

Results of a field transplant experiment using newly-settled *Porites* corals in Palau in 2023

Website: <https://www.bco-dmo.org/dataset/997286>

Data Type: experimental

Version: 1

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Project

» [Collaborative Research: How do selection, plasticity, and dispersal interact to determine coral success in warmer and more variable environments?](#) (Palau coral selection plasticity dispersal)

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Abstract

We aimed to investigate whether coral larvae spawned in semi-enclosed lagoons in Palau have the potential to disperse out of the lagoons, settle, and survive on outer reefs. We focused on massive *Porites*, which is a common mounding coral on both classic and extreme reefs in Palau. We conducted an experiment to determine whether post-settlement survival differs between corals settling on their natal (home) extreme reef or at a classic (away) reef. Adult massive *Porites* corals were collected from six sites in Palau immediately prior to their spawning season in April 2023. *Porites* gametes from 3 males and 2 females were used in a bulk cross. Two dpf, larvae were settled on limestone tiles (15 x 15 cm) with crushed CCA used as a cue. Tiles were maintained in individual plastic containers in flow-through ASW tanks at PICRC. Nine days post fertilization, tiles were deployed to their home reef and an away site (n=10 tiles per site). Sixteen days after deployment (25 days post fertilization), tiles were recovered and examined under a dissecting microscope to identify and count surviving individuals. The number of corals was counted on all tiles post transplantation. Light and temperature were quantified at transplant locations at each site using Hobo Pendants (Onset, Wareham, USA).

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Coverage

Location: Palau

Spatial Extent: N:7.3386 E:134.4664 S:7.267217 W:134.383317

Dataset Description

Coral adults were collected from a reef called Taoch (7 16.033 N, 134 23.233 E), spawned in the lab at the Palau International Coral Reef Center, and settled on tiles. We then outplanted the tiles at Taoch (same coordinates) and a nearby reef called Outer Taoch (7 16.232 N, 134 22.999 E).

Methods & Sampling

We conducted an experiment to determine whether post-settlement survival differs between corals settling on their natal (home) extreme reef or at a classic (away) reef. Adult massive *Porites* corals were collected from six sites in Palau immediately prior to their spawning season in April 2023. Corals were either whole colonies or fragments of large colonies removed with a hammer and chisel (15 - 30 cm diameter). Collected corals were held in individual plastic containers (4.2 L; 17 x 13 x 19 cm) in ambient unfiltered flow-through seawater tanks at the Palau International Coral Reef Center (PICRC). At sunset, water levels in flow-through tanks were lowered to ~15 cm so that each colony was isolated in its individual container, maintaining gametes separate until fertilization. Sperm was collected directly from male colonies using a large plastic pipette during release, and eggs were collected by pipette or by scooping from the surface with a clean petri dish. *Porites* gametes from 3 males and 2 females were used in a bulk cross in April 2023. Two different crosses were conducted, with one male differing between the two crosses, but larvae were pooled for the experiment. One hour after fertilization began, embryos underwent a series of dilutions with 5 µm filtered seawater (FSW) and gently split into multiple containers filled with 5 µm FSW to dilute any remaining sperm and prevent polyspermy. Two days post fertilization (dpf), larvae were settled on limestone tiles (15 x 15 cm) with crushed crustose coralline algae (CCA) used as a cue. Tiles were maintained in individual plastic containers in flow-through seawater tanks at PICRC. Additional CCA was added to each tile on the fourth dpf to encourage additional settlement. Immediately prior to transplantation, the number of settled corals on 7 randomly-selected tiles was counted using a dissecting microscope to estimate the mean number of individuals settled on each tile (272 ± 36 , mean \pm SE). Nine days post fertilization, tiles were deployed to Taoch (home) and Outer Taoch (away) (n=10 tiles per site). Tiles were randomly distributed between sites and deployed in a horizontal orientation on stainless steel all-thread driven into the reef, with ~10 cm distance between the seafloor and the tile. The most densely populated side of each tile was deployed facing downward to mimic the cryptic spaces where most corals settle. Sixteen days after deployment (25 dpf), tiles were recovered and examined under a dissecting microscope to identify and count surviving individuals. The number of corals was counted on all tiles post transplantation. Light and temperature were quantified at transplant locations at each site using Hobo Pendants (Onset, Wareham, USA).

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Data Files

File
997286_v1_transplant.csv (Comma Separated Values (.csv), 1.45 KB) MD5:6c8c3b5106ec30dd1bb9019f990ddee6
Primary data file for dataset ID 997286, version 1

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Supplemental Files

File	
Data transplant temp light.csv	(Comma Separated Values (.csv), 26.39 KB) MD5:15cb082907abd2d3ba44d6c401fb59f6
Supplemental file of light and temperature measurements taken during the transplant experiment.	
Column descriptions: Parameter,Description,Units Date,Date of measurement,dimensionless Time,Time of measurement,dimensionless AM_PM,Time of day,unitless Temp_OT,Water temperature at site Outer Taoch,degrees Celsius Light_OT,Light intensity at site Outer Taoch,Lux Temp_T,Water temperature at site Taoch,degrees Celsius Light_T,Light intensity at site Taoch,Lux	

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Parameters

Parameter	Description	Units
Tile_identification	Identification label of the settlement tile that was counted and/or used in the experiment(s)	unitless
Number_Corals	Number of corals on settlement tile	unitless
Category	Categories include Pre-transplant (sub-set of tiles counted prior to transplantation), Taoch survivors (tiles recovered from the Taoch site), and Outer Taoch survivors (tiles recovered from the Outer Taoch site)	unitless
Location	Location of tile treatment prior to counting (PICRC lab, home reef or away reef)	unitless
Latitude	Latitude of tile treatment location	decimal degrees
Longitude	Longitude of tile treatment location	decimal degrees

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Instruments

Dataset-specific Instrument Name	limestone tiles
Generic Instrument Name	Ceramic tile settlement plate
Generic Instrument Description	An artificial colonization substrate made of ceramic tiles. It is used to determine the extent of colonization and/or the diversity of settled organisms in a marine or artificial environment.

Dataset-specific Instrument Name	flow-through seawater tanks
Generic Instrument Name	circulating water bath
Generic Instrument Description	A device designed to regulate the temperature of a vessel by bathing it in water held at the desired temperature. [Definition Source: NCI]

Dataset-specific Instrument Name	dissecting microscope
Generic Instrument Name	Microscope - Optical
Generic Instrument Description	Instruments that generate enlarged images of samples using the phenomena of reflection and absorption of visible light. Includes conventional and inverted instruments. Also called a "light microscope".

Dataset-specific Instrument Name	
Generic Instrument Name	Onset HOBO Pendant Temperature/Light Data Logger
Dataset-specific Description	Light and 233 temperature were quantified at transplant locations at each site using Hobo Pendants (Onset, 234 Wareham, USA).
Generic Instrument Description	The Onset HOBO (model numbers UA-002-64 or UA-001-64) is an in-situ instrument for wet or underwater applications. It supports light intensity, soil temperature, temperature, and water temperature. A two-channel logger with 10-bit resolution can record up to approximately 28,000 combined temperature and light measurements with 64K bytes memory. It has a polypropylene housing case. Uses an optical USB to transmit data. A solar radiation shield is used for measurement in sunlight. Temperature measurement range: -20 deg C to 70 deg C (temperature). Light measurement range: 0 to 320,000 lux. Temperature accuracy: +/- 0.53 deg C from 0 deg C to 50 deg C. Light accuracy: Designed for measurement of relative light levels. Water depth rating: 30 m.

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Project Information

Collaborative Research: How do selection, plasticity, and dispersal interact to determine coral success in warmer and more variable environments? (Palau coral selection plasticity dispersal)

Coverage: Palauan coral reefs

NSF Award Abstract:

Coral reefs host thousands of marine species, help protect coastlines from storm damage, generate tourism, and house fish used for human consumption. However, corals are vulnerable to increasing water temperatures, which can lead to coral death. One way for reefs to survive in warming oceans is for corals that are well-suited to warmer waters to repopulate reefs that have less temperature-tolerant individuals. For this strategy to succeed, however, the more temperature-tolerant corals need to be able to disperse to and survive in these different environments. This project takes advantage of reef systems in the Pacific nation of Palau that naturally experience a wide range in temperatures across short geographic distances. Using cutting-edge

ecological and genomic techniques, the team of investigators is directly testing whether young corals from Palau's warmest reefs can successfully be carried by ocean currents to Palau's currently cooler reefs and subsequently survive and thrive in these habitats. Given the relevance of this research for the local ecology, the team is disseminating results to the Palauan government through a written report in conjunction with Palauan scientists who are interning with the team, and to the Palauan people through public presentations. As part of this work, the investigators are maintaining a blog and are organizing a music-lecture series combining dance, music, and science to promote awareness of the coral reef crisis across English and Spanish-speaking communities in the US. Results from this project are informing restoration and conservation practices of the Coral Conservation Consortium as well as other efforts worldwide.

A major question in evolutionary biology is how plasticity and adaptation interact to influence survival under novel environments. Understanding these processes is increasingly important as rising temperatures associated with climate change influence species globally. For marine organisms with pelagic larval phases, including reef-building corals, the post-settlement period constitutes a critical bottleneck for adaptation and plasticity, with the added complexity that the conditions experienced and time spent as larvae can incur carryover effects. This project leverages reefs in Palau that span a steep environmental gradient to study how environmental variation drives selection and plasticity and to examine if dispersal between reefs limits success across habitats due to carryover effects. The investigators are testing the overarching hypothesis that corals from warmer and more variable environments are adapted to warmer temperatures and exhibit increased plasticity, but that dispersal between reefs incurs a fitness cost. The team integrates field and molecular techniques to: 1) investigate the degree of selection occurring on warmer and more variable reefs, 2) test whether corals transplanted to more variable environments improve their thermal tolerance through developmental plasticity, and 3) examine whether delays in metamorphosis required for dispersal across reefs comes at a fitness cost due to carryover effects.

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.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-2048678

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