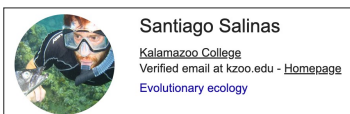
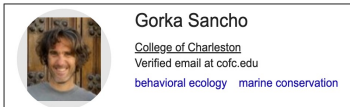
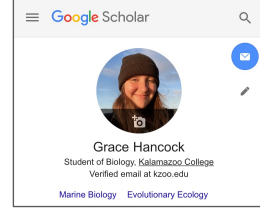


These Fish Did WHAT When Exposed to Fluctuating Temperatures?!

A population of *Menidia menidia* (a TSD fish) showed changes in sex ratio, critical thermal maximum, and length-at-age when exposed to diel temperature fluctuations.




introduction

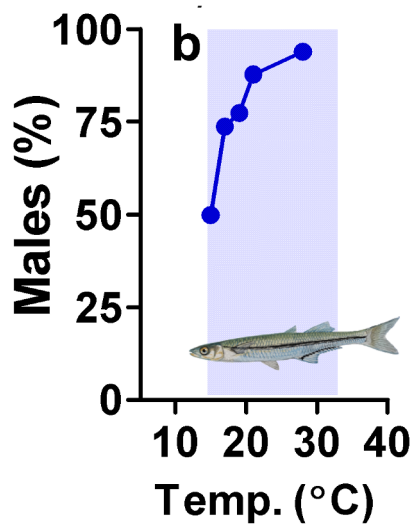
 **Graces Poster**
@GracesPoster

In temperature-dependent sex determination (TSD), the sex of an organism is determined by the temperature of the environment. Many reptiles (e.g., crocodiles, tuatara, turtles, some lizards) and ~60 fish species display TSD (Valenzuela 2014).


11:18 AM · Feb 22, 2022 · Twitter Web App

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Replying to @GracesPoster
The silverside, *Menidia menidia*, for example, produces ~80% males when embryos from South Carolina are raised at 28°C (Conover and Kynard 1981).




 1    

 **Graces Poster** @GracesPoster · 31s
Most TSD research to date exposes organisms to constant temperatures. Though useful, results of these studies could be erroneously used to predict population responses in the wild...


 1    

 **Graces Poster** @GracesPoster · 31s
since we now know that diel temperature fluctuations alter the physiology and life history of many species; e.g., Podrabsky and Somero 2004, Salinas et al. 2019).

 1    

 **Graces Poster** @GracesPoster · 31s
As temperatures continue to become more variable because of climate change (AR6 IPCC Report 2021), we must understand TSD dynamics under (more realistic) daily thermal fluctuations.

 1    

 **Graces Poster** @GracesPoster · 31s
We explored the dynamics of sex determination in *M. menidia* from South Carolina under a constant temperature (28°C), small daily fluctuations (28±2°C), and large daily fluctuations (28±4°C). We quantified sex ratios, length-at-age, and CT_{max}.



Methods

 **Grace's Poster**
Yesterday at 2:55am · 

- Here's what we did...
- (1) Caught ripe *M. menidia* from Charleston Harbor, SC in late May-early June 2021
 - (2) Spawned fish at the Grice Marine Lab (College of Charleston) and shipped them overnight to Kalamazoo College
 - (3) There were two batches of fish that experienced the temp treatments differently (see below)
 - (4) TEMP TREATMENTS: constant 28°C ± 0.2, small fluctuations (28 ± 2°C; 26°C at midnight, 30°C at noon), large fluctuations (28 ± 4°C; 24°C at midnight, 32°C at noon). All temps controlled by APEX Jr. microprocessor systems
 - (5) We replicated the 3 thermal environments 6 times (i.e., 6 tanks of each treatment for a total of 18 tanks). Each tank housed 4 large chambers with ~14 fish in each
 - (6) For care, we followed standard rearing conditions (salinity = 20 psu, regular water quality testing, twice daily feeding of 1-d-old brine shrimp supplemented with Otohime dry food)
 - (7) STATS: generalized linear models with trait (sex, length-at-age, CT_{max}) and batch number as response variables and temp treatment as the independent one (for sex ratio, we used a binomial error distribution and logit link function; for the other two, Gaussian error distributions and identity functions)

   4 people like this.

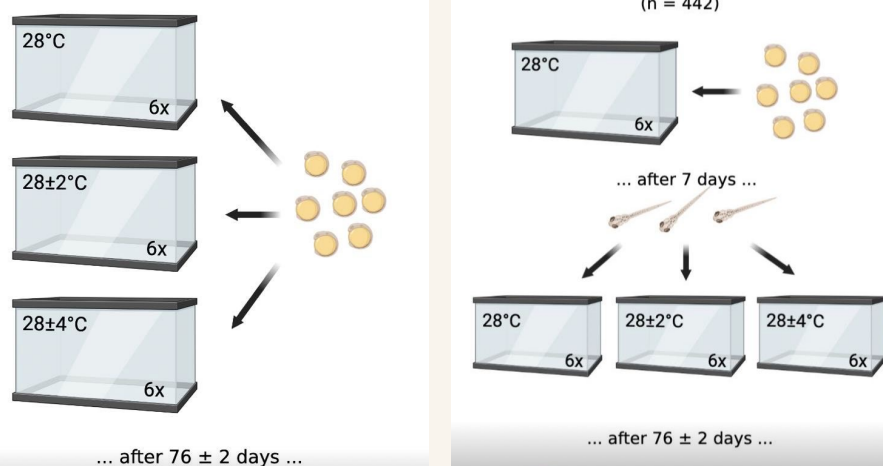
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
Experimental set-up

 **Grace Hancock**
5m ago from Camera Roll

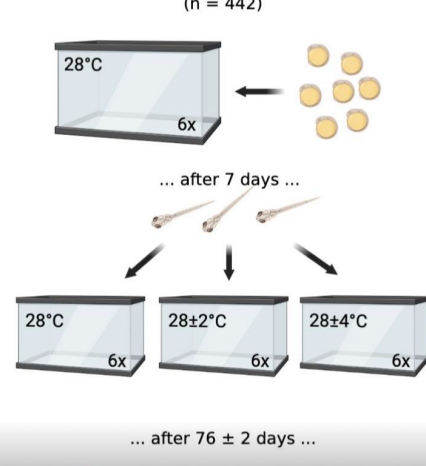
Fish in temp treatments as embryos
-- Batch 1 --
(n = 510)



CT_{max} Length Sex


 **Grace Hancock**
4m ago from Camera Roll

Fish in temp treatments as 7-d-olds
-- Batch 2 --
(n = 442)



CT_{max} Length Sex

Results

●●●● Vodafone 10:04 AM 100% 

 Instagram  

 **GracesPoster**
Kalamazoo MI

Treatment	% female	n
28°C (1)	5%	95
28°C (2)	11%	226
28°C	10%	321
28±2°C (1)	12%	222
28±2°C (2)	18%	114
28±2°C	16%	336
28±4°C (1)	11%	193
28±4°C (2)	22%	102
28±4°C	17%	295

   Liked by Menidia and 20 others

GracesPoster Sex ratio results separated by batch:
(1) = fish moved to temp treatment as embryos
(2) = fish moved to temp treatment ~6 d post-hatch

Temperature treatment and batch number influenced the sex ratio of fish (GLM: temperature p = 0.021, batch number p = 0.002) but their interaction did not (p = 0.749)

 Add a comment...

1 DAY AGO

References

Temperature-dependent sex determination in vertebrates

N. Valenzuela, V. Laroche - 2004 - pdfs.semanticscholar.org

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Environmental sex determination: interaction of temperature and genotype in a

D.O. Conover, B.E. Kynard - Science, 1981 - science.org

Sex determination in an atherinid fish, the Atlantic silverside (*Menidia menidia*), is under the control of both genotype and temperature during a specific period of larval development. ...

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AR6 Climate Change 2021: The Physical Science Basis

Z. Zhongming, L. Linong, Y. Xiaona, Z. Wangqiang, L. Wei - 2021 - resp.ilas.ac.cn

... The IPCC is currently preparing its Sixth Assessment Report (AR6). During this cycle, the ...

Assessment Report (AR6). More information on the sixth assessment cycle is available here. ...

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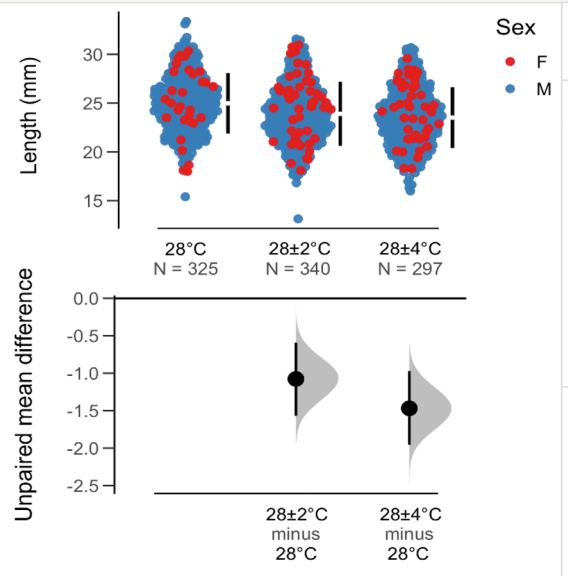
Trait variation in extreme thermal environments under constant and fluctuating


temperatures

S. Salinas, S.E. Irvine, C.L. Schertzinger, ... - of the Royal Society, 2019 - royalsocietypublishing.org

Climate change is increasingly exposing populations to rare and novel environmental conditions. Theory suggests that extreme conditions will expose cryptic phenotypes, with a ...

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Kalamazoo MI

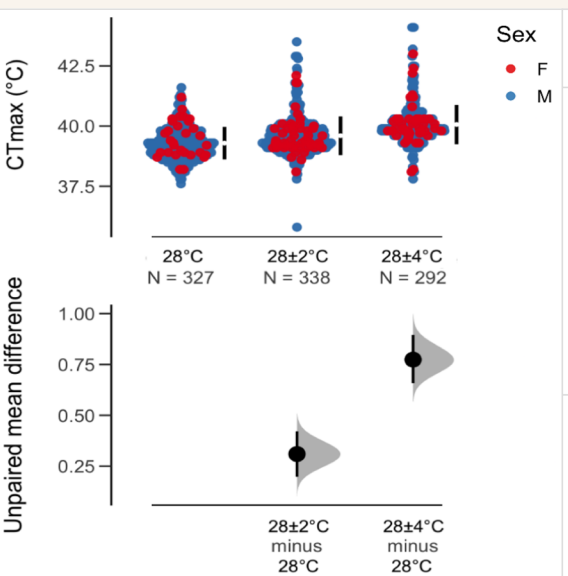
GracesPoster Fish under constant 28°C were significantly longer than those at either of the two fluctuating temperature treatments (GLM: p < 0.001). There was no significant difference between the length of the fish in the two fluctuating temperature treatments (p = 0.361).


[above: raw data, mean, and SD; below: effect sizes, sampling distributions, and 95 CIs]

#CummingPlot #EstimationStats #nofilter

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




 **GracesPoster**
Kalamazoo MI

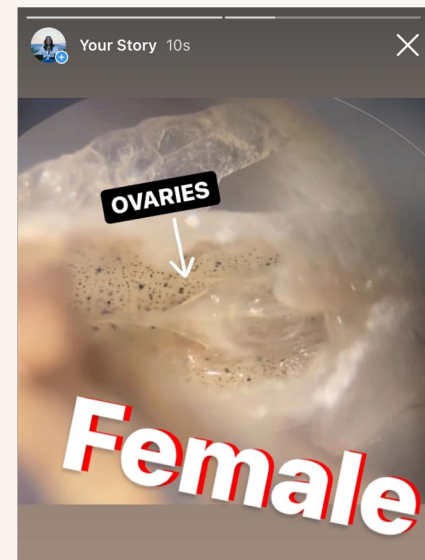
GracesPoster Fish under constant 28°C had a significantly lower critical thermal maximum (CT_{max}) than those at large fluctuating temperatures (GLM: p < 0.001) but were similar to those under small fluctuations (p = 0.253). CT_{max} was different in the high and low fluctuation treatments (p < 0.001).

[above: raw data, mean, and SD; below: effect sizes, sampling distributions, and 95 CIs]

#CummingPlot #EstimationStats #nofilter

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


Discussion

 **Graces Poster**
online

so... what was the biggest finding?

2:40 PM 


when silversides are grown under temperatures that fluctuate daily, they produce more females than when raised in a constant temp (ratio bias is less extreme)

and diel fluctuations also led to more heat-tolerant fish (higher CT_{max}) that were also smaller

that's wild! but why does it matter?

well, for one, this species' sex ratio doesn't change THAT much in constant vs fluct temps (like, e.g., turtles do). But it is still important to realize that these changes could alter population dynamics significantly

comparing the differences in sex ratio between const and fluct temps in populations of *M. menidia* that experience different levels of TSD (Duffy et al. 2015) could tell us much more about TSD under more realistic conditions

 Type a message 