

Supplementary Information for

Multiple carbonate system parameters independently govern shell formation in a marine mussel

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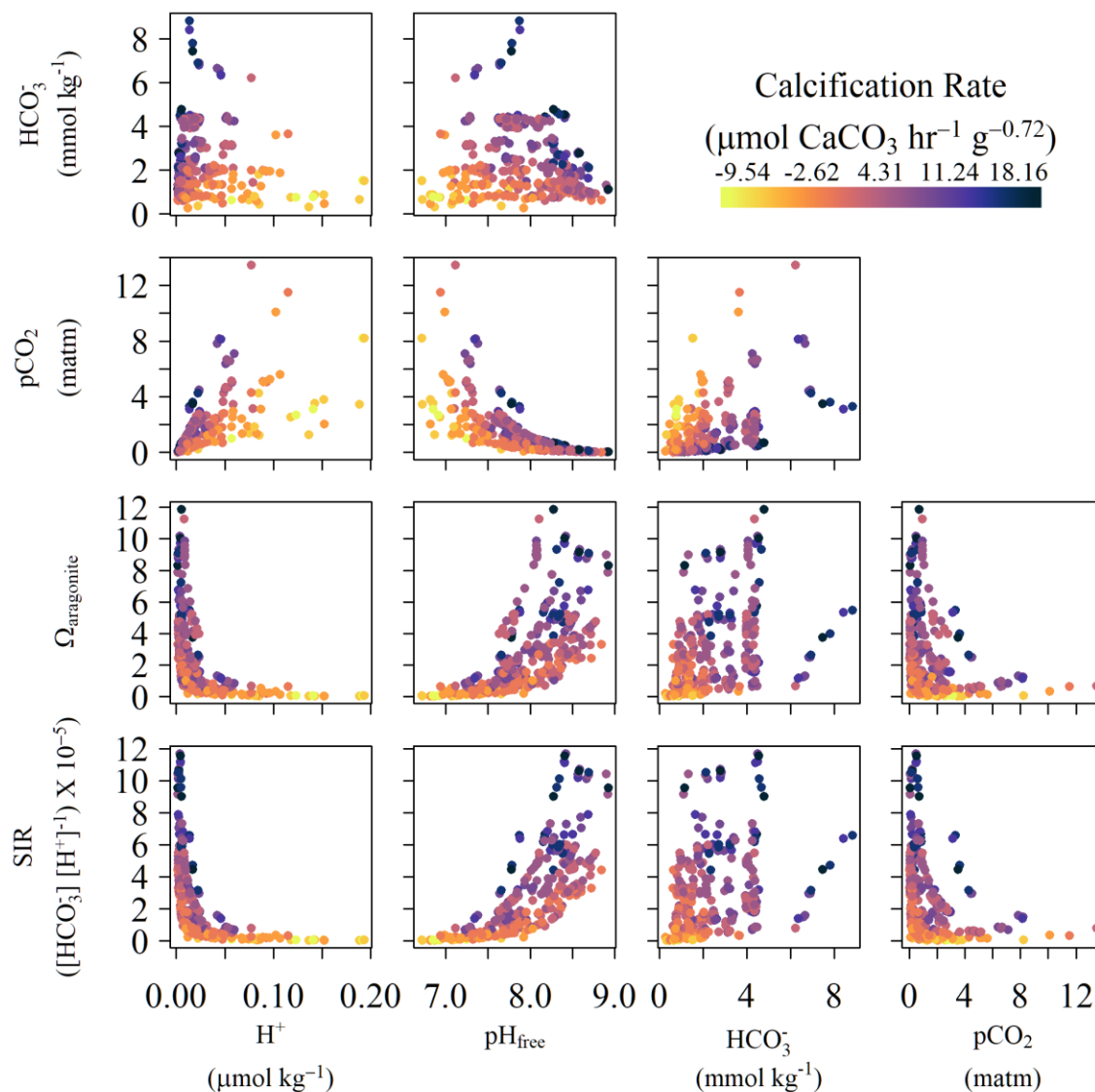
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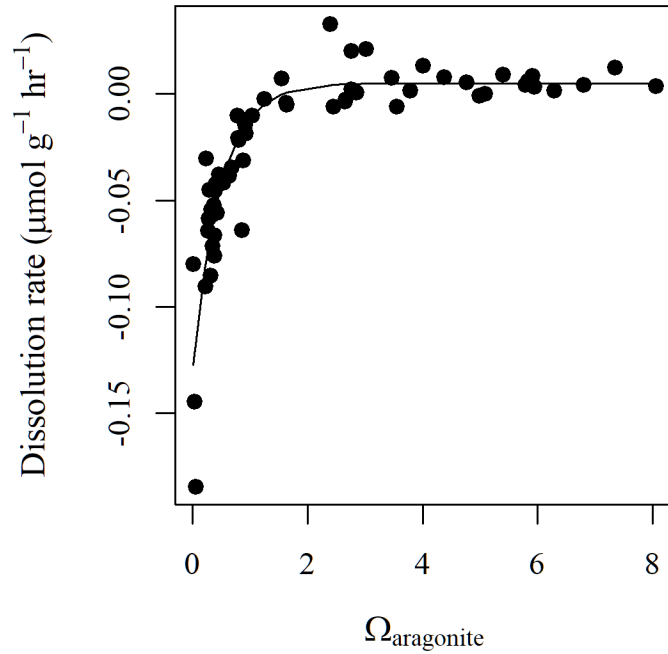
This PDF file includes:

Supplementary Figures S1 to S7

47 **Supplementary Figures**



48 **Supplementary Figure S1.** Measured calcification rates (represented by colors, in μmol
 49 $\text{hr}^{-1} \text{ g}^{-0.72}$), as a function of various pairs of carbonate system parameters, as explored in
 50 this study ($n = 324$ separate incubations). Total alkalinity ranged between 337 and 9584
 51 $\mu\text{mol kg}^{-1}$ while dissolved inorganic carbon ranged between 299 and 9322 $\mu\text{mol kg}^{-1}$.
 52 Note that for convenience in plotting data, units for HCO_3^- and pCO_2 are in mmol/kg and
 53 matm, different from corresponding values shown in the main text, which use $\mu\text{mol/kg}$
 54 and uatm.

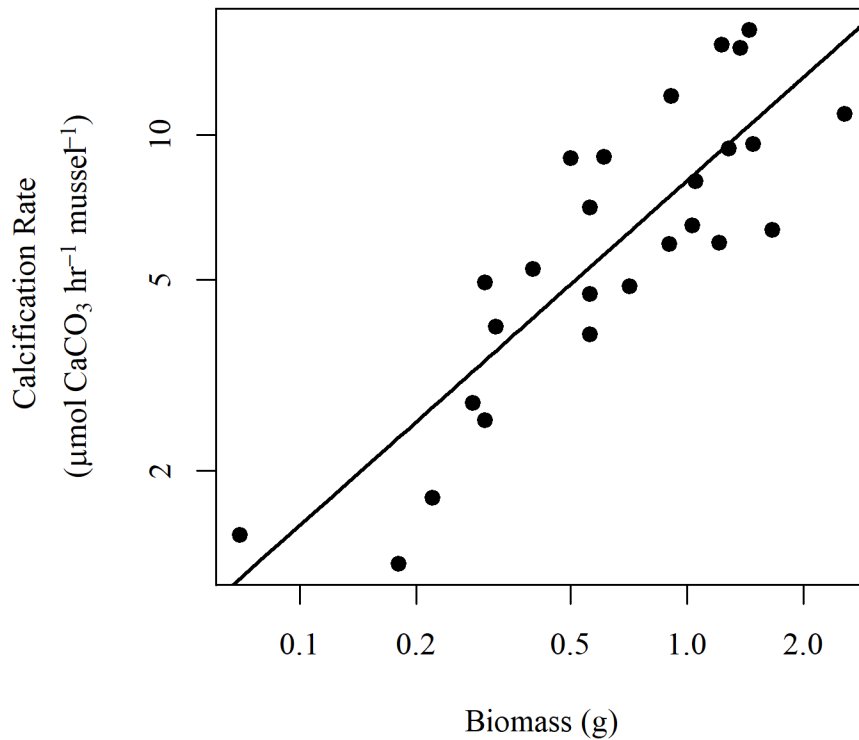


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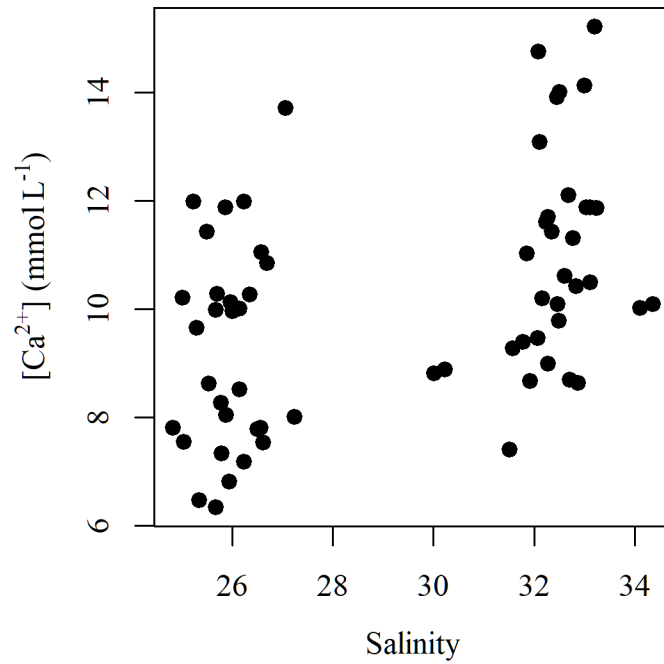
61 **Supplementary Figure S2.** Dissolution rates of *Mytilus californianus* shell material.
 62 These incubations (n=60) were conducted separate from the live mussel incubations and
 63 were undertaken across a decoupled carbonate system. Therefore, different data points at
 64 a given saturation state correspond to distinct bicarbonate concentrations, pH values, etc.
 65 Only calcium carbonate saturation state adequately described dissolution rates. The
 66 Arrhenius-derived mineral dissolution model was parameterized as $\text{Rate} = 0.005 -$
 67 $0.135 \cdot e^{(-2.08 \cdot \Omega_{\text{aragonite}})}$. Rates were calculated as the rate of change in seawater
 68 alkalinity divided by two.

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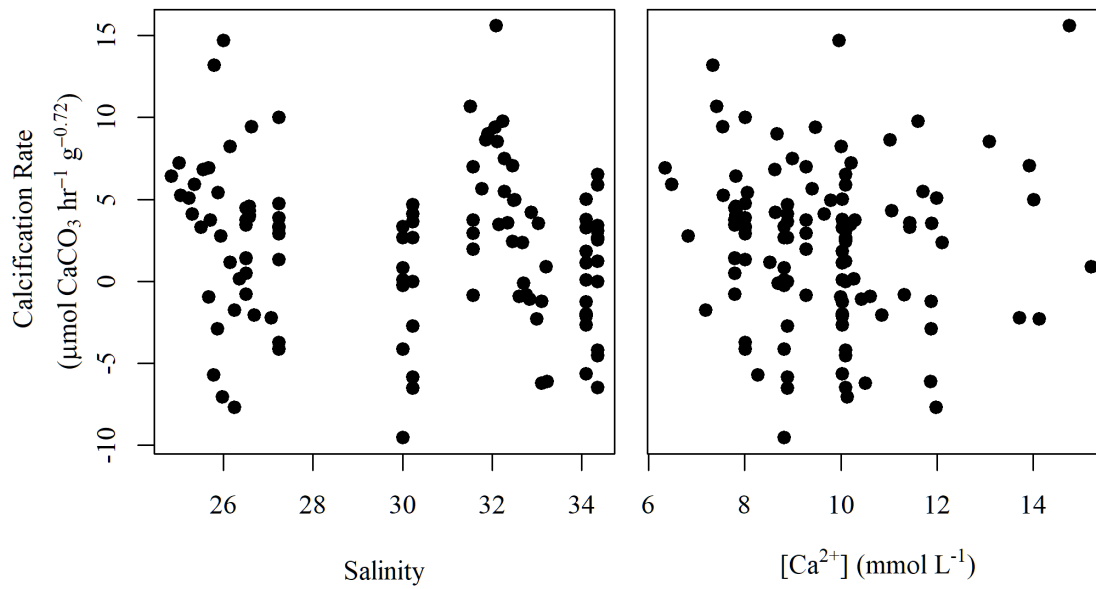
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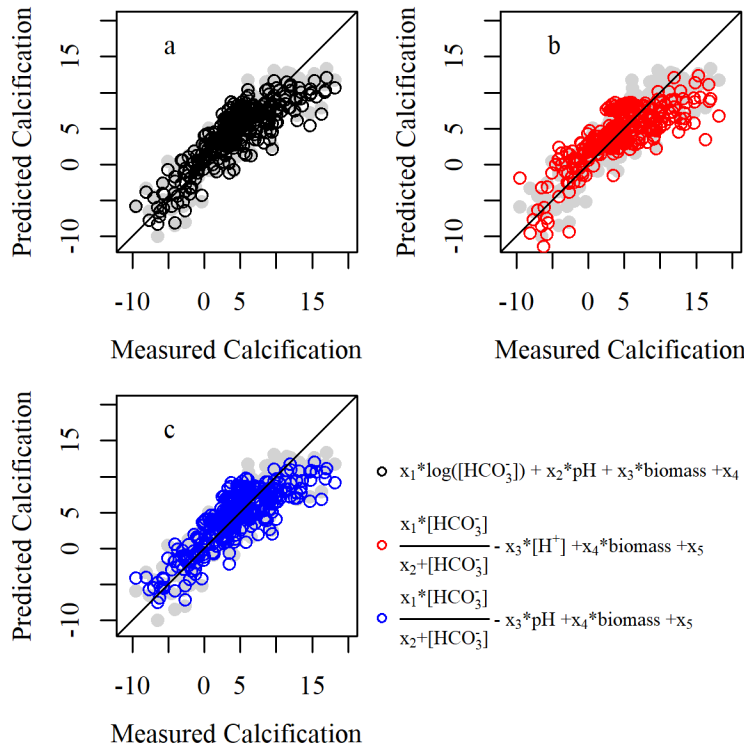
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73 **Supplementary Figure S3.** Allometric relationship between mussel biomass and net
74 calcification (not normalized by g^{-0.72}) in ambient seawater. Both the x and y axes are on
75 log scales. Net calcification per individual increased with greater dry tissue biomass (g)
76 according to the relationship $\text{Calcification} = 8.01 * \text{Biomass}^{0.72}$.



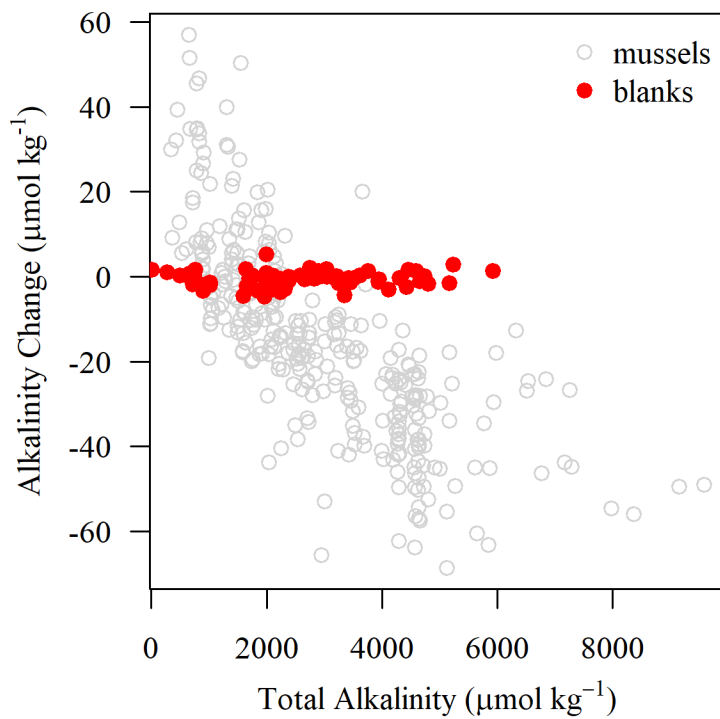
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79 **Supplementary Figure S4.** Modifying salinity with distilled water alters calcium
80 concentrations, so calcium was replaced/enhanced in relevant incubations, to separate the
81 potential effects of each on calcification rates.
82



Supplementary Figure S5. Neither a) salinity nor b) calcium concentrations predicted calcification rates in *Mytilus californianus*.



Supplementary Figure S6. Predicted gross calcification rates ($\mu\text{mol CaCO}_3 \text{ hr}^{-1} \text{ g}^{-0.72}$) based on various model options. Calcification rates approximated by the full model from Table 1 (light grey points) are compared with rates based on modeling the $[HCO_3^-]$ uptake saturation by a) a simplified logarithmic transformation and pH (black circles) where $x_1 = 10.5$, $x_2 = -4.8$, $x_3 = -1.9$, and $x_4 = -38$ (residual variance = 6.89) ; b) Michaelis-Menten kinetics further modified by $[H^+]$ where $x_1 = 18.9$, $x_2 = 4070$, $x_3 = 66$, $x_4 = -2.3$, and $x_5 = 1.9$ (residual variance = 8.17); and c) Michaelis-Menten kinetics further modified by pH_{free} where $x_1 = 19.9$, $x_2 = 1809$, $x_3 = -4.9$, $x_4 = -1.9$, and $x_5 = -42$ (residual variance = 6.92). In all panels, the solid lines indicate a 1:1 relationship. In panels b and c, the two Michaelis-Menten approximations of the HCO_3^- relationships tended to overestimate calcification when measured calcification rates were low and underestimate calcification when measured calcification rates were high. Differences between the overall model (light gray points, Table 1) and the simplified model (black points) derive from the additional contribution of a random intercept in the full experimental module which had a minor, though significant, effect on fit.



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106 **Supplementary Figure S7.** Alkalinity of seawater changed less than $5 \mu\text{mol hr}^{-1}$ in
 107 experimental blank trials (incubations without mussels; red dots). Changes measured in
 108 the presence of mussels in other trials are included for comparison (gray circles).
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