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 μmol photons m^{-2} s^{-1}, light:dark = 14 : 10 h, replicates = 3
Seawater Sr/Ca = 8.42 ± 0.30, Mg/Ca = 5.29 ± 0.15

Species	T	pCO_2	pH	Ω	DIC	TA	CO_2	HCO_3^-	CO_3^{2-}
	°C	μatm	total scale		μmol kg^{-1}			μmol kg^{-1}	
C. braarudii	10	417 ± 15	8.04 ± 0.03	3.29 ± 0.38	2139 ± 19	2322 ± 9	18 ± 1	1984 ± 33	137 ± 16
C. braarudii	15	320 ± 17	8.15 ± 0.02	5.00 ± 0.18	2107 ± 8	2393 ± 5	12 ± 1	1887 ± 15	208 ± 8
C. braarudii	18	501 ± 30	7.99 ± 0.02	4.12 ± 0.17	2182 ± 8	2408 ± 7	17 ± 1	1993 ± 13	172 ± 7
C. quadriperforatus	15	308 ± 2	8.17 ± 0.01	5.33 ± 0.03	2149 ± 2	2453 ± 2	12 ± 1	1915 ± 2	222 ± 1
C. quadriperforatus	18	451 ± 45	8.04 ± 0.03	4.66 ± 0.24	2221 ± 8	2478 ± 7	16 ± 2	2012 ± 17	194 ± 10
C. quadriperforatus	20	316 ± 46	8.15 ± 0.03	4.10 ± 0.23	2115 ± 7	2351 ± 17	14 ± 1	1930 ± 10	171 ± 9
E. huxleyi	10	276 ± 6	8.21 ± 0.01	4.75 ± 0.26	2151 ± 13	2425 ± 6	12 ± 1	1941 ± 19	198 ± 7
E. huxleyi	15	306 ± 5	8.17 ± 0.01	5.30 ± 0.05	2133 ± 3	2436 ± 1	12 ± 1	1901 ± 5	221 ± 2
E. huxleyi	20	400 ± 41	8.07 ± 0.03	5.15 ± 0.27	2126 ± 5	2415 ± 12	13 ± 1	1899 ± 15	214 ± 11
E. huxleyi	25	427 ± 30	8.05 ± 0.03	5.97 ± 0.31	2140 ± 10	2470 ± 14	12 ± 1	1882 ± 20	246 ± 13

Experiment 2: North Sea water, salinity = 34, light = 130 μmol photons m^{-2} s^{-1}, light:dark = 14 : 10 h, replicates = 2
Seawater Sr/Ca = 8.42 ± 0.30, Mg/Ca = 5.29 ± 0.15

Species	T	pCO_2	pH	Ω	DIC	TA	CO_2	HCO_3^-	CO_3^{2-}
	°C	μatm	total scale		μmol kg^{-1}			μmol kg^{-1}	
E. huxleyi	10	193 ± 3	8.35 ± 0.01	6.36 ± 0.07	2150 ± 1	2520 ± 3	9 ± 1	1876 ± 4	265 ± 3
E. huxleyi	10	467 ± 9	7.99 ± 0.01	2.99 ± 0.06	2148 ± 1	2311 ± 3	21 ± 1	2002 ± 2	125 ± 2
E. huxleyi	10	699 ± 5	7.82 ± 0.01	2.05 ± 0.01	2143 ± 1	2240 ± 1	31 ± 1	2027 ± 1	85 ± 1
E. huxleyi	10	898 ± 24	7.72 ± 0.01	1.60 ± 0.04	2138 ± 1	2199 ± 2	39 ± 1	2032 ± 2	67 ± 2
E. huxleyi	10	1238 ± 23	7.58 ± 0.01	1.16 ± 0.02	2131 ± 1	2150 ± 2	54 ± 1	2028 ± 1	48 ± 1

E. huxleyi	20	175 ± 1	8.39 ± 0.01	9.76 ± 0.01	2139 ± 1	2689 ± 1	6 ± 1	1728 ± 1	405 ± 1
E. huxleyi	20	365 ± 4	8.11 ± 0.01	5.60 ± 0.05	2135 ± 1	2449 ± 3	12 ± 1	1891 ± 1	232 ± 2
E. huxleyi	20	690 ± 12	7.85 ± 0.01	3.24 ± 0.04	2135 ± 1	2305 ± 3	22 ± 1	1978 ± 2	135 ± 2
E. huxleyi	20	812 ± 20	7.78 ± 0.01	2.76 ± 0.05	2118 ± 3	2257 ± 1	26 ± 1	1978 ± 5	114 ± 2
E. huxleyi	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 = $130\,\mu\mathrm{mol\,photons\,m^{-2}\,s^{-1}}$, light:dark = $16:08\,\mathrm{h}$, replicates = 3
Seawater Sr/Ca = 8.42 ± 0.30, Mg/Ca = 5.29 ± 0.15

Species	T	pCO_2	pH	Ω	DIC	TA	CO_2	HCO_3^-	CO_3^{2-}
	°C	μatm	total scale		$\mu\mathrm{mol\,kg^{-1}}$			$\mu\mathrm{mol\,kg^{-1}}$	
C. braarudii	17	524 ± 27	7.95 ± 0.02	3.33 ± 0.12	2056 ± 7	2242 ± 6	18 ± 1	1899 ± 11	139 ± 6
C. braarudii	17	1151 ± 130	7.61 ± 0.05	1.57 ± 0.21	2046 ± 21	2105 ± 29	41 ± 5	1939 ± 19	66 ± 8
C. braarudii	17	1799 ± 257	7.42 ± 0.06	1.00 ± 0.10	2037 ± 28	2038 ± 16	63 ± 9	1931 ± 25	42 ± 5
C. braarudii	17	2311 ± 122	7.31 ± 0.02	0.80 ± 0.01	2052 ± 18	2021 ± 12	81 ± 4	1938 ± 15	33 ± 1
C. braarudii	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 = $150\,\mu\mathrm{mol\,photons\,m^{-2}\,s^{-1}}$, light:dark = $16:08\,\mathrm{h}$, replicates = 1
Seawater Sr/Ca = 9.66 ± 0.21, Mg/Ca = 5.43 ± 0.13

Species	T	pCO_2	pH	Ω	DIC	TA	CO_2	HCO_3^-	CO_3^{2-}
	°C	μatm	free scale		$\mu\mathrm{mol\,kg^{-1}}$			$\mu\mathrm{mol\,kg^{-1}}$	
G. oceanica	20	25	8.90	14.83	1421	2340	1	800	620
G. oceanica	20	59	8.66	11.64	1581	2296	2	1092	487
G. oceanica	20	108	8.48	9.35	1719	2288	4	1324	391
G. oceanica	20	280	8.17	5.88	1942	2291	9	1687	246
G. oceanica	20	413	8.04	4.58	2014	2280	13	1809	192
G. oceanica	20	574	7.91	3.63	2065	2268	19	1895	152
G. oceanica	20	764	7.81	2.95	2122	2278	25	1974	123

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

Experiment 1: North Sea water, salinity = 34, light = 180 μmol photons m^{-2} s^{-1}, light:dark = 14 : 10 h, replicates = 3
Seawater Sr/Ca = 8.42 ± 0.30, Mg/Ca = 5.29 ± 0.15

Species	T	pCO_2	growth rate	POC_{prod}	PIC_{prod}	TPN_{prod}	$Chla_{prod}$	PIC:POC	POC:TPN
	°C	μatm	d^{-1}	pgC $cell^{-1}day^{-1}$		pgN $cell^{-1}day^{-1}$	pgChla $cell^{-1}day^{-1}$	mol/mol	
C. braarudii	10	417 ± 15	0.38 ± 0.01	149 ± 8	75 ± 1	18.8 ± 1.1	2.33 ± 0.22	0.50 ± 0.03	9.27 ± 0.37
C. braarudii	15	320 ± 17	0.52 ± 0.01	155 ± 6	120 ± 10	16.0 ± 0.1	4.07 ± 0.42	0.78 ± 0.09	11.25 ± 0.45
C. braarudii	18	501 ± 30	0.56 ± 0.01	205 ± 5	137 ± 6	20.2 ± 0.3	5.43 ± 0.22	0.67 ± 0.04	11.84 ± 0.14
C. quadriperforatus	15	308 ± 2	0.51 ± 0.01	28.6 ± 2.4	40.9 ± 0.7	7.84 ± 1.44	0.91 ± 0.37	1.43 ± 0.12	4.31 ± 0.52
C. quadriperforatus	18	451 ± 45	0.54 ± 0.01	44.9 ± 7.2	54.4 ± 6.1	5.10 ± 0.53	0.44 ± 0.12	1.23 ± 0.24	10.25 ± 1.21
C. quadriperforatus	20	316 ± 46	0.64 ± 0.01	55.8 ± 1.1	72.8 ± 1.1	5.92 ± 0.06	1.16 ± 0.06	1.31 ± 0.01	10.99 ± 0.13
E. huxleyi	10	276 ± 6	0.53 ± 0.01	12.2 ± 0.52	5.81 ± 0.17	2.21 ± 0.13	0.59 ± 0.02	0.48 ± 0.01	6.43 ± 0.09
E. huxleyi	15	306 ± 5	1.03 ± 0.01	8.21 ± 0.06	6.27 ± 0.16	1.42 ± 0.09	0.27 ± 0.01	0.76 ± 0.01	6.76 ± 0.47
E. huxleyi	20	400 ± 41	1.24 ± 0.01	5.56 ± 0.04	5.05 ± 0.04	0.96 ± 0.01	0.22 ± 0.01	0.91 ± 0.01	6.75 ± 0.07
E. huxleyi	25	427 ± 30	1.34 ± 0.01	7.31 ± 0.16	7.72 ± 0.19	1.11 ± 0.06	0.27 ± 0.01	1.06 ± 0.01	7.66 ± 0.42

Experiment 2: North Sea water, salinity = 34, light = 130 μmol photons m^{-2} s^{-1}, light:dark = 14 : 10 h, replicates = 2
Seawater Sr/Ca = 8.42 ± 0.30, Mg/Ca = 5.29 ± 0.15

Species	T	pCO_2	growth rate	POC_{prod}	PIC_{prod}	TPN_{prod}	$Chla_{prod}$	PIC:POC	POC:TPN
	°C	μatm	d^{-1}	pgC $cell^{-1}day^{-1}$		pgN $cell^{-1}day^{-1}$	pgChla $cell^{-1}day^{-1}$	mol/mol	
E. huxleyi	10	193 ± 3	0.64 ± 0.01	5.78 ± 0.53	8.10 ± 0.70	0.87 ± 0.06	0.07 ± 0.01	1.40 ± 0.01	7.81 ± 1.27
E. huxleyi	10	467 ± 9	0.65 ± 0.01	5.48 ± 0.07	8.21 ± 0.25	0.79 ± 0.03	0.07 ± 0.01	1.50 ± 0.03	8.09 ± 0.36
E. huxleyi	10	699 ± 5	0.63 ± 0.01	5.33 ± 0.65	7.72 ± 0.04	0.79 ± 0.06	0.07 ± 0.01	1.46 ± 0.17	7.90 ± 0.40
E. huxleyi	10	898 ± 24	0.62 ± 0.01	5.13 ± 0.02	6.68 ± 0.54	0.73 ± 0.01	0.06 ± 0.01	1.30 ± 0.10	8.17 ± 0.06
E. huxleyi	10	1238 ± 23	0.57 ± 0.01	5.11 ± 0.09	5.70 ± 0.77	0.69 ± 0.02	0.06 ± 0.01	1.12 ± 0.17	8.59 ± 0.44

E. huxleyi	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
E. huxleyi	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
E. huxleyi	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
E. huxleyi	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
E. huxleyi	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 μmol photons m^{-2} s^{-1}, light:dark = 16 : 08 h, replicates = 3
Seawater Sr/Ca = 8.42 ± 0.30, Mg/Ca = 5.29 ± 0.15

Species	T	pCO_2	growth rate	POC_{prod}	PIC_{prod}	TPN_{prod}	$Chla_{prod}$	PIC:POC	POC:TPN
	°C	μatm	d^{-1}	pgC $cell^{-1}day^{-1}$		pgN $cell^{-1}day^{-1}$	pgChla $cell^{-1}day^{-1}$	mol/mol	
C. braarudii	17	524 ± 27	0.63 ± 0.06	215 ± 14	335 ± 24	24.5 ± 1.8	-	1.60 ± 0.17	8.33 ± 0.46
C. braarudii	17	1151 ± 130	0.57 ± 0.06	289 ± 94	346 ± 115	25.8 ± 9.2	-	1.37 ± 0.70	7.80 ± 0.78
C. braarudii	17	1799 ± 257	0.43 ± 0.06	140 ± 6	82 ± 39	5.6 ± 2.8	-	0.57 ± 0.31	9.40 ± 0.20
C. braarudii	17	2311 ± 122	0.13 ± 0.06	89 ± 17	22 ± 16	1.5 ± 1.4	-	0.27 ± 0.29	7.10 ± 0.70
C. braarudii	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 μmol photons m^{-2} s^{-1}, light:dark = 16 : 08 h, replicates = 1
Seawater Sr/Ca = 9.66 ± 0.22, Mg/Ca = 5.43 ± 0.14

Species	T	pCO_2	growth rate	POC_{prod}	PIC_{prod}	TPN_{prod}	$Chla_{prod}$	PIC:POC	POC:TPN
	°C	μatm	d^{-1}	pgC $cell^{-1}day^{-1}$		pgN $cell^{-1}day^{-1}$	pgChla $cell^{-1}day^{-1}$	mol/mol	
G. oceanica	20	25	0.29	5.6	6.6	1.24	0.06	1.18	5.23
G. oceanica	20	59	0.54	6.2	13.4	0.53	0.12	2.17	13.65
G. oceanica	20	108	0.82	12.2	24.6	0.94	0.23	2.02	15.16
G. oceanica	20	280	1.00	14.3	26.0	1.14	0.24	1.81	14.68
G. oceanica	20	413	1.06	12.2	21.0	0.97	0.23	1.73	14.70
G. oceanica	20	574	1.05	12.7	20.3	1.01	0.23	1.59	14.74
G. oceanica	20	764	0.88	16.7	19.7	1.18	0.22	1.18	16.46

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