Seawater carbonate chemistry for brooded coral larval experiments, Taiwan, March 2011 and 2012 (Cumbo, 2013)(MCR LTER project, Climate_Coral_Larvae project)

Website: https://www.bco-dmo.org/dataset/528806
Version: 2014-08-30

Project
» Moorea Coral Reef Long-Term Ecological Research site (MCR LTER)
» The ecophysiological basis of the response of coral larvae and early life history stages to global climate change (Climate_Coral_Larvae)

Program
» Long Term Ecological Research network (LTER)

Contributors	Affiliation	Role
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Dataset Description

To evaluate the effects of temperature and pCO2 on coral larvae, brooded larvae of Pocillopora damicornis from Nanwan Bay, Taiwan (21°56.179' N, 120°44.85' E), were exposed to ambient (419-470 µatm) and high (604-742 µatm) pCO2 at ~25 and ~29 °C in two experiments conducted in March 2010 and March 2012. Larvae were sampled from four consecutive lunar days (LD) synchronized with spawning following the new moon, incubated in treatments for 24 h, and measured for respiration, maximum photochemical efficiency of PSII (F v/F m), and mortality.

The most striking outcome was a strong effect of time (i.e., LD) on larvae performance: respiration was affected by an LD × temperature interaction in 2010 and 2012, as well as an LD × pCO2 × temperature interaction in 2012; F v/F m was affected by LD in 2010 (but not 2012); and mortality was affected by an LD × pCO2 interaction in 2010, and an LD × temperature interaction in 2012. There were no main effects of pCO2 in 2010, but in 2012, high pCO2 depressed metabolic rate and reduced mortality. Therefore, differences in larval performance depended on day of release and resulted in varying susceptibility to future predicted environmental conditions. These results underscore the importance of considering larval brood variation across days when designing experiments. Subtle differences in experimental outcomes between years suggest that transgenerational plasticity in combination with unique histories of exposure to physical conditions can modulate the response of brooded coral larvae to climate change and ocean acidification.

These data include the seawater carbonate chemistry monitored from the experimental tanks, March 2011 and 2012.

Related datasets:

brooded coral larvae 2 - larval release March 2003-2008
brooded coral larvae 2 - respiration_photosyth_mortality

These data are published in Vivian R Cumbo, Peter J Edmunds, Christopher B Wall, Tung-Yung Fan. (2013) Brooded coral larvae differ in their response to high temperature and elevated pCO2 depending on the day of release. Marine Biology. See Table 1.

Download complete data for this publication (Excel file)
Data also available from PANGAEA: DOI 10.1007/s00227-013-2280-y

Methods & Sampling

To determine the dissolved inorganic carbon (DIC) chemistry of seawater in the treatments, total alkalinity (TA), pH on the total scale, temperature, and salinity were measured using standard procedures, and used to calculate pCO2 (uatm), HCO3 - (umolkg-1), CO3 2- (umolkg-1), and the aragonite saturation state (XArag) of seawater using CO2SYS (Pierrot et al. 2006). TA (umol kg-1) was measured through potentiometric titration (SOP 3b, Dickson et al. 2007) using an automatic titrator (DL50, Mettler Toledo) filled with certified acid titrant (0.1 M HCl, 0.6 NaCl, Dickson Laboratory, Scripps Institution of Oceanography). The pH probe (DG101-SC, Mettler Toledo) attached to the titrator was 3-point calibrated with pH 4.00, 7.00, and 10.00 buffers (Fisher, NBS). Certified reference material with a known TA (Batch 98, http://andrew.ucsd. edu/index.html) was titrated daily to determine the accuracy and precision of the analyses.

Seawater samples (50 mL) from the treatment tanks were brought to 25C, weighed and titrated in a waterjacketed beaker within 2-3 h of collection. The pH values and the titrant volumes (cm3) obtained from the titrations were sub-sampled for the range between pH 3.0 and 3.5 and inserted into a Microsoft Excel spreadsheet (Fangue et al. 2010), which calculated Gran's function as a product of the mass of titrant added (Dickson et al. 2007). Treatment tank pH was determined spectrophotometrically using m-cresol purple dye (Sigma-Aldrich) following SOP 6b of Dickson et al. (2007) with modification (Fangue et al. 2010). Preliminary sampling of the seawater in the tanks throughout the day confirmed that the pCO2 treatments were stable over a 24-h period.

References:

Dickson AG, Sabine CL, Christian JR (eds) (2007) Guide to best practices for ocean CO2 measurements. PICES Special Publication 3, p 191

Fangue NA, O'Donnell MJ, Sewell MA, Matson PG, MacPherson AC, Hoffman GE (2010) A laboratory-based, experimental system for the study of ocean acidification effects on marine invertebrate larvae. Limnol Oceanogr Methods 8:441-452

Data Processing Description

BCO-DMO processing notes:

- added conventional header with dataset name, PI name, version date, reference information
- added lab, lat, lon, expt columns
- renamed parameters to BCO-DMO standard
- combined data from Table 1, 2012 and 2012 - sorted by date, temp, treatment

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Data Files

File
brood2_carb_chem.csv (Comma Separated Values (.csv), 5.99 KB) MD5:3db9b129ca78efc0405b3f84c1be2845 Primary data file for dataset ID 528806

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Parameters

Parameter	Description	Units
expt	experiment id	unitless
lab	laboratory	unitless
lat	latitude; north is positive	decimal degrees
lon	longitude; east is positive	decimal degrees
month	experiment month	unitless
tank	tank id number	tank
date	local date of measurement	yyyy-mm-dd
pH	pH: The measure of the acidity or basicity of an aqueous solution	pH scale
temp	temperature	degees Celsius
sal	salinity	PSU scale
TA	total alkalinity	umol/kg
pCO2	partial pressure of carbon dioxide by computation from pH and alkalinity	uatm
bicarbonate	concentration of bicarbonate ion ([HCO3]-) in seawater	umol/kg
carbonate	concentration of carbonate ion ([CO3]2-)	umol/kg
omega_Ara	the saturation state of seawater with respect to aragonite	unitless

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Instruments

Dataset-specific Instrument Name	Automatic titrator
Generic Instrument Name	Titrator
Dataset-specific Description	Model DL50, Mettler-Toledo, Columbus, OH, USA
Generic Instrument Description	Titrators are instruments that incrementally add quantified aliquots of a reagent to a sample until the end-point of a chemical reaction is reached.

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Deployments

lab_Edmunds_NMMBA

Website	https://www.bco-dmo.org/deployment/58892
Platform	Natl Museum Mar. Bio. and Aquar. Taiwan
Start Date	2010-03-18
End Date	2010-03-24
Description	Experiments related to the research project: 'RUI- The ecophysiological basis of the response of coral larvae and early life history stages to global climate change' were conducted at the laboratories of the National Museum of Marine Biology and Aquarium in Southern Taiwan.

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Project Information

Moorea Coral Reef Long-Term Ecological Research site (MCR LTER)

Website: http://mcr.lternet.edu/

Coverage: Island of Moorea, French Polynesia

NSF Award Abstract:

Coral reefs provide important benefits to society, from food to exceptional biodiversity to shoreline protection and recreation, but they are threatened by natural perturbations and human activities, including those causing global-scale changes. These pressures increasingly are causing coral reefs to undergo large, often abrupt, ecological changes where corals are being replaced by seaweeds or other undesirable organisms. Historically, the major agent of disturbance to coral reefs has been powerful storms, but in recent decades, episodes of mass coral bleaching from marine heat waves have become more frequent and severe as the temperature of ocean surface waters continues to rise. Coral reefs are further stressed by local human activities that cause nutrient pollution and deplete herbivorous fishes that control growth of seaweeds. Studying how coral reefs respond to these two types of disturbance under different levels of nutrient pollution and fishing provides essential information on what affects the ability of coral reefs to buffer environmental change and disturbances without collapsing to a persistent, degraded condition. The fundamental goals of the Moorea Coral Reef Long Term Ecological Research program (MCR LTER) are to understand how and why coral reefs change over time, to assess the consequences of these changes, and to contribute scientific knowledge needed to sustain coral reef ecosystems and the important societal services they provide. This research improves understanding and management of coral reefs, which benefits all groups concerned with the welfare of this ecologically, economically and culturally important ecosystem. In addition to academic communities, scientific findings are communicated to interested individuals, non-governmental organizations, island communities and governmental entities. These findings also are integrated into K-12, undergraduate, graduate and public education activities through a multi-pronged program that includes inquiry-based curricula, interactive and media-based public education programs, and internet-based resources. MCR?s research, training, education and outreach efforts all emphasize broadening participation in STEM fields and strengthening STEM literacy.

New research activities build on MCR LTER?s powerful foundation of long-term observations and broad ecological understanding of oceanic coral reefs to address the following core issues: How is the changing disturbance regime (recurrent heat waves in addition to cyclonic storms) altering the resilience of coral reefs, and what are the ecological consequences of altered resilience? Research activities are organized around a unifying framework that explicitly addresses how reef communities are affected by the nature and history of coral-killing disturbances, and how those responses to disturbance are influenced by the pattern of local human stressors. New studies answer three focal questions: (1) How do different disturbance types, which either remove (storms) or retain (heat waves) dead coral skeletons, affect community dynamics, abrupt changes in ecological state, and resilience? (2) How do local stressors interact with new disturbance regimes to create spatial heterogeneity in community dynamics, ecosystem processes, and spatial resilience? And (3) What attributes of coral and coral reef communities influence their capacity to remain resilient under current and future environmental conditions? These questions provide an unparalleled opportunity to test hypotheses and advance theory regarding ecological resilience and the causes and consequences of abrupt ecological change, which is broadly relevant across aquatic and terrestrial ecosystems.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

From http://www.lternet.edu/sites/mcr/ and http://mcr.lternet.edu/:
The Moorea Coral Reef LTER site encompasses the coral reef complex that surrounds the island of Moorea, French Polynesia (17°30'S, 149°50'W). Moorea is a small, triangular volcanic island 20 km west of Tahiti in the Society Islands of French Polynesia. An offshore barrier reef forms a system of shallow (mean depth ~ 5-7 m), narrow (~0.8-1.5 km wide) lagoons around the 60 km perimeter of Moorea. All major coral reef types (e.g., fringing reef, lagoon patch reefs, back reef, barrier reef and fore reef) are present and accessible by small boat.

The MCR LTER was established in 2004 by the US National Science Foundation (NSF) and is a partnership between the University of California Santa Barbara and California State University, Northridge. MCR researchers include marine scientists from the UC Santa Barbara, CSU Northridge, UC Davis, UC Santa Cruz, UC San Diego, CSU San Marcos, Duke University and the University of Hawaii. Field operations are conducted from the UC Berkeley Richard B. Gump South Pacific Research Station on the island of Moorea, French Polynesia.

MCR LTER Data: The Moorea Coral Reef (MCR) LTER data are managed by and available directly from the MCR project data site URL shown above. The datasets listed below were collected at or near the MCR LTER sampling locations, and funded by NSF OCE as ancillary projects related to the MCR LTER core research themes.

This project is supported by continuing grants with slight name variations:

- LTER: Long-Term Dynamics of a Coral Reef Ecosystem
- LTER: MCR II - Long-Term Dynamics of a Coral Reef Ecosystem
- LTER: MCR IIB: Long-Term Dynamics of a Coral Reef Ecosystem
- LTER: MCR III: Long-Term Dynamics of a Coral Reef Ecosystem
- LTER: MCR IV: Long-Term Dynamics of a Coral Reef Ecosystem

The ecophysiological basis of the response of coral larvae and early life history stages to global climate change (Climate_Coral_Larvae)

Coverage: Moorea, French Polynesia; Southern Taiwan; California State University Northridge

Tropical coral reefs face a suite of environmental assaults ranging from anchor damage to the effects of global climate change (GCC). The consequences are evident throughout the tropics, where many coral reefs have lost a substantial fraction of their coral cover in a few decades. Notwithstanding the importance of reducing the impacts of environmental stresses, the only means by which these ecosystems can recover (or simply persist) is through the recruitment of scleractinians, which is a function of successful larval development, delivery, settlement, metamorphosis, and post-settlement events. Despite wide recognition of the importance of these processes, there are few pertinent empirical data, and virtually none that address the mechanisms mediating the success of early coral life stages in a physical environmental varying at multiple spatio-temporal scales.

The objective of this research is to complete one of the first comprehensive ecophysiological analyses of the early life stages of corals through a description of: (1) their functionality under 'normal' conditions, and (2) their response to the main drivers of GCC. These analyses will be completed for 2 species representative of a brooding life history strategy, and the experiments will be completed in two locations, one (Taiwan) that provides unrivalled experience in coral reproductive biology, and superb microcosm facilities, and the other (Moorea), with access to a relatively pristine environment, a well described ecological and oceanographic context (through the MCR-LTER), and the capacity to bring a strong biogeographic contrast to the project. The results of the study will be integrated through modeling to explore the effects of GCC on coral community structure over the next century.

The following publications and data resulted from this project:

2013 Wall CB, Fan TY, Edmunds PJ. Ocean acidification has no effect on thermal bleaching in the coral *Seriatopora caliendrum*. Coral Reefs 33: 119-130.
Symbiodinium_Seriatopora photosynthesis
Symbiodinium_Seriatopora PI curve
Symbiodinium_Seriatopora temp-salinity-light
Symbiodinium_Seriatopora water chemistry
- Download complete data for this publication (Excel file)

2013 Wall CB, Edmunds PJ. *In situ* effects of low pH and elevated HCO3- on juvenile *Porites* spp. in Moorea, French Polynesia. Biological Bulletin 225:92-101.
Data at MCR and PANGEA: doi.pangaea.de/10.1594/PANGAEA.833913
- Download complete data for this publication (Excel file)

2013 Vivian R Cumbo, Peter J Edmunds, Christopher B Wall, Tung-Yung Fan. Brooded coral larvae differ in their response to high temperature and elevated pCO2 depending on the day of release. Marine Biology DOI 10.1007/s00227-013-2280-y.
Data also at PANGEA: doi.pangaea.de/10.1594/PANGAEA.831612
brooded coral larvae 2 - carbonate chemistry
brooded coral larvae 2 - larval release March 2003-2008
brooded coral larvae 2 - respiration_photosyth_mortality
- Download complete data for this publication (Excel file)

2013 Edmunds PJ, Cumbo VR, Fan TY. Metabolic costs of larval settlement and metamorphosis in the coral *Seriatopora caliendrum* under ambient and elevated pCO2. Journal Experimental Marine Biology and Ecology 443: 33-38 Data also at PANGEA: doi:10.1594/PANGAEA.821644

Coral post-settlement physiology
- Download complete data for this publication (Excel file)

2013 Aaron M Dufault, Aaron Ninokawa, Lorenzo Bramanti, Vivian R Cumbo, Tung-Yung Fan, Peter J Edmunds. The role of light in mediating the effects of ocean acidification on coral calcification. Journal of Experimental Biology 216: 1570-1577.
coral-light expt.- PAR
coral-light expt.- carbonate chemistry
coral-light expt.- temp_salinity
coral-light expt.- growth
coral-light expt.- protein
coral-light expt.- survival
- Download complete data for this publication (Excel file)

2012 Cumbo, VR, Fan TY, Edmunds PJ. Effects of exposure duration on the response of *Pocillopora damicornis* larvae to elevated temperature and high pCO2. J Exp Mar Biol Ecol 439: 100-107.
Data is also at PANGEA: doi:10.1594/PANGAEA.823582
brooded coral larvae 3 - carbonate chemistry
brooded coral larvae 3 - light
brooded coral larvae 3 - mortality
brooded coral larvae 3 - protein
brooded coral larvae 3 - respiration and protein
brooded coral larvae 3 - respiration raw data
brooded coral larvae 3 - symbiont density
brooded coral larvae 3 - tank temperature
- Download part 1 of data for this publication (Excel file)
- Download tank parameters data for this publication (Excel file)

2012 Cumbo, VR, Fan TY, Edmunds PJ. Physiological development of brooded larvae from two pocilloporid corals in Taiwan. Marine Biology 159: 2853-2866.
brooded coral - carbonate chemistry
brooded coral - release
brooded coral - respiration
brooded coral - settlement competency
brooded coral - size_July
brooded coral - size_protein_symbionts_photosynth
- Download complete data for this publication (Excel file)

2012 Dufault, Aaron M; Vivian R Cumbo; Tung-Yung Fan; Peter J Edmunds. Effects of diurnally oscillating pCO2 on the calcification and survival of coral recruits. Royal Society of London (B) 279: 2951-2958. doi:10.1098/rspb.2011.2545
Data is also at PANGEA: doi:10.1594/PANGAEA.830185
recruit_growth_area
recruit_growth_weight
recruit_seawater_chemistry
recruit_survival
- Download complete data for this publication (Excel file)

2011 Edmunds PJ, Cumbo V, Fan TY. Effects of temperature on the respiration of brooded larvae from tropical reef corals. Journal of Experimental Biology 214: 2783-2790.
CoralLarvae_comparison_respir
CoralLarvae_release
CoralLarvae_respir
CoralLarvae_size
- Download complete data for this publication (Excel file)

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Program Information

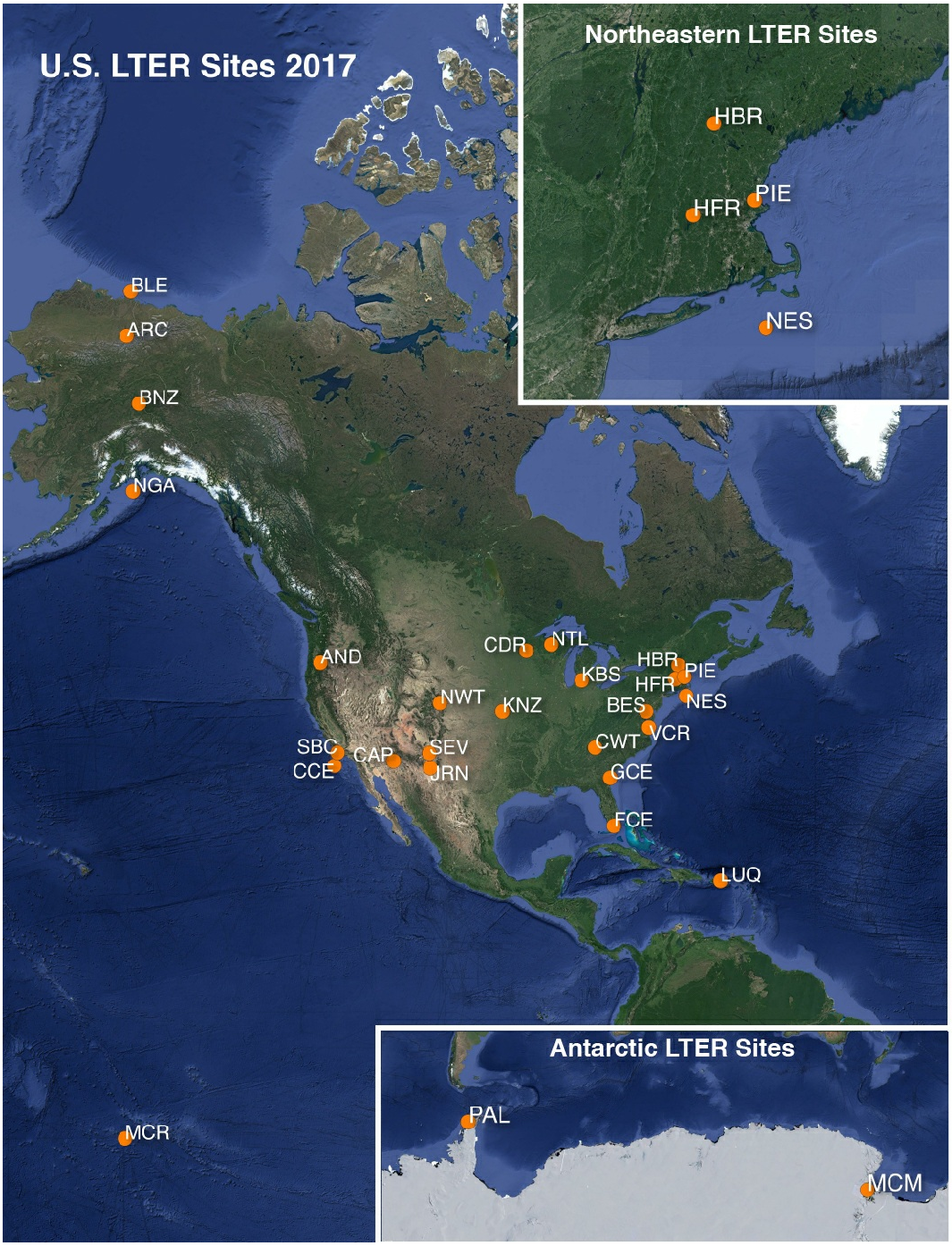
Long Term Ecological Research network (LTER)

Website: http://www.lternet.edu/

Coverage: United States

adapted from http://www.lternet.edu/

The National Science Foundation established the LTER program in 1980 to support research on long-term ecological phenomena in the United States. The Long Term Ecological Research (LTER) Network is a collaborative effort involving more than 1800 scientists and students investigating ecological processes over long temporal and broad spatial scales. The LTER Network promotes synthesis and comparative research across sites and ecosystems and among other related national and international research programs. The LTER research sites represent diverse ecosystems with emphasis on different research themes, and cross-site communication, network publications, and research-planning activities are coordinated through the LTER Network Office.



2017 LTER research site map obtained from https://lternet.edu/site/lter-network/

Site Codes

AND	Andrews Forest LTER
ARC	Arctic LTER
BES	Baltimore Ecosystem Stu
BLE	Beaufort Lagoon Ecosystems LTER
BNZ	Bonanza Creek LTER
CCE	California Current Ecosystem LTER
CDR	Cedar Creek Ecosystem Science Reserve
CAP	Central Arizona-Phoenix LTER
CWT	Coweeta LTER
FCE	Florida Coastal Everglades LTER
GCE	Georgia Coastal Ecosystems LTER
HFR	Harvard Forest LTER
HBR	Hubbard Brook LTER
JRN	Jornada Basin LTER
KBS	Kellogg Biological Station LTER
KNZ	Konza Prairie LTER
LUQ	Luquillo LTER
MCM	McMurdo Dry Valleys LT
MCR	Moorea Coral Reef LTEF
NWT	Niwot Ridge LTER
NTL	North Temperate Lakes I
NES	Northeast U.S. Shelf LTE
NGA	Northern Gulf of Alaska I
PAL	Palmer Antarctica LTER
PIE	Plum Island Ecosystems LTER
SBC	Santa Barbara Coastal L
SEV	Sevilleta LTER
VCR	Virginia Coast Reserve L

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0844785

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