**Diatom acclimation to elevated CO2 via cAMP signalling and coordinated gene expression**

LETTERS

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**Gwenn M. M. Hennon1, Justin Ashworth2, Ryan D. Groussman1, Chris Berthiaume1,**

**Rhonda L. Morales1, Nitin S. Baliga2, Mónica V. Orellana2,3 and E. V. Armbrust1**

 School of Oceanography, University of Washington, Seattle, Washington 98105, USA. 2Institute for Systems Biology, Seattle, Washington 98109, USA. 3Polar Science Center, University of Washington, Seattle, Washington 98105, USA. \*e-mail: gwennm@uw.edu; armbrust@uw.edu

Diatoms are responsible for ∼40% of marine primary carbon cycle and productivity, fueling the oceanic carbon cycle and contributing to natural carbon sequestration in the deep ocean. Diatoms rely on energetically expensive carbon concentrating mechanisms (**CCMs**) to fix carbon efficiently at modern levels of CO2. How diatoms may respond over the short and long-term to rising atmospheric CO2 remains an open question. Here we use nitrate-limited chemostats to show that the model diatom *Thalassiosira pseudonana* rapidly responds to increasing CO2 by differentially expressing gene clusters that regulate transcription and chromosome folding, and subsequently reduces transcription of photosynthesis and respiration gene clusters under steady-state elevated CO2. These results suggest that exposure to elevated CO2 first causes a shift in regulation, and then a metabolic rearrangement. Genes in one CO2-responsive cluster included CCM and photorespiration genes that share a putative cAMP-responsive *cis*-regulatory sequence, implying these genes are co-regulated in response to CO2, with cAMP as an intermediate messenger. We verified cAMP induced downregulation of CCM gene δ-CA3 in nutrient-replete diatom cultures by inhibiting the hydrolysis of cAMP. These results indicate an important role for cAMP in downregulating CCM and photorespiration genes under elevated CO2 and provide insights into mechanisms of diatom acclimation in response to climate change.

**1. Highlight in the text and then check off the terms that you find in this abstract:**

\_\_\_\_\_carbon sequestration \_\_\_\_\_ steady-state \_\_\_\_\_ downregulation

\_\_\_\_\_energetically expensive \_\_\_\_\_putative \_\_\_\_\_CCM

\_\_\_\_\_chemostats \_\_\_\_\_ metabolic/metabolism \_\_\_\_\_cAMP

\_\_\_\_\_transcription \_\_\_\_\_ photorespiration \_\_\_\_\_acclimation

\_\_\_\_\_carbon fix/fixation ­­­

**2. Use a science dictionary (text or online) for help in defining these terms.**  Be prepared to help your group make meaning of these terms by taking notes for each word.

carbon sequestration-

steady-state-

downregulation-

energetically expensive-

putative-

chemostats-

metabolic/metabolism -

cAMP-

transcription-

photorespiration-

acclimation-

carbon fix/fixation-

CCM-

3. How did *Thalassiosira pseudonana* respond to increased levels of CO2?

4. How does cAMP seem to be related to CCM?

5. Make a prediction: how will diatoms such as *Thalassiosira pseudonana* respond to high

 levels of CO2 (climate change)?