

Supplementary Information

Sodium and potassium in individual coccoliths of *Gephyrocapsa huxleyi* (*Emiliana huxleyi*)

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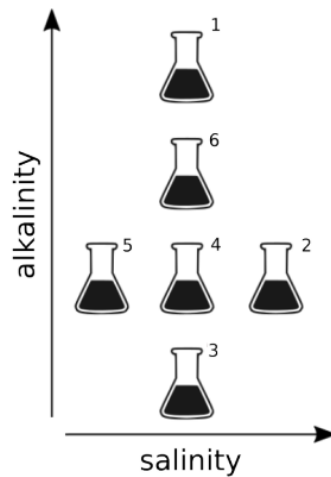


Figure S-1:

Scheme of the culturing media used to grow *E. huxleyi* cells. Salinity and alkalinity were uncoupled during the culture experiments. Salinities varied at a lower-intermediate alkalinity level, while alkalinities varied at an intermediate salinity level. The numbers indicate the culture condition C1–C6.

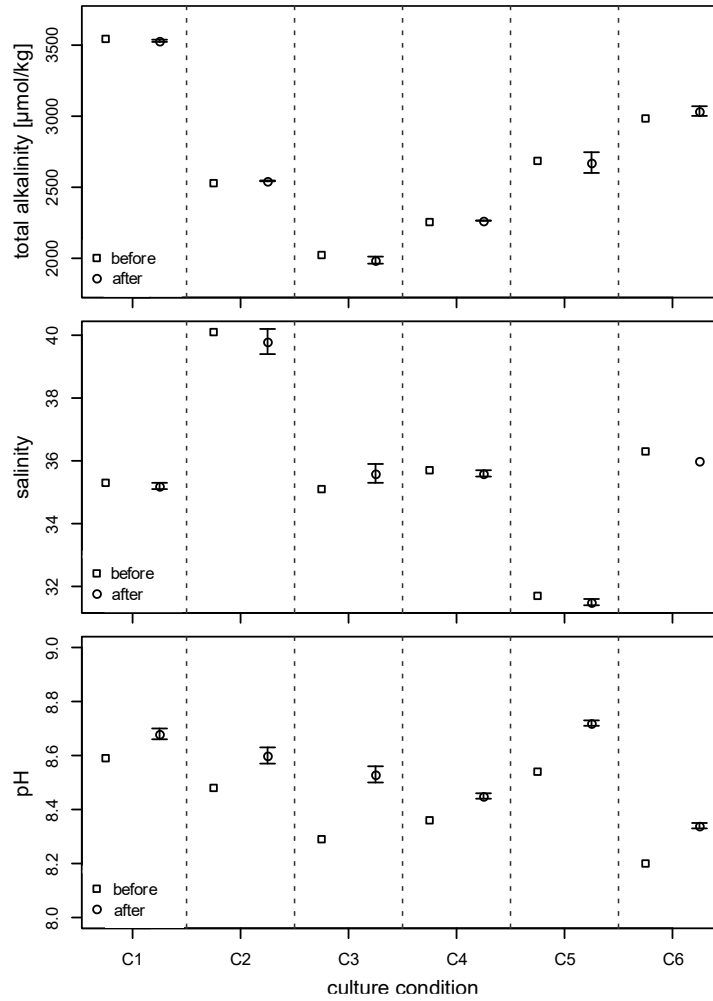


Figure S-2:
Chemical characteristics of the culturing media used to grow *E. huxleyi* cells. Shown are total alkalinity, salinity and pH of the media for the different experimental treatments before (squares) and after (circles) conducting the experiments with *E. huxleyi*. Error bars depict ± 1 SD of triplicate measurements.

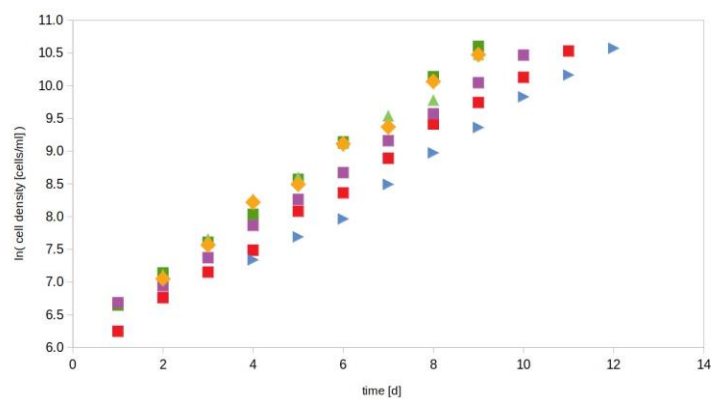


Figure S-3:
Growth of *E. huxleyi* cells. Shown are ln-transformed cell densities of the culture batches over time during the experiment. Specific growth rates per batch, μ in $[\text{d}^{-1}]$, were obtained by regression and are given in Table S-3.

Table S-1:

Results of ANOVA testing for significant differences between samples from cultures and from the field.

ion count ratio	culture samples		field samples	
	<i>F</i> value	<i>p</i> value	<i>F</i> value	<i>p</i> value
$^{23}\text{Na}^+ / ^{44}\text{Ca}^+$	36.1	< 0.01	167.1	< 0.01
$^{24}\text{Mg}^+ / ^{44}\text{Ca}^+$	6.0	< 0.01	35.9	< 0.01
$^{39}\text{K}^+ / ^{44}\text{Ca}^+$	20.1	< 0.01	n.d.	n.d.
$^{88}\text{Sr}^+ / ^{44}\text{Ca}^+$	8.3	< 0.01	7.1	< 0.01
$^{138}\text{Ba}^+ / ^{44}\text{Ca}^+$	171.6	< 0.01	n.d.	n.d.

Table S-2:

Culture conditions of the media. Reported are average values $\pm$ 1 SD of measurements before and after conducting the experiments.

culture condition	pH	alkalinity [mol kg^{-1}]	salinity
C1	8.64 ± 0.06	3537 ± 9	35.3 ± 0.1
C2	8.54 ± 0.08	2537 ± 11	40.0 ± 0.2
C3	8.41 ± 0.17	2005 ± 25	35.4 ± 0.4
C4	8.41 ± 0.06	2260 ± 7	35.6 ± 0.1
C5	8.63 ± 0.13	2680 ± 8	31.6 ± 0.1
C6	8.27 ± 0.10	3010 ± 37	36.2 ± 0.2

Table S-3:

Growth rates of the batch cultures. Specific growth rate, μ in d^{-1} , is the slope of the regression of ln-transformed cell densities (Figure S-3).

culture condition	specific growth rate, μ [d^{-1}]	R^2 †
C1	0.48	0.994
C2	0.46	0.992
C3	0.43	0.998
C4	0.42	0.997
C5	0.43	0.998
C6	0.5	0.999

†For all culture conditions, $p < 0.001$.

Table S-4:

Settings of the NanoSIMS 50L instrument during acquisition of data from different samples.

Measurement session	Aug 2016	Nov & Dec 2016	Jun 2018	Jan 2019
Sample ID [†]	BS-2, EM-2, WM-10	EM-6, WM-1, WM-7, WM-9	C1-C6	C1, C2, C6, BS-2
Pre-sputtering conditions				
Primary ion beam current (in FC ₀)	20 pA (in D1-3)	10 pA (in D1-3)	20 pA (in D1-3)	20 pA (in D1-3)
Diaphragm and slits	D1-1	D1-1	D1-1	D1-1
FOV size [$\mu\text{m} \times \mu\text{m}$]	10 $\times$ 10 to 30 $\times$ 30	10 $\times$ 10 to 30 $\times$ 30	60 $\times$ 60	60 $\times$ 60
Duration [min]	1	2	2-3	5
Image acquisition conditions				
Primary ion beam current (in FC ₀)	20 pA	10 pA	5 pA	10 pA
Diaphragm and slits	D1-3, ES-2	D1-3, ES-2	D1-3, ES-2	D1-3, ES-2
Detected secondary ions	$^{23}\text{Na}^+$, $^{24}\text{Mg}^+$, $^{44}\text{Ca}^+$, $^{88}\text{Sr}^+$	$^{23}\text{Na}^+$, $^{24}\text{Mg}^+$, $^{44}\text{Ca}^+$, $^{88}\text{Sr}^+$	$^{23}\text{Na}^+$, $^{24}\text{Mg}^+$, $^{39}\text{K}^+$, $^{44}\text{Ca}^+$, $^{88}\text{Sr}^+$, $^{138}\text{Ba}^+$	$^{23}\text{Na}^+$, $^{24}\text{Mg}^+$, $^{39}\text{K}^+$, $^{44}\text{Ca}^+$, $^{88}\text{Sr}^+$, $^{138}\text{Ba}^+$
Dwell time [$\mu\text{s pixel}^{-1}$]	1000	1000	1000	1000
FOV size [$\mu\text{m} \times \mu\text{m}$]	7 $\times$ 7 to 20 $\times$ 20	5 $\times$ 5 to 10 $\times$ 10	6 $\times$ 6 to 13 $\times$ 13	6 $\times$ 6 to 13 $\times$ 13
Image size [pixel $\times$ pixel]	128 $\times$ 128, occasionally 64 $\times$ 64 and 256 $\times$ 256	64 $\times$ 64, occasionally 128 $\times$ 128	64 $\times$ 64, occasionally 128 $\times$ 128	64 $\times$ 64
Number of planes	1000	1000	1000	1000

[†]Abbreviations of the field samples (BS = Black Sea, EM = Eastern Mediterranean, WM = Western Mediterranean, sampling station numbers shown in Figure 6) and cultured samples (C, culturing conditions shown in Supplementary Figure S-1 and Table S-2).