

***Interactive comment on “Effects of CO<sub>2</sub>-induced changes in seawater carbonate chemistry speciation on *Coccolithus braarudii*: a conceptual model of coccolithophorid sensitivities” by S. A. Krug et al.***

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1) Why wasn't pressure filtration also used for TA measurements? Wouldn't one expect the loss of CO<sub>2</sub> during vacuum filtration to affect the pH?

Indeed, the loss of CO<sub>2</sub> is higher during vacuum filtration and this affects pH and DIC. But it does not affect TA.

2) How long were the incubations? We will address this point in a revised version of the manuscript as:

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Depending on growth rate the cultures grew for 6-8 days. Only the five highest pCO<sub>2</sub> treatments of the first experiment were incubated for 17 days.

3) Were POC and PIC and cell number measured at both the beginning and end of each experimental period?

For cell abundance see reply to Referee #1 question 4b)

POC and PIC were only measured at the end of the experimental period.

We will clarify this points in the revised version of the manuscript

4) What exactly do the units pg C cell<sup>-1</sup> d<sup>-1</sup> mean in Figure 1a and 1b? Does this mean the change in C uptake divided by the change in cell number over the experimental period (days); i.e., carbon/cells(days); or does it mean the change in C uptake divided by the average of the total number of cells during the experimental period; i.e., carbon/<total cells>(days); or does it mean the total particulate C in the flask divided by the total number of cells in the flask at the end of the experimental period; i.e. C<sub>total</sub>/(cells total)(days)?

Here pg C cell<sup>-1</sup> d<sup>-1</sup> corresponds to the net production rate either by photosynthesis or calcification. For that PIC or POC standing stocks were divided by cell density (n), giving cellular PIC and POC quotas which were then multiplied with the growth rate (d<sup>-1</sup>).

5) POC: Because of the way the data is presented, it is difficult to compare the rate of carbon uptake with the rate of cell multiplication. Is C<sub>organic</sub>/Cells fairly constant over the experimental TA range (after allowing for any change in cell size)?

For our study, the POC and PIC cell quotas are not as representative as the POC and PIC production rates. This is because of changing growth rate. Cells which are growing significantly slower and did not divide during the night are likely to have a larger POC and PIC fraction at the measurement in the morning. Hence, the content per cell could increase but not as a response to OA but due to lower growth rates. For this reason

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the POC content per cell is normalized to the growth rate.

6) Corganic should equal the difference Cphotosynthesis – Crespiration? Under conditions of slowing or no growth, shouldn't Cphotosynthesis decrease faster than Crespiration?

Corganic (measured POC) is the result of net photosynthesis, i.e. gross photosynthesis minus respiration, and DOC production. In this experiment no conclusions on Crespiration neither on DOC production can be drawn.

7) How do rates of respiration and photosynthesis compare in Coccolithus?

See 6)

8) Does slower carbon fixation under some experimental conditions really indicate a direct effect on the photosynthesis machinery (e. g., under saturation of the enzymes or receptors), or do the experimental conditions effect growth rate by another mechanism which in turn effects photosynthetic efficiency (by for example up or down regulating rubisco expression)? This is not an important distinction from the standpoint of the ability of the organism to draw down DIC, but it is relevant to conclusions in the paper which seem to indicate that the experimental conditions are directly effecting the photosynthetic apparatus.

Strictly speaking we do not know. If internal pH is changing it could also affect enzymes other than RUBISCO, which are likely to have individual pH optima. Changes in photosynthesis could then also be brought about by adjusting the demand for fixed carbon to an overall slowed down cell metabolism.

9) PIC: How can one interpret the data on inorganic carbon uptake during the experimental period without knowing the change in PIC relative to the change in cell number; i.e., PIC/cells?

See 5)

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10) Does PIC/ cell change with experimental conditions – more than can be explained by any changes in cell size?

Although PIC per cell is more likely to be the driving force, it is not completely solved, if POC or PIC are the dominating factors for cell size. The daily fluctuations in cell size and the changes in growth rate (see 5.) do not allow for answering this question.

11) Since the cells grow (divide) slower when the medium composition is displaced from the optimal composition, PIC/cell/day should decrease, but PIC/cell (and PIC/cells) may remain constant over the range of experimental conditions tested. In the limit of no cell growth there should be no PIC/cell since the coccospheres would be complete – unless the cells are producing multilayered coccospheres or shedding coccoliths into the medium. Do the authors have any information as to whether the cells continue to produce coccoliths once a single layered coccosphere is complete?

Both PIC and POC per cell are fluctuating between divisions. Changes in growth rate (See 5) do not allow for any assumptions on POC and PIC per cell. Therefore the growth rate normalized production rates for POC and PIC are shown.

SEM pictures indicate that *C. braarudii* does not produce multilayered coccospheres when in the stationary phase. No free coccoliths were observed.

Cells were growing in the exponential phase under nutrient-replete conditions and therefore, never stopped growing. A possible but very unlikely overproduction of coccoliths should not influence the results of this experiment.

12) Is there any microscopic data indicating incomplete coccospheres or undermineralized coccoliths in *Coccolithus braarudii* grown under suboptimal conditions of TA or DIC? As above these may not be an important considerations from the stand point of the organism's ability to precipitate CaCO<sub>3</sub>, but it is relevant to the conclusions in the paper which seem to indicate that the experimental conditions are directly effecting precipitation of CaCO<sub>3</sub> in the coccolith-forming vesicle when in actuality the rate of

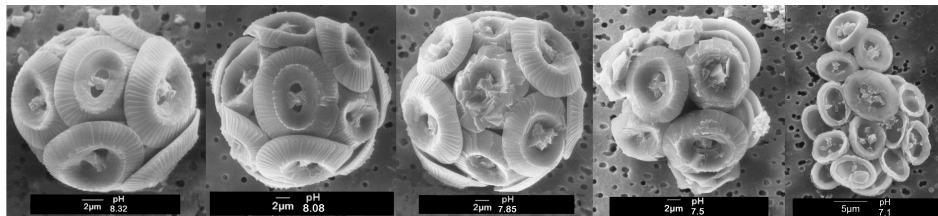
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formation of the coccolith-producing apparatus (vesicle, base-plate, transporters, and enzymes) is probably slowed.

As shown in earlier studies SEM pictures indicate malformations in *C. braarudii* under suboptimal carbonate chemistry conditions. Due to the lack of a quantitative analysis these pictures (see below) were removed from the manuscript. If the editor considers this helpful we offer to include these SEM pictures (Figure 1 of comment).

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**Fig. 1.** SEM pictures of *Coccolithus braarudii*

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