# Stress-induced adaptation in marine colonial tunicates

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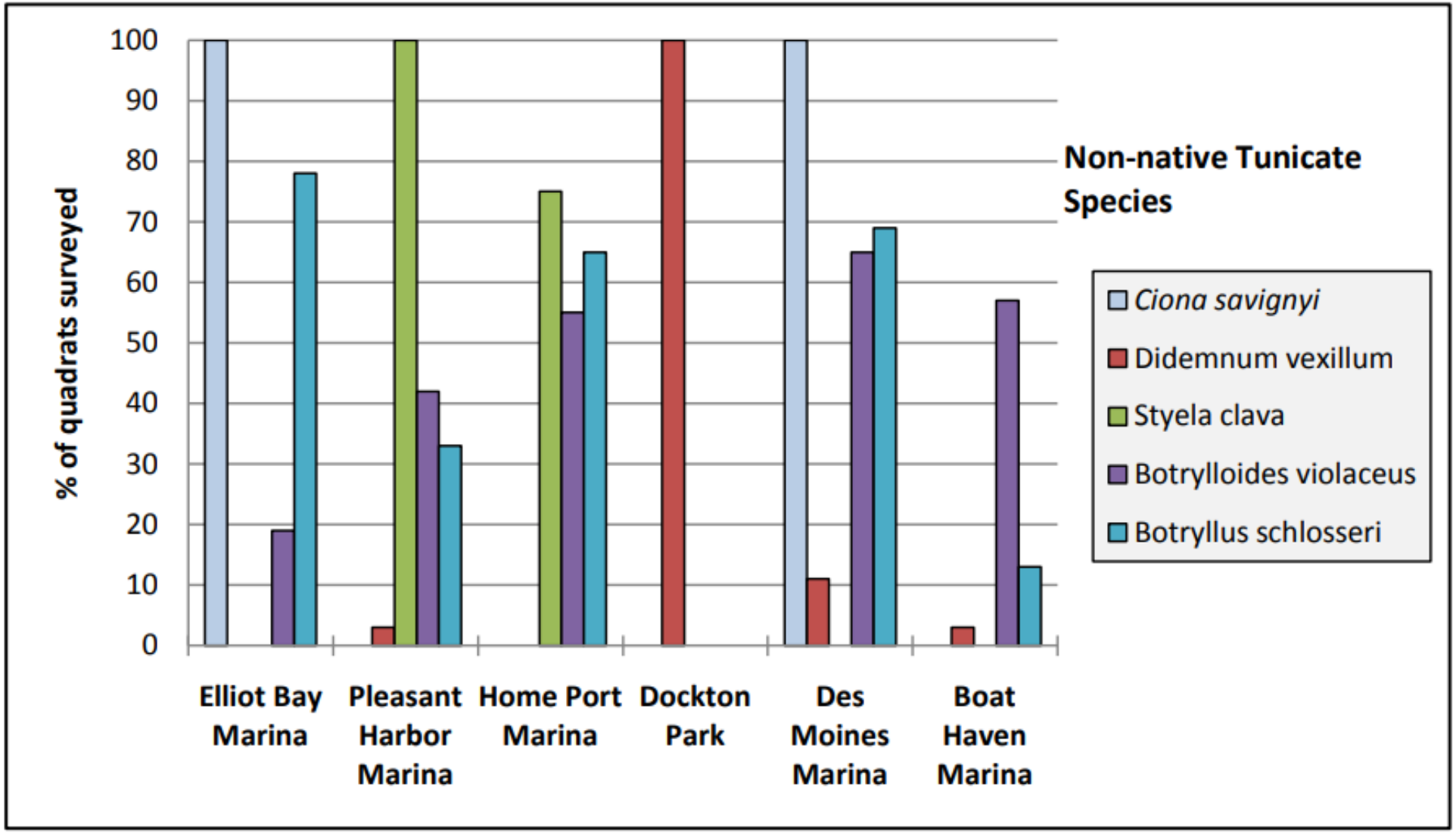
# NSF-BSF Collaborative Research

- University of California Davis
- Israel Oceanographic and Limnological Research Institute
- University of Washington Tacoma

# Marine Invertebrates of Puget Sound

WA Department of Ecology

# Botryllids in Puget Sound Marinas




Leclair et al. 2007

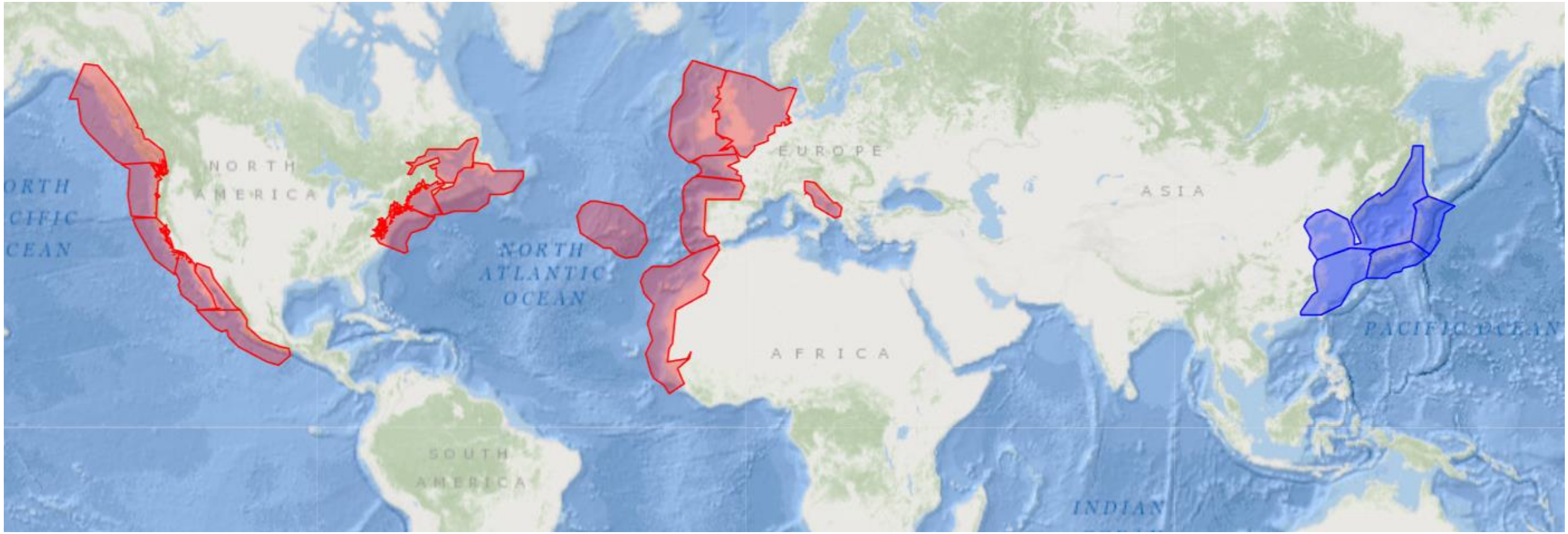
# Botryllid ascidians

- Benthic, sessile, filter-feeders
- Colonial → many individuals embedded in a common tunic
- Reproduces sexually and asexually
- Interesting biology!

*Botrylloides violaceus*

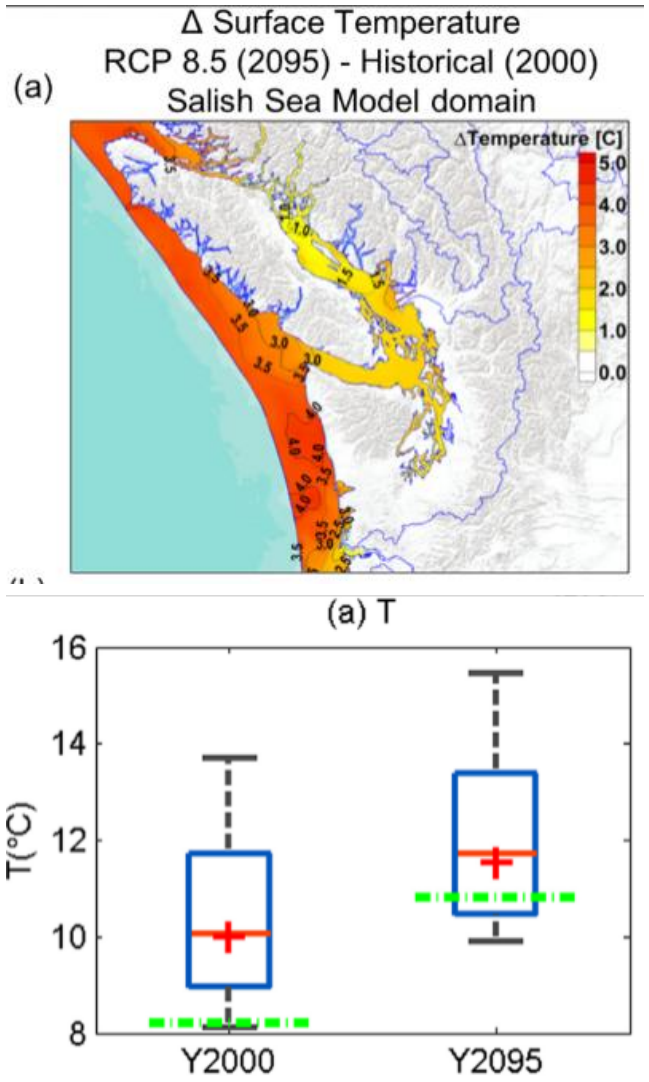
*Botryllus schlosseri*

# Botryllids as candidate species for evaluating gene x environment interactions




Smithsonian Environmental Research Center

# Salish Sea predicted to warm by ~1.5°C by 2095




- Native species are less resilient to changing temperatures than invasives (Stachowicz et al., 2002)
- Warming correlated with change in species distributions (Sagarin et al., 1999)

Khangaonkar et al. 2019

# Does temperature alter botryllid physiology?

Olivia Wing, NSF REU

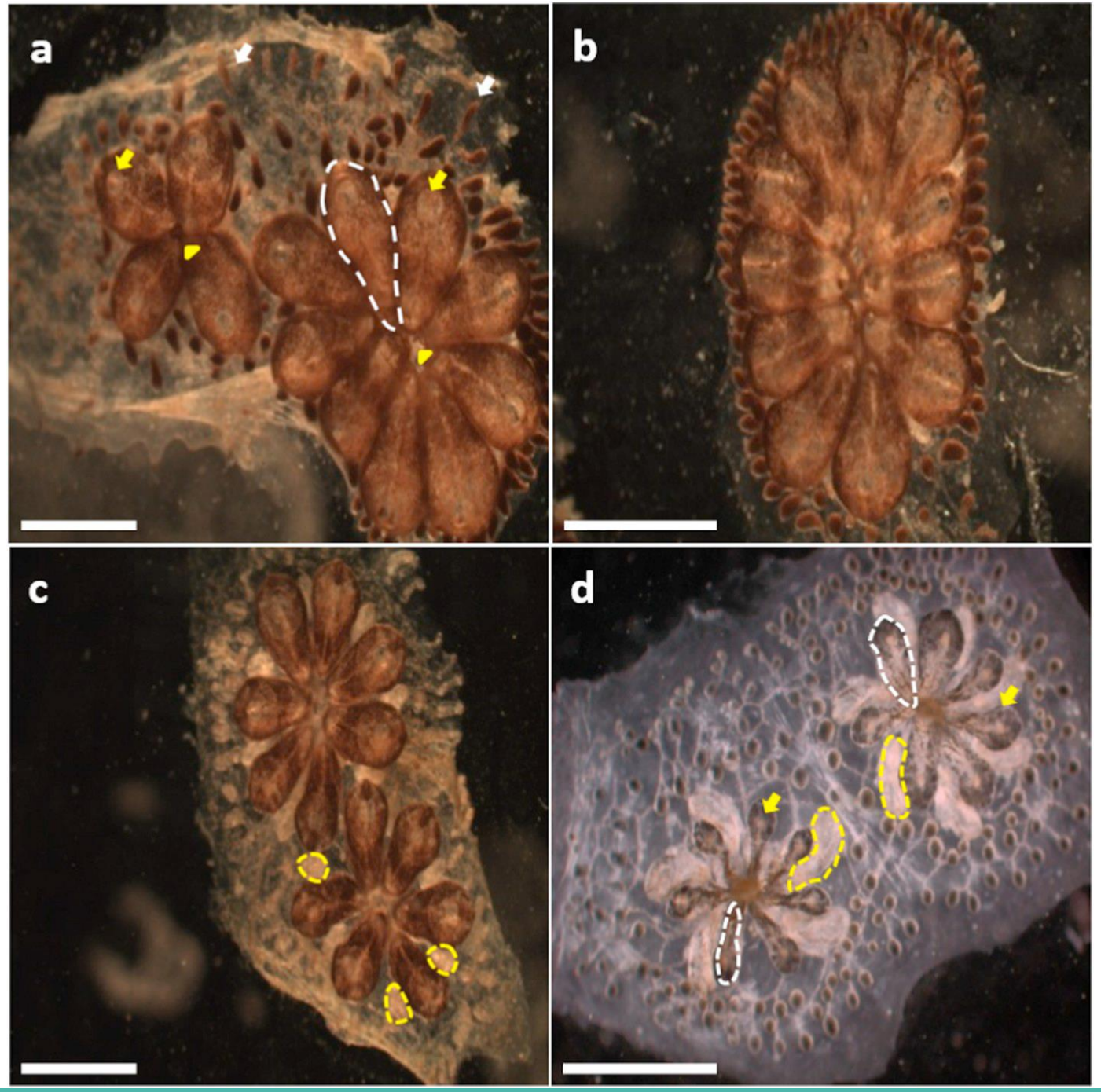
# Blastogenesis

STAGE A

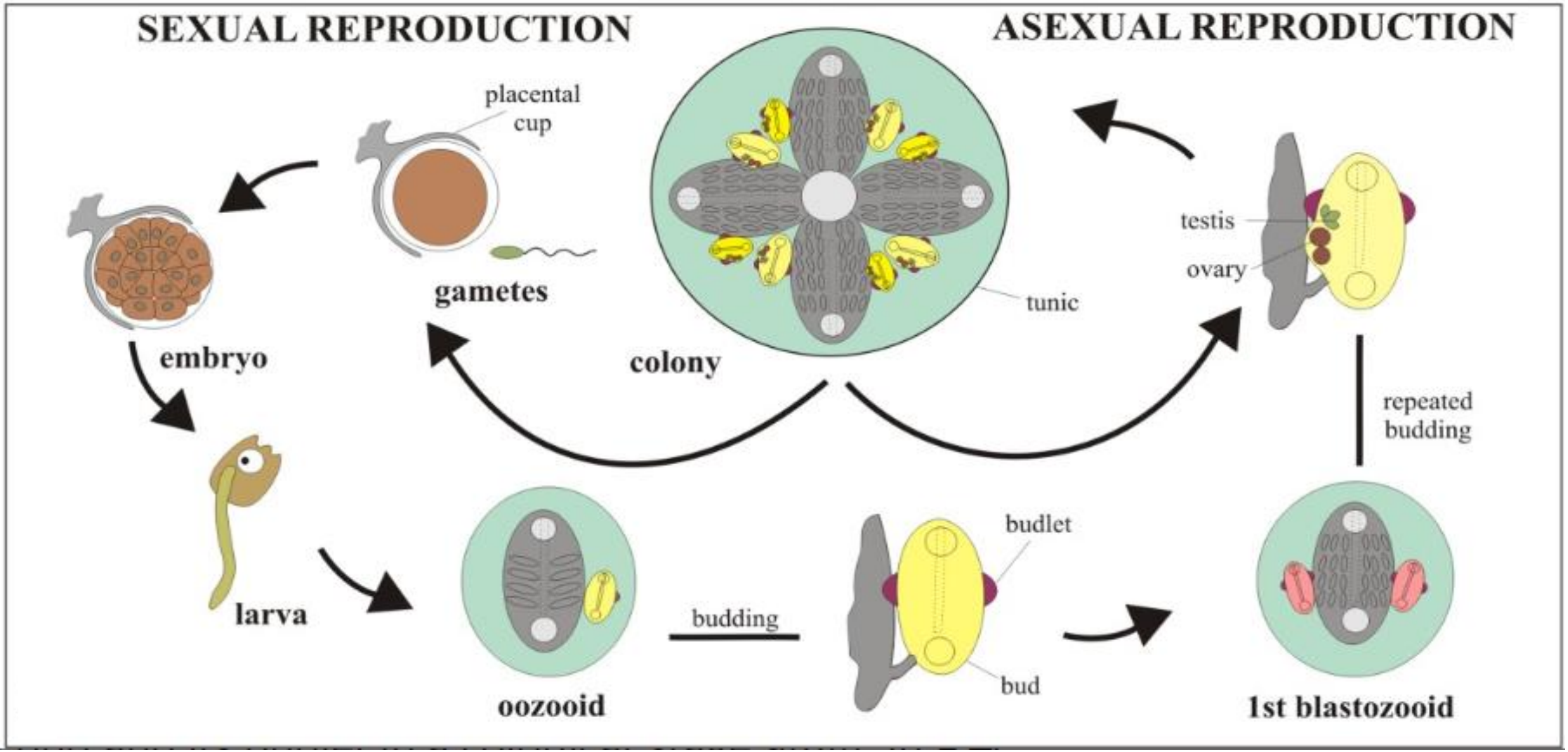
STAGE B

STAGE C

STAGE D

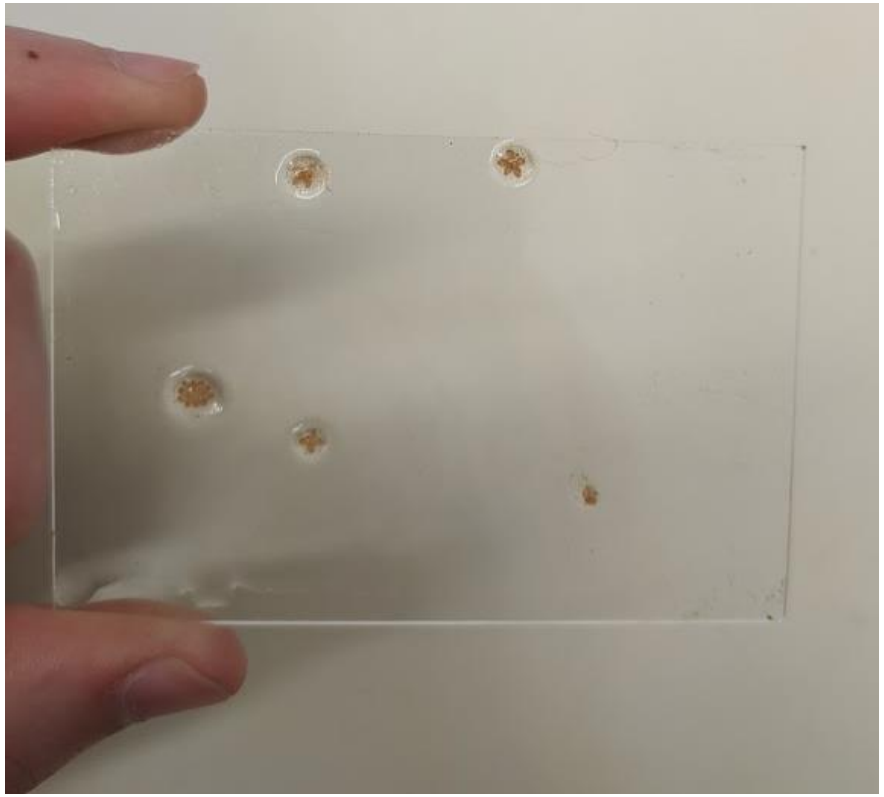



Qarri et al. 2020

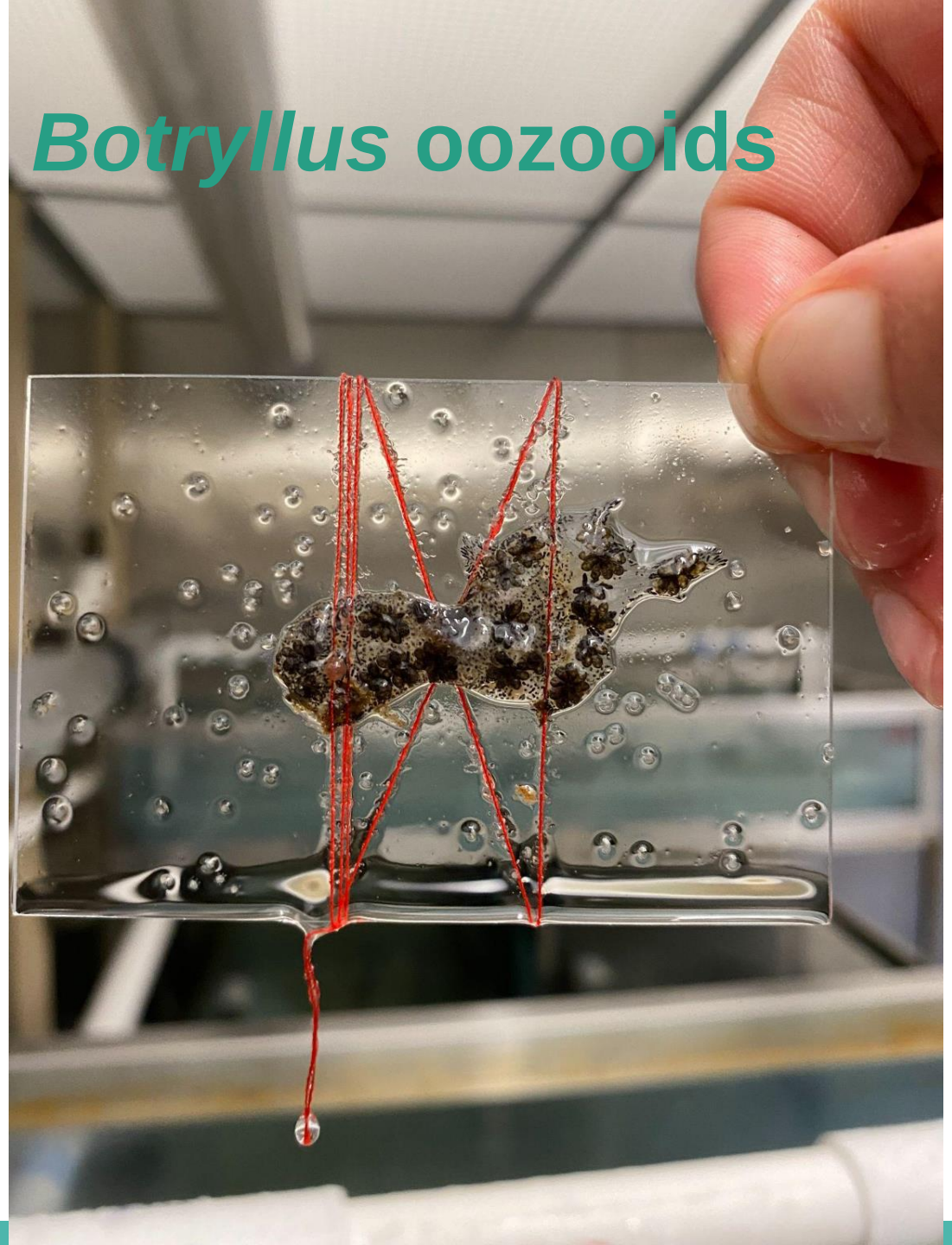


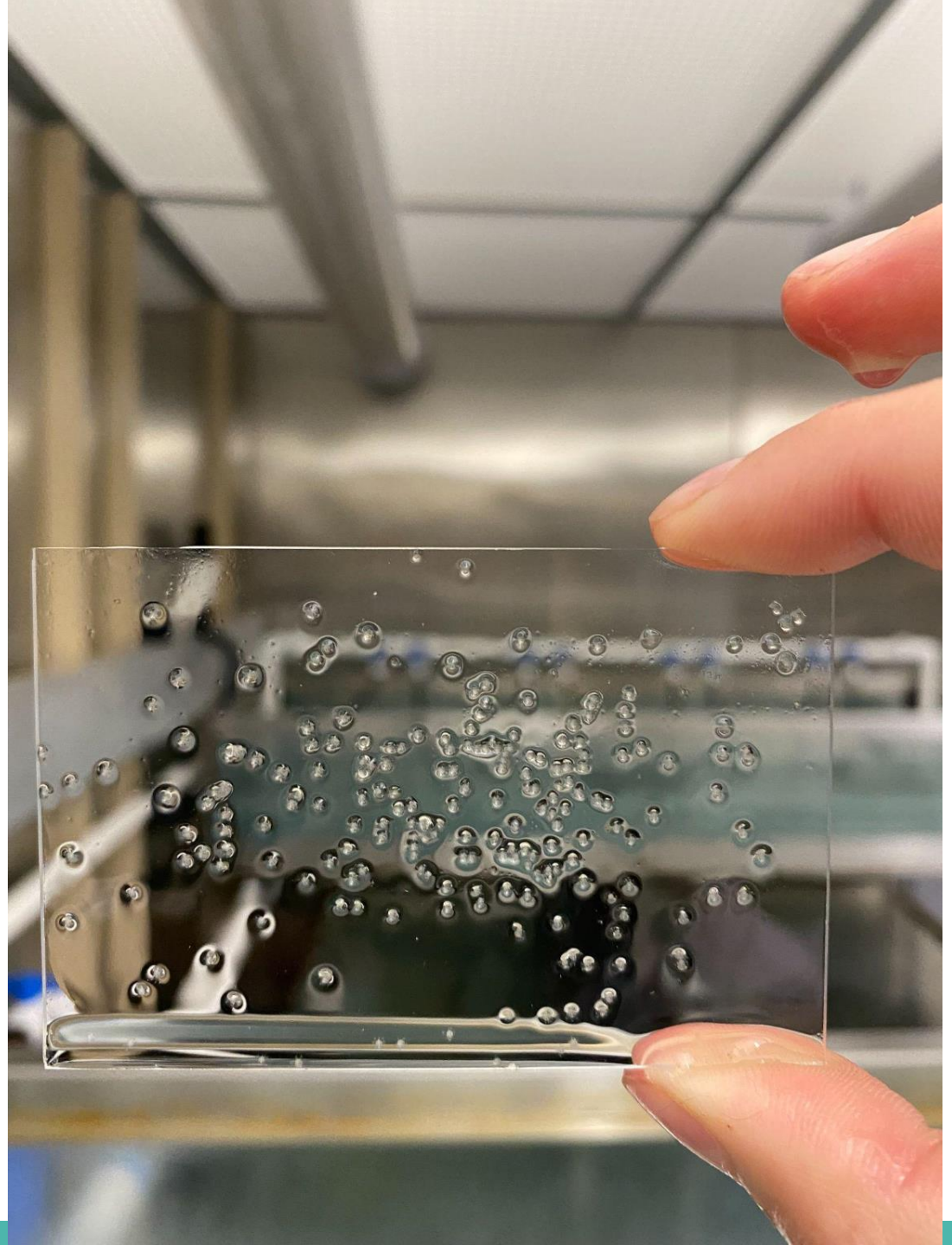

Gasparini et al. 2014

# Larvae settlement on glass microscope slides



# *Botryllus* oozooids

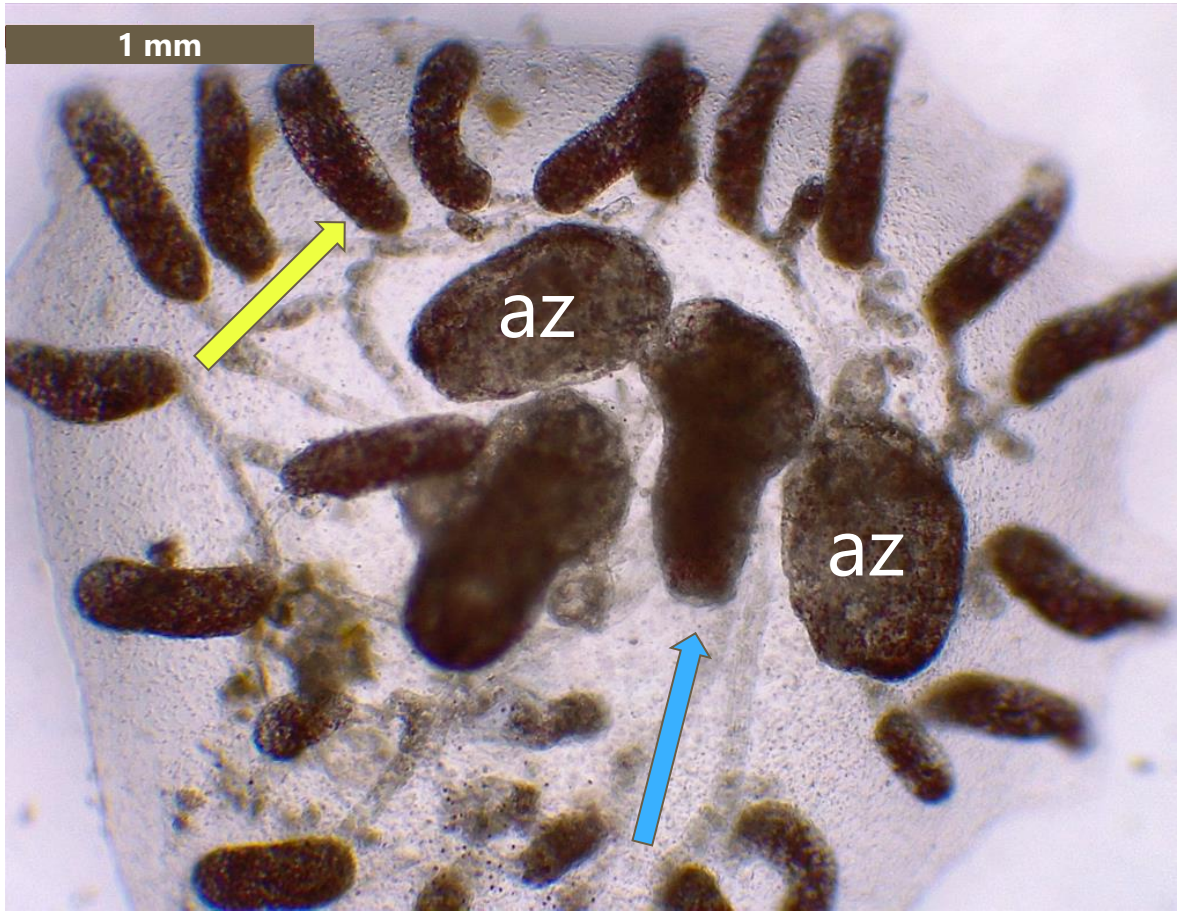


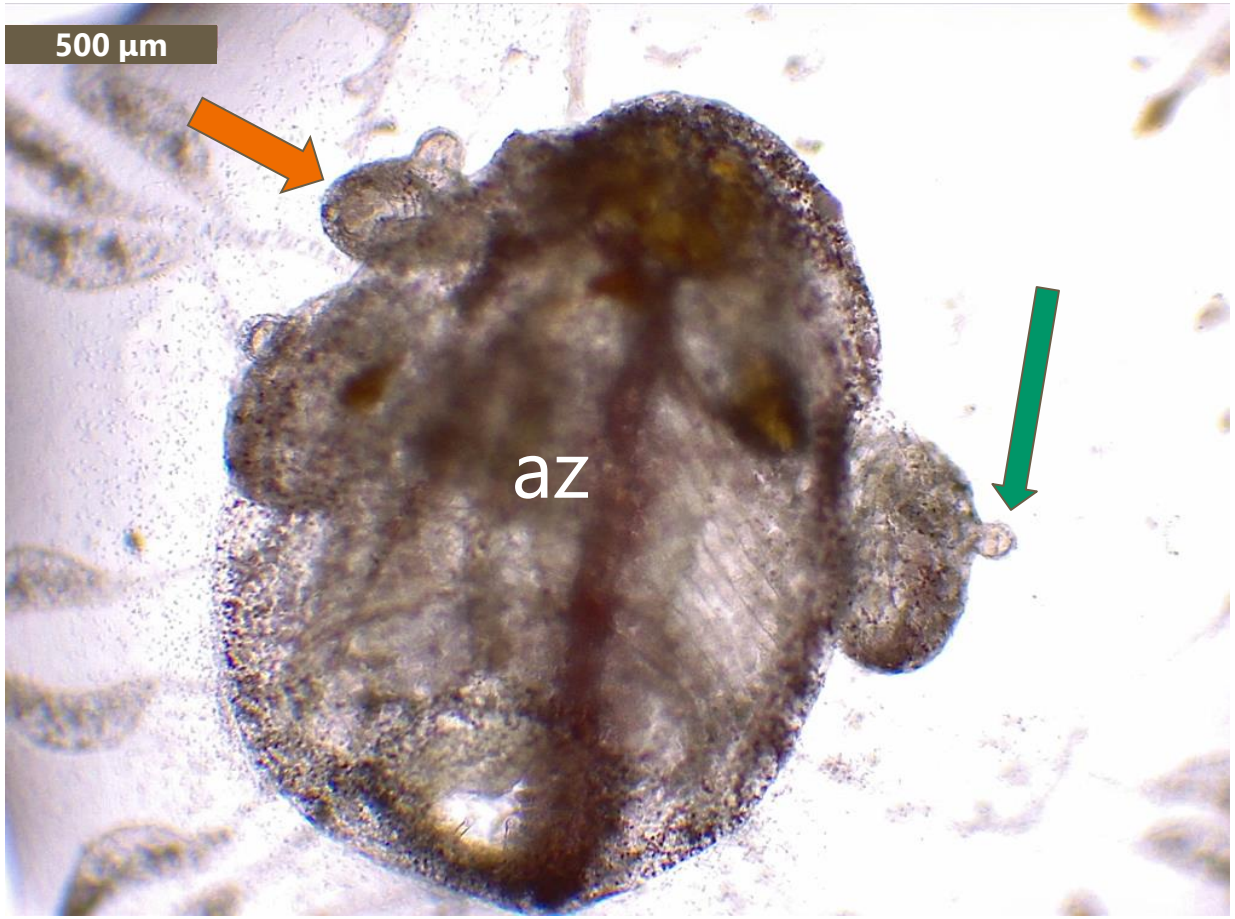


# Colonies were cultured at 3 temperatures (n = 11) over 10 days

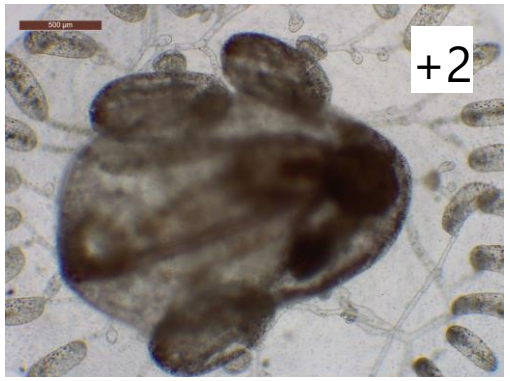

Temperature Treatment Tanks

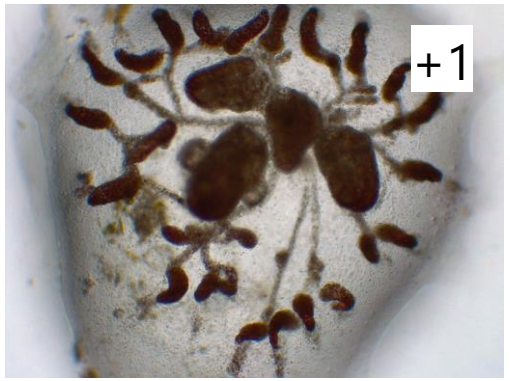
# Zooid and bud numbers are good proxies for colony health and growth



# Qualitative matrix of colony health





| Category | Healthy (+2) | Unhealthy (+1) | Dead/Dying (+0) |
|---|---|---|---|
| Tunic | Transparent, firm to the touch (in larger colonies) | Translucent, less firm, seeming to detach from the colony, parts have been dissolved/eaten away | Opaque (cannot see zooid detail), gelatinous, easy to peel off/away |
| Circulatory System | Constant visible blood flow in siphon, brachial basket, and external vasculature | Very little flow, really localized, hard to find | No discernible flow or heartbeat |
| Ampullae | Bottle-shaped, visible new growth, distinct from each other, close to the edge of the tunic | Close together, deflated, retracted from the edge of the tunic | Thin, highly pigmented |
| Siphons | Highly responsive to touch, visible contractions, circulation, translucent | Some siphons seem unresponsive, highly pigmented, small | No visible contractions or water circulation |
| Overall | Brightly colored, distinct siphons | Thinner/collapsed siphons, no visible cloacal openings, “the zoo” | Grayish, smell of decay, loss/lack of original pigment, ciliates and other protozoans, disintegration |

# Healthy zooid number increases at high temperature

Kruskal-Wallis Test

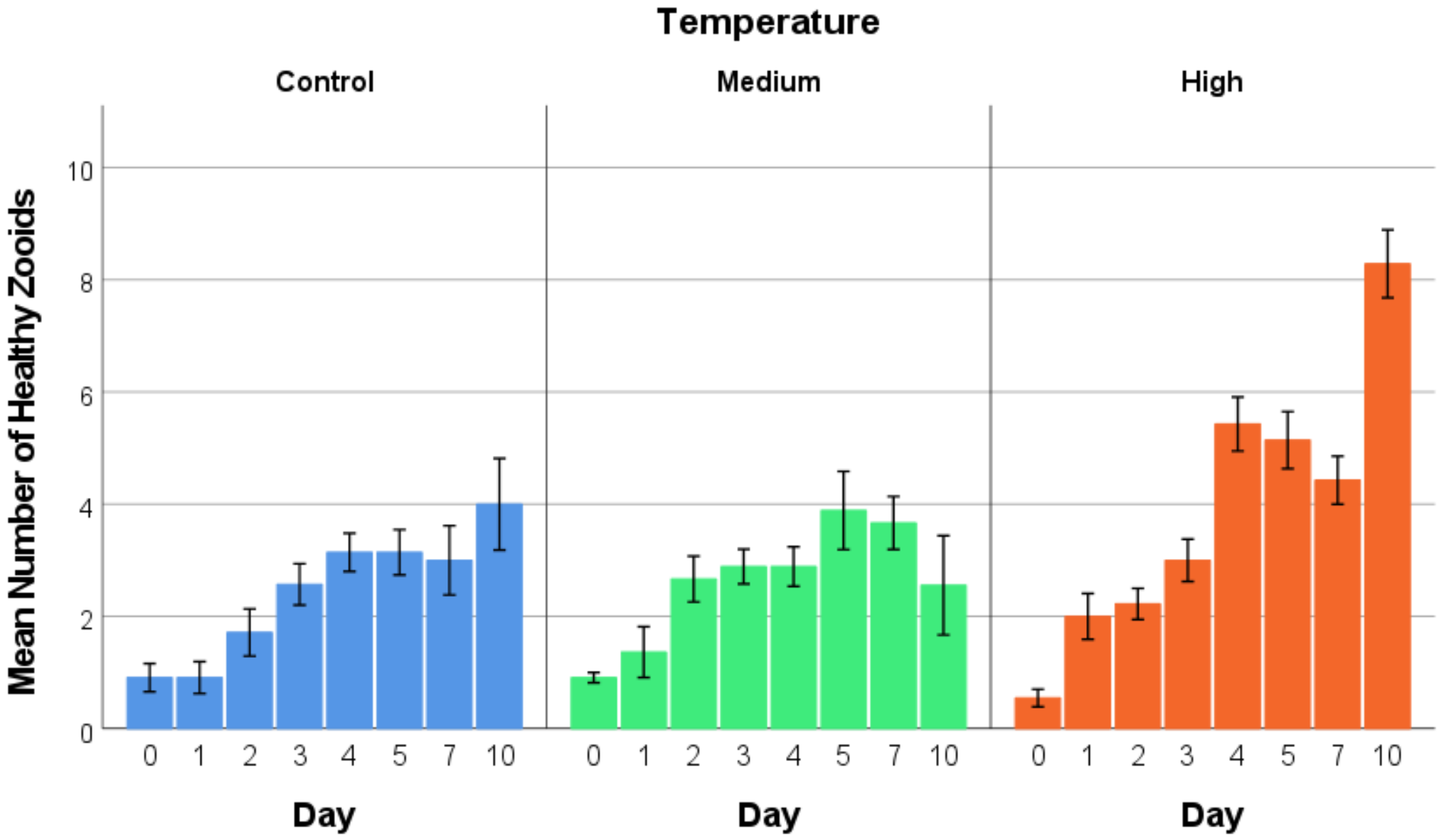
Day:
**p < 0.001**

Temperature:
**p = 0.007**

Control-Medium
p = 0.376

Control-High
**p = 0.002**

Medium-High
**p = 0.023**



# Regressing zooids is not affected by temperature

Kruskal-Wallis Test

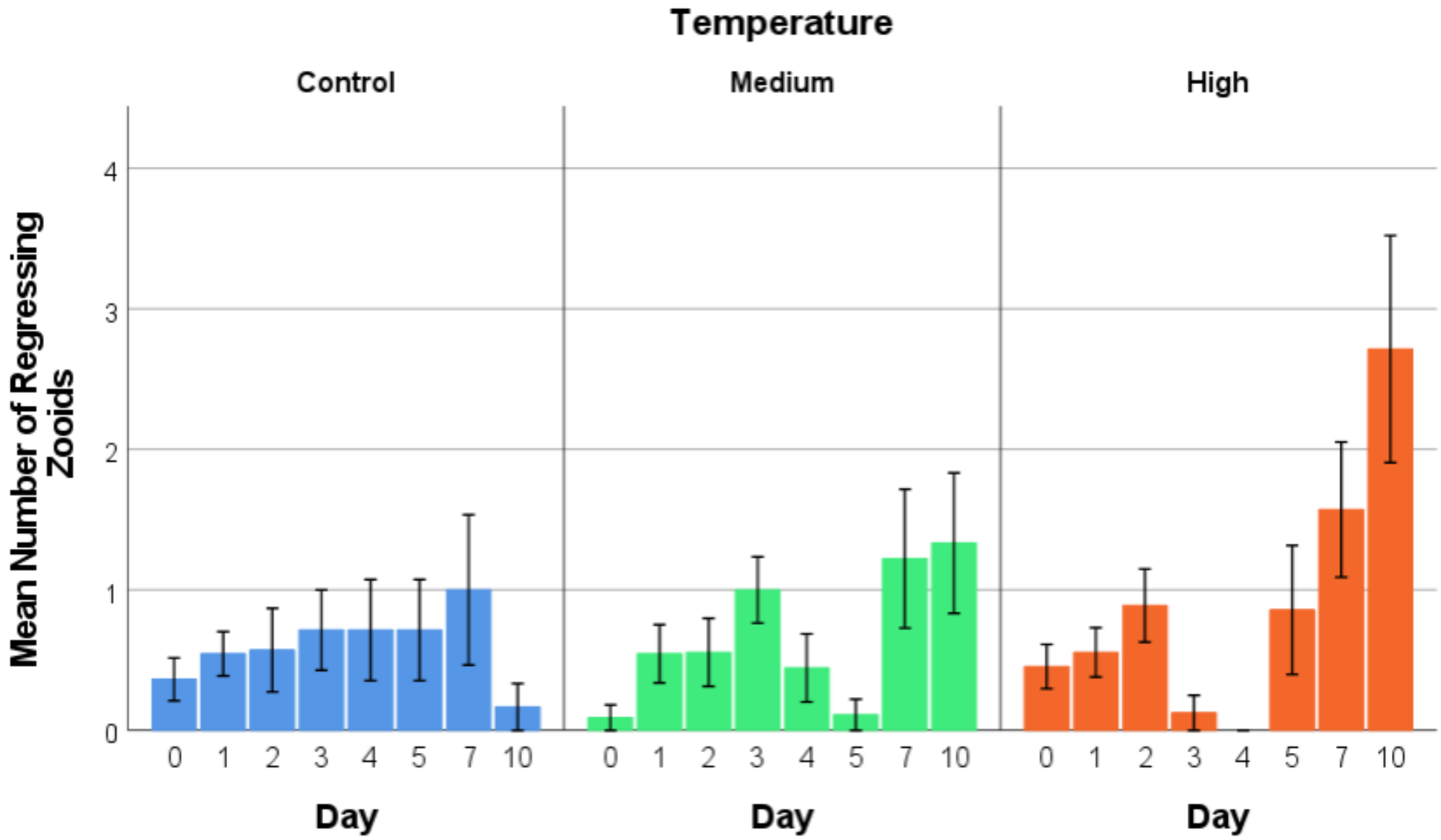
Day:
**p = 0.021**

Temperature:
p = 0.638

Medium-Control
p = 0.927

Medium-High
p = 0.379

Control-High
p = 0.451



# Production of primary buds is lower in mid-temperature

Kruskal-Wallis Test

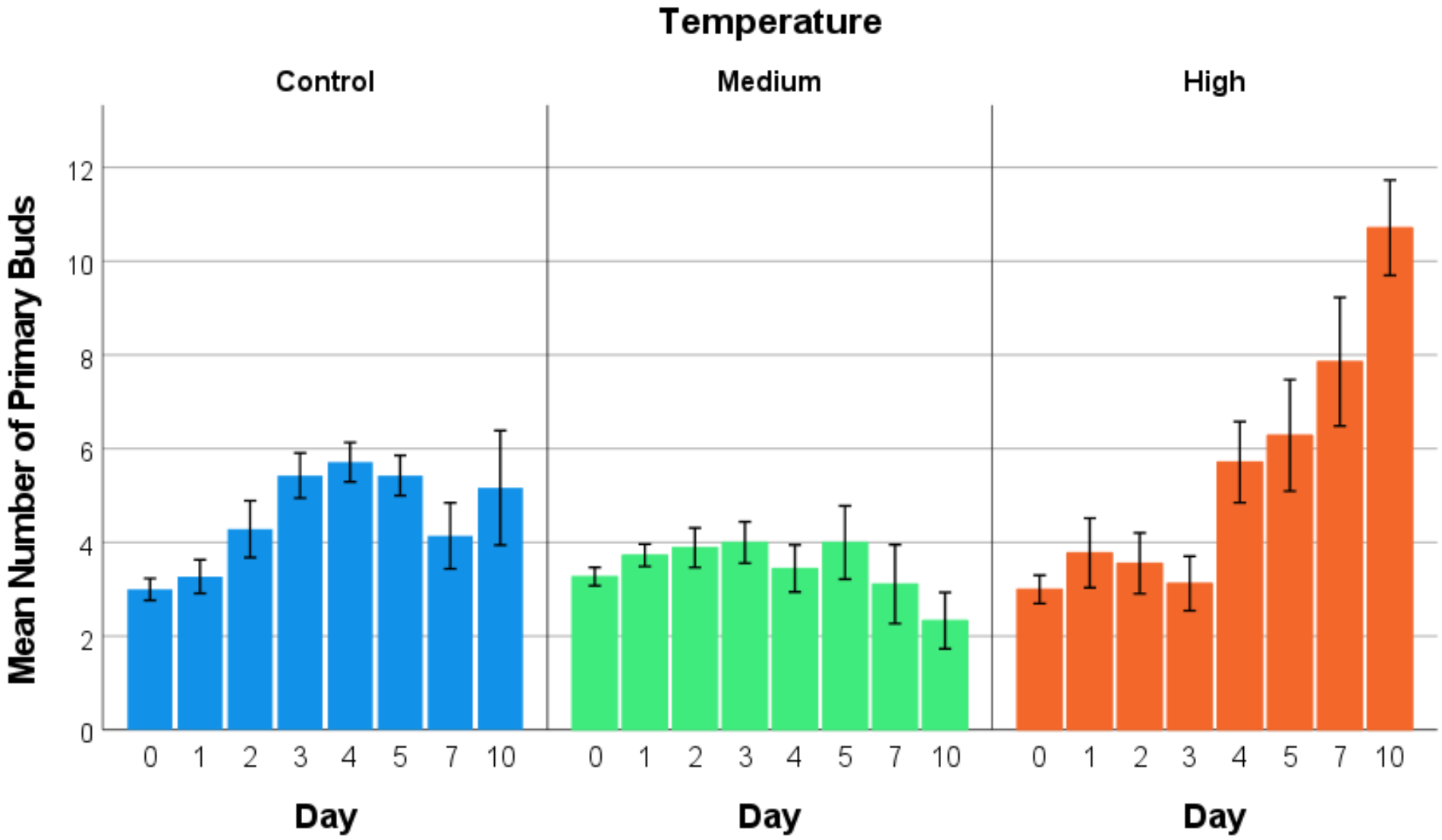
Day:
**p = 0.003**

Temperature:
**p = 0.004**

Medium-Control
**p = 0.010**

Medium-High
**p = 0.003**

Control-High
p = 0.692



# Production of secondary buds is not affected by temperature

Kruskal-Wallis Test

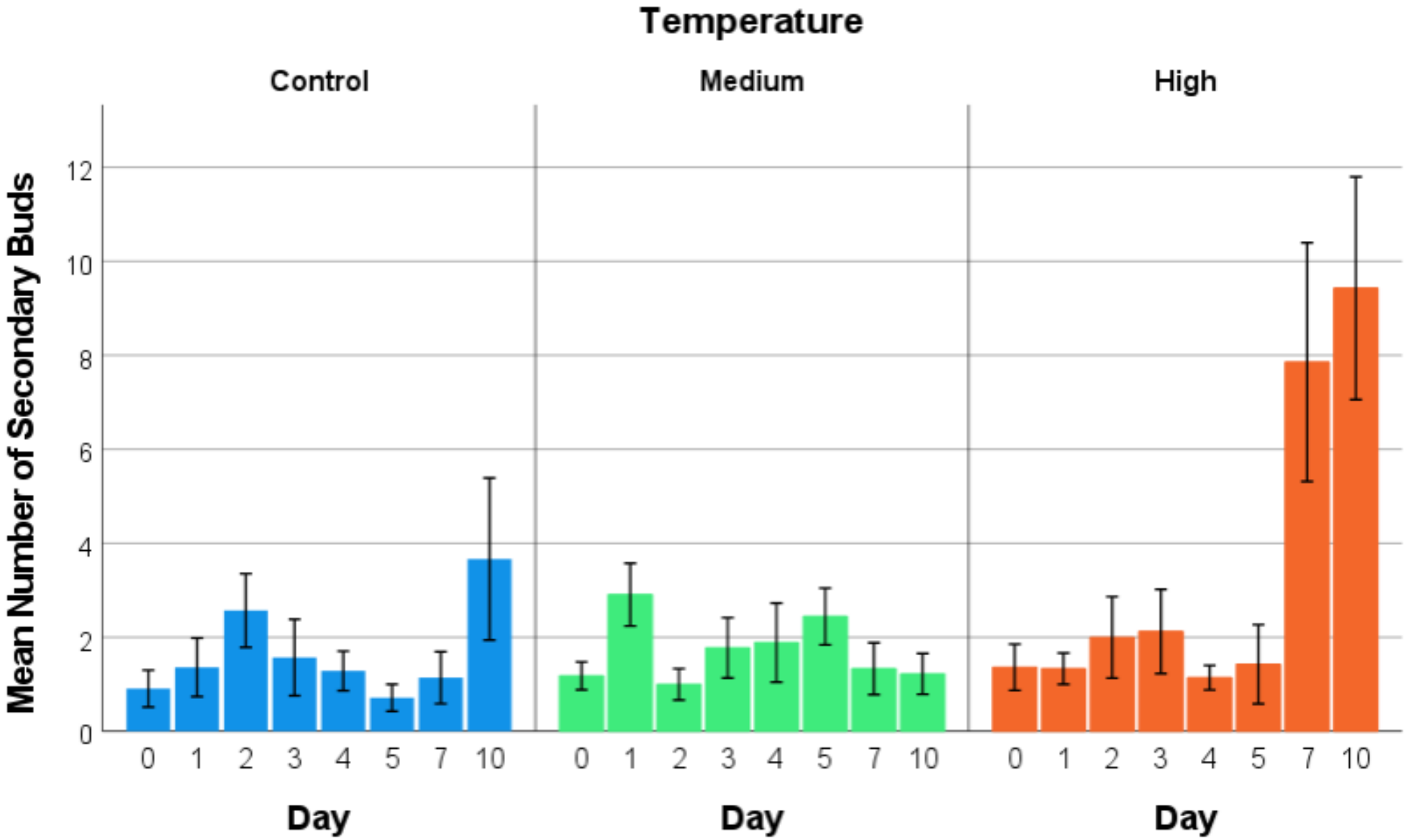
Day:
p = 0.187

Temperature:
p = 0.148

Control-Medium
p = 0.359

Control-High
p = 0.051

Medium-High
p = 0.265



# Colonies in high temperatures exhibited lower heart rate

Kruskal-Wallis Test

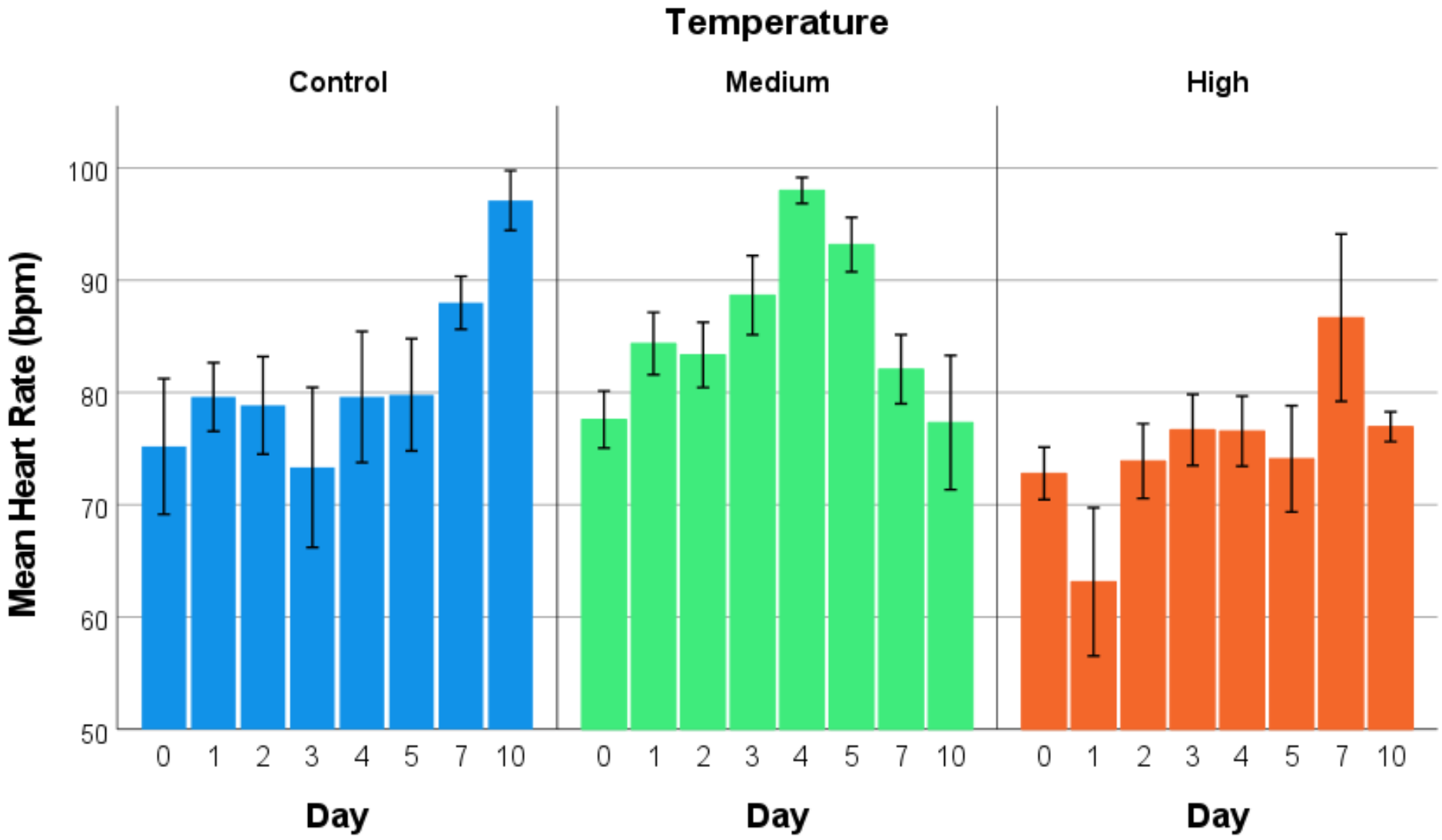
Day:
**p = 0.011**

Temperature:
**p < 0.001**

High-Control
**p = 0.002**

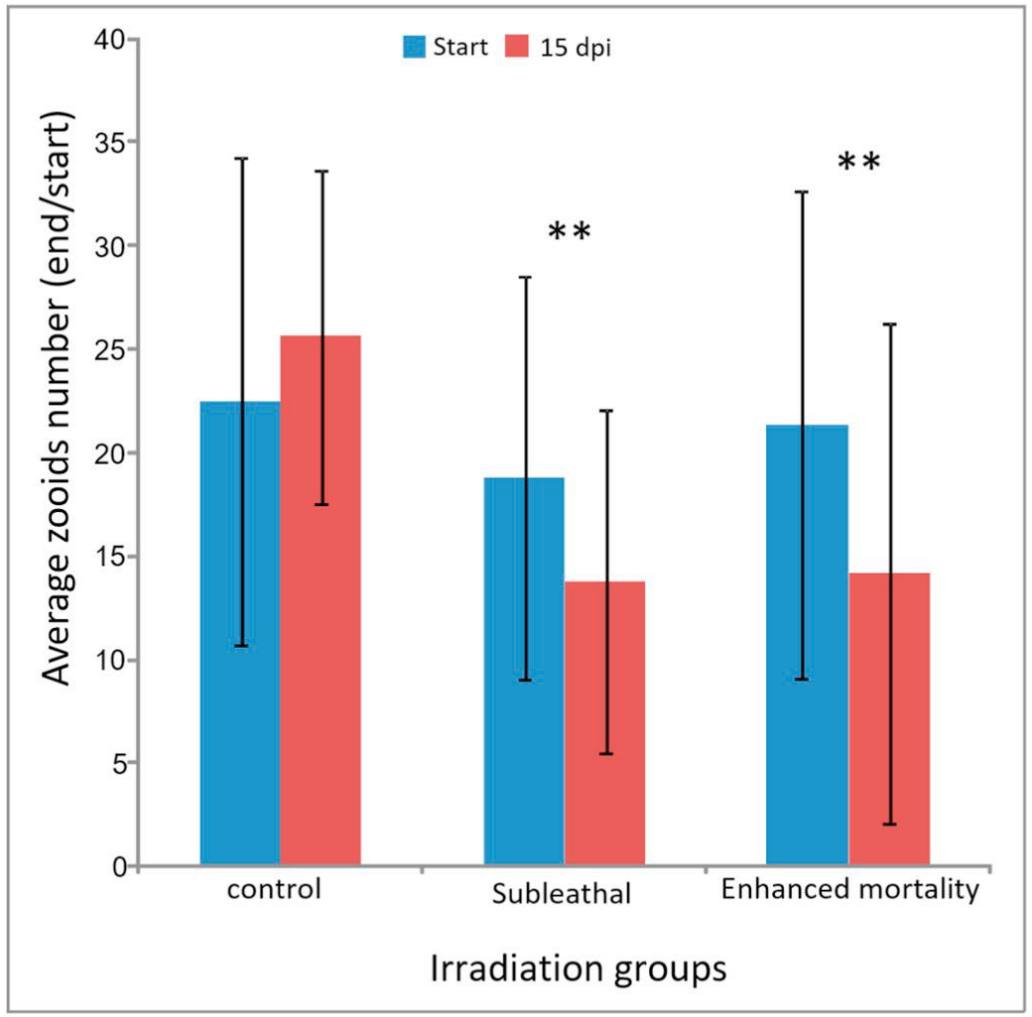
High-Medium
**p < 0.001**

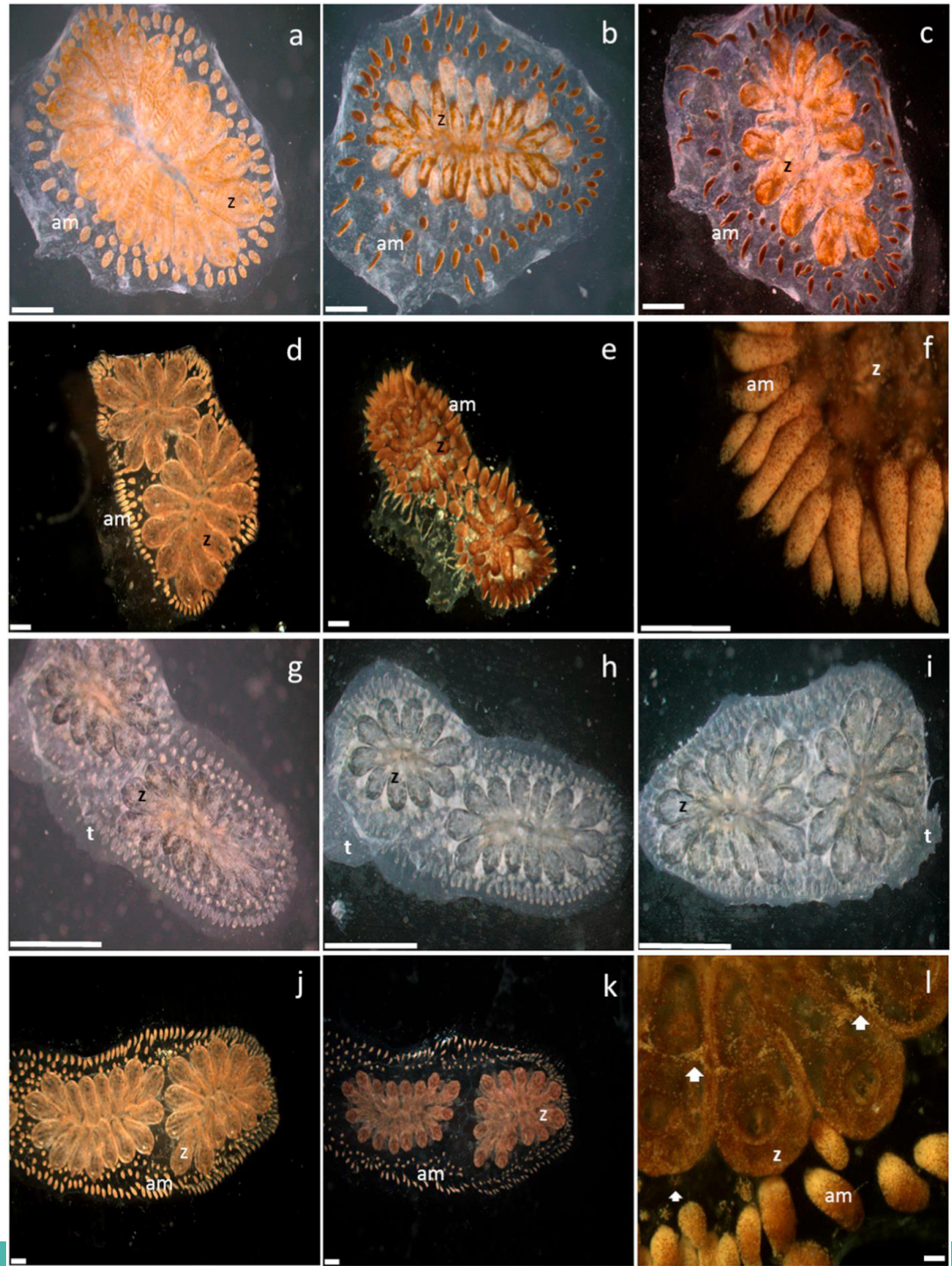
Control-Medium
p = 0.132



# Does UV radiation alter morphology and gene expression?

# UV radiation generates abnormal phenotypes and alters blastogenesis

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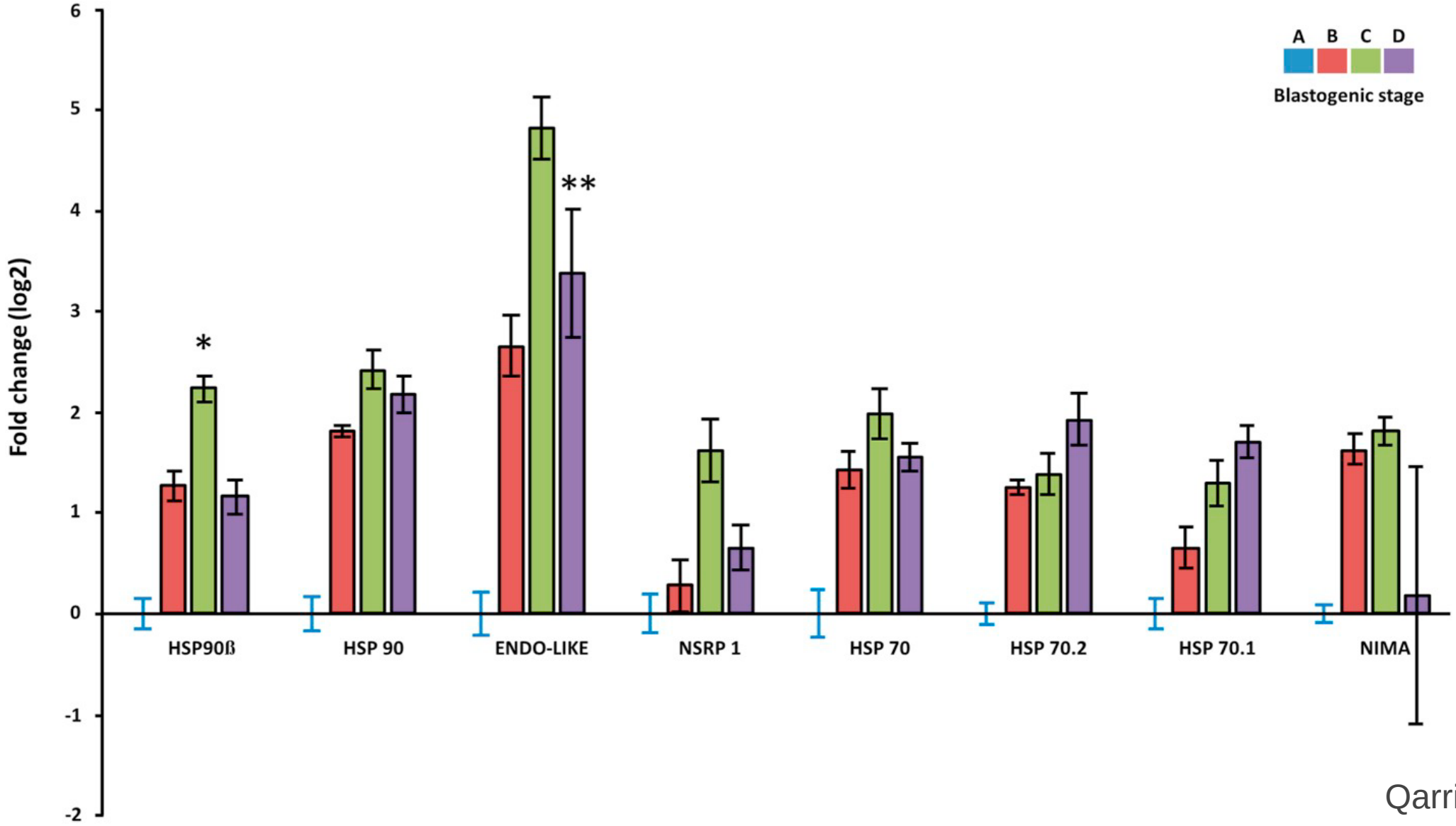
# UV stress alters gene expression profiles

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# Conclusions & Future Work

- Blastogenesis in botryllids is positively affected by temperature stress and negatively impacted by UV radiation.
- Colonies demonstrate high level of plasticity in gene expression and morphological phenotypes in response to environmental stressors.
- Future comparative study with populations across different latitudes and native colonial ascidian species.

# Acknowledgements

This research was supported by grants from the National Science Foundation (MCB-2127517; DBI-2149705) and a UW Friday Harbor Laboratories New Faculty Research Fellowship.

Research Collaborators:
Baruch Rinkevich
Dietmar Kültz
Olivia Wing
Andy Qarri
Amalia Rosner
Claudette Rabinowitz

Questions?