceanica</i>	25	980	1.15	12.2	18.4	2.05	0.18	1.51	6.92
<i>G. oceanica</i>	25	1284	0.99	14.5	19.0	2.56	0.22	1.31	6.62
<i>G. oceanica</i>	25	1731	0.85	11.3	12.0	2.08	0.15	1.07	6.30
<i>G. oceanica</i>	25	2067	0.61	11.0	10.4	1.75	0.10	0.95	7.32
<i>G. oceanica</i>	25	3517	0.69	10.4	10.7	1.73	0.12	1.02	7.02
