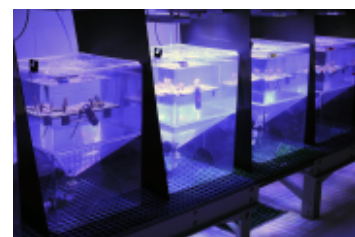


Photophysiology of *Acropora millepora* and *Pachyseris speciosa* in response to variability in daily light integrals (NESP TWQ Project 2.3.1, AIMS and JCU)



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Title	Photophysiology of <i>Acropora millepora</i> and <i>Pachyseris speciosa</i> in response to variability in daily light integrals (NESP TWQ Project 2.3.1, AIMS and JCU)
Date	2019-05-03
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Abstract	<p>The dataset consists of four data files from a 20-day experiment to investigate different photophysiological responses of two species of coral (<i>Acropora millepora</i> and <i>Pachyseris speciosa</i>) to constant and variable daily light integrals.</p> <p>Methods:</p> <p>Eight partial colonies each of <i>Pachyseris speciosa</i> (from 5 – 8 m depth) and <i>Acropora millepora</i> (from 3 – 5 m depth) were collected from Davies Reef, central Great Barrier Reef, Australia (-18.823390, 147.6518563) in July 2016, and taken to the National Sea Simulator at the Australian Institute of Marine Science (AIMS), Townsville. Experiment consisted of four types of light exposure treatments, wherein nubbins from the partial colonies were either exposed to 20 days of high light (32 mol photons m⁻² d⁻¹), low light (6 mol photons m⁻² d⁻¹), or alternating variable light treatments. Four sets of photoacclimation and physiological responses were measured and the corresponding data has been placed in four separate csv files;</p> <p>(1) Fluorescence measurements were conducted using a diving pulse-amplitude modulated fluorometer (DPAM). Measurements were taken twice with the DPAM: once at 0.5 h before sunrise, to assess the maximum quantum yield of photosystem II (Fv/Fm), and at noon, after 0.5 h exposure to maximum irradiance, to assess effective quantum yield (PSII). For each nubbin, at least five measurements were taken from different regions on each nubbin and the values averaged. The excitation pressures on PSII, (see Ralph et al. 2016) was assessed to estimate the degree of photoinhibition versus light limitation. Non-photochemical quenching (NPQ), also derived from PAM pre-dawn and noontime measurements based on equations by Genty et al 1987, was measured to assess the amount of excess photon energy dissipated safely as heat.</p> <p>(2) At the end of the experiment, the concentration of chlorophyll a (photosynthetic) and total carotenoids (photosynthetic and photoprotective) of nubbins were compared between treatments. Tissue was removed from the skeleton with an air gun and filtered seawater, and homogenized. The slurry was centrifuged for 6-8 min at 1,500 g and the coral host supernatant was separated from the symbiont pellet. The pellet was then rinsed with filtered seawater and re-centrifuged at 10,000 g for 3 min prior to extraction. Pigments were obtained via a double extraction procedure (1 mL 95% ethanol at 40C for 20 minutes each, with sonicator), and the absorbance was spectrophotometrically measured at 665, 664, 649 and 470 nm wavelengths. Concentrations of chlorophyll a and total carotenoids (µg/mL) were calculated based on equations by Lichtenthaler (1987) and Ritchie (2008) and standardized to nubbin surface area, which was estimated via a single wax dip protocol (Veal et al 2010).</p> <p>(3) At the end of the experiment, 18 nubbins were selected for respirometry measurements. Their ceramic plugs were carefully cleaned to remove algal growth. Nubbins were individually placed in 634 mL sealed stirred chambers that contained oxygen sensor spots (optodes), and the Firesting hardware/software (Pyroscience, Germany) was used to measure oxygen</p>
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concentrations within the chambers every minute. Incubations ran for an hour each at ten light levels (0, 15, 40, 80, 120, 200, 300, 500, 700 and 1000 $\mu\text{mol photons m}^{-2} \text{ s}^{-1}$), measured with an upwards facing, calibrated, cosine corrected light sensor (meter LI-250A, sensor LI-192, Li-COR, USA). Water was flushed in the chambers at the beginning of each light level measurement. Rates of oxygen consumption (estimated respiration in the dark) and production (estimated net photosynthesis in the light) were standardized to coral surface area estimates derived from the wax dipping procedure. Photosynthesis to irradiance (P-I) curves were fitted to the data using a hyperbolic tangent fit, as described by Jassby and Platt (1976) using the 'stats' package (version 3.6.0) in the statistical platform R (version 3.4.0, R Development Core Team 2017). Parameters for maximum photosynthetic production (P_{max}), saturation irradiance (I_k) and dark respiration (R_{dark}) for each treatment were estimated from fitted models. Net daily oxygen production (P_n) was calculated by predicting production using the P-I curves at actual logged experimental light levels, over a 24 h period.

(4) Growth rates of *A. millepora* were assessed as differences in buoyant weight over time (Davies 1989). Nubbins were individually weighed to the nearest 0.001 g by suspending them on a tray below a semi-micro balance (Shimadzu AUW220D, Japan) in a water bath at ~ 25 OC. The percent change in buoyant weight between days 8 and 20 was assessed.

Literature Cited

Lichtenthaler HK. [34] Chlorophylls and carotenoids: Pigments of photosynthetic biomembranes. *Methods in Enzymology*. 148: Academic Press; 1987. p. 350-82.

Ritchie RJ. Universal chlorophyll equations for estimating chlorophylls a, b, c, and d and total chlorophylls in natural assemblages of photosynthetic organisms using acetone, methanol, or ethanol solvents. *Photosynthetica*. 2008;46(1):115–26.

Veal CJ, Holmes G, Nunez M, Hoegh-Guldberg O, Osborn J. A comparative study of methods for surface area and three-dimensional shape measurement of coral skeletons. *Limnology and Oceanography: Methods*. 2010;8(5):241-53. doi: 10.4319/lom.2010.8.241.

Jassby AD, Platt T. Mathematical formulation of the relationship between photosynthesis and light for phytoplankton. *Limnology and Oceanography*. 1976;21(4):540-7. doi: 10.4319/lo.1976.21.4.0540.

Davies S. Short-term growth measurements of corals using an accurate buoyant weighing technique. *Marine Biology*. 1989;101(3):389–95. doi: 10.1007/BF00428135.

Ralph PJ, Hill R, Doblin MA, Davy SK (2016) Theory and application of pulse amplitude modulated chlorophyll fluorometry in coral health assessment. In: *Diseases of Coral*, pp. 506–523.

Format:

The dataset consists of four separate components, stored as .csv files, pertaining to the different physiological aspects used to understand coral responses to variable light conditions; fluorometry (85KB), pigment analysis (6KB), respirometry (9KB) and growth (1KB).

Data Dictionary:

pam.csv

- Date: Date of sampling (DD/MM/YY)
- Group: Which sampling group the individual was placed in.
- Treatment: Which treatment the individual was in, where HL is High Light, LL is Low Light, VLH is Variable Light starting High and VLL is Variable Light starting Low.
- Tank: Tank number each nubbins resided in
- Species: Either *Acropora millepora* or *Pachyseris speciosa*
- Coral_ID: Colony identification
- Fo_mean: minimum fluorescence yield in dark
- Fm_mean: maximum fluorescence yield in dark
- DA_yield; Refers to the maximum quantum yield, quantifies the maximum potential for photosynthesis through proportion of available photosystems in a dark-adapted state (dimensionless)
- F_mean; steady-state fluorescence yield in light
- Fm._mean; maximum fluorescence yield in light
- LA_yield: refers to the effective quantum yield, quantifying the relative number of open to closed photosystems in a light-adapted state (dimensionless)

- Qm; Excitation pressure of photosystem II, which is a relationship between effective and maximum quantum yields and gives an idea of the relative light-limitation or photoinhibitory stress on the coral (dimensionless)

pigments.csv

- Treatment: Which treatment the individual was in, where HL is High Light, LL is Low Light, VLH is Variable Light starting High and VLL is Variable Light starting Low.
- Tank: Tank number
- Species: Either *Acropora millepora* or *Pachyseris speciosa*
- Coral_ID: Colony identification
- Individual_ID: Individual identification
- Surface: Relevant for *P. speciosa* only, refers to whether tissue was taken from the top or the bottom of the nubbin
- surfaceArea: Surface area in cm²
- ChlA: estimated total of chlorophyll a (micrograms) per individual coral nubbin
- Caro: estimated total of total carotenoids (micrograms) per individual coral nubbin
- chlSA: estimate of chlorophyll a by surface area (micrograms per cm²) per individual coral nubbin
- caroSA: estimate of total carotenoids by surface area (micrograms per cm²) per individual coral nubbin
- Ratio: Ratio of chlorophyll a to carotenoids

respirometry.csv

- Date: Date of sampling (DD/MM/YY)
- Group: Which sampling group the individual was placed in, based solely on order of respirometry run
- Pattern: Whether the treatment was constant (HL or LL) or variable (VLH or VLL)
- Treatment: Which treatment the individual was in, where HL is High Light, LL is Low Light, VLH is Variable Light starting High and VLL is Variable Light starting Low
- Light: Whether light levels were low or high
- Irradiance (umolEm-2s-1); Instantaneous irradiance measurement in micromoles photons per m² per second
- Species: Either *Acropora millepora* or *Pachyseris speciosa*
- ID: Individual ID
- Production_mgO2hr-1: Oxygen production based on respirometry in milligrams of oxygen produced per hour

weight.csv (only *Acropora millepora* in this dataset)

- Treatment: Which treatment the individual was in, where HL is High Light, LL is Low Light, VLH is Variable Light starting High and VLL is Variable Light starting Low
- Tank: Tank number
- Coral_ID: Colony and individual ID
- Percent_change: percent change in buoyant weight

Data Location:

This dataset is filed in the eAtlas enduring data repository at: data\2016-18-NESP-TWQ-2\2.3.1_Benthic-light\AU_NESP-TWQ-2.3.1_AIMS_BenthicLight_experiment2

Metadata language	eng
Character set	UTF8
Hierarchy level	Dataset

OnLine resource

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Point of contact

Individual name	DiPerna, Stephanie
Organisation name	James Cook University
Role	Point of contact
Topic category	Biota

Extent

Description	Davies Reef, Great Barrier Reef (sample collection)
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Metadata language	eng
Character set	UTF8

Metadata author

Individual name	eAtlas Data Manager
Organisation name	Australian Institute of Marine Science (AIMS)
Role	metadataContact
Date stamp	2019-05-03T05:15:47