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Over-calcified forms of the coccolithophore *Emiliania huxleyi* in high-CO_2 waters are not preadapted to ocean acidification

Peter von Dassow et al.

Correspondence to: Peter von Dassow (pvondassow@bio.puc.cl)

Supplementary Section S1

Variation in relative abundance of E. huxleyi morphotypes with depth.

We note that the dominant morphotype of *Emiliania huxleyi* was usually the same at the surface and deeper in the water column (Fig. S1-S2). One exception was a station near Punta Lengua de Vaca (Tongoy Station 18) where lightly calcified morphotypes dominated below the thermocline and R/overcalcified morphotypes dominated above (Fig. S1f). Another exception was the station 2 in the JF survey, where the lightly calcified morphotypes were dominant within and below the picnocline but the A morphotype was dominant, although at the lower total abundance (Fig. S1h). Table S3 (Supplementary section S4) gives abundances with depth at the stations shown in Fig. S1-S2.

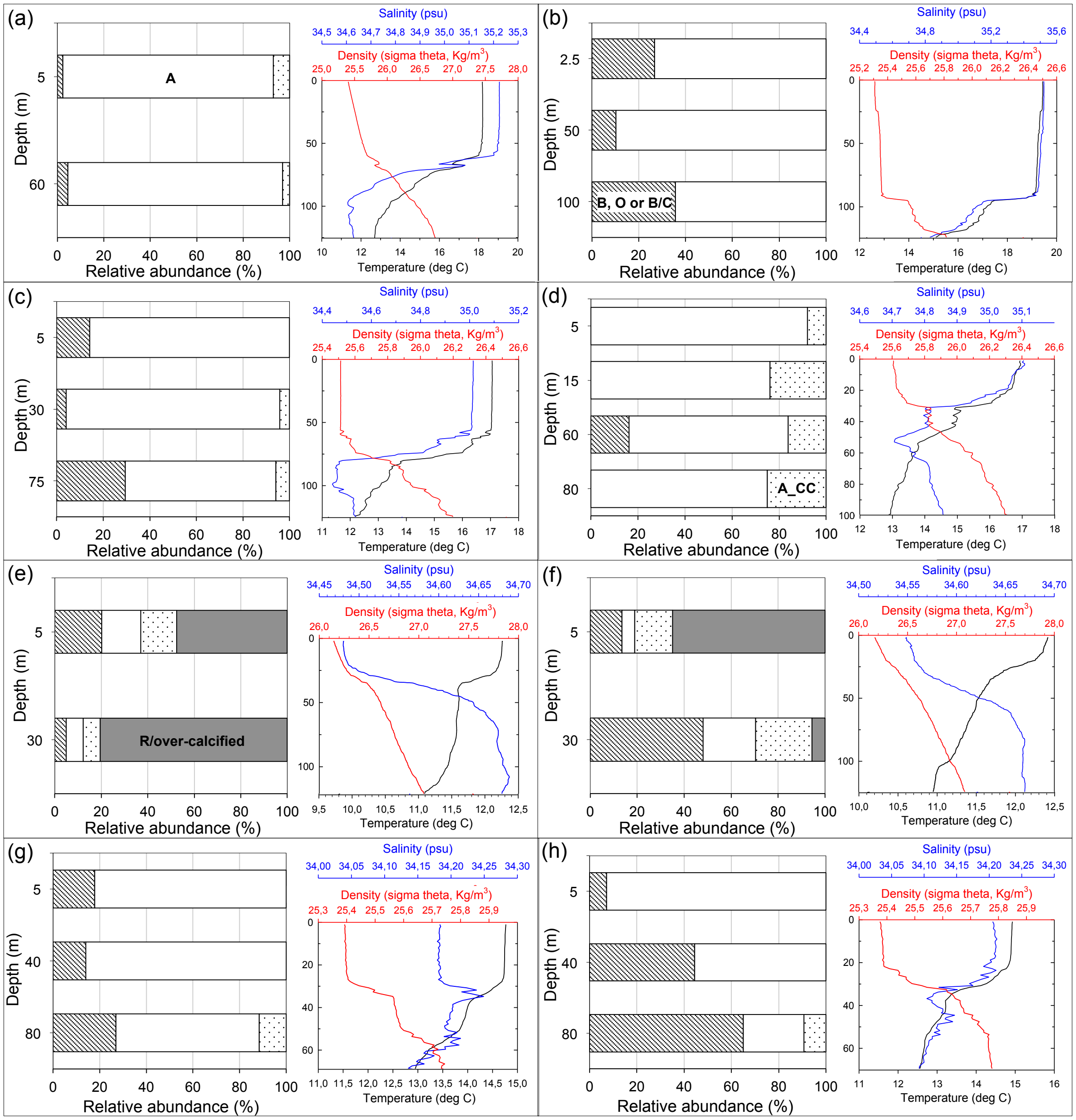

Figure S1. Relative abundances of *Emiliania huxleyi* morphotypes in the upper water column by study site. In a-d), e-f) and g-h) the relative abundances yielded by *E. huxleyi* morphotypes in NBP cruise (st. H04, H13, H19, BB2f), Tongoy Bay (st. 01 and 18) and Juan Fernandez surveys (st. 01, 02) are shown, respectively. Temperature (black), salinity (blue) and density (red) profiles for each station are shown at the right. Morphotypes are indicated on the bars.

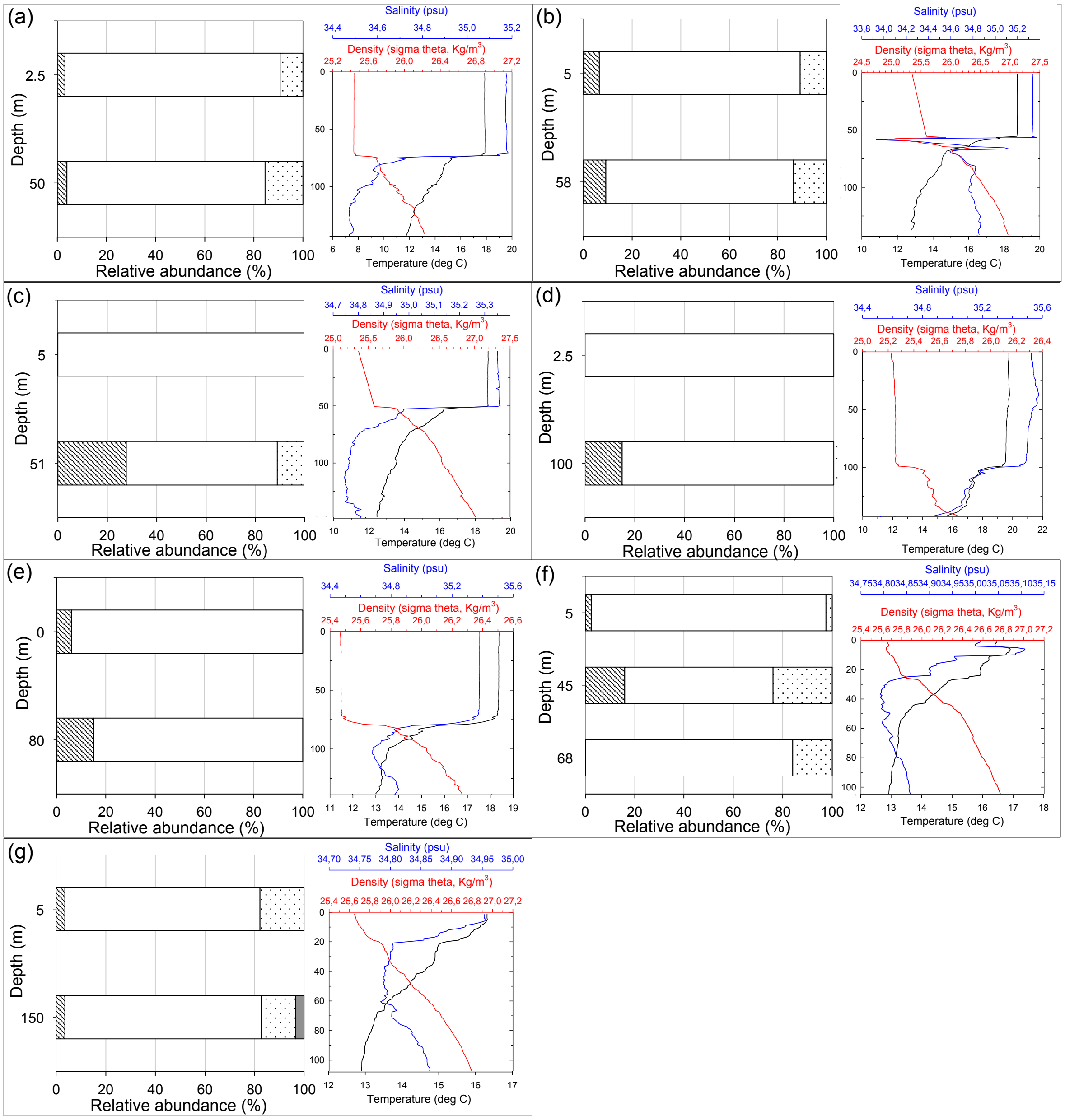

Figure S2. Relative abundances of *Emiliania huxleyi* morphotypes in the upper water column. In a-g) the relative abundances yielded by *E. huxleyi* morphotypes in NBP cruise (st. H01, BB1a, BB1b, H10, H17, BB2b, BB2c) are shown in panels a-g. Temperature (black), salinity (blue) and density (red) profiles for each station are shown at the right. Morphotypes are as in Fig. S1. A conductivity sensor error in BB1a caused a spike that was not filtered out successfully.

Supplementary Section S2

Redundancy analysis (RDA) methodology used and RDA results for Emiliania huxleyi morphotype distributions constrained by environmental variables.

To determine the abiotic variables driving the *Emiliania huxleyi* populations a redundancy analysis (RDA) was performed (rda function in vegan package Oksanen et al., 2007, performed in RStudio version 1.0.143 for mac OS). RDA is a direct constrained method that combine multivariate multiple linear regression with principal component analysis (Borcard et al., 2011). To RDA analyses we followed the methodology provide by Borcard et al. (2011). The variation in *E. huxleyi* morphotypes (matrix composed by relative abundances) were regressed on environmental conditions (temperature, salinity and pCO2), while controlling for sampling location (vector of offshore distances in km). To test for significance of RDA model and axis the pseudo-F statistic was calculated by set a minimal number of 1,000 sample permutations (Borcard et al., 2011). As linear dependencies between environmental variables can inflated the regression coefficient (Borcard et al., 2011), variance inflation factors were checked after each RDA analysis (vif.cca function in vegan package). RDA results are plotted in Fig. S3.

References.

Borcard, D., Gillet, F. and Legendre, P. 2011. Numerical ecology with R. Springer Science+Business Media. pp. 306.

Oksanen, J., Blanchet, F., Kindt, R., Legendre, P., Minchin, P., O'Hara, R., Simpson, G., Solymos, P., Stevens, M. and Wagner, H. 2007. Vegan: Community Ecology Package. R package version 2.3-1. Available at: https://cran.r-project.org/web/packages/vegan/index.html (last accessed 16 July 2017).

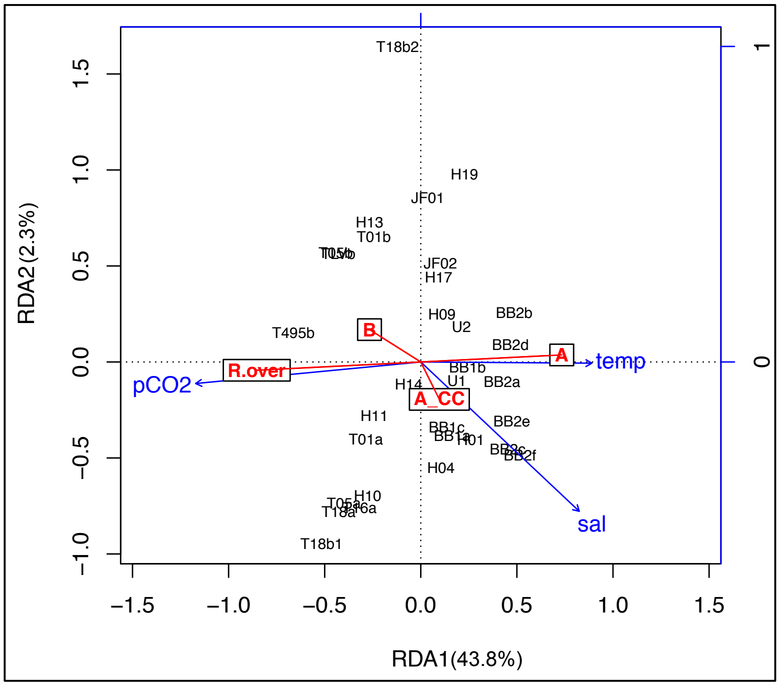

Figure S3. Redundancy analysis results for *Emiliania huxleyi* morphotype distributions constrained by environmental variables. The relative abundances of *E. huxleyi* morphotypes (red labels) from surface stations (black labels) were constrained by three environmental variables (blue arrows). Percentage of variance explained by each RDA axis are displayed. Only the first RDA axis appeared to be significant ($p < 0.05$). RDA triplot was performed with site scores and scaling 2.

Supplementary Section S3

Measured alkalinity change versus alkalinity changes predicted from PIC and nutrient consumption.

All carbonate system parameters are provided in Supplementary Table S1. Precipitation of 1 mole of $CaCO_3$ should consume 2 moles of alkalinity. Thus there should be a linear relationship between PIC production and alkalinity decrease (Zeebe and Wolf-Gladrow, 2003). In an initial analysis we observed that alkalinity decreases in strain CHC342 at the control (400 µatm) CO_2 treatment were higher than expected (-421.4 ± 32.2 µmol kg^{-1}). Over all strains and all treatments, observed alkalinity decreases were significantly linearly related ($R^2 = 0.594$, $p < 0.0001$ for difference from a slope of 0) to the expected alkalinity decreases calculated as twice the PIC contents (in µmole kg^{-1}). However, the slope between observed and expected alkalinity change was significantly greater than 1 (slope 1.54 ± 0.22, 95% confidence interval 1.09 to 1.99). Visual inspection indicated that all replicates from strain CHC342 at the control CO_2 treatment, and three out of four replicates from strain CHC440 at the control treatment, but no other samples, were above the 95% confidence interval for the regression. We performed the regression again, eliminating all samples of CHC342 and CHC440 (both control and high CO_2/low pH treatments). In that case, there was also a significant linear relationship between observed and expected alkalinity decreases ($R^2 = 0.73$, $p < 0.0001$), but the slope was not significantly different from 1 (slope 0.89 ± 0.13, 95% confidence interval 0.62 to 1.17) (curve not shown).

Smaller alkalinity changes are also associated with the uptake of nutrients by phytoplankton (Zeebe and Wolf-Gladrow, 2003): Assuming most phosphate is in the form HPO_4^{2-} at the experimental pH, alkalinity should decrease by one mole for every mole of phosphate consumed. Alkalinity should increase by one mole for every nitrate consumed. Nutrient data is not available (samples were taken but lost in transit). However, when nutrients are not limiting, nitrate and phosphate are consumed (and particulate organic N and particulate organic P is formed) in approximately Redfield ratios with C, while N and P quotas are decreased under nutrient limitation (e.g., Rokitta et al., 2014, 2016). A corrected estimation of expected alkalinity change was calculated as:

$$\text{Expected } \Delta_{\text{alkalinity}} = -2\text{xPIC} - \text{POC}/106 + \text{POC}/6.625,$$

where PIC, POC, and alkalinity values are in µmol kg^{-1}. This estimation lacks precision. For example, if PIC is underestimated, POC is overestimated, so the correction will be overestimated. However, it aids in determining whether or not the correction could improve the match between expected and observed alkalinity. When all data is considered, the slope is 1.62 ± 0.24 ($R^2 = 0.58$, $p < 0.0001$) (Fig. S4). The slope is significantly greater than one (95% confidence interval 1.13 to 2.11), and the y-intercept is not significantly different from 0 (9.94 ± 22.5, 95% confidence interval -35.8 to 55.6). When data from strains CHC342 and CHC440 are excluded, there is also a significant relationship, with slope = 0.920 ± 0.140 ($R^2 = 0.717$, $p < 0.0001$) (Fig. S4). The slope is not significantly different from 0 (95% confidence interval 0.62 to 1.22) and the y-intercept is also not significantly different from 0 (-0.96 ± 11.93, 95% confidence interval -26.1 to 24.2). More importantly, the correction did not decrease the difference between measured and expected alkalinity changes for either strains CHC342 or CHC440 under the control CO_2/pH condition.

Table S1. Complete carbonate system parameters during the experiment. Means (Ave) ± standard deviations of experimental replicates at the time of inoculation (Initial and harvesting (Final) are given. pH at the experimental temperature is calculated from measured pH at 25° C. Treatment is specified by CO_2 partial pressure (μatm) of air:CO_2 mix. $p$$CO_2$ units are μatm, alkalinity, [CO_2], [HCO_3^-], and [CO_3^{2-}] units are μmol kg^{-1}. "na" indicates data not available.

Strain	Treatment		pCO2				alkalinity				pH				[CO_2] dissolved				[HCO_3^-]				[CO_3^{2-}]				Omega-Ca			
			Initial		Final		Initial		Final		Initial		Final		Initial		Final		Initial		Final		Initial		Final		Initial		Final	
			Ave	Stan dev	Ave	Stan dev	Ave	Stan dev	Ave	Stan dev	Ave	Stan dev	Ave	Stan dev	Ave	Stan dev	Ave	Stan dev	Ave	Stan dev	Ave	Stan dev	Ave	Stan dev	Ave	Stan dev	Ave	Stan dev	Ave	Stan dev
342	380	cont.	399.0		386.4		2262		2268		8.041		8.053		14.92		14.43		1881		1875		153.4		158.1		3.665		3.770	
		cult.	422.0	38.2	332.4	4.3	2260	7	1839	25	8.020	0.033	8.029	0.010	15.76	1.45	12.42	0.17	1892	29	1524	16	148.1	9.6	121.1	4.1	3.531	0.225	2.891	0.097
	1200	cont.	1230		1279		2273		2268		7.604		7.586		50.79		47.78		2117		2117		62.7		60.8		1.500		1.451	
		cult.	1314	26.7	1257	36.4	2264	5	2207	19	7.574	0.008	7.582	0.010	49.36	1.03	46.92	1.32	2118	5	2060	20	58.6	1.1	58.7	0.9	1.402	0.026	1.400	0.022
352	380	cont.	418.5		373.4		2289		2294		8.027		8.071		16.18		14.30		1927		1896		145.9		160.6	0.0	3.483		3.835	
		cult.	402.5	5.9	370.0	na	2292	13	2168	na	8.042	0.005	8.035	0.021	15.56	0.23	14.17	na	1918	12	1801	na	150.4	1.7	146.4	na	3.591	0.041	3.494	na
	1200	cont.	1270		1260		2278		2138		7.589		7.595		47.88		48.27		2132		2138		58.9		60.5		1.406		1.444	
		cult.	1226	27.6	1341	64.6	2274	12	2261	20	7.601	0.007	7.561	0.018	47.58	1.06	51.37	2.48	2124	13	2122	20	60.3	0.6	56.1	2.4	1.440	0.015	1.339	0.057
360	380	cont.	423.6				2260				8.018				15.37				1884				151.6				3.623			
		cult.	441.4	18.7	457.4	47.7	2270	6	2126	7	8.005	0.016	7.965	0.040	16.00	0.67	16.64	1.78	1901	0	1799	25	148.8	8.7	129.5	11.8	3.552	0.105	3.079	0.270
	1200	cont.	na		1336		2264		2248		na		7.564		na		48.86		na		2100		na		59.4		na		1.416	
		cult.	1186	94.7	1409	156.3	2289	10	2254	4	7.623	0.033	7.545	0.043	42.98	3.39	51.46	5.80	2118	19	2111	17	69.1	4.4	57.6	5.5	1.648	0.107	1.370	0.128
428	380	cont.	432.2		419.4		2255		2250		8.009		8.019		15.65		15.38		1883		1876		149.4		150.1		3.564		3.579	
		cult.	440.3	21.5	418.5	12.9	2261	6	2157	19	8.004	0.018	8.004	0.010	15.95	0.78	15.34	0.47	1893	15	1807	20	148.3	4.9	139.6	2.3	3.537	0.117	3.328	0.035
	1200	cont.	1191		1285		2256		2268		7.614		7.585		43.13		47.09		2090		2114		66.8		62.2		1.594		1.483	
		cult.	1259	6.4	1247	30.6	2262	4	2250	5	7.592	0.002	7.592	0.009	45.76	0.23	45.87	1.13	2104	4	2094	8	63.8	0.3	62.7	1.1	1.521	0.007	1.494	0.027
440	380	cont.	496.6		407.8		2260		2281		7.958		8.060		18.78		15.33		1940		1932		129.0		144.5		3.077		3.610	
		cult.	457.4	26.0	381.6	5.6	2254	6	2114	17	7.988	0.021	8.033	0.005	17.30	0.98	13.84	0.29	1915	16	1751	7	136.6	5.3	144.8	5.5	3.259	0.127	3.469	0.104
	1200	cont.	1455		1290		2270		2274		7.533		7.586		54.77		46.61		2137		2117		53.6		63.4		1.278		1.514	
		cult.	1486	32.2	1249	55.0	2261	5	2235	7	7.522	0.009	7.591	0.019	56.18	1.21	45.05	1.82	2131	6	2077	7	52.1	0.9	63.5	1.8	1.243	0.022	1.512	0.050

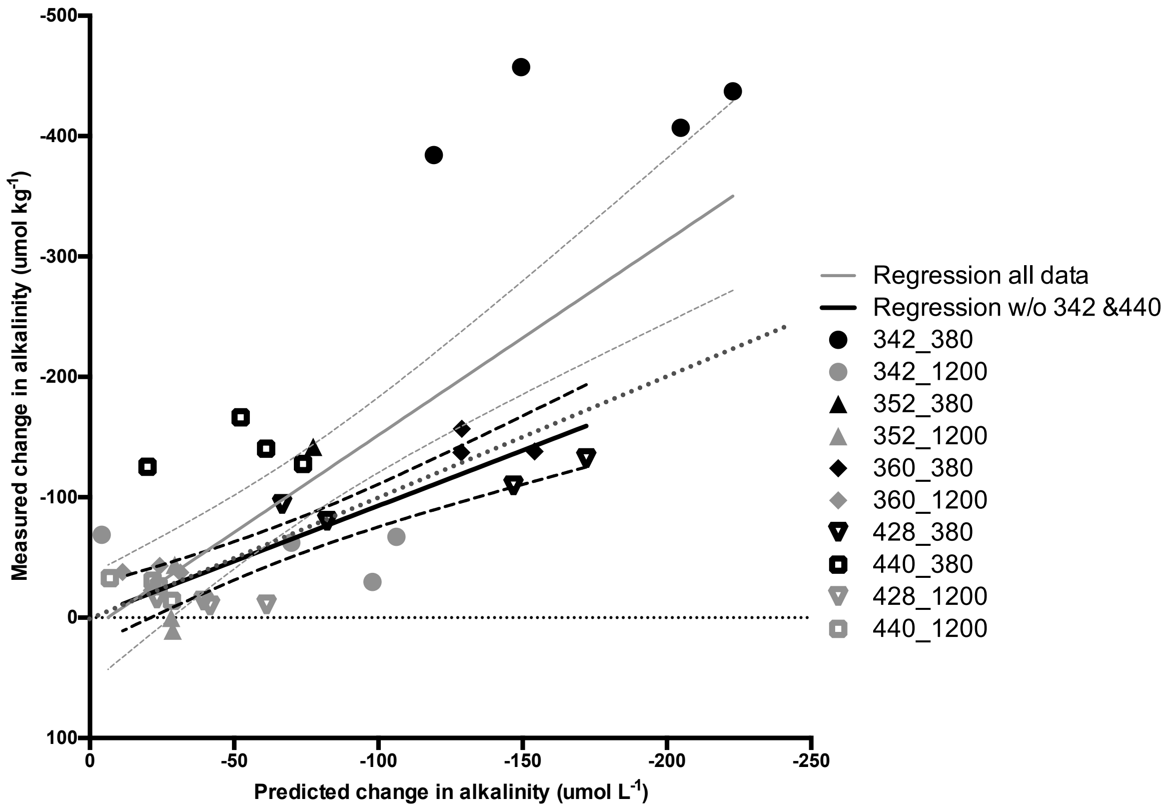

Figure S4. Measured change in alkalinity versus change in alkalinity predicted from measured PIC and POC. The grey continuous line represents the linear regression considering all data, with the grey dashed lines representing the 95% confidence interval of the regression. The black continuous and dashed lines similarly represent the linear regression and 95% confidence interval when data from strains CHC342 and CHC440 is left out. The dotted black line represents the 1:1 relationship between observed and predicted alkalinity change.

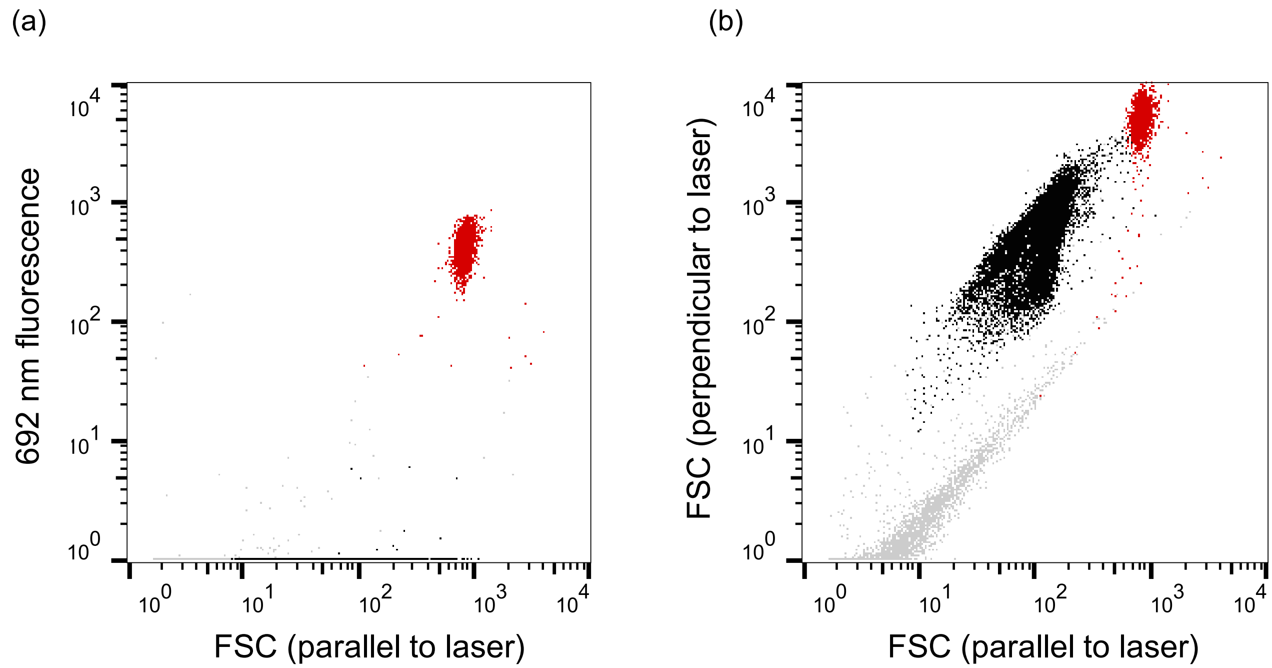

Figure S5: Example flow cytograms (of CHC352 at 400 µatm CO2) showing identification of chlorophyll-containing (red fluorescent cells) in plot of 692 nm (40 nm band pass) fluorescence (y-axis) vs forward scatter with polarization parallel to laser (FSC) (a) and cytogram of scatter depolarization (FSC with polarization perpendicular to laser vs FSC with polarization parallel to laser) (b). Chlorophyll-containing cells are represented by red dots, black dots represent detached coccoliths, and grey dots represent other particles, which are mostly not optically active and fall on a straight line in panel b.

Supplementary Section S4

Environmental paramenters and associated coccolithophore absolute counts, and taxonomic occurrences and relative abundances.

Table S2. Environmental and biological data for the Eastern South Pacific corresponding to spring 2011 (JF and TONa surveys), spring 2012 (TONb,c and QUI surveys), and winter 2013 (NBP 1305 cruise) periods.

Station ID	Latitude (South)	Longitude (West)	Z (m)	Offshore distance (km)	Temp. (ºC)	Sal. (PSU)	pCO_2 (µatm)	pH	CO_3^{2-} (µmol kg SW^{-1})	Ωcal	Coccolith. abundances (cells L^{-1})	*E. huxleyi* morphotypes rel. abundances (%)			
												B, O, B/C	A	A_CC	R/over-calcified
JF01	-33.596	-78.630	5	650	14.76	34.18	353.9	8.09	164.1	3.93	29721	17.9	82.1	0.0	0.0
JF02	-33.660	-78.602	5	645	14.91	34.21	333.5	8.11	173.2	4.15	3336	7.1	92.9	0.0	0.0
TON01a	-30.117	-71.619	5	23	12.25	34.48	718.0	7.81	87.9	2.10	25677	20.2	16.7	15.5	47.6
TON05a	-30.181	-71.573	5	11	12.72	34.49	658.9	7.85	97.2	2.32	16579	16.7	6.3	18.8	58.3
TON16	-30.248	-71.650	5	1	12.35	34.54	614.0	7.88	103.3	2.47	13614	16.2	10.8	21.6	51.4
TON18a	-30.247	-71.694	5	6	12.40	34.55	620.8	7.87	101.9	2.43	5762	13.5	5.4	16.2	64.9
TON01b	-30.117	-71.619	5	23	14.10	33.83	635.2	7.86	101.7	2.44	42660	44.8	18.4	5.7	31.0
TON05b	-30.181	-71.573	5	11	13.90	34.18	637.7	7.86	103.4	2.47	76223	42.9	4.8	3.6	48.8
TON18b	-30.247	-71.694	5	6	14.10	34.44	559.7	7.92	117.6	2.81	54185	6.5	2.2	10.8	80.6
TON495c	-30.495	-71.774	5	8	13.54	34.50	809.4	7.77	85.6	2.05	5055	13.6	0.0	9.1	77.3
TONLVc	-30.238	-71.652	5	2	14.40	34.00	723.6	7.82	95.2	2.28	16444	19.3	11.4	1.1	68.2
TON18c	-30.247	-71.694	5	6	14.46	34.60	618.7	7.88	110.1	2.63	21330	54.3	28.3	6.5	10.9
QUI01	-33.379	-71.734	5	4	14.12	34.41	934.0	7.71	77.2	1.84	885	5.0	0.0	5.0	90.0
HYDRO01	-22.216	-74.227	2.5	414	17.88	35.18	396.0	8.06	180.7	4.31	44480	3.1	87.5	9.4	0.0
HYDRO04	-17.092	-78.635	5	701	18.19	35.22	412.2	8.04	177.8	4.24	20117	2.3	90.7	7.0	0.0
BB1a	-13.999	-81.199	5	532	18.75	35.34	413.5	8.04	181.8	4.33	22644	6.5	82.6	10.9	0.0
BB1b	-13.921	-81.277	5	527	18.76	35.35	416.6	8.04	180.9	4.31	10311	0.0	100	0.0	0.0
BB1c	-13.710	-81.389	5	560	18.82	35.39	418.1	8.04	180.9	4.31	19612	8.3	80.6	11.1	0.0
HYDRO09	-12.992	-82.198	5	622	19.24	35.42	405.2	8.05	187.4	4.46	16680	8.6	90.0	1.4	0.0
HYDRO10	-16.749	-85.998	int	1424	19.77	35.53	398.6	8.05	193.8	4.62	43267	0.0	100	0.0	0.0
HYDRO11	-16.749	-84.998	0*	1307	19.77	35.50	409.7	8.04	190.0	4.53	26082	1.9	98.1	0.0	0.0
HYDRO13	-16.750	-83.000	int	1094	19.43	35.52	403.9	8.05	189.7	4.52	33259	26.8	73.2	0.0	0.0
HYDRO14	-16.749	-82.000	0	1010	19.24	35.51	405.9	8.05	188.0	4.48	48119	1.3	98.7	0.0	0.0
HYDRO17	-16.749	-79.000	0	674	18.38	35.38	402.5	8.05	183.0	4.36	42660	6.0	94.0	0.0	0.0
U1	-19.467	-76.150	int	623	17.53	35.14	444.8	8.01	164.9	3.93	23037	0.0	100	0.0	0.0
HYDRO19	-21.499	-73.499	int	355	17.06	35.02	389.7	8.06	175.9	4.20	19829	14.3	85.7	0.0	0.0
U2	-21.502	-73.246	int	329	16.68	34.89	396.0	8.05	171.4	4.09	43547	18.4	71.4	10.2	0.0
BB2a	-20.419	-70.675	int	53	17.20	35.11	448.0	8.01	161.6	3.85	39223	8.2	77.6	14.3	0.0
BB2b	-20.769	-70.659	int	48	16.81	35.09	464.3	8.00	155.3	3.70	48524	2.6	94.9	2.6	0.0
BB2c	-20.755	-70.650	int	47	16.30	34.96	490.7	7.97	145.8	3.48	39270	3.6	78.6	17.9	0.0
BB2d	-20.742	-70.644	int	47	16.69	34.98	467.9	7.99	153.1	3.65	61059	4.4	88.9	6.7	0.0
BB2e	-20.748	-70.657	int	47	17.14	35.10	457.2	8.00	158.9	3.79	55802	2.4	85.4	12.2	0.0
BB2f	-20.718	-70.682	5	52	16.92	35.10	453.0	8.01	160.3	3.82	38881	0.0	92.0	8.0	0.0

na – no available data; no obs. – no observed.
* – bucket; int – onboard uncontaminated seawater intake (onboard running seawater system)

Table S3. Absolute abundances of coccolithophores recorded in stations that appear in Fig. S1-S2.

Station ID	Depth (m)	Total coccolithophore abundances (10^3 cells L^{-1})
H04	5	20.1
	60	17.3
H13	2.5	33.3
	50	33.8
	100	5.0
H19	5	19.8
	30	44.5
	75	17.7
BB2f	5	38.9
	15	26.1
	60	na
	80	na
TON01	5	25.7
	30	7.6
TON18	5	5.8
	30	30.4
JF01	5	29.7
	40	14.7
	80	3.1
JF02	5	3.3
	40	24.5
	80	3.4
H01	2.5	44.5
	50	51.6
BB1a	5	22.6
	58	14.4
BB1b	5	10.3
	51	2.7
H10	2.5	43.3
	100	14.0
H17	0	42.7
	80	13.6
BB2b	5	48.5
	45	2.0
	68	3.1
BB2c	5	39.3
	150	na

na – no available data

Table S4. Taxonomic identification and counts of coccolithophore species.

Cruise or survey		Juan Fernández 2011						Tongoy Bay 2011						Tongoy Bay 2012a			Tongoy Bay 2012b			El Quisco 2012	
Station ID		01			02			01a		05a	16	18a		01b	05b	18b	495	LV	18c	01	
Depth (m)		5	40	80	5	40	80	5	30	5	5	5	30	5	5	5	5	5	5	5	15
Coccolithophore species	Family																				
Emiliania huxleyi	Noelaerhabdaceae	57	57	26	14	18	44	84	41	48	37	37	55	88	86	106	22	88	92	8	12
Gephyrocapsa parvula		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gephyrocapsa ericsonii		7	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gephyrocapsa muellerae		5	11	5	2	1	3	3	1	7	2	13	3	7	17	4	0	4	19	0	0
Gephyrocapsa oceanica		0	0	0	0	0	0	0	1	2	0	0	0	0	1	0	0	0	0	0	0
Rhabdosphaera clavigera	Rhabdosphaeraceae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Palusphaera vandelii		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Discosphaera tubifera		0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acanthoica quattrospina		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Algirosphaera robusta		0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Syracosphaera ossa	Syracosphaeraceae	0	2	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0
Syracosphaera prolongata		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Syracosphaera squamigera		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Syracosphaera molischii		0	0	0	0	0	0	3	0	2	0	0	3	3	0	0	0	2	1	0	0
Syracosphaera pulchra		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Syracosphaera cf. bannockii		0	1	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Syracosphaera histrica		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Syracosphaera anthos		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Syracosphaera lamina		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Michaelsarsia elegans		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ophiaster formosus		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calciosolenia brasiliensis	Calciosoleniaceae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calciosolenia murrayi		0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Oolithotus antillarum	Calcidiscaceae	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Calcidiscus leptoporus		0	1	5	1	0	16	1	0	0	0	0	3	4	0	0	0	0	1	0	0
Hayaster perplexus		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Umbilicosphaera sibogae		0	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Alisphaera unicornis	Alisphaeraceae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alisphaera pinnigera		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Umbellosphaera irregularis	Umbellosphaeraceae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Umbellosphaera tenuis		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pontosphaera syracusana	Pontosphaeraceae	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scyphosphaera apsteinii		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helicosphaera carteri	Helicosphaeraceae	0	1	0	0	0	0	1	0	0	0	0	0	1	2	1	0	0	0	0	0
Helicosphaera hyalina		0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
Pappomonas sp. type 2	Papposphaera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Florisphaera profunda	a	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gladiolithus flabellatus		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coronosphaera mediterranea	b	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Tetralithoides quadrilaminata	c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table S4. Continued.

Cruise		NBP 2013																			
Station ID		H01		H04		BB1a		BB1b		BB1c	H09	H10			H11	H13			H14	H17	
Depth (m)		2.5	50	5	60	5	58	5	51	5	0-70	2.5	60	100	0	2.5	50	100	int	int	80
Coccolithophore species	Family																				
Emiliania huxleyi	Noelaerhabdaceae	33	28	43	67	47	24	19	20	37	71	35	52	69	54	56	87	42	79	50	40
Gephyrocapsa parvula		16	10	38	15	9	6	23	7	24	15	7	3	0	3	3	6	3	7	16	21
Gephyrocapsa ericsonii		21	38	18	13	11	4	12	11	17	15	4	4	5	3	7	7	7	15	40	41
Gephyrocapsa muellerae		2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gephyrocapsa oceanica		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhabdosphaera clavigera	Rhabdosphaeraceae	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Palusphaera vandelii		0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0
Discosphaera tubifera		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acanthoica quattrospina		0	0	0	0	0	0	0	0	0	0	2	0	1	1	1	0	0	0	0	0
Algirosphaera robusta		1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Syracosphaera ossa	Syracosphaeraceae	2	1	0	1	0	0	0	0	1	0	2	0	0	1	1	0	1	1	1	0
Syracosphaera prolongata		1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Syracosphaera squamigera		0	0	2	1	0	0	0	0	0	0	1	0	0	3	0	0	0	0	0	0
Syracosphaera molischii		0	0	0	0	1	0	1	0	0	2	0	0	0	1	0	1	1	0	0	0
Syracosphaera pulchra		0	0	0	0	0	0	0	0	3	0	0	0	1	0	0	0	0	0	0	0
Syracosphaera cf. bannockii		0	0	0	0	0	0	0	1	0	2	2	0	0	0	0	1	1	1	0	0
Syracosphaera histrica		0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Syracosphaera anthos		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Syracosphaera lamina		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Michaelsarsia elegans		1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Ophiaster formosus		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0

Calciosolenia brasiliensis	Calciosoleniaceae	0	0	0	0	1	0	1	0	0	1	0	1	0	1	0	0	0	0	0	0
Calciosolenia murrayi		0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Oolithotus antillarum	Calcidiscaceae	1	2	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	1	1
Calcidiscus leptoporus		0	0	0	1	0	1	4	10	1	2	0	0	0	0	0	0	0	0	0	0
Hayaster perplexus		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Umbilicosphaera sibogae		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alisphaera unicornis	Alisphaeraceae	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alisphaera pinnigera		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Umbellosphaera irregularis	Umbellosphaeraceae	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Umbellosphaera tenuis		0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Pontosphaera syracusana	Pontosphaeraceae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scyphosphaera apsteinii		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helicosphaera carteri	Helicosphaeraceae	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Helicosphaera hyalina		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pappomonas sp. type 2	Papposphaera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Florisphaera profunda	a	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	10	1	0	0
Gladiolithus flabellatus		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Coronosphaera mediterranea	b	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Tetralithoides quadrilaminata	c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0

Table S4. Continued.

Cruise		NBP 2013 (continuation)																		
Station ID		U1	H19			U2	BB2a		BB2b			BB2c	BB2d	BB2e	BB2f					
Depth (m)		int	int	30	75	int	int	88	int	45	68	int	int	int	5	15	30	60	80	100
Coccolithophore species	Family																			
Emiliania huxleyi	Noelaerhabdaceae	11	36	25	36	50	49	26	39	30	25	28	46	41	27	21	34	31	25	20
Gephyrocapsa parvula		21	6	5	4	6	26	21	26	15	17	22	32	30	20	31	19	23	25	18
Gephyrocapsa ericsonii		36	23	38	19	10	25	10	26	10	17	16	18	28	18	11	13	10	9	22
Gephyrocapsa muellerae		0	0	1	2	3	3	4	5	2	4	6	9	2	2	3	4	4	3	0
Gephyrocapsa oceanica		0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	3	1
Rhabdosphaera clavigera	spha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Palusphaera vandelii		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Discosphaera tubifera		0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acanthoica quattrospina		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Algirosphaera robusta		0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Syracosphaera ossa	Syracosphaeraceae	1	4	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Syracosphaera prolongata		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Syracosphaera squamigera		1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Syracosphaera molischii		0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0
Syracosphaera pulchra		0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Syracosphaera cf. bannockii		0	0	1	0	0	0	0	1	0	0	0	2	0	0	1	0	0	0	0
Syracosphaera histrica		0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Syracosphaera anthos		0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Syracosphaera lamina		0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Michaelsarsia elegans		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ophiaster formosus		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calciosolenia brasiliensis	Calciosoleniaceae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calciosolenia murrayi		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oolithotus antillarum	Calcidiscaceae	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Calcidiscus leptoporus		0	2	2	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hayaster perplexus		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Umbilicosphaera sibogae		0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alisphaera unicornis	Alisphaeraceae	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alisphaera pinnigera		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Umbellosphaera irregularis	Umbellosphaeraceae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Umbellosphaera tenuis		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pontosphaera syracusana	Pontosphaeraceae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scyphosphaera apsteinii		0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helicosphaera carteri	Helicosphaeraceae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helicosphaera hyalina		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pappomonas sp. type 2	Papposphaera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Florisphaera profunda	a	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gladiolithus flabellatus		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coronosphaera mediterranea	b	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tetralithoides quadrilaminata	c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

a – nannoliths *incertae sedis*, b – genus *incertae sedis*, c – narrow-rimmed placoliths. int – onboard uncontaminated seawater intake (onboard running seawater system