Holobiont composition and seasonal plasticity in physiology are key to understanding reef building coral performance

Ariana S. Huffmyer, Emma L Strand, Kevin Wong, Danielle Becker, Serena Hackerott, Dennis Connetta, Kristina X Terpis, Ferdi Pfab, Juliet Wong, Frank Oliaro, Ross Cunning, José M Eirín-López, Steven B Roberts, Holly V Moeller, Roger Nisbet, Hollie M Putnam

Email: ashuff@uw.edu

GitHub: https://github.com/urol-e5/timeseries

2024 Moorea Coral Reef LTER All-Investigators Meeting

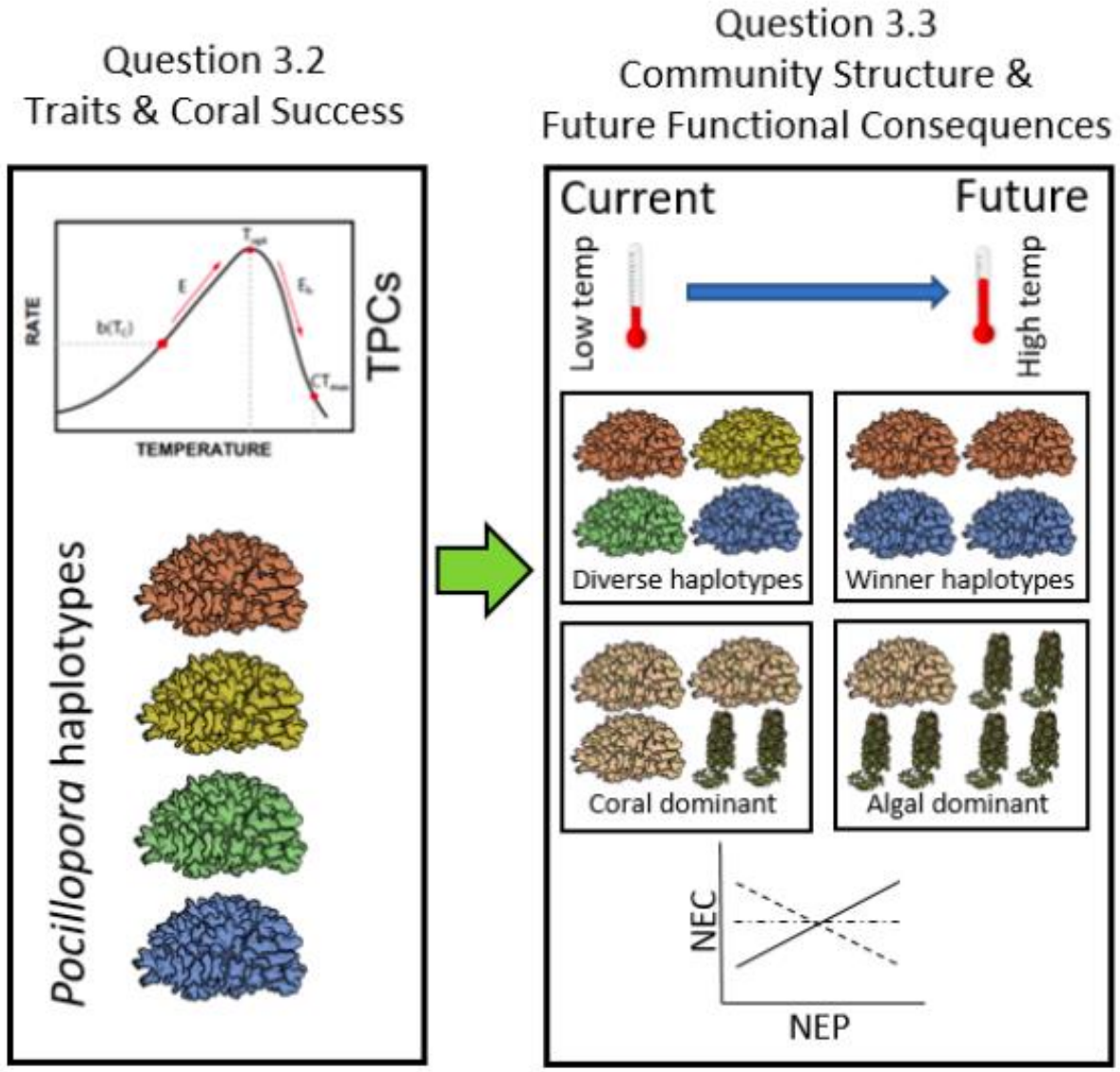
MOOREA CORAL REEF
LONG TERM ECOLOGICAL RESEARCH

NSF

LTER NETWORK

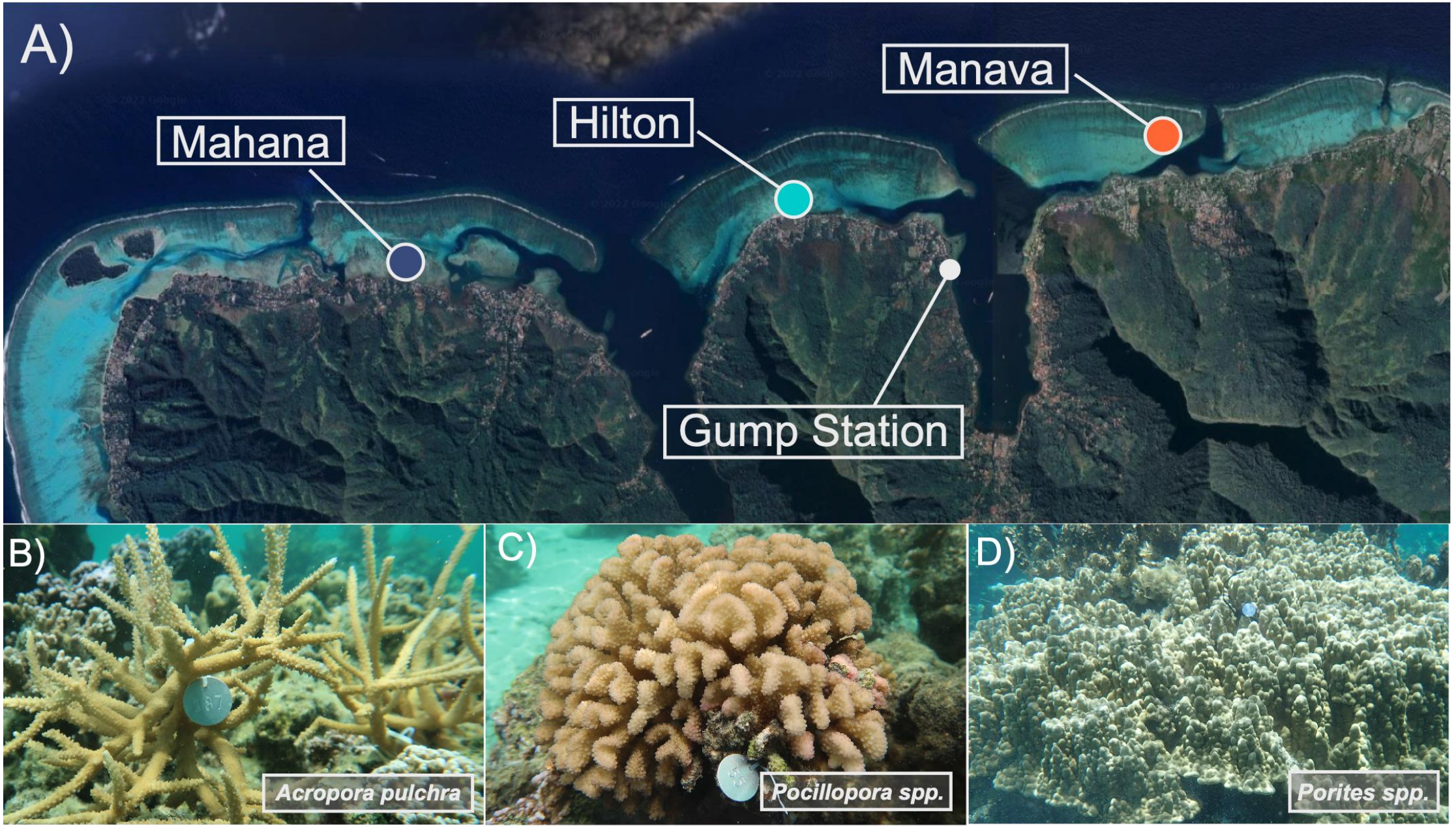
E5 Coral

Theme 3: How do disturbances generate information legacies in corals and coral reef communities that influence their resilience under current and future environmental conditions?



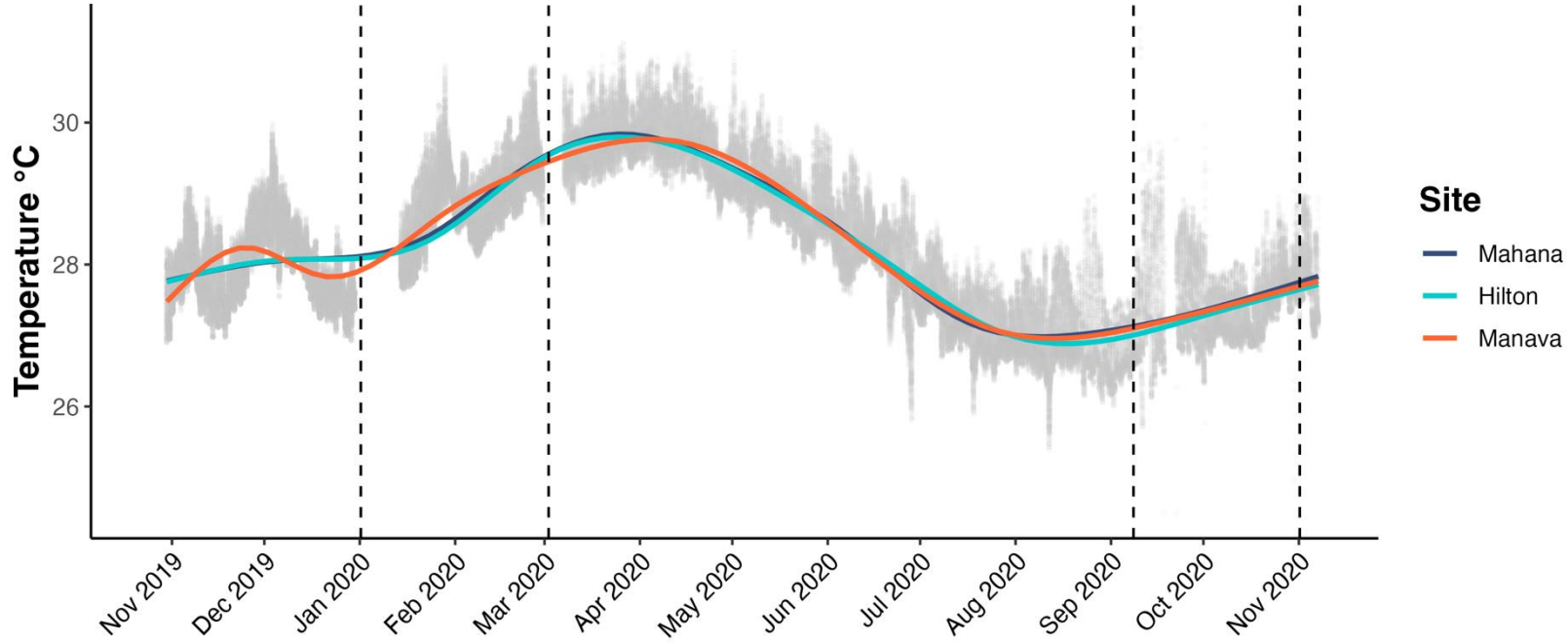
*3.2 What are the **traits** mediating the success of coral species and their **genetic variants**?*

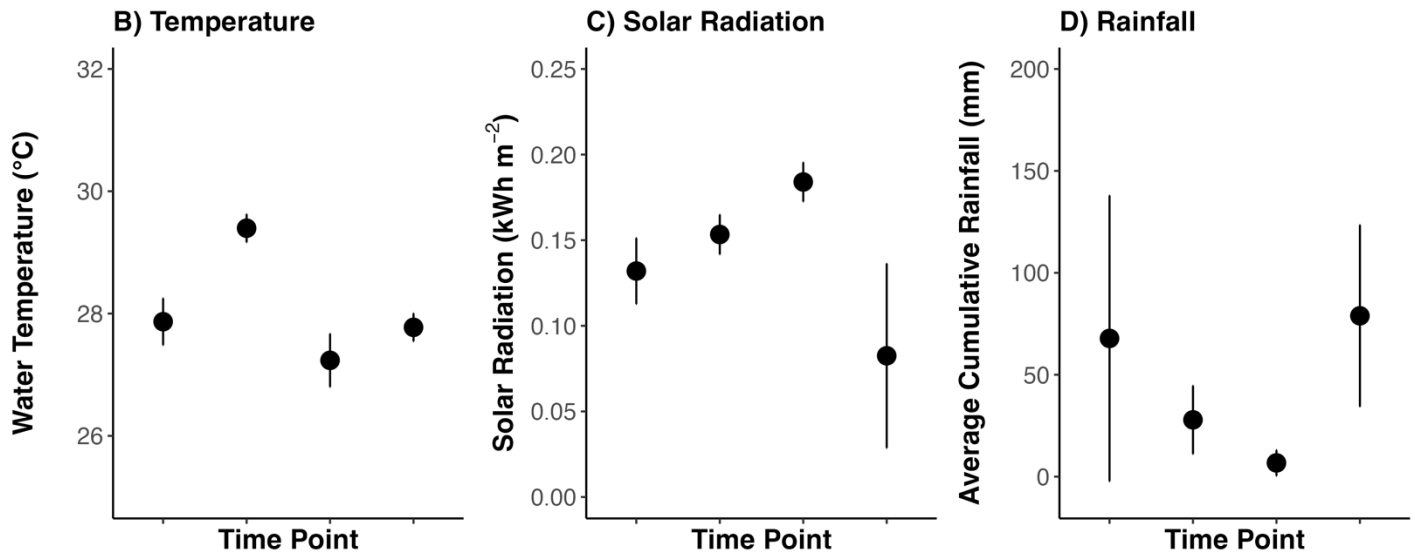
*3.3 How do information legacies of disturbances on benthic community structure impact ecosystem function and their **capability to withstand additional MHWs**?*



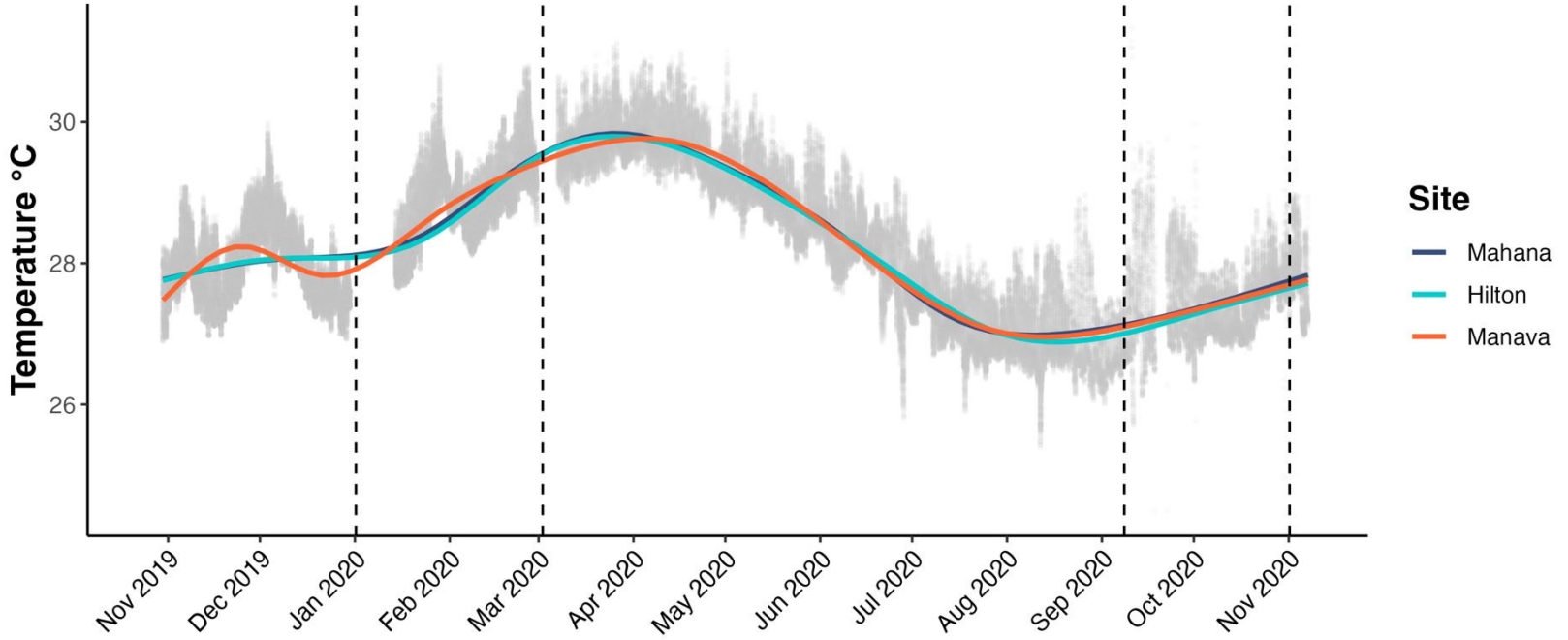
N=15 colonies per genus per site

E5 Loggers

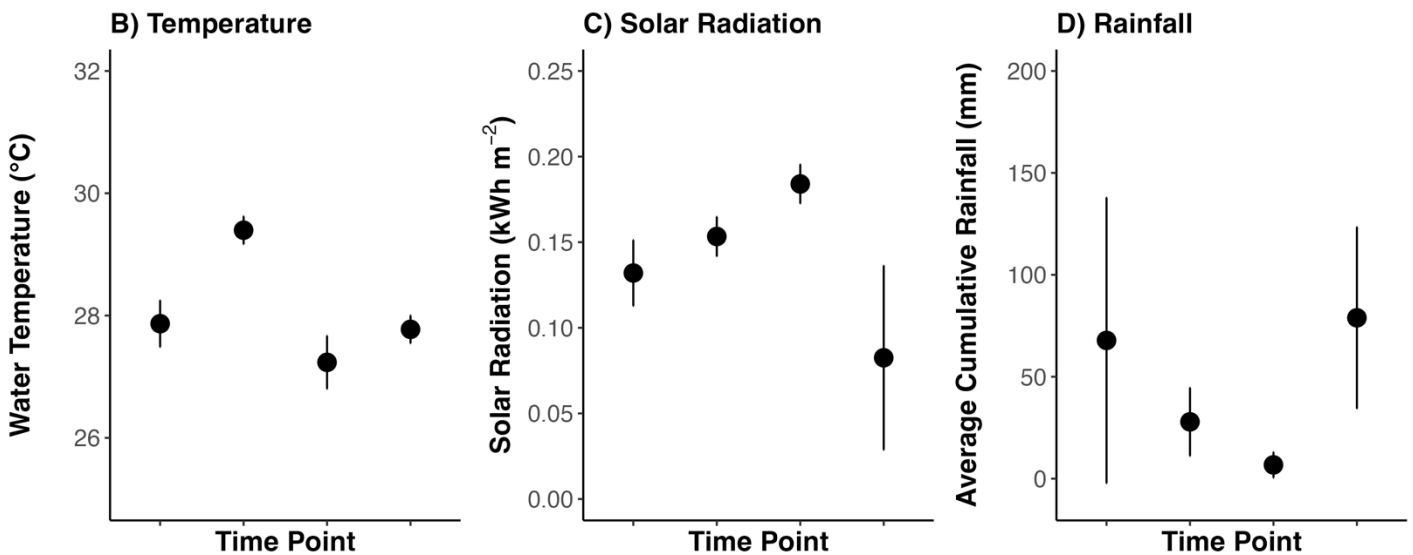

Temperature °C
30
28
26
Nov 2019
Dec 2019
Jan 2020
Feb 2020
Mar 2020
Apr 2020
May 2020
Jun 2020
Jul 2020
Aug 2020
Sep 2020
Oct 2020
Nov 2020
Site
Mahana
Hilton
Manava


B) Temperature
Water Temperature (°C)
32
30
28
26
Time Point
C) Solar Radiation
Solar Radiation (kWh m^{-2})
0.25
0.20
0.15
0.10
0.05
0.00
Time Point
D) Rainfall
Average Cumulative Rainfall (mm)
200
150
100
50
0
Time Point

E5 Loggers



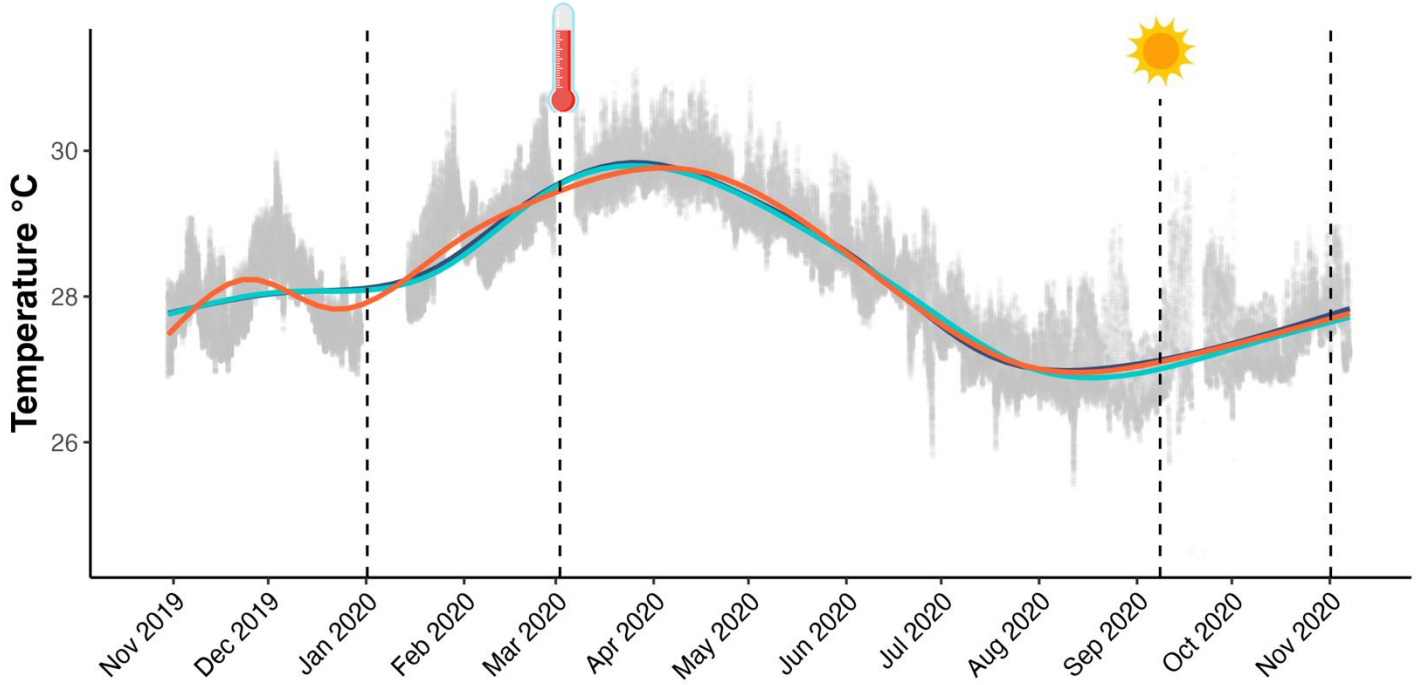
MCR Data



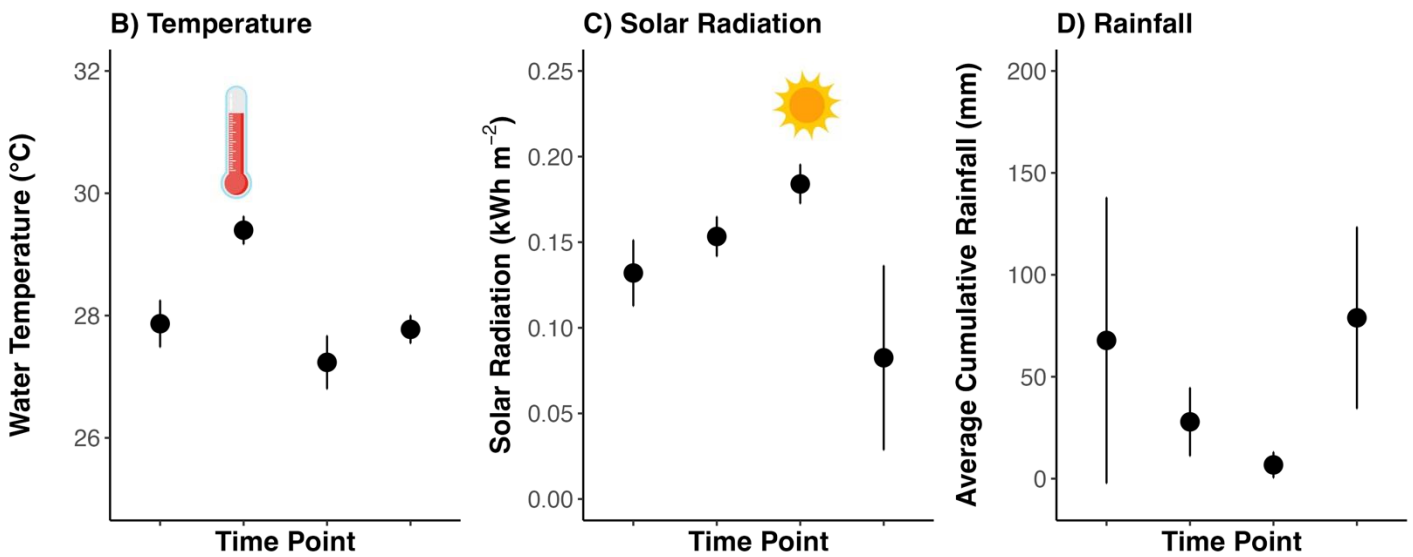
Washburn & Brooks 2024
Gump Station Meteorological Data

Mean values from 4 weeks leading up to sampling time point

E5 Loggers

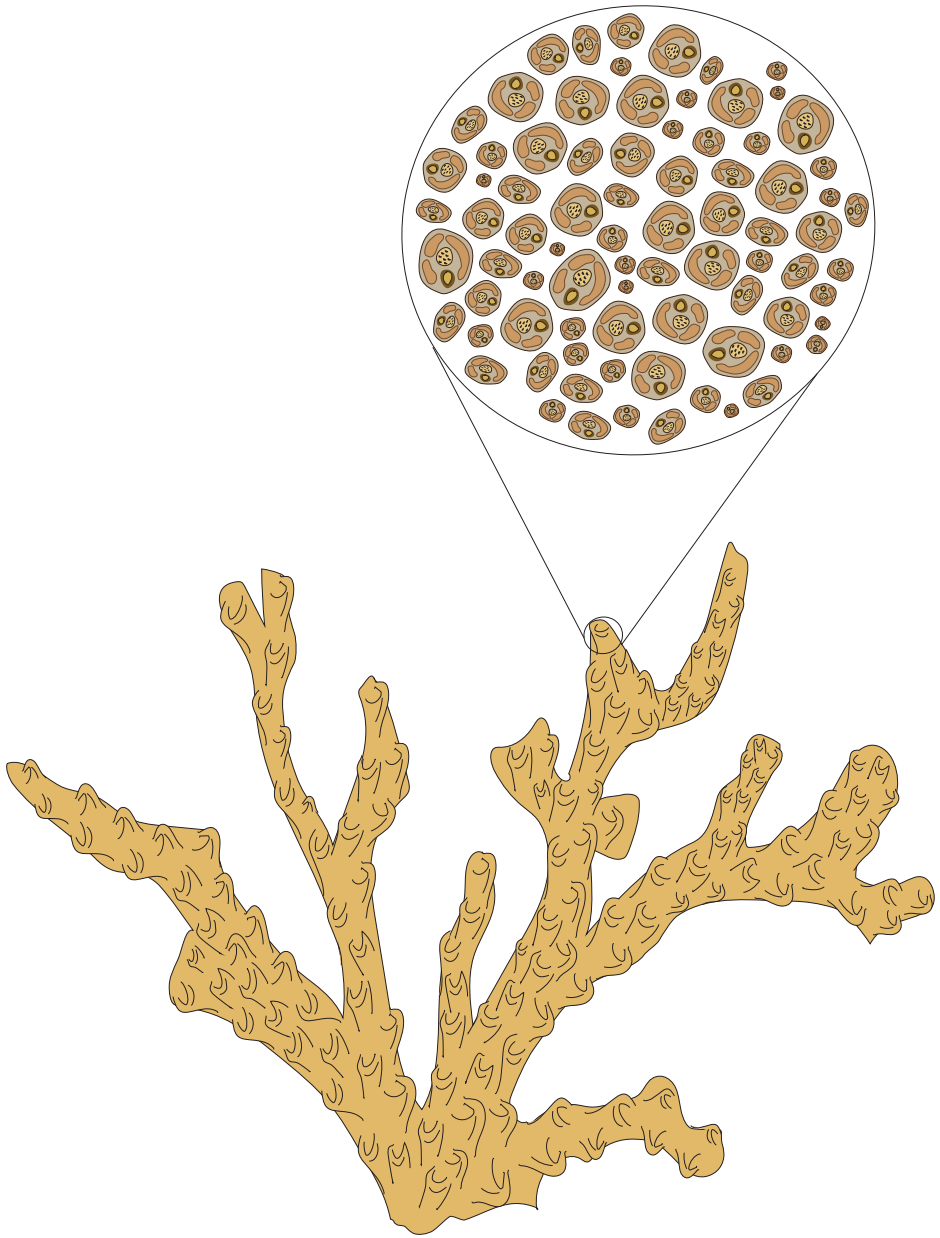


MCR Data



Washburn & Brooks 2024
Gump Station Meteorological Data

Mean values from 4 weeks leading up to sampling time point



Symbiont Responses

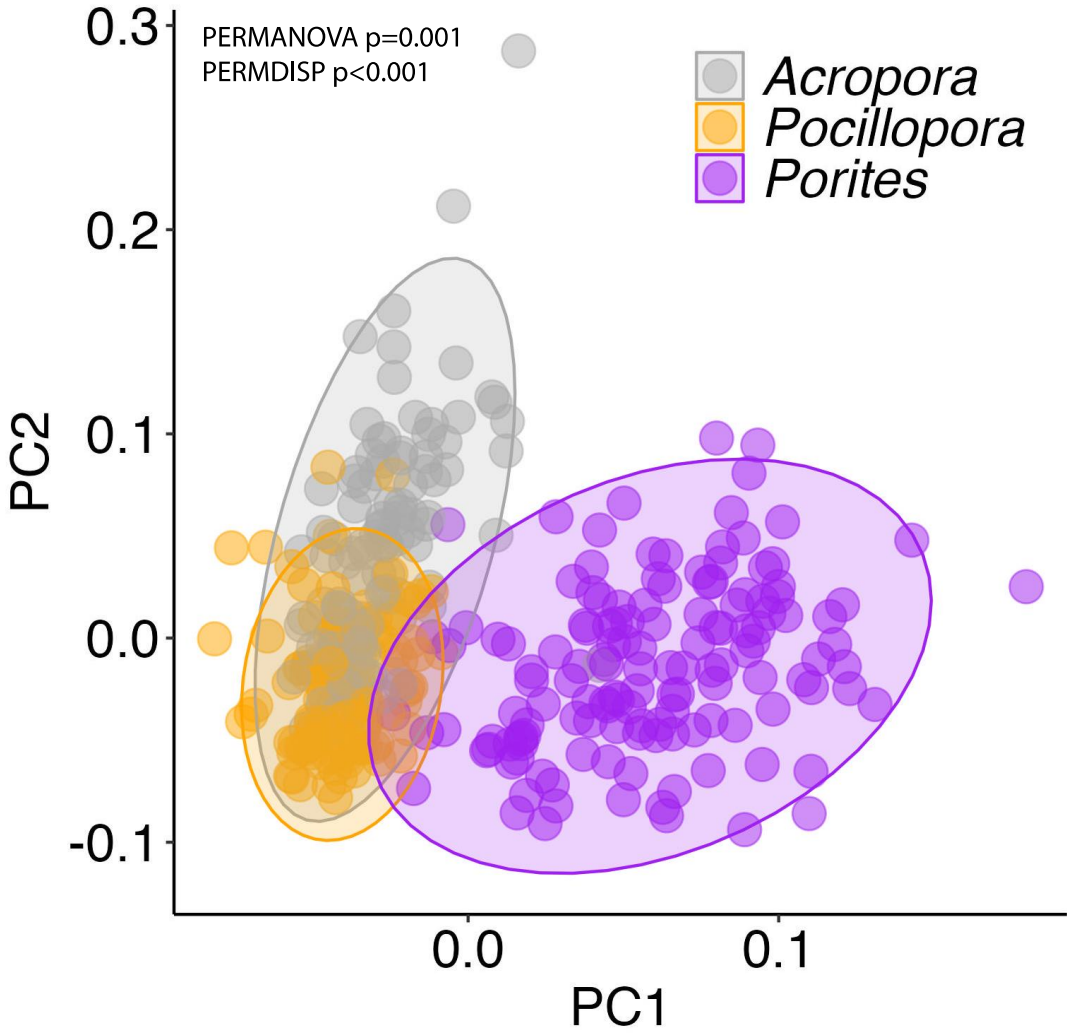
- Cell density
- Biomass
- Chlorophyll content
- Max. photosynthesis (P_{MAX})
- Apparent quantum yield (AQY)
- Saturating irradiance (I_K)
- Compensation irradiance (I_C)
- Symbiont : host biomass

Host Responses

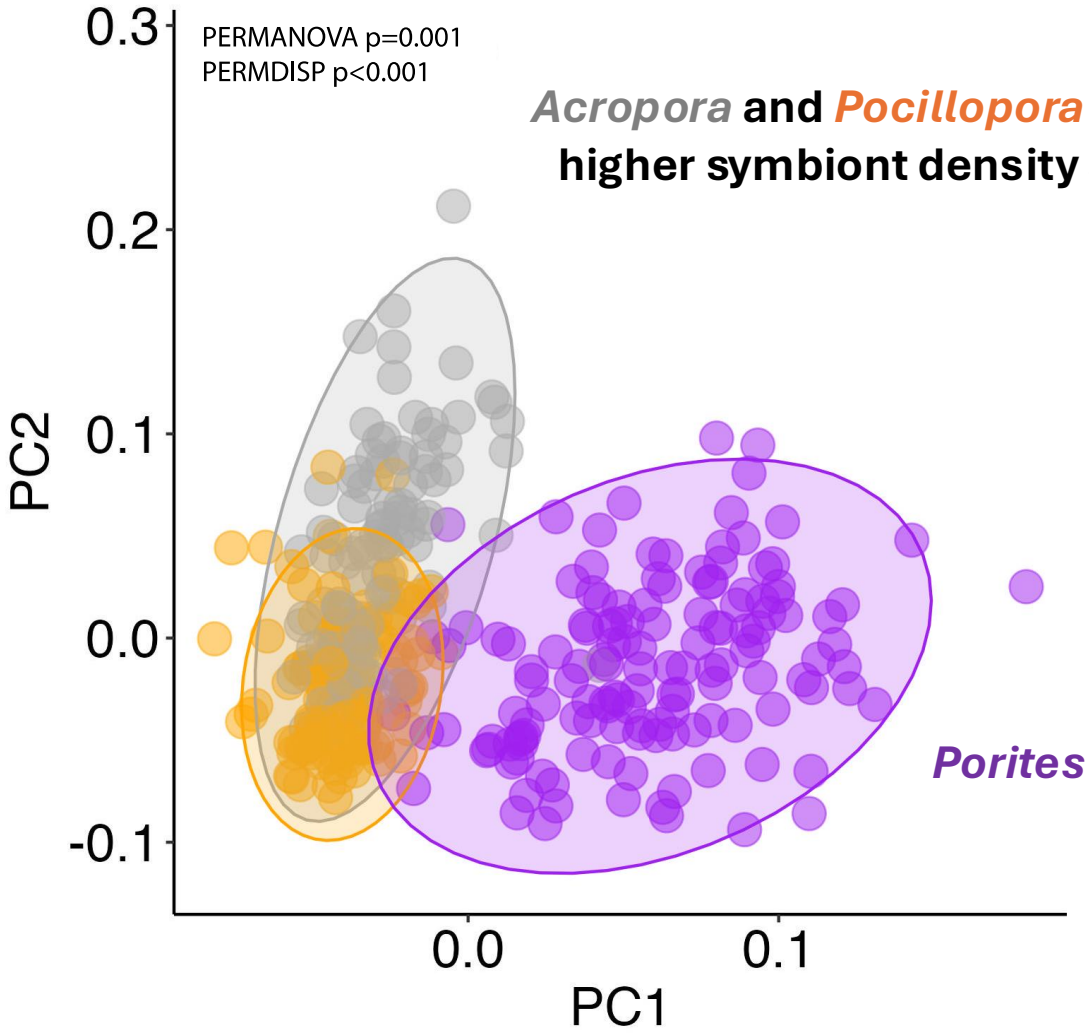
- Biomass
- Protein
- Calcification
- Antioxidant capacity
- Respiration (R_D)

Combined Responses

Each genus displayed distinct physiology



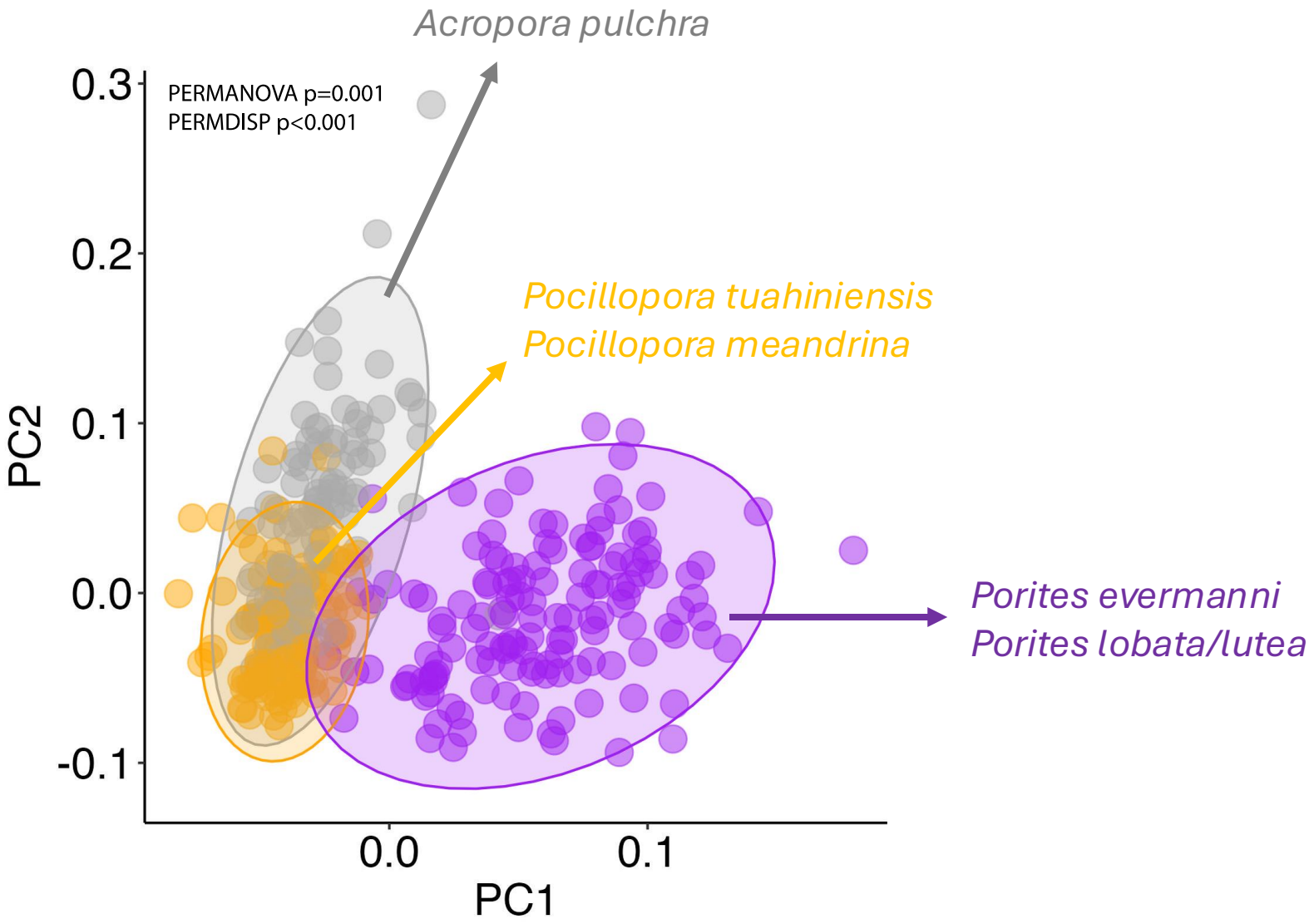
Each genus displayed distinct physiology



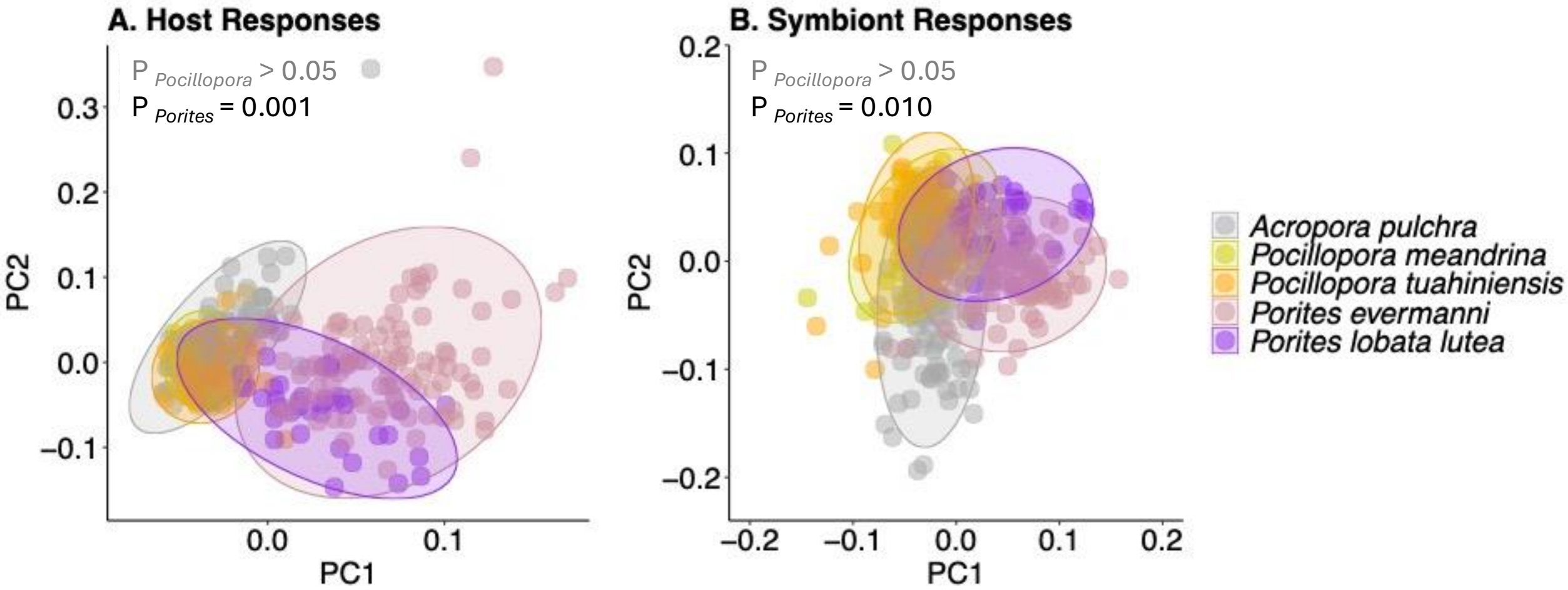
Acropora **and** ***Pocillopora*** **characterized by higher symbiont density and chlorophyll**

Porites **characterized by high biomass and metabolic rates**

Presence of cryptic *Pocillopora* and *Porites* species



Cryptic species exhibit significant differences in host and symbiont physiology in *Porites*, but not *Pocillopora*



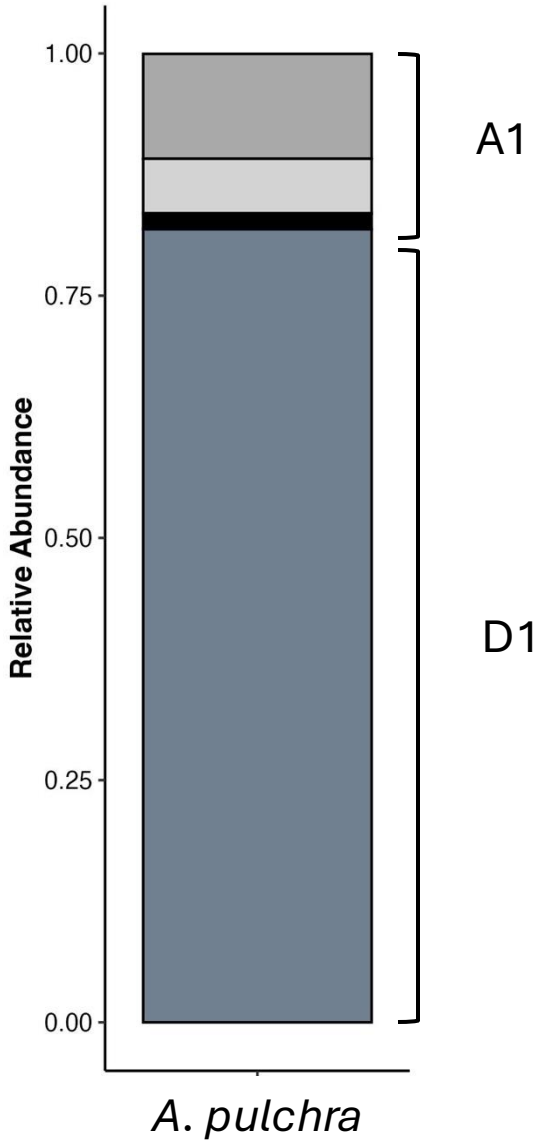
<u>Host and symbiont biomass</u>

P. evermanni > *P. lobata lutea*

Cryptic species host distinct symbiont communities

Acropora

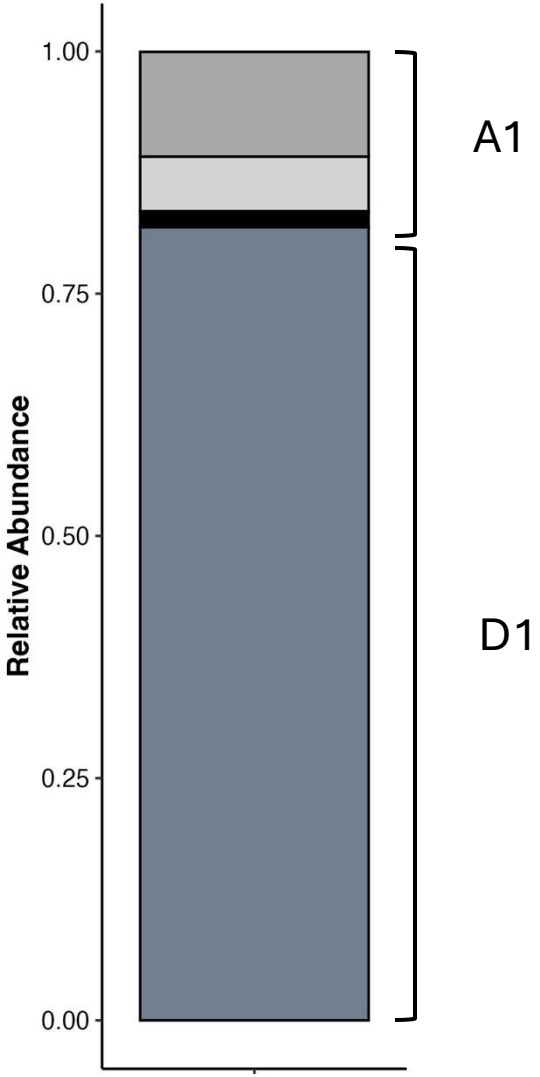
Durusdinium spp. &
Symbiodinium spp.



Cryptic species host distinct symbiont communities

Acropora

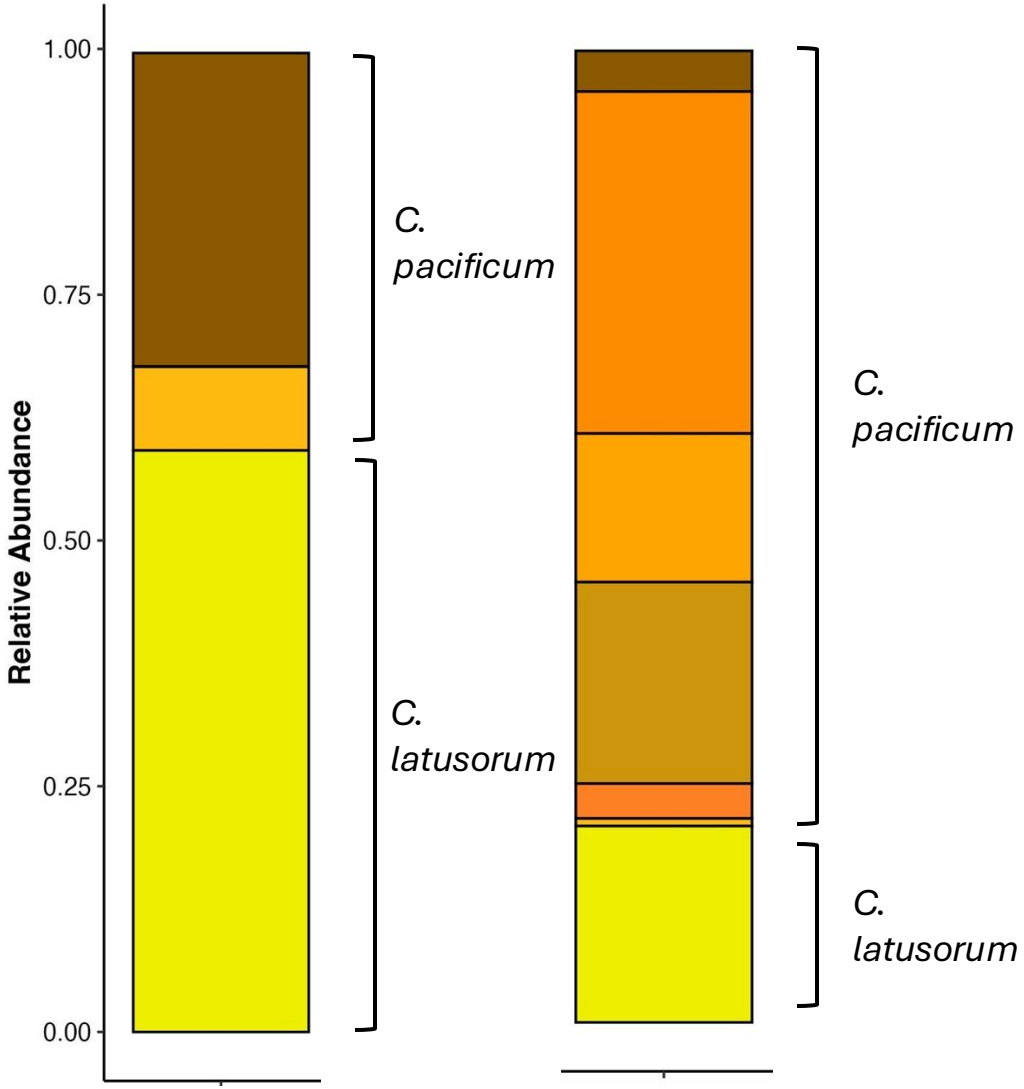
Durusdinium spp. &
Symbiodinium spp.



A. pulchra

Pocillopora

Cladocopium pacificum & C. latusorum
Aligns with Johnston et al. 2022



P. meandrina

P. tuahiniensis (hap. 10)

Cryptic species host distinct symbiont communities

Acropora

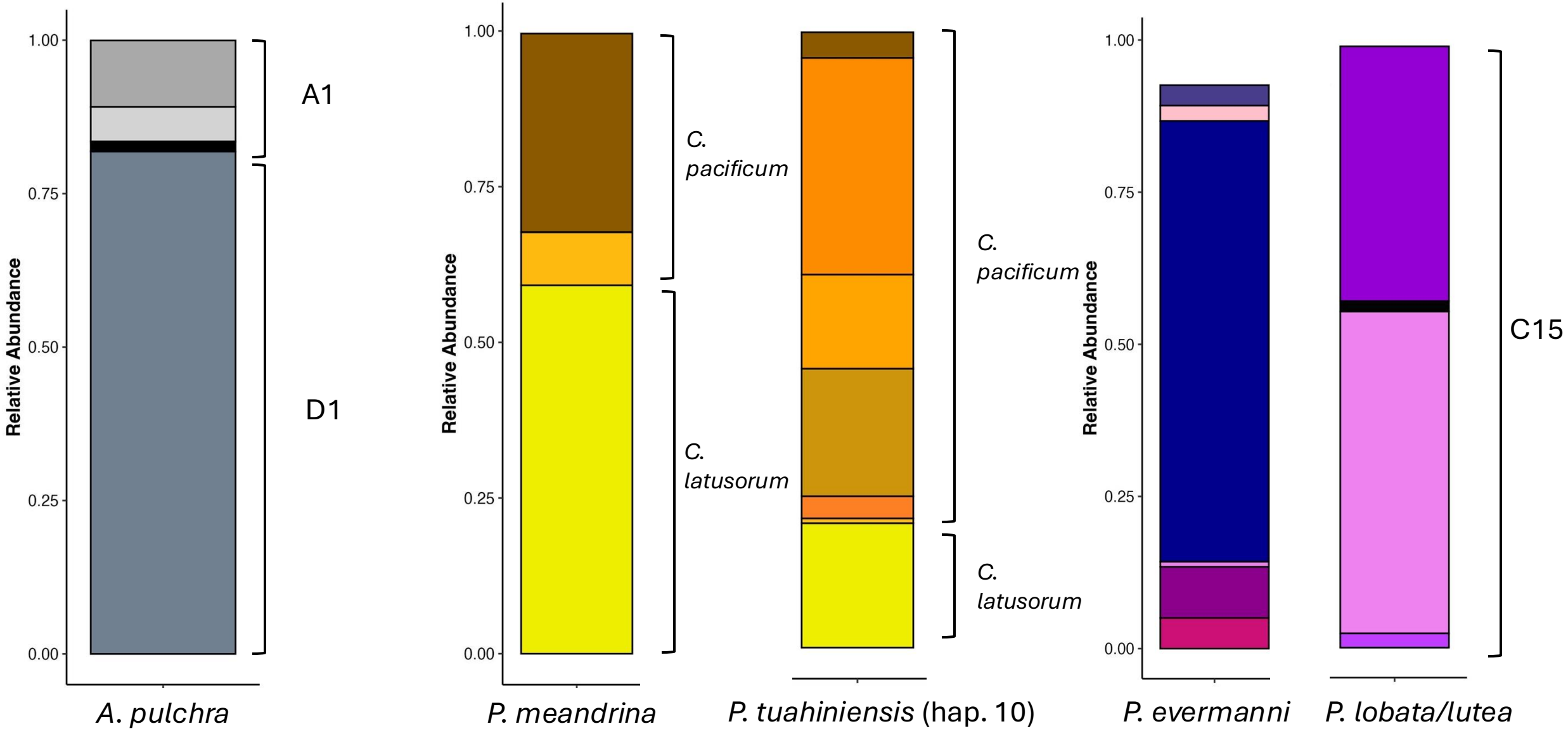
Durusdinium spp. &
Symbiodinium spp.

Pocillopora

Cladocopium pacificum & C. latusorum
Aligns with Johnston et al. 2022

Porites

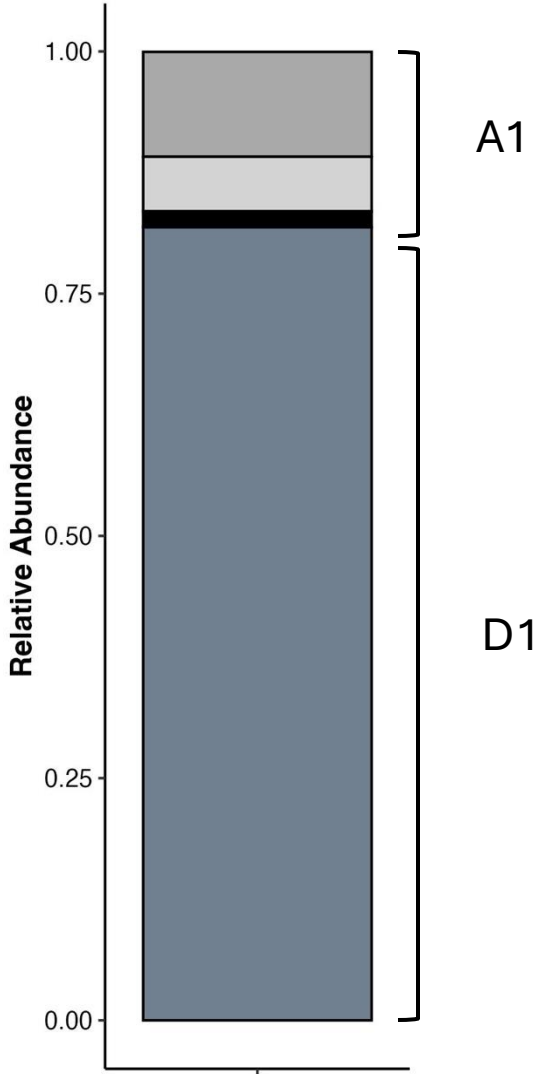
High fidelity Cladocopium spp.
C15



Physiological characteristics are related to symbiont community

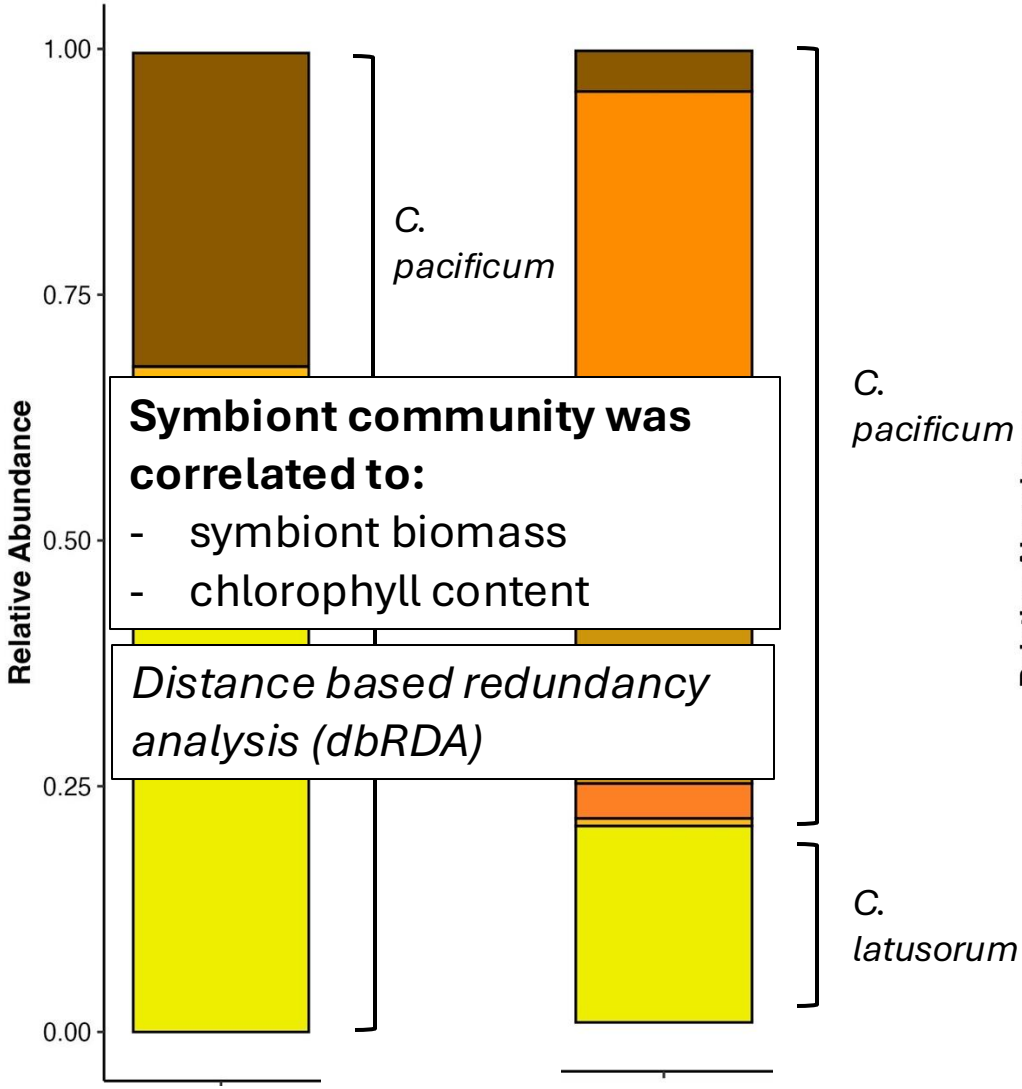
Acropora

Durusdinium spp. & *Symbiodinium* spp.



Pocillopora

Cladocopium pacificum & C. latusorum
Aligns with Johnston et al. 2022



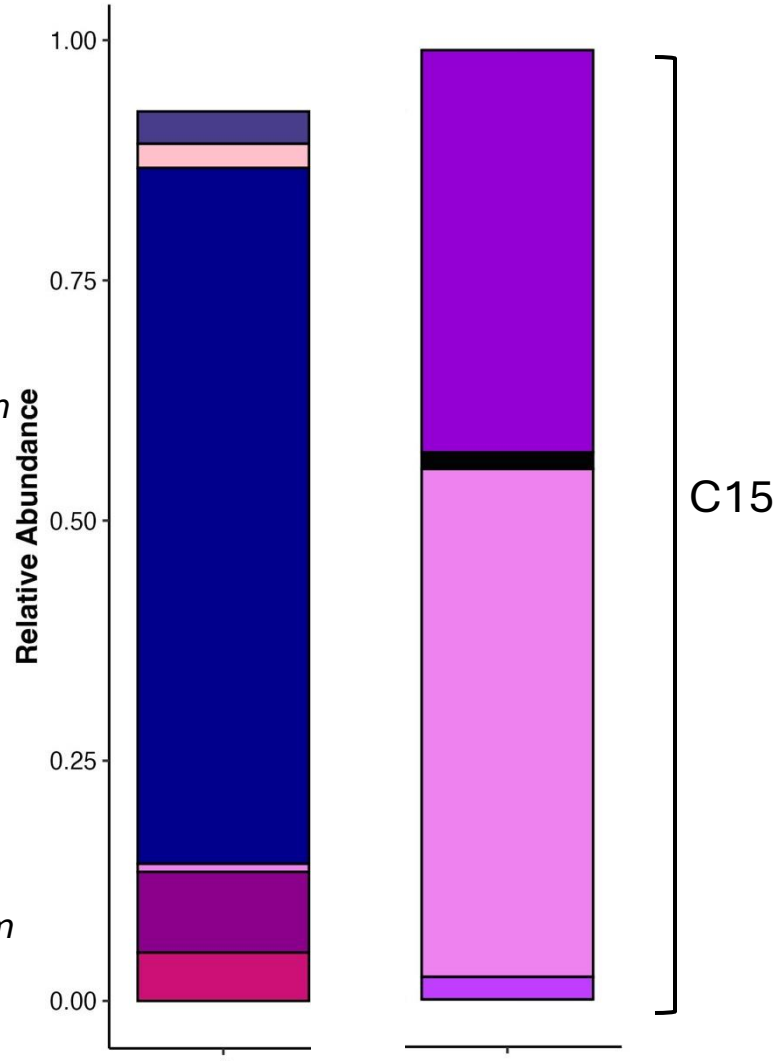
Symbiont community was correlated to:

- symbiont biomass
- chlorophyll content

Distance based redundancy analysis (dbRDA)

Porites

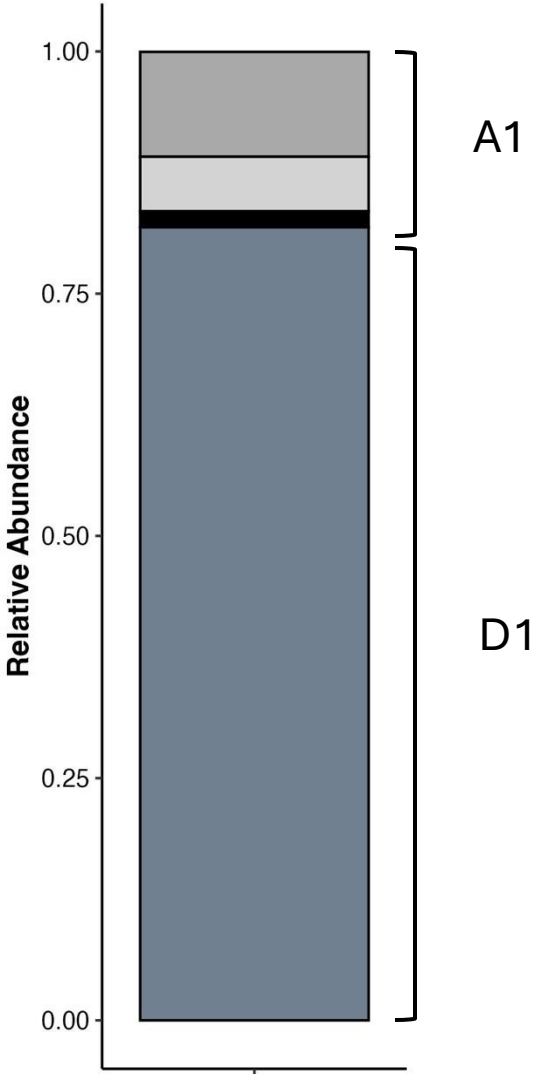
High fidelity Cladocopium spp.
C15



Physiological characteristics are related to symbiont community

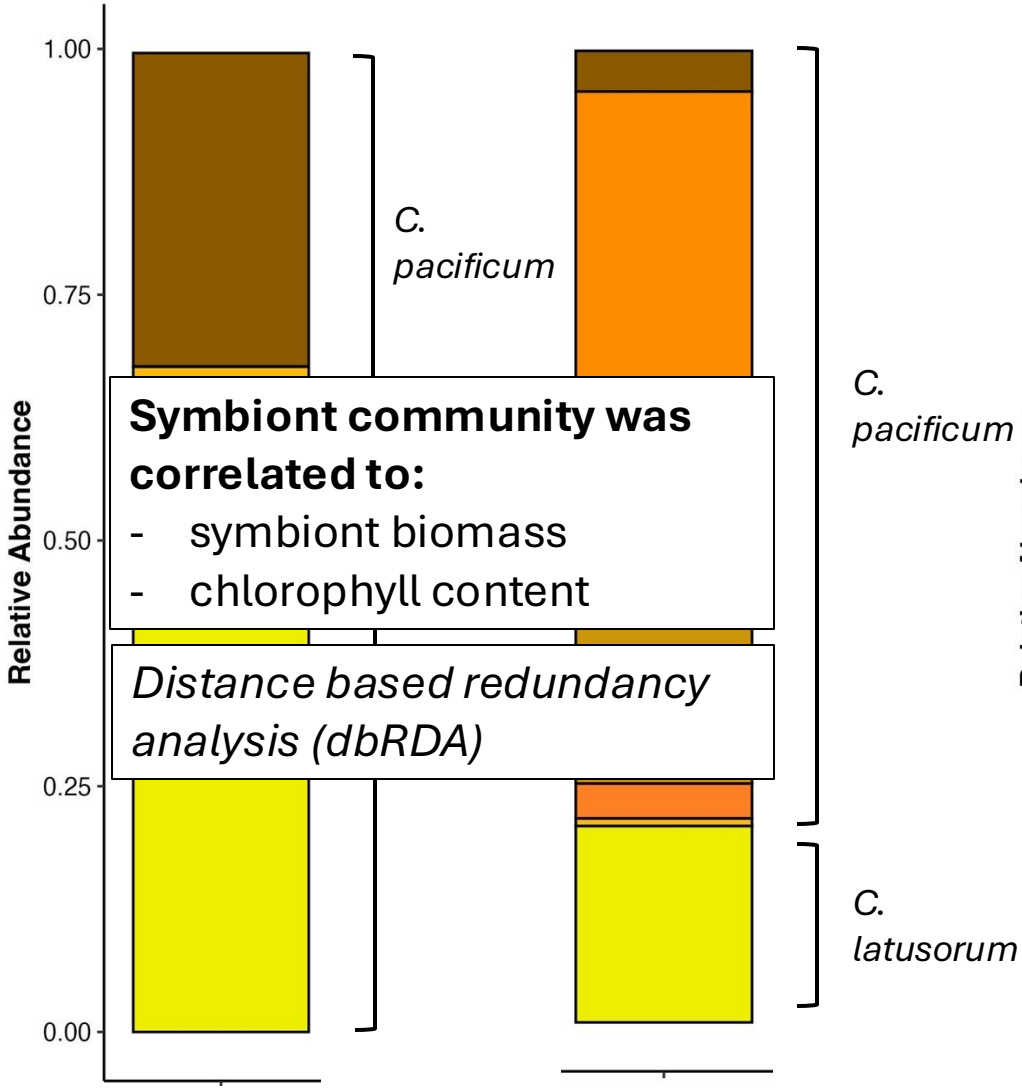
Acropora

Durusdinium spp. & *Symbiodinium* spp.



Pocillopora

Cladocopium pacificum & C. latusorum
Aligns with Johnston et al. 2022

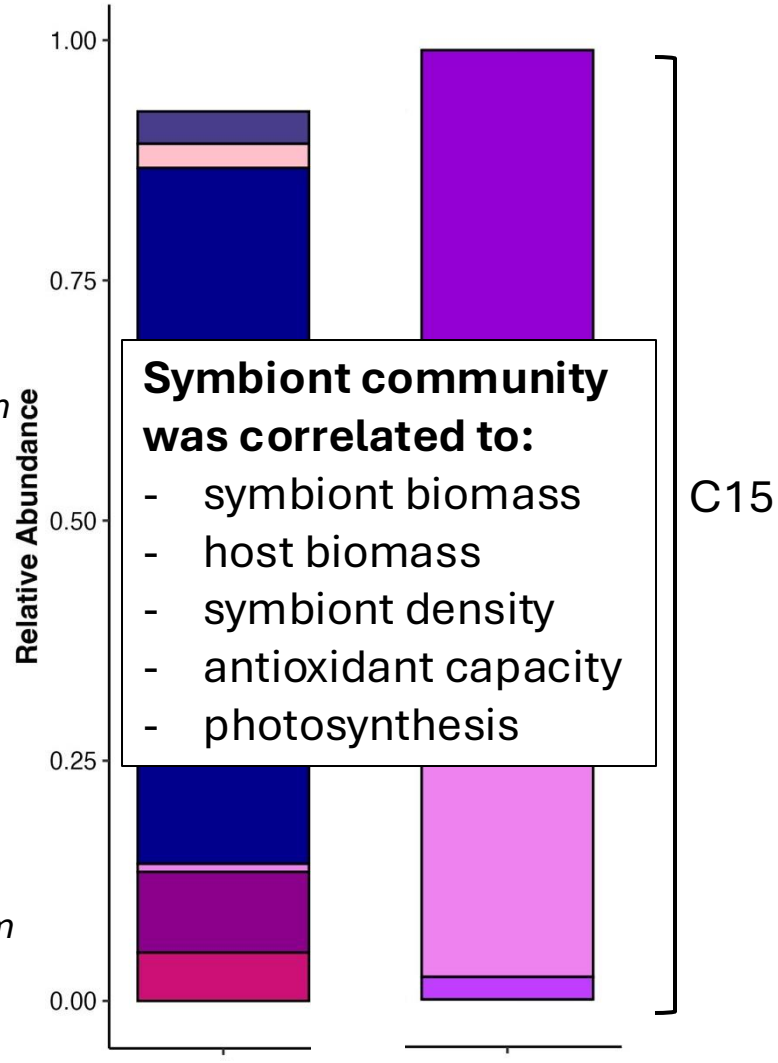


Symbiont community was correlated to:
- symbiont biomass
- chlorophyll content

Distance based redundancy analysis (dbRDA)

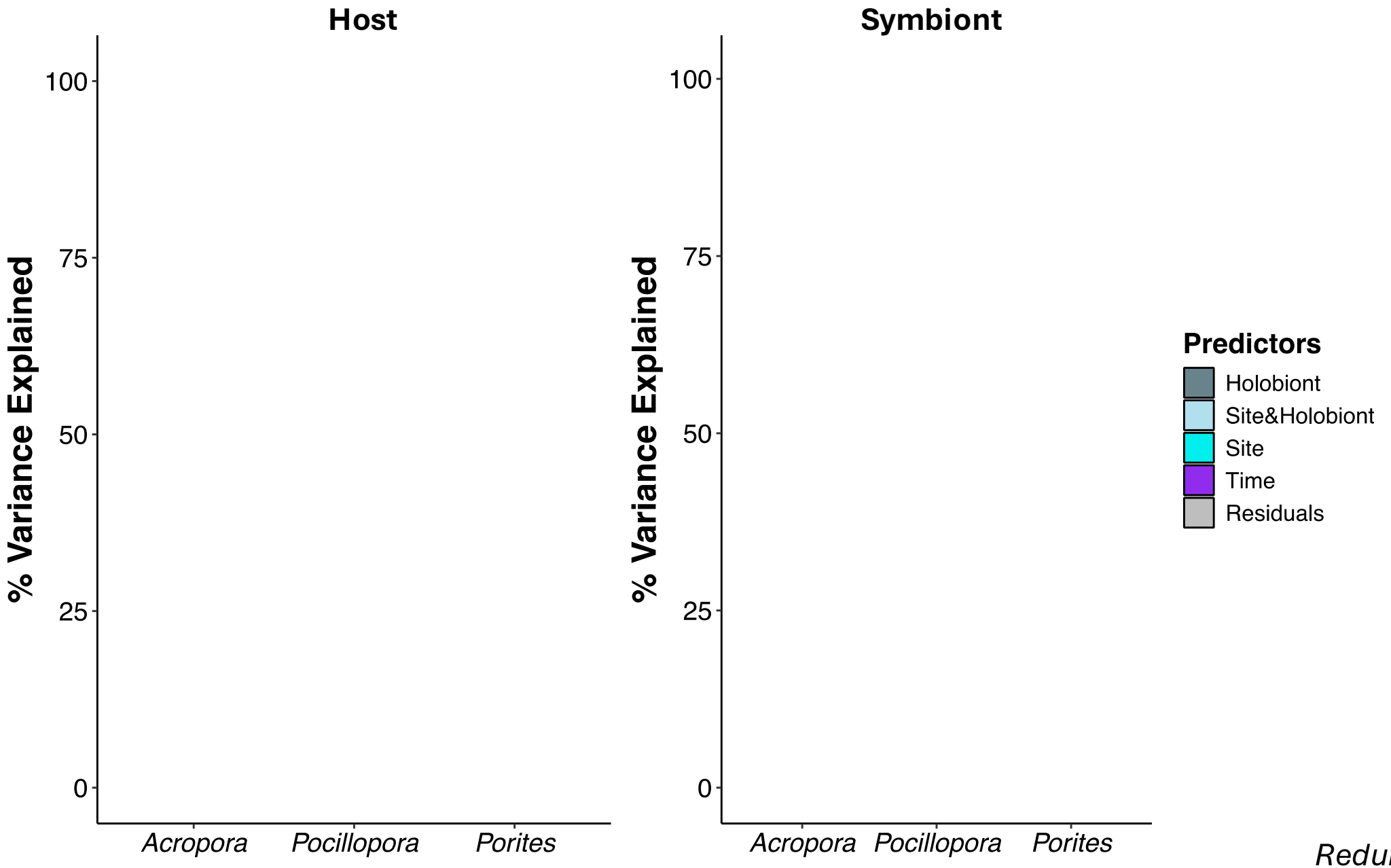
Porites

High fidelity Cladocopium spp.
C15



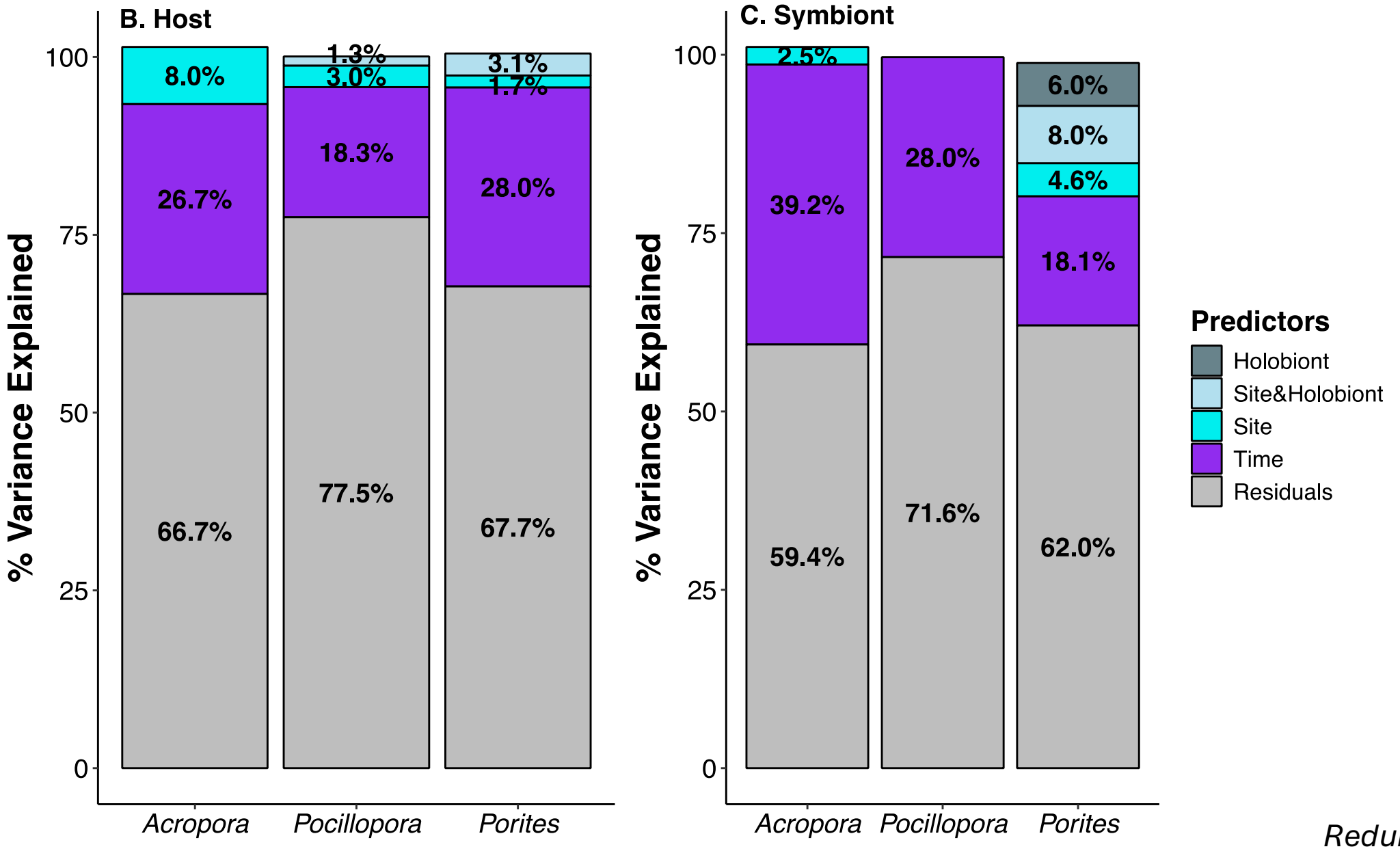
Symbiont community was correlated to:
- symbiont biomass
- host biomass
- symbiont density
- antioxidant capacity
- photosynthesis

Does site and/or season explain variation in physiology in these distinct holobionts?



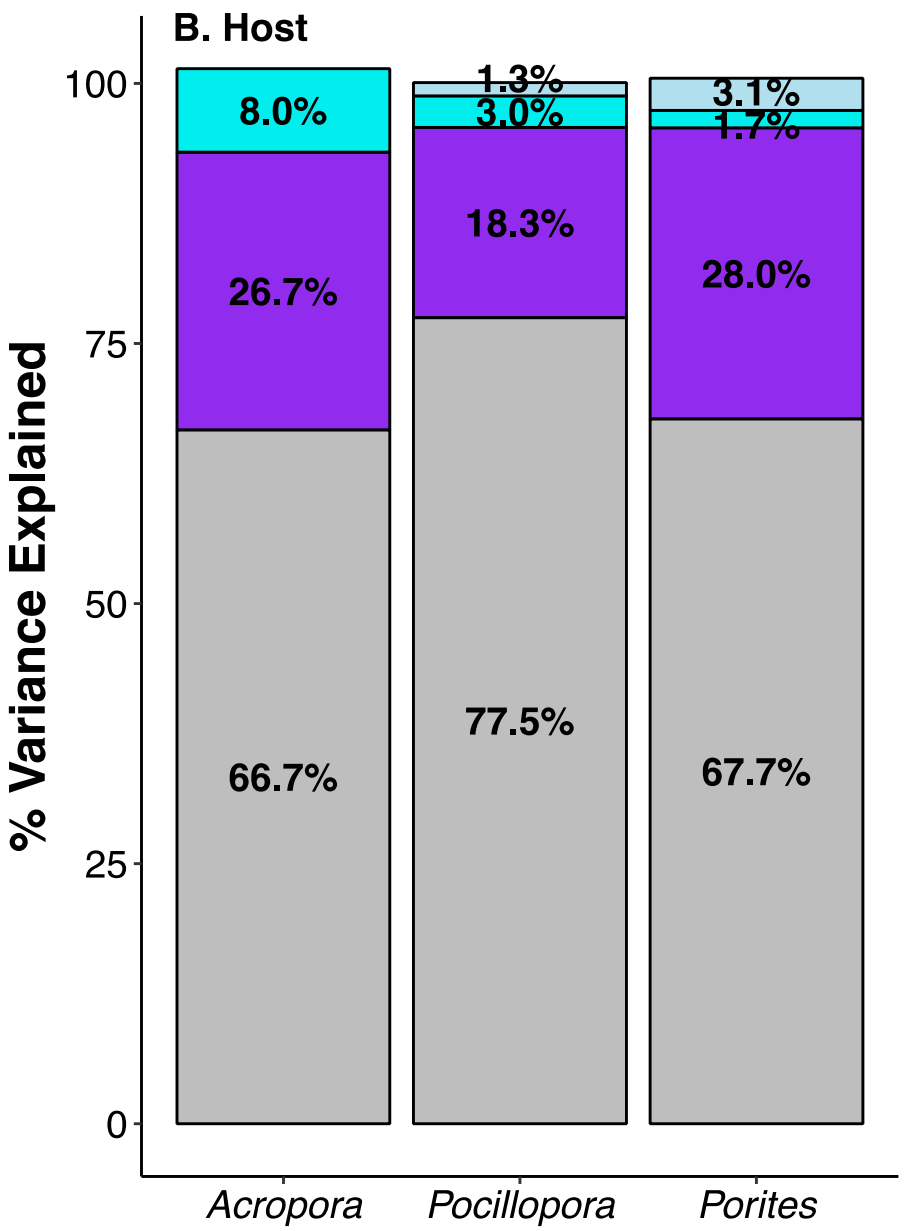
Redundancy analysis (RDA)

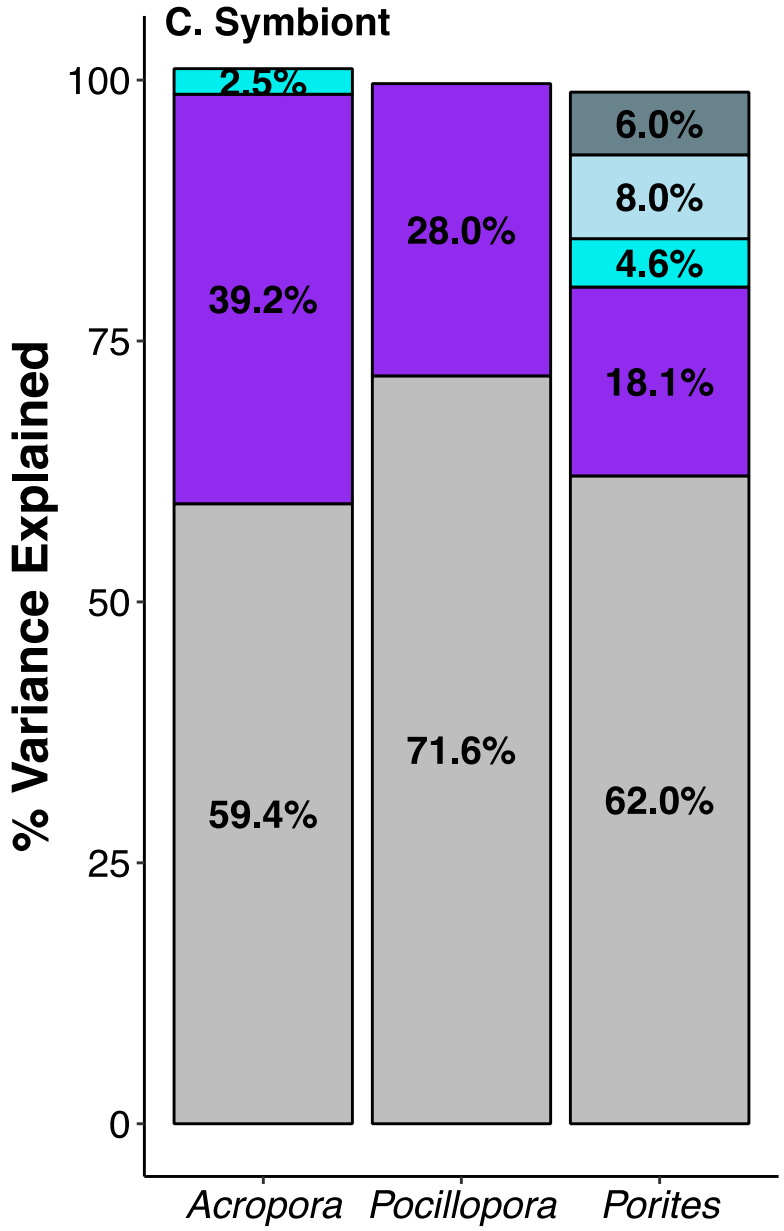
Does site and/or season explain variation in physiology in these distinct holobionts?



Redundancy analysis (RDA)

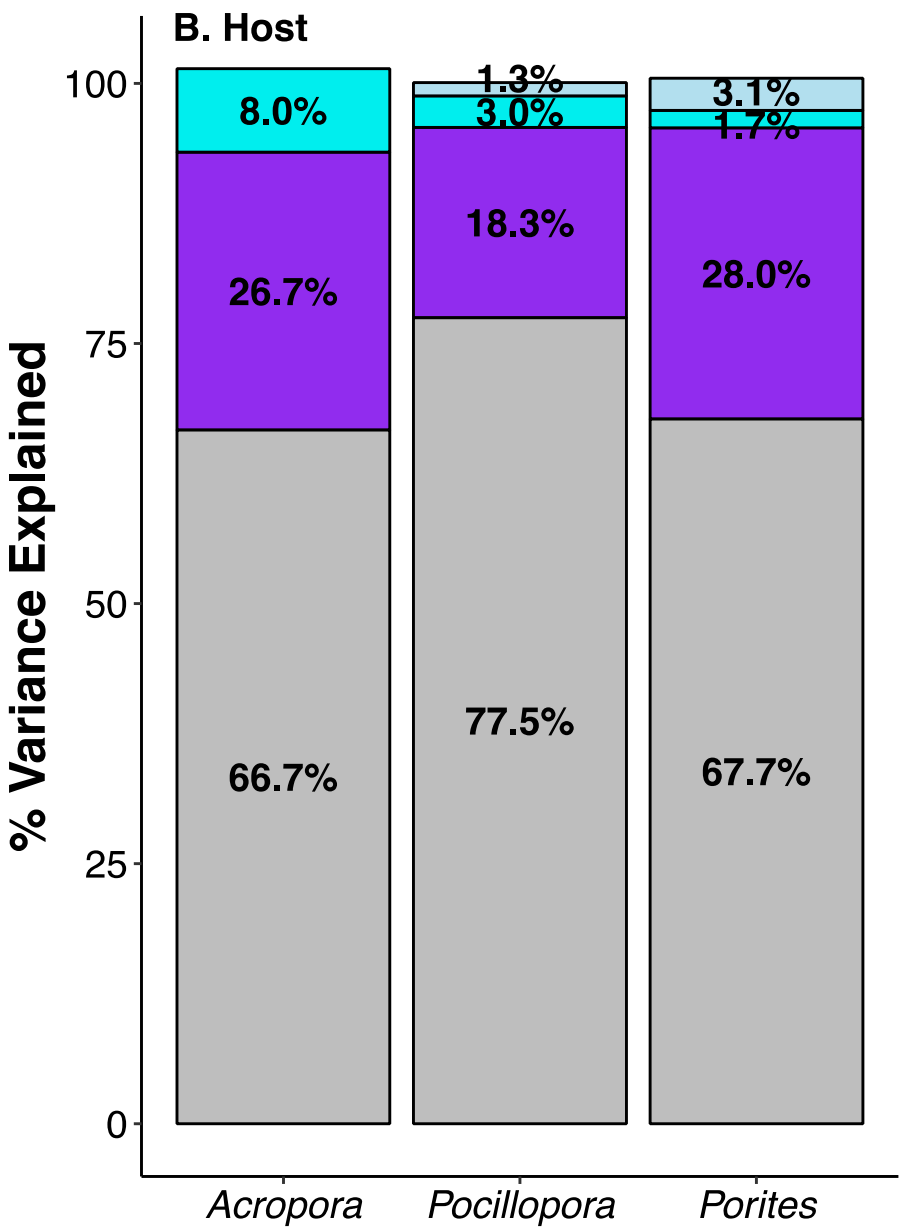
Does site and/or season explain variation in physiology in these distinct holobionts?

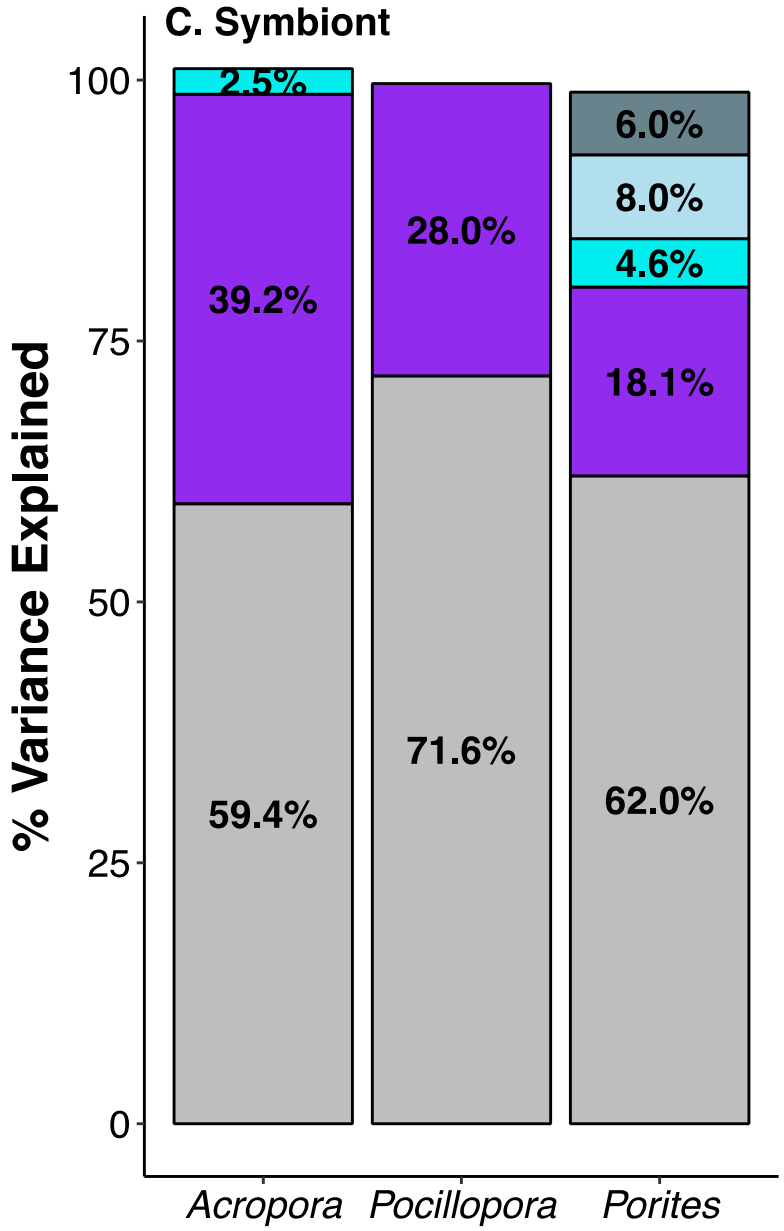




- **Seasonal variation** had the strongest effect on physiology
  - Amount of variation explained varies by species

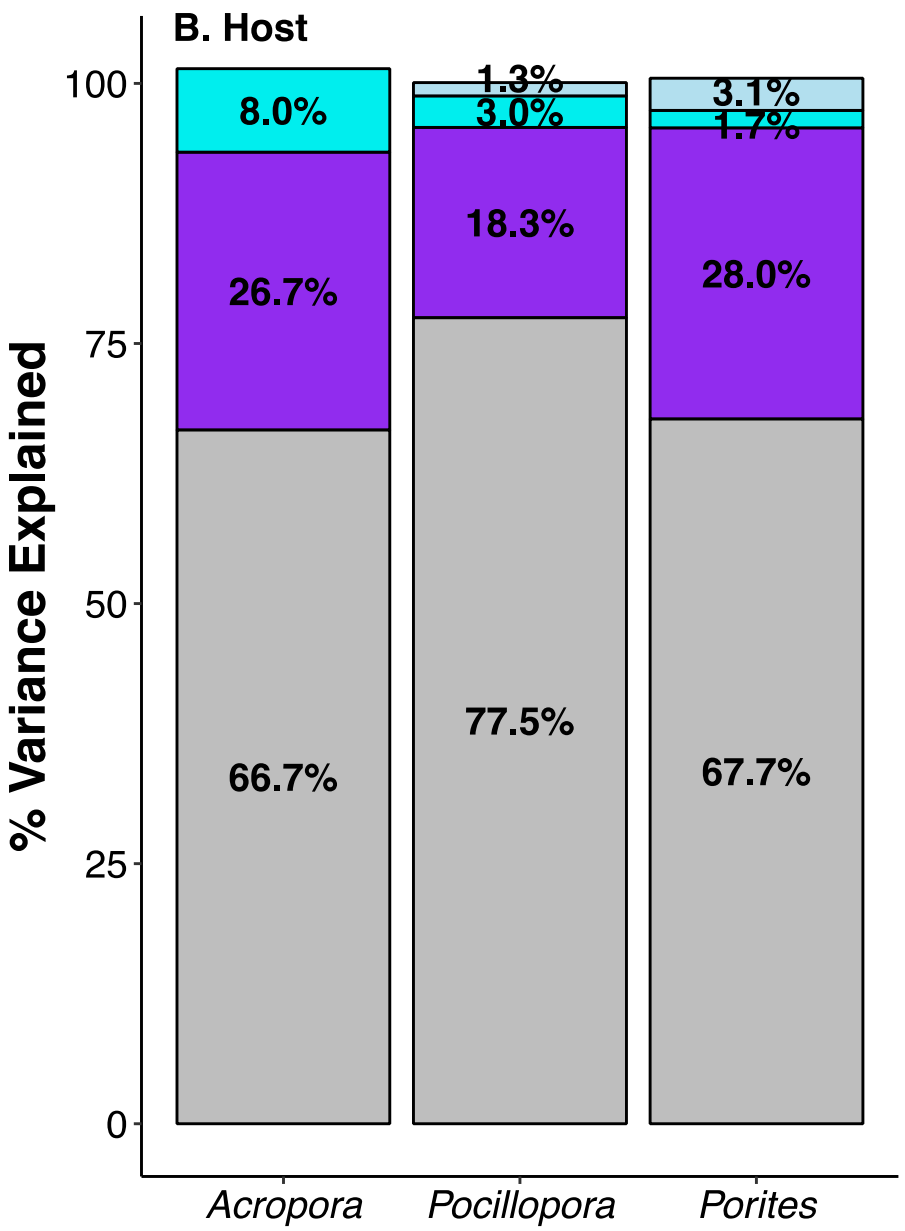
Does site and/or season explain variation in physiology in these distinct holobionts?

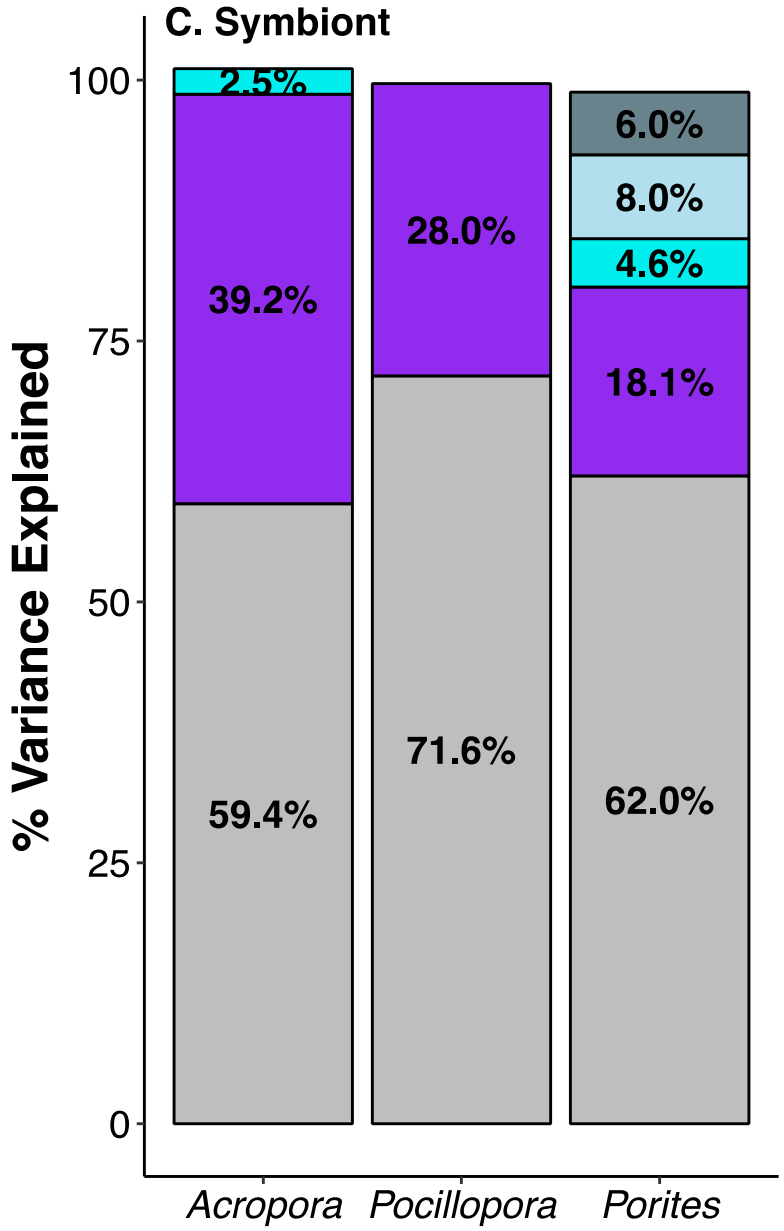




- **Seasonal variation** had the strongest effect on physiology
- Minimal **site effects**, especially in the symbiont
  - *Acropora* only found in natural abundance at Mahana

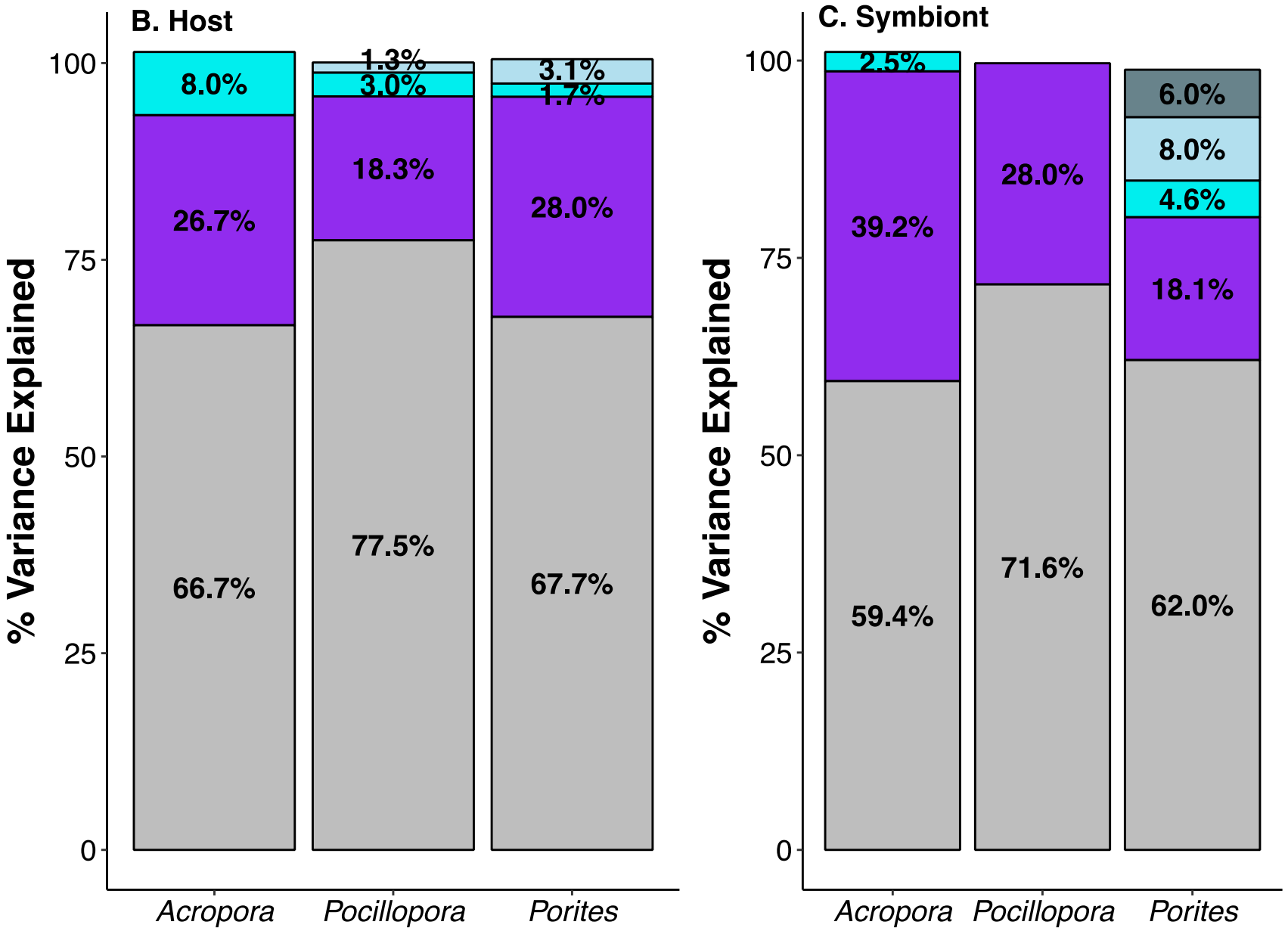
Does site and/or season explain variation in physiology in these distinct holobionts?





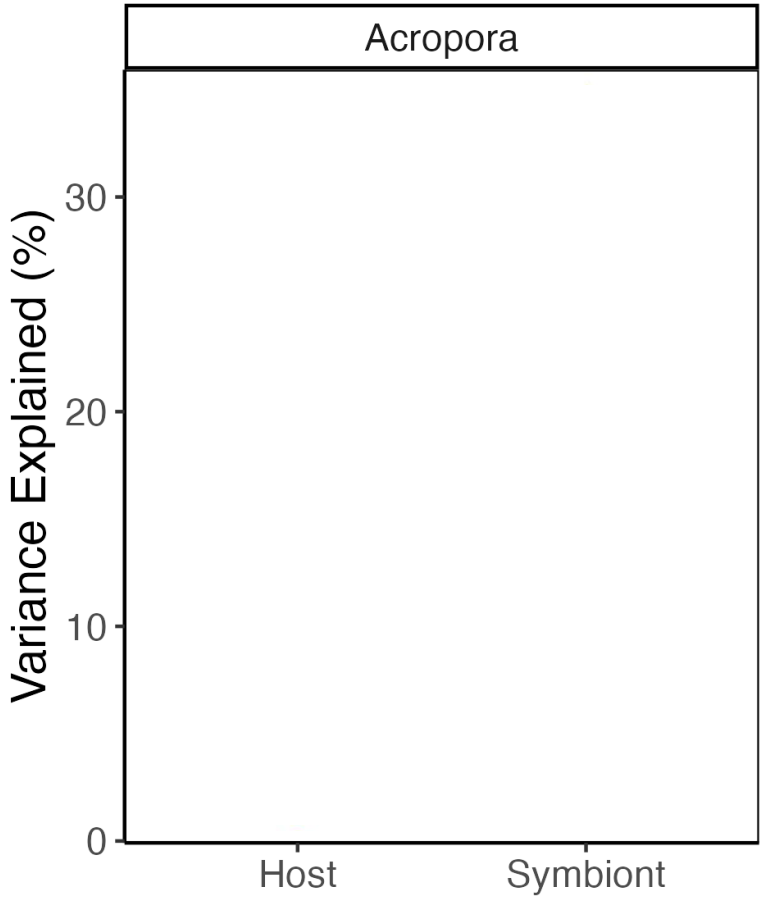
- **Seasonal variation** had the strongest effect on physiology
- Minimal **site effects**, especially in the symbiont
- **Cryptic species and associated symbionts** were more influential on symbiont physiology in *Porites*

Does site and/or season explain variation in physiology in these distinct holobionts?



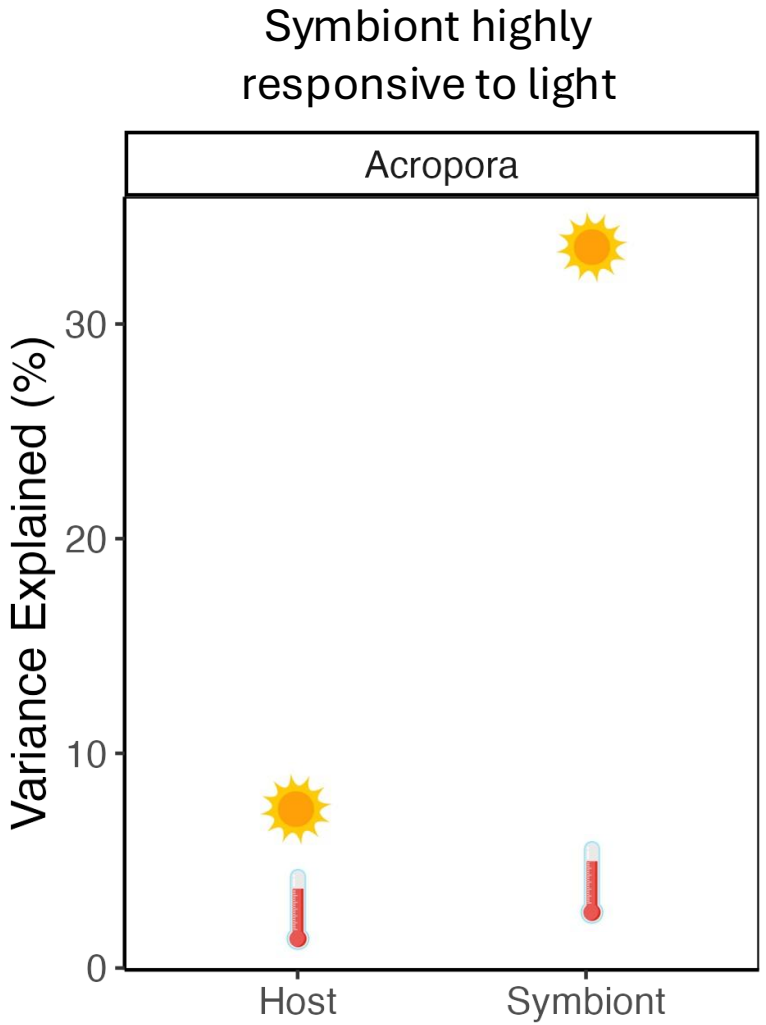
- **Seasonal variation** had the strongest effect on physiology
- Minimal **site effects**, especially in the symbiont
- **Cryptic species and associated symbionts** were more influential on symbiont physiology in *Porites*
- Most physiological variation is **due to other factors**

How do seasonal changes in light or temperature affect physiology?



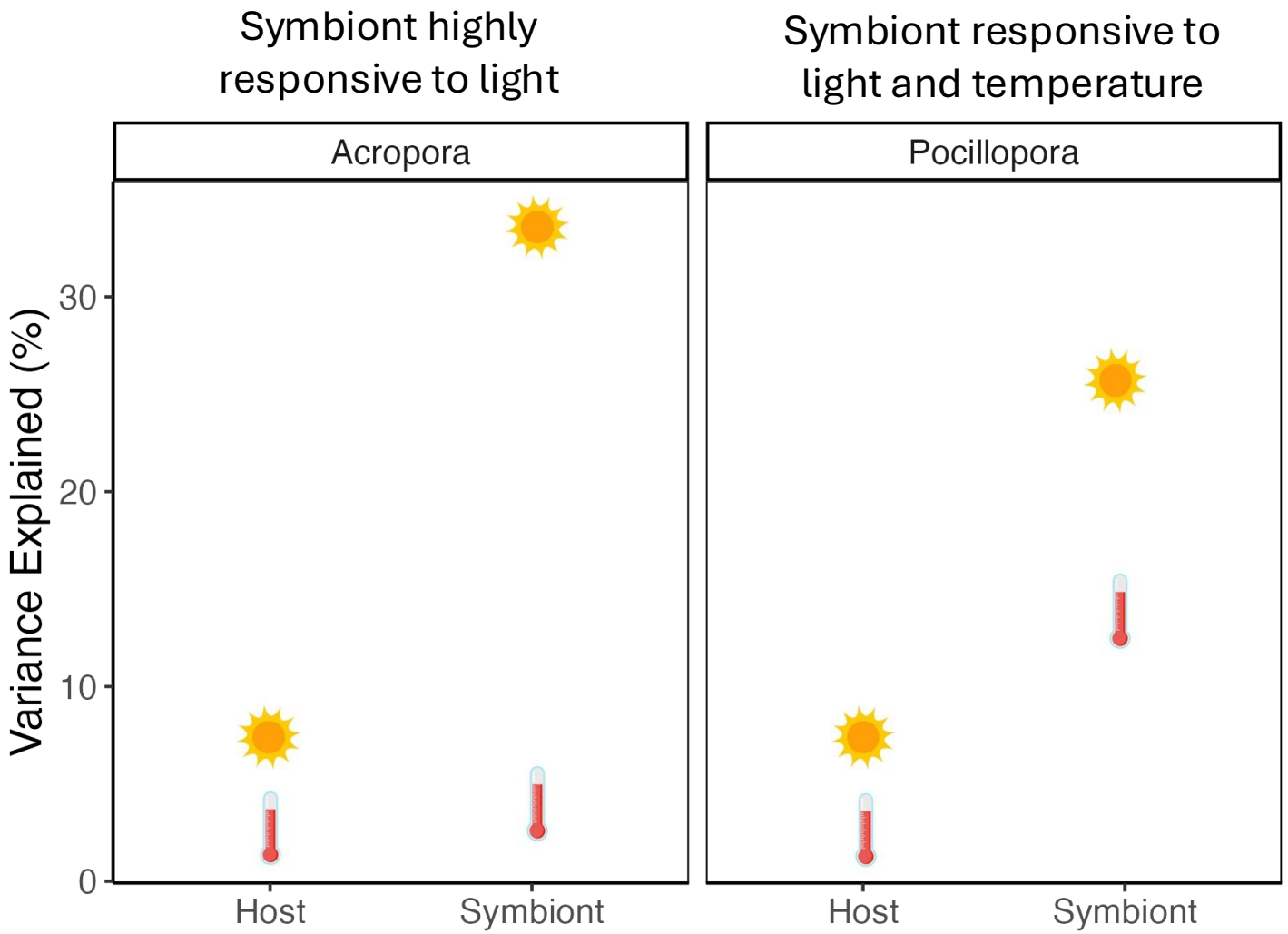
Redundancy analysis (RDA)

Symbiont physiology was responsive to light, but this was genus-specific



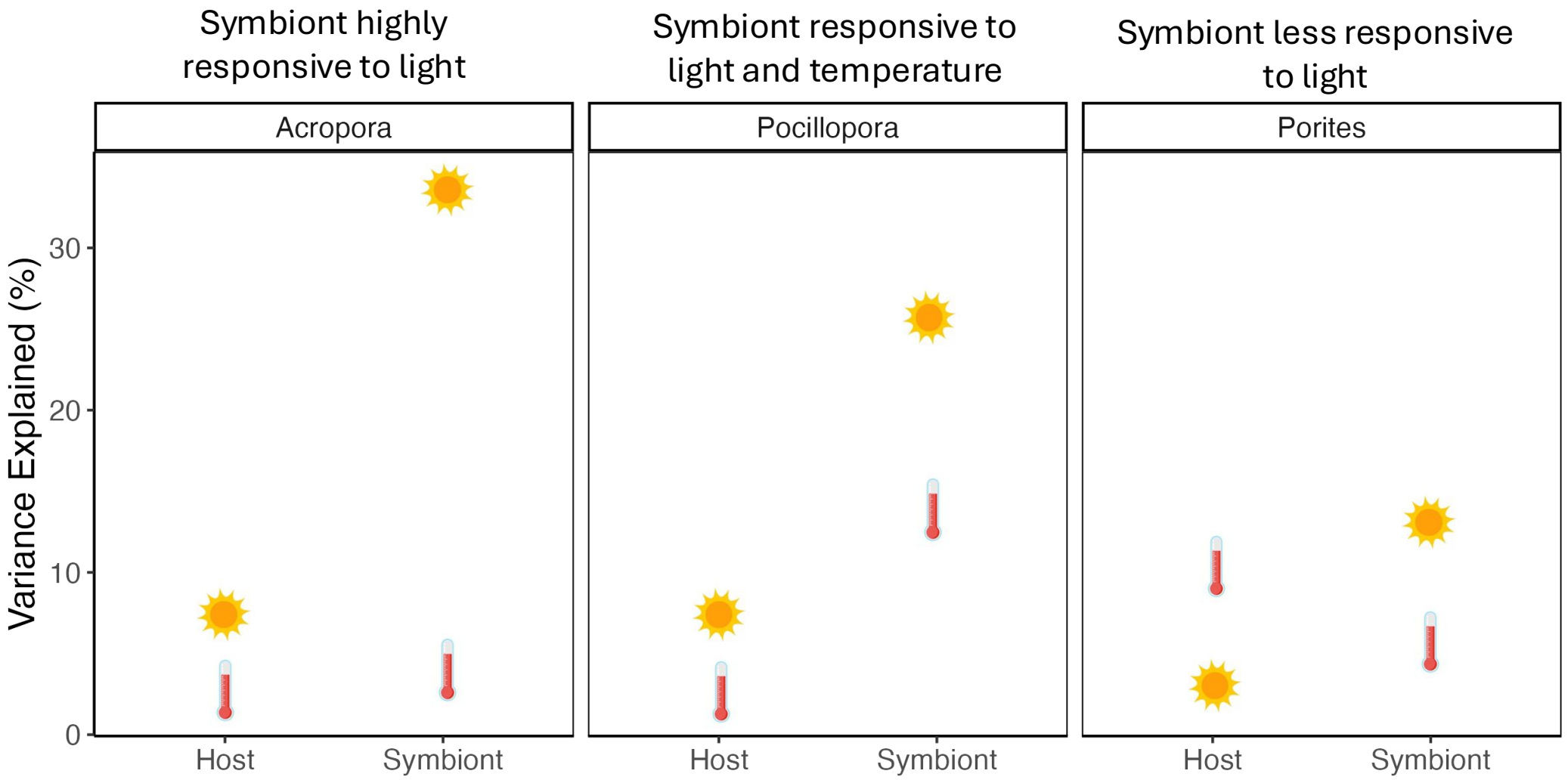
Redundancy analysis (RDA)

Symbiont physiology was responsive to light, but this was genus-specific



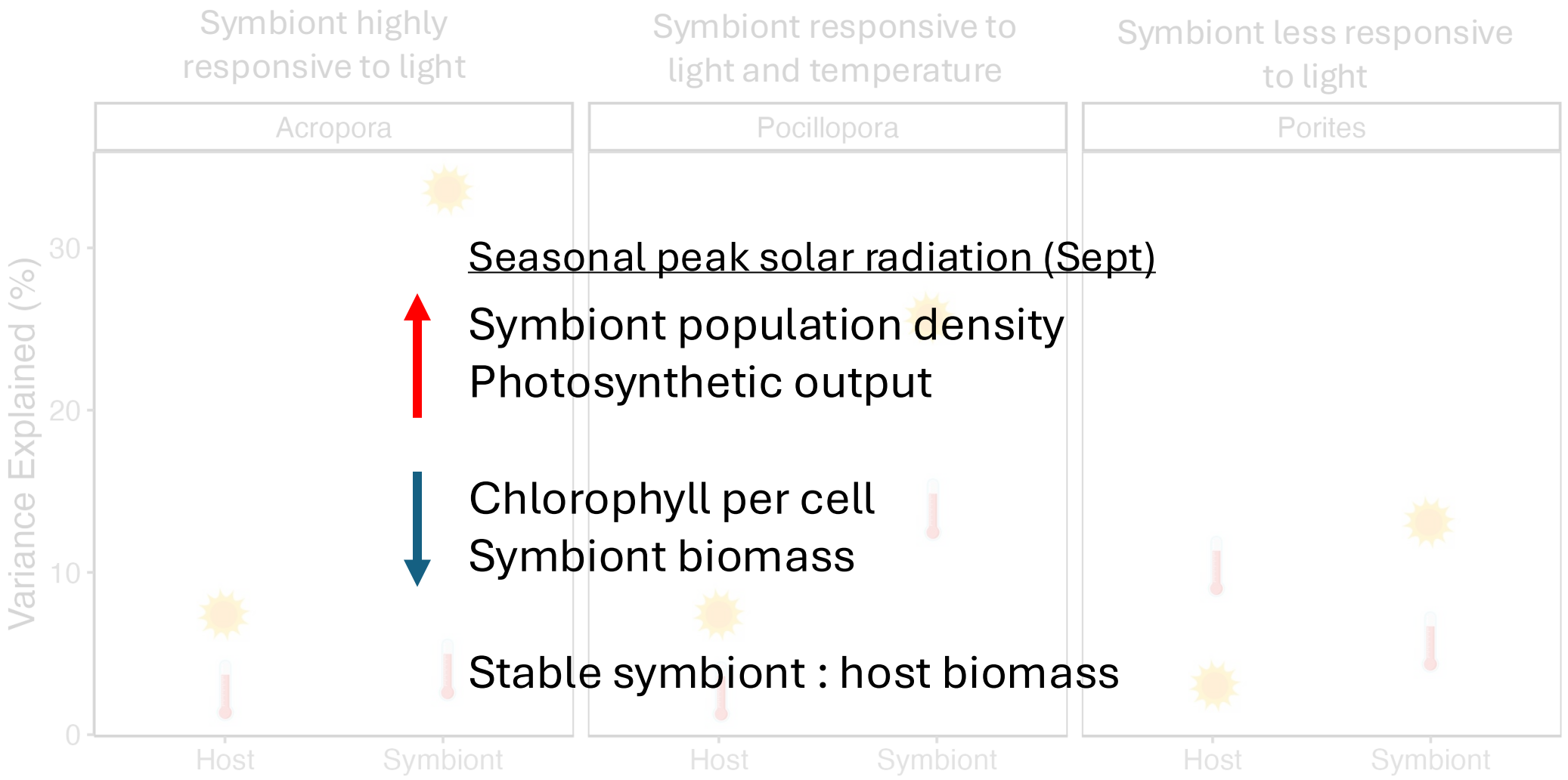
Redundancy analysis (RDA)

Symbiont physiology was responsive to light, but this was genus-specific

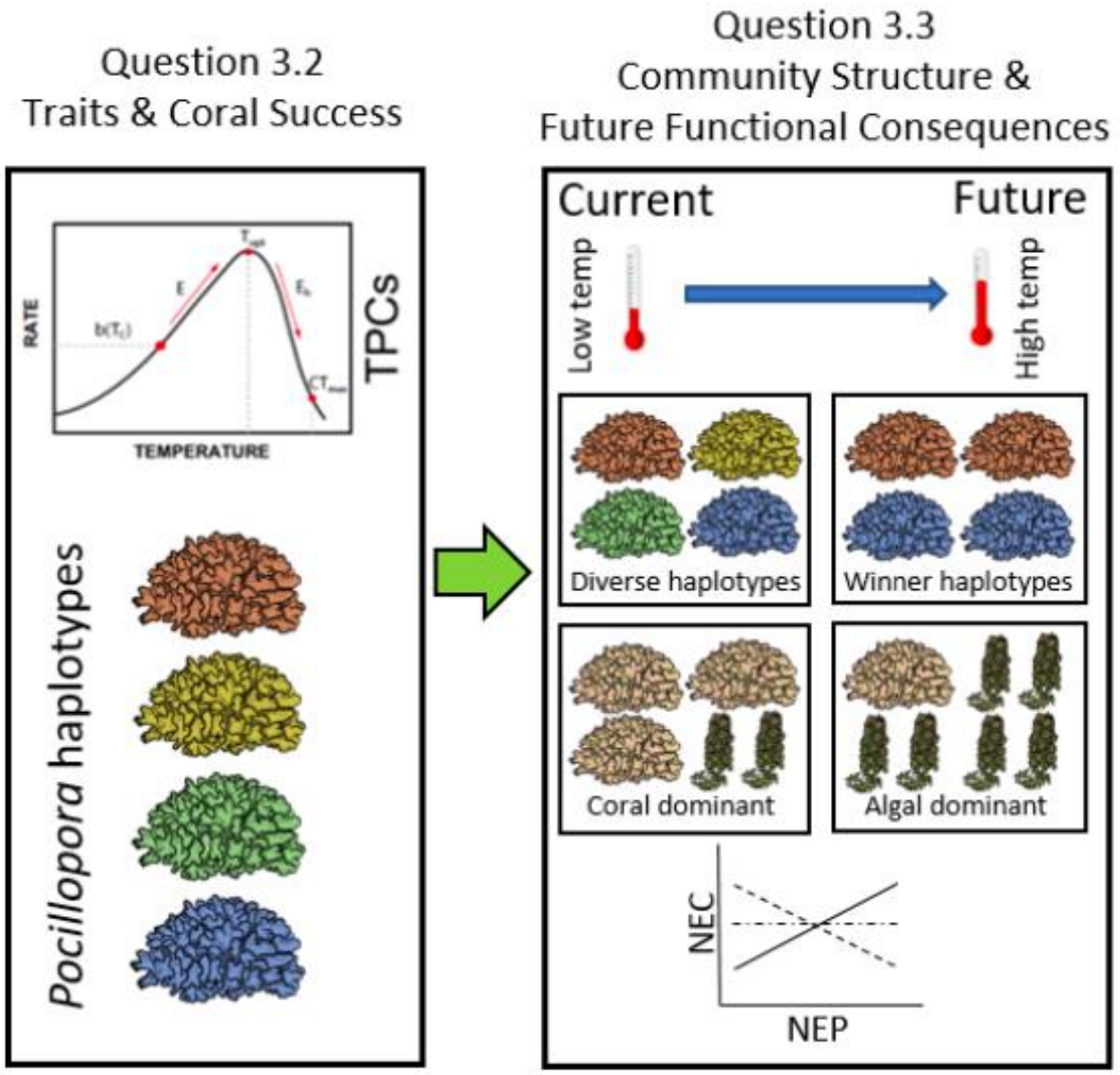


Redundancy analysis (RDA)

Photoacclimation in the symbiont community across seasons



Theme 3: How do disturbances generate information legacies in corals and coral reef communities that influence their resilience under current and future environmental conditions?



- **Seasonal baselines** are critical to understanding coral performance and response to stress
- **Holobiont identity** (host + symbiont species) drive coral environmental responsiveness
  - Especially between cryptic *Porites* species
- **Symbiont response to light** drives seasonal physiological responses
  - Variation between coral species in degree of symbiont response to light
- Increased availability of **MCR environmental data resources** will improve our capacity to understand environmental drivers of coral performance

Thank you!

Email: ashuff@uw.edu
GitHub: https://github.com/urol-e5/timeseries