Fertilization success rates from gamete age assays using eggs and sperm from Porites lobata corals in April-May 2023

Website: https://www.bco-dmo.org/dataset/926315
Data Type: experimental
Version: 1
Version Date: 2024-04-30

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)

Contributors	Affiliation	Role
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Abstract
This dataset includes fertilization success rates from gamete age assays using eggs and sperm from Porites lobata corals in April-May 2023. Porites lobata colonies were collected from study sites in the Rock Islands Southern Lagoon in the Republic of Palau. Colonies were isolated in individual plastic containers at the Palau International Coral Reef Center. Sperm from selected male colonies were pooled in a single container, and eggs were gently poured into this pool, allowing fertilization to commence. Fertilization success was evaluated visually 2-3 hours after fertilization began by observing a sub-sample of the eggs from each cross under a dissecting microscope and counting whole (undivided) eggs and dividing embryos.

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Coverage

Location: Rock Islands Southern Lagoon, Republic of Palau
Spatial Extent: **N**:7.4 **E**:134.5 **S**:7.1 **W**:134.3
Temporal Extent: 2023-04-20 - 2023-05-13

Methods & Sampling

In April to May 2023, we conducted gamete age assays using eggs and sperm from *Porites lobata* corals. *Porites lobata* colonies (minimum diameter 15 centimeters (cm)) were collected from study sites in the Rock Islands Southern Lagoon (Chelbacheb) in the Republic of Palau. Colonies were isolated in individual plastic containers in flow-through seawater tanks at the Palau International Coral Reef Center. Sperm were collected directly from colonies using a large plastic pipette during release. Eggs were allowed to float to the surface so they could more easily be collected by pipette or by skimming the surface with a plastic tri-pour beaker or petri dish. Sperm from selected male colonies were pooled in a single container, and eggs (from n=1 female per batch cross) were gently poured into this pool, allowing fertilization to commence. A small aliquot (~10 milliliters (mL)) of concentrated sperm and ~1000 eggs were added to triplicate wells of a 6-well plate for each time-point. Cell strainers (70 micrometers (µm) mesh) were used to separate eggs from sperm ~45 minutes after fertilization began, and eggs were gently rinsed into a 50 mL beaker filled with 5 µm filtered seawater. Fertilization success

was evaluated visually 2-3 hours after fertilization began by observing a sub-sample of the eggs from each cross under a dissecting microscope (Leica S9i) and counting whole (undivided) eggs and dividing embryos.

Data Processing Description

Some crosses were excluded because results showed gamete contamination. No other processing was conducted. Analysis code (used to produce Figure 8 in Bennett et al., 2024) is shown below in the R language.

```
cpath<-file.choose() #Gamete_age
Gamage<-read.csv(cpath)
Gamage<-Gamage[1:16,]
Gamage$Cross[13:16]="India"
colnames(Gamage)<-c("Cross","Age_min","Fert_rate","SE")

Gamagefig<-ggplot(data=Gamage)+
  geom_point(aes(x=Age_min,y=Fert_rate,colour=as.factor(Cross)),size=4)+

scale_colour_manual(values=c("Alpha"="#88CCEE","Echo"="#44AA99","Foxtrot"="#AA4499","India"="#DDCC77"))+
  geom_errorbar(aes(x=Age_min,y=Fert_rate,ymin=Fert_rate-SE,ymax=Fert_rate+SE,width=.1)) +
  geom_smooth(aes(x=Age_min,y=Fert_rate),se=F,linetype="dashed",colour="black")+
  theme_classic()+xlab("Egg age (minutes)")+ylab("Percent fertilization")+
  guides(colour=guide_legend("Cross"))
Gamagefig
ggsave("Figure 7 gamete age.png",width=5,height=3,units=c("in"),bg="White",dpi=300)
```

BCO-DMO Processing Description

- Imported original file "Gamete_age_full.csv" into the BCO-DMO system.
- Renamed fields to comply with BCO-DMO naming conventions.
- Saved the final file as "926315_v1_fertilization_success_p_lobata_gamete_age_assays.csv".

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Data Files

File	
926315_v1_fertilization_success_p_lobata_gamete_age_assays.csv	(Comma Separated Values (.csv), 835 bytes) MD5:41562d9adc876ef3a4cc1a9c22b0185f
Primary data file for dataset ID 926315, version 1	

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Related Publications

Bennett, M-J, Grupstra, CGB, Da-Anoy, J, Andres, M, Holstein, D, Rossin, A, Davies, SW, & Meyer-Kaiser KS. (2024) Ex situ spawning, larval development, and settlement in the massive reef-building coral Porites lobata in Palau. Invert Biol, under review.
Results

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Parameters

Parameter	Description	Units
Cross	"Cross" represents a unique mixture of eggs from one female and sperm from at least 3 males. The age assays were conducted using 4 unique combinations of eggs from one female and sperm from 3 males. The phonetic alphabet was used to name the crosses (alpha, echo, foxtrot, india). These desingations are arbitrary.	unitless
Age	Age in minutes	minutes
Replicate	Replicate number	unitless
Fert_rate	Fertilization success: proportion of observed eggs that were dividing, indicating successful fertilization	unitless

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Instruments

Dataset-specific Instrument Name	flow-through seawater tanks
Generic Instrument Name	Aquarium
Generic Instrument Description	Aquarium - a vivarium consisting of at least one transparent side in which water-dwelling plants or animals are kept

Dataset-specific Instrument Name	cell strainers (70 µm mesh)
Generic Instrument Name	cell strainer
Generic Instrument Description	Cell strainers are devices used for straining stem and primary cell samples to obtain uniform cell suspensions from tissues and preparation of flow cytometry samples.

Dataset-specific Instrument Name	Leica S9i 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".

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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)

Website: https://www.nsf.gov/awardsearch/showAward?AWD_ID=2048589&HistoricalAwards=false

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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