Series 3B: Supplemental experiments on T. pseudonana (CCMP1014) growth under bubbling stress: NPQ1 protocol (Non-Photochemical chlorophyll fluorescence Quenching) computed photochemical measurements

Website: https://www.bco-dmo.org/dataset/749160
Data Type: experimental
Version: 1
Version Date: 2018-10-31

Project
» Collaborative Research: Effects of multiple stressors on Marine Phytoplankton (Stressors on Marine Phytoplankton)

Contributors	Affiliation	Role
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Abstract
Experiments were conducted to investigate the impact of bubbling on the growth yield of Thalassiosira pseudonana CCMP 1014 grown in 80 ml culture tubes. This dataset includes NPQ1 protocol (Non-Photochemical chlorophyll fluorescence Quenching) computed photochemical measurements for non-aerated samples and aerated samples.

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Coverage

Temporal Extent: 2018-07-03 - 2018-07-06

Dataset Description

Experiments were conducted to investigate the impact of bubbling on the growth yield of Thalassiosira pseudonana CCMP 1014 grown in 80 ml culture tubes. This dataset includes NPQ1 protocol (Non-Photochemical chlorophyll fluorescence Quenching) computed photochemical measurements for non-aerated samples and aerated samples.

Methods & Sampling

Experiments were conducted to investigate the impact of bubbling gas through cultures of Thalassiosira

pseudonana CCMP 1014 grown in Multicultivator MC-1000 OD culture tubes. TP1014 stock cultures were maintained in artificial seawater (Kester et. al 1967), enriched as with f/2 media (Guillard 1975). For the experiment, 5 ml of the TP1014 stock cultures were inoculated into 75 ml of ASW in eight tubes. The tubes were incubated in a Multicultivator MC-1000 OD unit (Qubit Systems), at 25 deg C and 400 µmol photons * m-2 * sec-1, set at a 12:12 day:night cycle for four days. Three tubes had no aeration (T1, T2, and T3); three tubes were bubbled with air at 60 ml·min-1 through a 0.2 µm stainless steel “carbonating stone” (T4, T5, and T6); and two tubes were bubbled with air at 120 ml·min-1 through a 0.2 µm stainless steel “carbonating stone” (T7 and T8). Samples were collected from each tube at the start of the experiment (day-0), and 5 hours after the start of the light phase each day (i.e. at 24-hour intervals) after that for four days. Samples were always collected 5 hours after the start of the light phase.

Three ml of samples from the non-aerated (T1, T2, and T3) and the 60 ml·min-1 aeration tubes (T4, T5, and T6) were used for assessment of photochemistry using the Aquapen-C AP-C 100 (Photon Systems Instruments). Samples were placed in the dark at 25 deg C for a minimum of 30 minutes prior to measuring photochemistry. The NPQ1 protocol on the instrument was used for assessment of non-photochemical quenching in samples, and the LC3 protocol was used to generate light curves that provide measurements of photosynthesis rates. The NPQ1 protocol administers 5 light pulses over 60 seconds during actinic light exposure, followed by 3 light pulses over 88 seconds during recovery in the dark. The LC3 protocol involves measurements of baseline fluorescence and maximal fluorescence during 7 phases of 60 seconds each, with each phase representing a light intensity from 10 to 1000 µmol * m-2 * s-1. Blue light (455 nm) was used as actinic light in these experiments. Baseline measurements were made at 0.03 µmol * m-2 * s-1, Saturating pulses were set at 2100 µmol * m-2 * s-1, and actinic light pulses (for the NPQ1 protocol only) were set at 1000 µmol * m-2 * s-1.

Data Processing Description

BCO-DMO Processing Notes:
- added conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions
- transformed rows and columns to conform to database best practices (each column has single description and units)

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Data Files

File	
3B_bubble_NPQ_computed_trans.csv	(Comma Separated Values (.csv), 1.44 KB) MD5:b982eee2d7ce8984f1b46d5fb45da359
Primary data file for dataset ID 749160	

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Related Publications

Guillard, R. R. L. (1975). Culture of Phytoplankton for Feeding Marine Invertebrates. Culture of Marine Invertebrate Animals, 29–60. doi:10.1007/978-1-4615-8714-9_3
Methods

Kester, D. R., Duedall, I. W., Connors, D. N., & Pytkowicz, R. M. (1967). Preparation of Artificial Seawater 1. Limnology and Oceanography, 12(1), 176–179. doi:10.4319/lo.1967.12.1.0176
Methods

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Parameters

Parameter	Description	Units
treatment	treatment and replicate: non-aerated or aerated; T1 to T3	unitless
Fo	minimum fluorescence in dark-adapted state.	RFU (Relative Fluorscence Units)
Fm	the maximum fluorescence in dark-adapted state; measured during the first saturation flash after dark adaptation	RFU (Relative Fluorscence Units)
Fp	the fluorescence in the peak of fast Kautsky induction	RFU (Relative Fluorscence Units)
Fm_L1	The first measurement of the maximum fluorescence following exposure to actinic light for 7 seconds (L1 indicates the first measurement in the "light" phase)	RFU (Relative Fluorscence Units)
Fm_L2	The second measurement of the maximum fluorescence following exposure to actinic light for another 12 seconds (L2 indicates the second measurement in the "light" phase)	RFU (Relative Fluorscence Units)
Fm_L3	The third measurement of the maximum fluorescence following exposure to actinic light for another 12 seconds (L3 indicates the third measurement in the "light" phase)	RFU (Relative Fluorscence Units)
Fm_L4	The fourth measurement of the maximum fluorescence following exposure to actinic light for another 12 seconds (L4 indicates the fourth measurement in the "light" phase)	RFU (Relative Fluorscence Units)
Fm_Lss	The fifth measurement of the maximum fluorescence following exposure to actinic light for another 12 seconds (Lss indicates the fifth and final measurement in the "light" phase; represents a "steady state" or ss)	RFU (Relative Fluorscence Units)
NPQ_L1	The first measurement of the non photochemical chlorophyll fluorscence quenching following exposure to actinic light for 7 seconds (L1 indicates the first measurement in the "light" phase)	unitless
NPQ_L2	The second measurement of the non photochemical chlorophyll fluorscence quenching following exposure to actinic light for another 12 seconds (L2 indicates the second measurement in the "light" phase)	unitless
NPQ_L3	The third measurement of the non photochemical chlorophyll fluorscence quenching following exposure to actinic light for another 12 seconds (L3 indicates the third measurement in the "light" phase)	unitless
NPQ_L4	The fourth measurement of the non photochemical chlorophyll fluorscence quenching following exposure to actinic light for another 12 seconds (L4 indicates the fourth measurement in the "light" phase)	unitless
NPQ_Lss	The fifth measurement of the non photochemical chlorophyll fluorscence quenching following exposure to actinic light for another 12 seconds (Lss indicates the fifth and final measurement in the "light" phase; represents a "steady state" or ss)	unitless
NPQ_D1	The first measurement of the non photochemical chlorophyll fluorscence quenching 11 seconds into the dark or recovery phase (D1 indicates the first measurement in the "darkt" phase)	unitless

NPQ_D2	The second measurement of the non photochemical chlorophyll fluorscence quenching after another 26 seconds into the dark or recovery phase (D2 indicates the second measurement in the "dark" phase)	unitless
NPQ_D3	The third and final measurement of the non photochemical chlorophyll fluorscence quenching after another 26 seconds into the dark or recovery phase (D3 indicates the third and final measurement in the "dark" phase	unitless
Qp_L1	The first measurement of the coefficient of photochemical quenching following exposure to actinic light for 7 seconds (L1 indicates the first measurement in the "light" phase)	unitless
Qp_L2	The second measurement of the coefficient of photochemical quenching following exposure to actinic light for another 12 seconds (L2 indicates the second measurement in the "light" phase)	unitless
Qp_L3	The third measurement of the coefficient of photochemical quenching following exposure to actinic light for another 12 seconds (L3 indicates the third measurement in the "light" phase)	unitless
Qp_L4	The fourth measurement of the coefficient of photochemical quenching following exposure to actinic light for another 12 seconds (L4 indicates the fourth measurement in the "light" phase)	unitless
Qp_Lss	The fifth measurement of the coefficient of photochemical quenching following exposure to actinic light for another 12 seconds (Lss indicates the fifth and final measurement in the "light" phase; represents a "steady state" or ss)	unitless
Qp_D1	The first measurement of the coefficient of photochemical quenching 11 seconds into the dark or recovery phase (D1 indicates the first measurement in the "darkt" phase)	unitless
Qp_D2	The second measurement of the coefficient of photochemical quenching after another 26 seconds into the dark or recovery phase (D2 indicates the second measurement in the "dark" phase)	unitless
Qp_D3	The third and final measurement of the coefficient of photochemical quenching after another 26 seconds into the dark or recovery phase (D3 indicates the third and final measurement in the "dark" phase	unitless
Rfd	the chlorophyll fluorescence decrease ratio	unitless
Fm_D1	The first measurement of the maximum fluorescence 11 seconds into the dark or recovery phase (D1 indicates the first measurement in the "darkt" phase)	RFU (Relative Fluorscence Units)
Fm_D2	The second measurement of the maximum fluorescence after another 26 seconds into the dark or recovery phase (D2 indicates the second measurement in the "dark" phase)	RFU (Relative Fluorscence Units)
Fm_D3	The third and final measurement of the maximum fluorescence after another 26 seconds into the dark or recovery phase (D3 indicates the third and final measurement in the "dark" phase	RFU (Relative Fluorscence Units)
QY_max	The maximum Quantum yield. A measure of the Photosystem II efficiency. In a dark-adapted sample this is equivalent to Fv/Fm. In a light-adapted sample it is equivalent to Fv'/Fm'.	unitless
QY_L1	The first measurement of the effective quantum yield of phorosystem II following exposure to actinic light for 7 seconds (L1 indicates the first measurement in the "light" phase)	unitless
QY_L2	The second measurement of the effective quantum yield of phorosystem II following exposure to actinic light for another 12 seconds (L2 indicates the second measurement in the "light" phase)	unitless

QY_L3	The third measurement of the effective quantum yield of phorosystem II following exposure to actinic light for another 12 seconds (L3 indicates the third measurement in the "light" phase)	unitless
QY_L4	The fourth measurement of the effective quantum yield of phorosystem II following exposure to actinic light for another 12 seconds (L4 indicates the fourth measurement in the "light" phase)	unitless
QY_Lss	The fifth measurement of the effective quantum yield of phorosystem II following exposure to actinic light for another 12 seconds (Lss indicates the fifth and final measurement in the "light" phase; represents a "steady state" or ss)	unitless
QY_D1	The first measurement of the effective quantum yield of phorosystem II 11 seconds into the dark or recovery phase (D1 indicates the first measurement in the "darkt" phase)	unitless
QY_D2	The second measurement of the effective quantum yield of phorosystem II after another 26 seconds into the dark or recovery phase (D2 indicates the second measurement in the "dark" phase)	unitless
QY_D3	The third and final measurement of the effective quantum yield of phorosystem II after another 26 seconds into the dark or recovery phase (D3 indicates the third and final measurement in the "dark" phase	unitless

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Instruments

Dataset-specific Instrument Name	Multicultivator MC-1000 OD (Qubit Systems)
Generic Instrument Name	Cell Cultivator
Dataset-specific Description	Used for incubation of TP1014 cultures.
Generic Instrument Description	An instrument used for the purpose of culturing small cells such as algae or bacteria. May provide temperature and light control and bubbled gas introduction.

Dataset-specific Instrument Name	Guava easyCyte HT Sampling Flow Cytometer
Generic Instrument Name	Flow Cytometer
Dataset-specific Description	Used to count cells.
Generic Instrument Description	Flow cytometers (FC or FCM) are automated instruments that quantitate properties of single cells, one cell at a time. They can measure cell size, cell granularity, the amounts of cell components such as total DNA, newly synthesized DNA, gene expression as the amount messenger RNA for a particular gene, amounts of specific surface receptors, amounts of intracellular proteins, or transient signalling events in living cells. (from: http://www.bio.umass.edu/micro/immunology/facs542/facswhat.htm)

Dataset-specific Instrument Name	Aquapen-C AP-C 100 (Photon Systems Instruments)
Generic Instrument Name	Fluorometer
Dataset-specific Description	Used to measure fluorescence. A hand-held cuvette version of the FluorPen fluorometer equipped with a blue and red LED emitter. Blue excitation light (455 nm) is intended for chlorophyll excitation, i.e., for measuring chlorophyll fluorescence in algal cultures. Red-orange excitation light (620 nm) is intended for excitation through phycobilins and is suitable for measuring in cyanobacteria.
Generic Instrument Description	A fluorometer or fluorimeter is a device used to measure parameters of fluorescence: its intensity and wavelength distribution of emission spectrum after excitation by a certain spectrum of light. The instrument is designed to measure the amount of stimulated electromagnetic radiation produced by pulses of electromagnetic radiation emitted into a water sample or in situ.

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Project Information

Collaborative Research: Effects of multiple stressors on Marine Phytoplankton (Stressors on Marine Phytoplankton)

The overarching goal of this project is to develop a framework for understanding the response of phytoplankton to multiple environmental stresses. Marine phytoplankton, which are tiny algae, produce as much oxygen as terrestrial plants and provide food, directly or indirectly, to all marine animals. Their productivity is thus important both for global elemental cycles of oxygen and carbon, as well as for the productivity of the ocean. Globally the productivity of marine phytoplankton appears to be changing, but while we have some understanding of the response of phytoplankton to shifts in one environmental parameter at a time, like temperature, there is very little knowledge of their response to simultaneous changes in several parameters. Increased atmospheric carbon dioxide concentrations result in both ocean acidification and increased surface water temperatures. The latter in turn leads to greater ocean stratification and associated changes in light exposure and nutrient availability for the plankton. Recently it has become apparent that the response of phytoplankton to simultaneous changes in these growth parameters is not additive. For example, the effect of ocean acidification may be severe at one temperature-light combination and negligible at another. The researchers of this project will carry out experiments that will provide a theoretical understanding of the relevant interactions so that the impact of climate change on marine phytoplankton can be predicted in an informed way. This project will engage high schools students through training of a teacher and the development of a teaching unit. Undergraduate and graduate students will work directly on the research. A cartoon journalist will create a cartoon story on the research results to translate the findings to a broader general public audience.

Each phytoplankton species has the capability to acclimatize to changes in temperature, light, pCO2, and nutrient availability - at least within a finite range. However, the response of phytoplankton to multiple simultaneous stressors is frequently complex, because the effects on physiological responses are interactive. To date, no datasets exist for even a single species that could fully test the assumptions and implications of existing models of phytoplankton acclimation to multiple environmental stressors. The investigators will combine modeling analysis with laboratory experiments to investigate the combined influences of changes in pCO2, temperature, light, and nitrate availability on phytoplankton growth using cultures of open ocean and coastal diatom strains (Thalassiosira pseudonana) and an open ocean cyanobacteria species (Synechococcus sp.). The planned experiments represent ideal case studies of the complex and interactive effects of environmental conditions on organisms, and results will provide the basis for predictive modeling of the response of phytoplankton taxa to multiple environmental stresses.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1538602

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