

ESSAY

## Bugs in the Brain

Time for a bit of humility.

Some microorganisms  
can manipulate  
neural circuitry  
better than  
we can



By Robert Sapolsky



Convey more  
information than a talk

Receive more  
feedback

Allows networking



Scientific Posters are one of the most common and effective  
methods for disseminating scientific information

A Poster is an means to communicate Science.

A Poster is a tool with which to communicate with a person!

A Poster is an advertisement/reflection of you and your science.



Even the best science  
will go unnoticed unless  
the poster is well made.



What do you care about most?

What do you notice First?

- Layout
- Title
- Figures
- Color

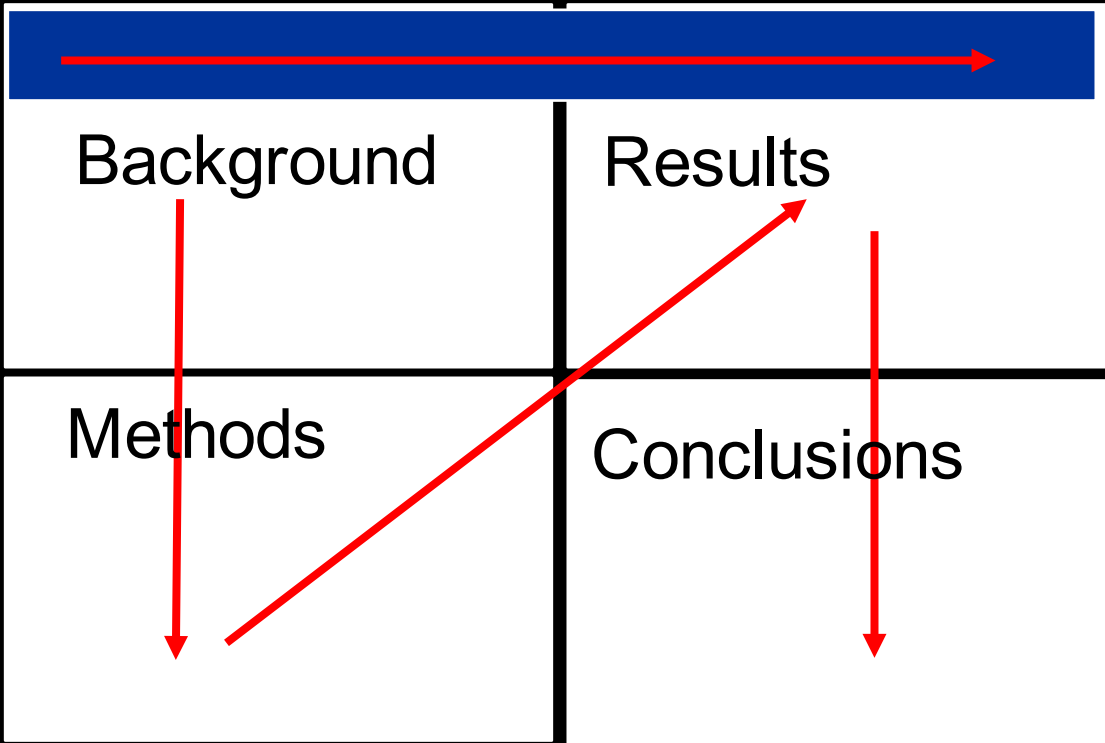
What do you notice Next?

- Research question
- Approach
- Results
- Importance

What do you notice Last?

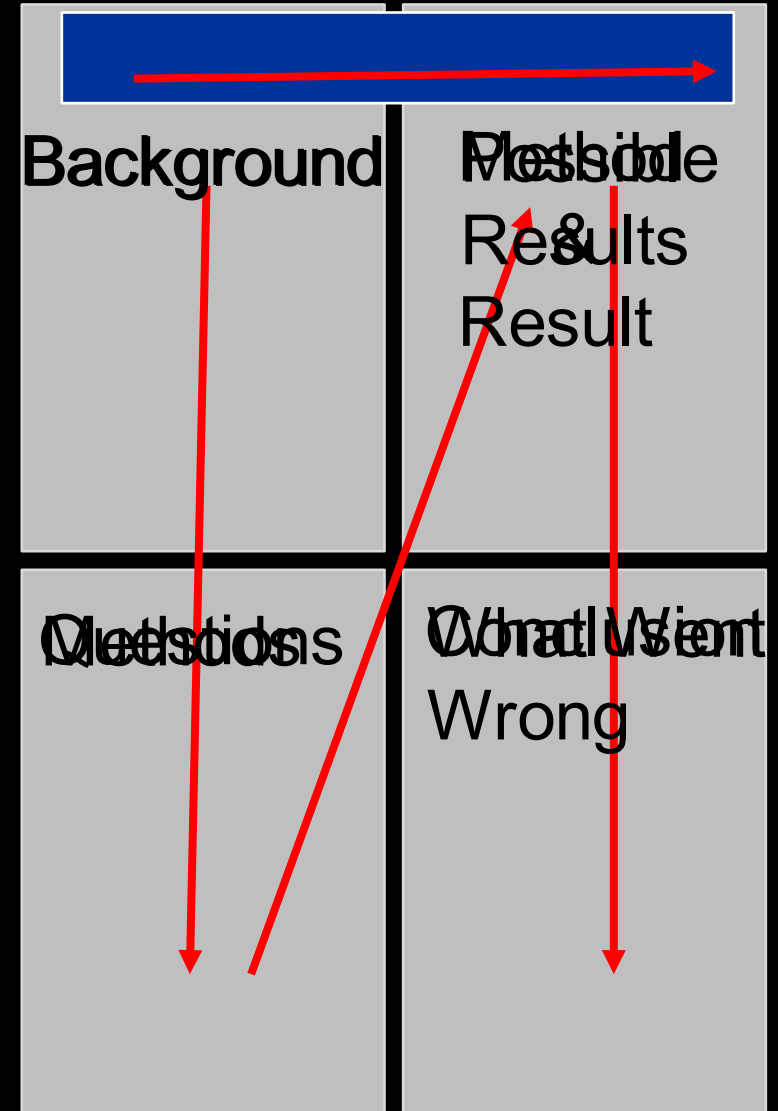
- Importance
- Logic of interpretation
- detailed methods
- Results
- Scientific Impact
- text





Landscape

Bio342 Constraints



Portrait

- nt Projects - **Basic Assignment**
- 10/24-25 - Week 8 - pick a project
  - 10/31-1 - Week 9 - **Animal Care protocol**
  - 11/7-8 - Week 10 -
  - 11/14-15 - Week 11 - Analysis M&B Chapter 9
  - 11/28-29 - Week 12 (after Tday) - Presenting Findings M&B Chapter 10
  - 12/8 - Week 13 - Abstract due on moodle (**suggestions**)
  - 12/10 - print your poster at the Reed Print Shop (elliott basement)
    - Post a .pdf of poster to Moodle
  - 12/11 - Finals Week - Tuesday 9:00 AM - 11:30 - Poster Session (templates **landscape, portrait**)
  - 12/11 - Bring Lab notebook to Poster Session
  - 12/12 - Self Assessment - upload to moodle by 5:00 PM (**template**)

## Avoid Excessive Text

- Practice writing with as few words as possible
- Delete even more words
- Think of a way to use a picture
- Don't include any superfluous words

# Playing it safe? Behavioral responses of a mosquito larva encountering a fish predator

Karthikeyan Chandrasegaran<sup>1,3,4</sup>, Aveshi Singh<sup>1,5</sup>, Moumita Laha<sup>1</sup> and Suhel Quader<sup>1,2</sup>  
<sup>1</sup> National Centre for Biological Sciences, Tata Institute of Fundamental Research, Bengaluru, India; <sup>2</sup> Nature Conservation Foundation, Mysuru, India; <sup>3</sup> SASTRA University, Thanjavur, India; <sup>4</sup> Centre for Ecological Sciences, Indian Institute of Science, Bengaluru, India; <sup>5</sup> Department of Natural Sciences, Reed College, Portland, USA

## Introduction

Detecting and responding to predators is crucial for prey survival (Lima, 1998). Prey are known to employ varied cues, both physical and chemical in nature, to sense and assess threat (Chivers and Smith, 1998). Most prey organisms then employ behavioral defenses as a key component of their predator avoidance strategies (Lima and Dill, 1990). These behaviors are often energetically costly, and reduce the ability of the animal to feed and reproduce (Shi, 1992). Since predation, like all ecological forces, rarely acts in isolation, animals often have to make tradeoffs between predator avoidance and investment in other activities such as foraging, seeking mates etc. (Wormington and Juliano, 1990). Exploring the contexts within which these tradeoffs occur is important to understand the evolution of these behaviors.

In this study, we sought to characterize the relative importance of physical and chemical predator cues in eliciting predator-avoidance movement behaviors in *Aedes aegypti* larvae. We asked whether the feeding state (satiation) of the prey affects the strength of response, expecting that starved larvae would be willing to take more risks than satiated larvae while sensing predator threat. Finally, we tested a critical assumption: whether these behaviors confer an advantage to the larvae in terms of their survival.



## Methods

*Aedes aegypti* larvae were maintained in our lab and used in trials when they were in the 3rd-4th instar. For the initial behavioral characterization, individual larvae were monitored in three environments: in tap water (control), kaironome only (guppies were maintained in a tank of water for three days and fed larvae and only the water was used - chemical cues) and kaironome and guppies (guppies were added with the water - chemical and physical cues). The larval movement was measured along four parameters: number of wriggle bursts, number of wriggles per wriggle burst, frequency of surface visits and time spent at surface. For the next experiment, we repeated the previous one with larvae that had been starved for 8-12 hours and larvae that had been fed ad libitum. Finally, we used the results of the previous experiments to determine the particular form of movement the larvae displayed in the presence of a predator. These, along with normal larval movement were simulated using NetLogo, an open source modeling environment. We played our simulations on two LCD screens (one with normal movement and one with predator avoidance movement) placed on two sides of a tank containing a starved guppy. We then measured the time the fish spent on each of the monitors and recorded the number of times the fish tried to 'bite' the simulated larvae.

## Results

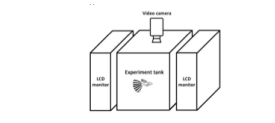
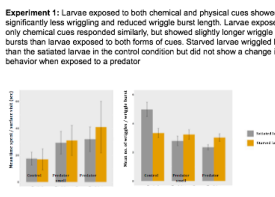
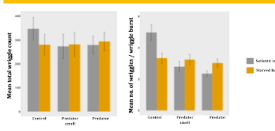
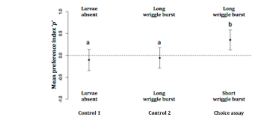


Diagram of setup used to determine whether changes in larval behavior confer a survival advantage to the larvae.

## Experiment 1: Larvae exposed to both chemical and physical cues showed significantly less wriggling and reduced wriggle burst length. Larvae exposed to only chemical cues responded similarly, but showed slightly longer wriggle bursts than larvae exposed to both forms of cues. Starved larvae wriggled less than the satiated larvae in the control condition but did not show a change in behavior when exposed to a predator.



Experiment 2: Both starved and satiated larvae spent more time on the surface when exposed to predation cues, but did not differ from each other in the strength of their responses.



Experiment 3: The fish preferentially spotted and responded to simulations of larvae moving in long wriggle bursts compared to those moving in short wriggle bursts.

## Conclusions

Our study shows that mosquito larvae alter movement patterns in response to predators in a cue-dependent manner - combinations of cues elicit stronger responses than individual cues. This indicates that these organisms assess their environment by integrating chemical and physical cues; chemical cues can indicate the presence of a predator and physical cues can indicate imminent danger. This allows the organisms to respond to stimuli in a risk-sensitive manner as predicted by the backup signal and multiple message hypotheses. We also demonstrate that these behaviors confer a survival advantage on the larvae, by exploiting the guppies' visual limitations. Starved larvae did not significantly alter their movement in the presence of a predator, indicating that predator-avoidance behaviors prevent the animal from foraging and that the animal can opt to not display these behaviors in times of stress. Taken together, our results show that larvae are sensitive to different types of predator cues and can alter their response towards predation based on both cue type and their physiological state. We also showed that the behaviors we measured did, in fact, confer a survival advantage to the larvae. *Aedes aegypti* is a vector for both dengue and chikungunya, thus, understanding the ways in which these animals have adapted to maximize their survival is important for conceiving and structuring vector control programs targeting disease vectors.

## Bibliography

1. Sih A. (1980). Antipredator responses and the perception of danger by mosquito larvae. *Ecology* 61, 438-441.
2. Lima S. and Dill L. (1990). Behavioral decisions made under the risk of predation: A review and prospect. *Can J Zool* 68, 619-640.
3. Lima S. (1998). Nonlinear effects in the ecology of predator-prey interactions. *BioScience* 48, 25-34.
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## Introduction

They employ different types of cues - physical and chemical - to sense and assess threat (Chivers and Smith, 1988). Behavioral defenses are a key component of many prey organisms' anti-predator responses (Lima and Dill, 1990). Behavioral defenses are often energetically costly, and reduce the animal's ability to feed and reproduce (Shi, 1992). Thus, animals have to make context-dependent tradeoffs between predator avoidance and investment in other activities such as foraging, seeking mates etc. (Wormington and Juliano, 1990).



*Aedes aegypti*

patronically distributed species of mosquito that is a vector for both dengue and chikungunya. good model organism to study predator-prey interactions as they inhabit different environments in different life stages - thus they have to adapt to the presence of different types of predators. Understanding the ways in which these animals have adapted to maximize their survival is important for conceiving vector control programs

1. We aim to characterize the relative importance of physical and chemical predator cues in eliciting predator-avoidance movement behaviors in *Aedes aegypti* larvae.
2. We ask whether the feeding state (satiation) of the larvae reduces the strength of response.
3. We test the critical assumption that these behaviors confer a survival advantage to the larvae.

## Conclusions

We show that:

1. Mosquito larvae alter movement patterns in response to predators - by reducing the number and length of their wriggle bursts.
2. Combinations of cues elicit stronger responses than individual cues.
3. Starved larvae responded less strongly to predator cues than satiated larvae.
4. We also demonstrate that these behaviors confer a survival advantage on the larvae, by exploiting the guppies' visual limitations.

These results indicate that larvae assess their environment by integrating chemical and physical cues as well as internal state; chemical cues can indicate the presence of a predator and physical cues can indicate imminent danger. This allows the organisms to respond to stimuli in a risk-sensitive manner as predicted by the backup signal and multiple message hypotheses. Hunger can override predator-avoidance behaviors that otherwise prevent the animal from foraging.

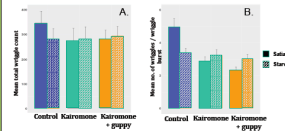
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Behavioral tests administered on 3rd-4th instar lab reared *Aedes aegypti* larvae. The larvae were either satiated or starved for 8-12 hours. Larvae were exposed to:

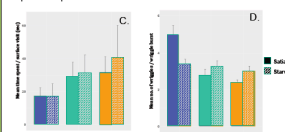
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The larval movement was measured along four parameters:  
 A. number of wriggle bursts,  
 B. number of wriggles per wriggle burst,  
 C. time spent at surface and  
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## Response to Predator Cues



Larvae exposed to both chemical and physical cues showed significantly less wriggling and reduced wriggle burst length. Larvae exposed to only chemical cues responded similarly, but showed slightly longer wriggle bursts than larvae exposed to both forms of cues. Starved larvae wriggled less than the satiated larvae in the control condition but did not show a change in behavior when exposed to a predator.



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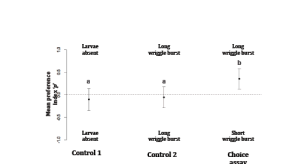
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Based on our behavioral observations, the particular form of movement the larvae displayed in the presence of a predator and normal larval movement were simulated using NetLogo. Simulations were played on LCD screens on either sides of a tank containing a starved guppy.

Guppy predator preference was measured as:  
 - The time spent at each of the monitors  
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## Survival Value



Experiment 3: The fish preferentially spotted and responded to simulations of larvae moving in long wriggle bursts compared to those moving in short wriggle bursts.

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The audience should know what you did if they only read the bold headers.



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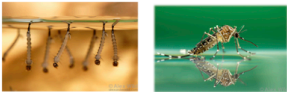
<sup>1</sup> National Centre for Biological Sciences, Tata Institute of Fundamental Research, Bengaluru, India; <sup>2</sup> Nature Conservation Foundation, Mysuru, India; <sup>3</sup> SASTRA University, Thanjavur, India; <sup>4</sup> Centre for Ecological Sciences, Indian Institute of Science, Bengaluru, India; <sup>5</sup> Department of Natural Sciences, Reed College, Portland, USA



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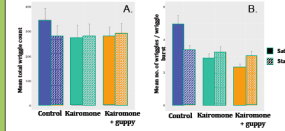
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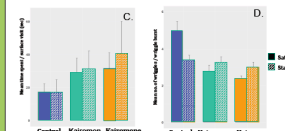
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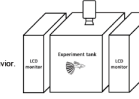
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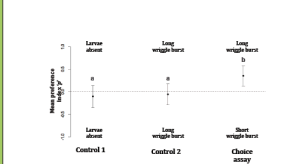
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Behavioral setup testing predatory behavior toward simulated larval behavior.

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## Bibliography

- 1998 A. (1998). Antipredator responses and the perception of danger by mosquito larvae. *Ecology*, 77, 434-441.
- 21Lima S. and Dill L. (1990). Behavioral decisions made under the risk of predation: A review and prospect. *Can J Zool*, 68, 619-640.
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Put the Method with the Result (same as you would in a talk) (different than you do in a paper)

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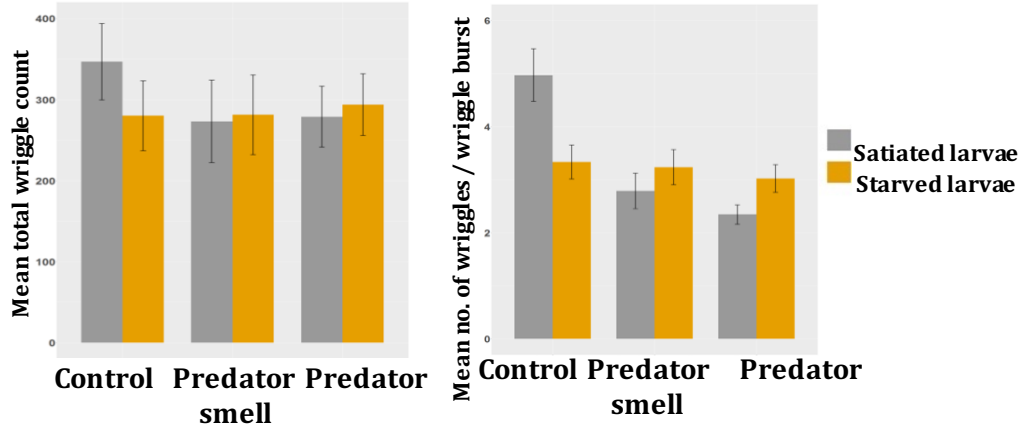
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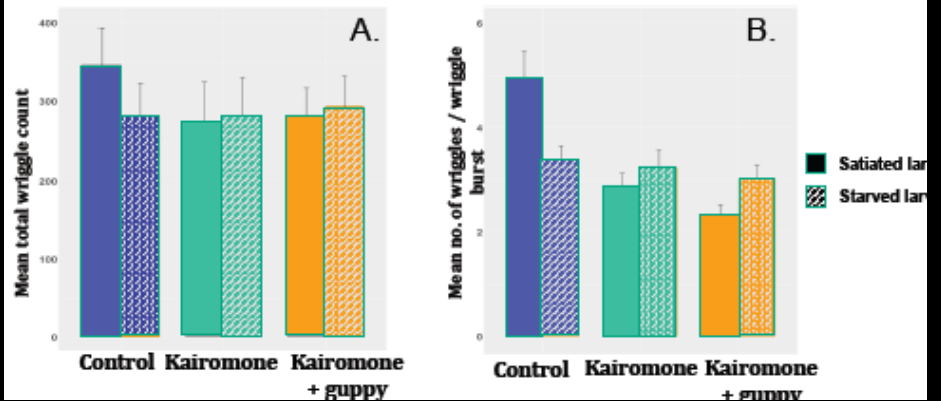
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## Response to Predator Cues



Use color to your advantage.



# Class Project to Test the Challenge Hypothesis in a Dear Enemy Paradigm

Bringing Integrative Animal Behavior into the Classroom

Leilani Ganser<sup>1</sup>, Chelsea A. Weitekamp<sup>2</sup>, Hans A. Hofmann<sup>2</sup>, & Suzy C.P. Renn<sup>1</sup>

<sup>1</sup>Reed College Biology Department

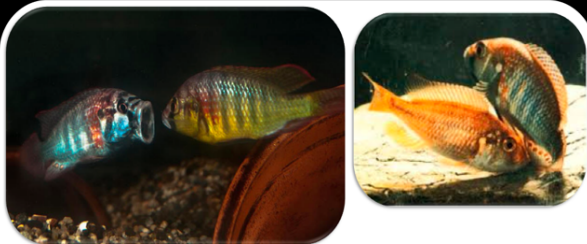
<sup>2</sup>University of Texas Austin, Department of Integrative Biology



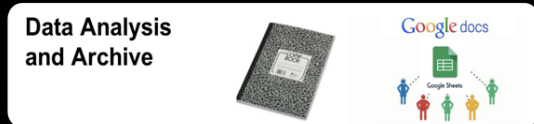
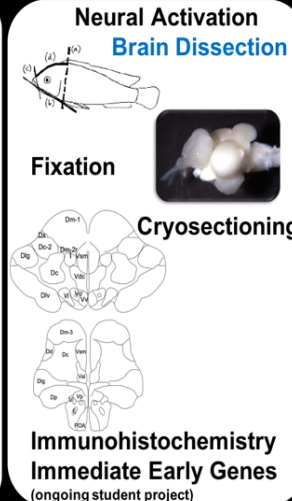
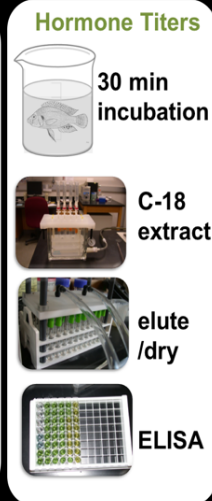
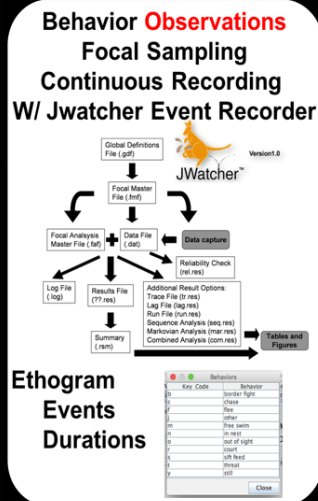
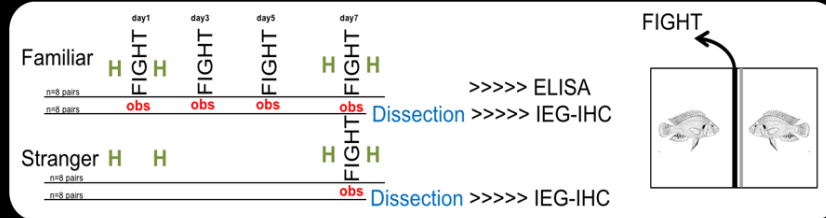
“The Challenge Hypothesis” outlines the dynamic relationship between testosterone and aggression in contexts related to reproduction. It predicts an increase in testosterone that is correlated with the demand for heightened aggression.

“The Dear Enemy Effect” explains social habituation seen as reduced territorial aggression observed between neighboring individuals as compared to strangers.

We test the hypothesis that a reduced hormonal challenge response is one component of the mechanisms that underlie the Dear Enemy.



An established model system in social neuroscience, *A. burtoni* display extraordinary cognitive abilities in a social context dependent manner, making them an excellent system in which to investigate the neural bases of complex social behaviors



**Acknowledgements:**  
32 students in Bio342 at Reed College performed the experiment and are currently analyzing the data. The Dear Enemy Project is funded by NSF-GRFP to CAW.

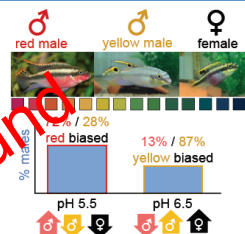
Your poster is a tool for you to interact with your audience  
Make your poster visually appealing  
Use as many images as possible in place of text

# Epigenetic regulation of aromatase in a cichlid with pH-influenced sex determination

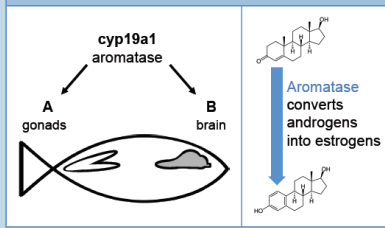
Rose MH Driscoll,<sup>1</sup> Peter L Hurd,<sup>2</sup> Suzy CP Renn<sup>1</sup>

<sup>1</sup> Reed College, Portland, Oregon  
<sup>2</sup> University of Alberta, Edmonton, Canada

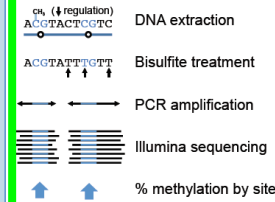
## pH impacts *P. pulcher* sex and morph<sup>1</sup>



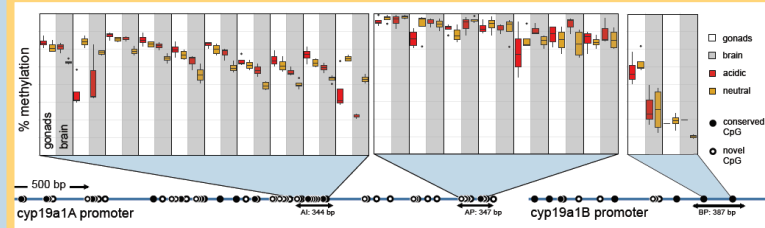
## A and B copies of the *cyp19a1* aromatase are expressed in gonads and brain<sup>2</sup>



## Detecting epigenetic regulation of aromatase



## Methylation of a new region of the *cyp19a1A* promoter is responsive to rearing pH

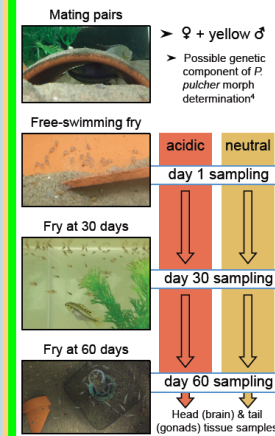


- Tissue-specific methylation
- BP in expected direction; AI in unexpected direction
- pH-specific methylation consistent with a role for A aromatase gene methylation in pH sex determination
- Methylation of AI region shows clear pH differences
- Same mechanism as temperature sex determination,<sup>4</sup> but active region of aromatase promoter differs
- AP (responsive to temperature) was unresponsive to pH

## Tissue and rearing pH explain 95% of the variation in methylation state



## Temporal study of *P. pulcher* ESD to detect critical period



## References

- Reed, A. R., and P. L. Hurd. 2015. Water pH during early development influences sex ratio and male length in a West African cichlid fish. *Evolutionary Ecology* 29: 111-120.
- Reed, A. R., P. L. Hurd, and S. C. P. Renn. 2015. The evolution of sex determination in a West African cichlid fish. *Evolutionary Ecology* 29: 111-120.
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Background

Results

Methods

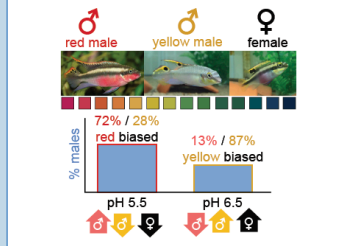
Leave plenty of open space  
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Figures = 40%  
Open Space = 40%

# Epigenetic regulation of aromatase in a cichlid with pH-influenced sex determination

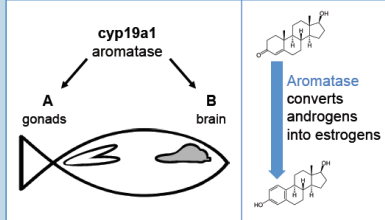
Rose MH Driscoll,<sup>1</sup> Peter L Hurd,<sup>2</sup> Suzy CP Renn<sup>1</sup>

<sup>1</sup> Reed College, Portland, Oregon  
<sup>2</sup> University of Alberta, Edmonton, Canada

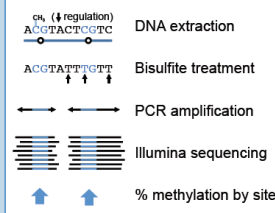
## pH impacts *P. pulcher* sex and morph<sup>1</sup>



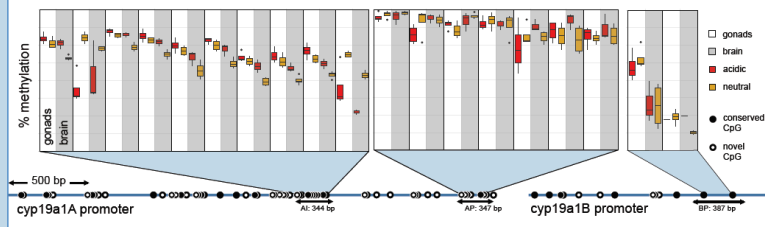
## A and B copies of the cyp19a1 aromatase are expressed in gonads and brain<sup>2</sup>



## Detecting epigenetic regulation of aromatase



## Methylation of a new region of the cyp19a1A promoter is responsive to rearing pH

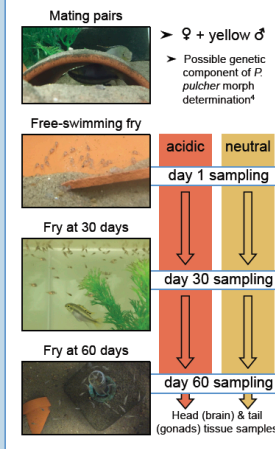


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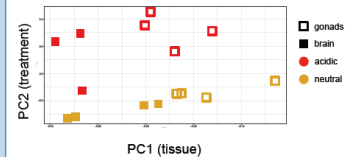
## References

- Reed, A. R., and P. L. Hurd. 2015. Water pH during early development influences sex ratio and male length in a West African cichlid fish. *Evolutionary Ecology* 29: 111-120.
- Hurd, P. L., and A. R. Reed. 2015. The evolution of sex determination in cichlid fish. *Evolutionary Ecology* 29: 111-120.
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## Temporal study of *P. pulcher* ESD to detect critical period



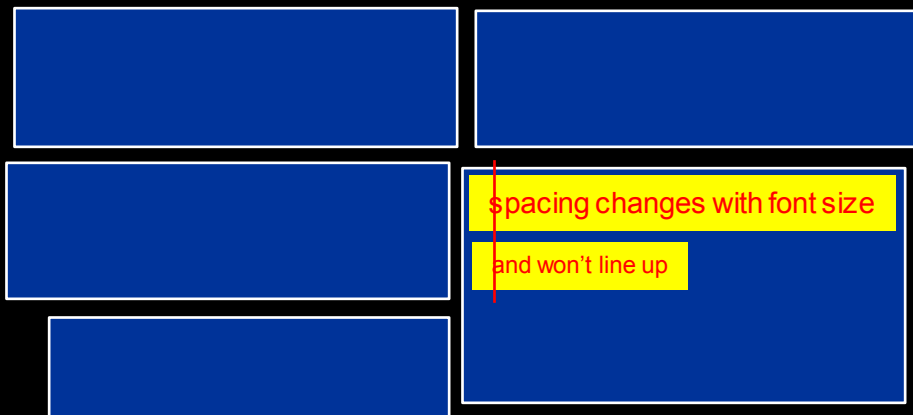
## Tissue and rearing pH explain 95% of the variation in methylation state



Make background and box colors subtle, not jarring

pH of Acid and Neutral

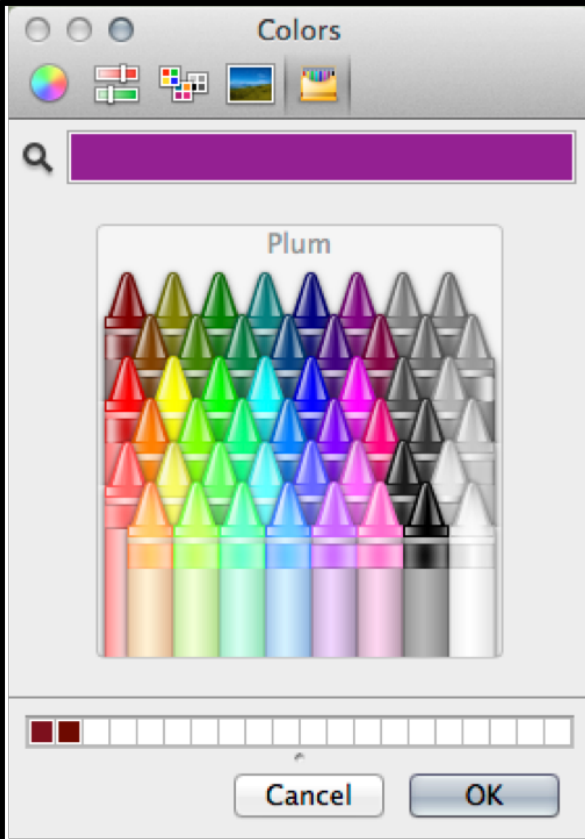
Make your colors work for you



Take the time to align everything

Don't use color filled text boxes

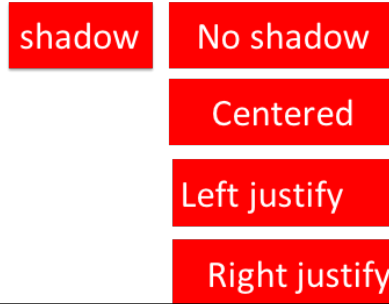
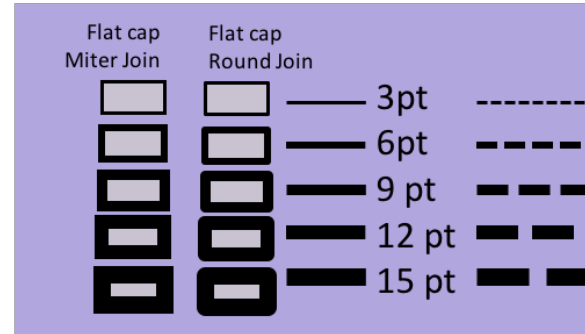
Use spaces not tabs to



Calibri : 12345  
 Arial : 12345  
 Times New Roman  
**Comic Sans: 12345**  
 Courier: 12345

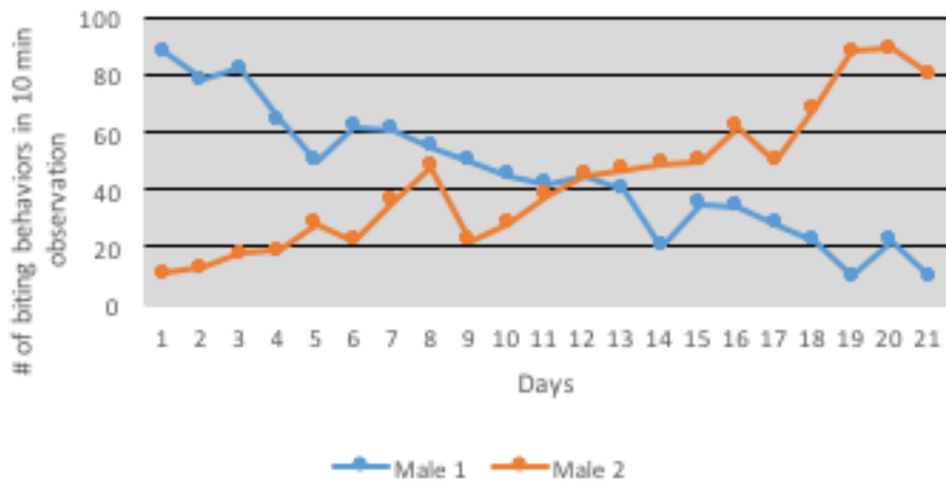
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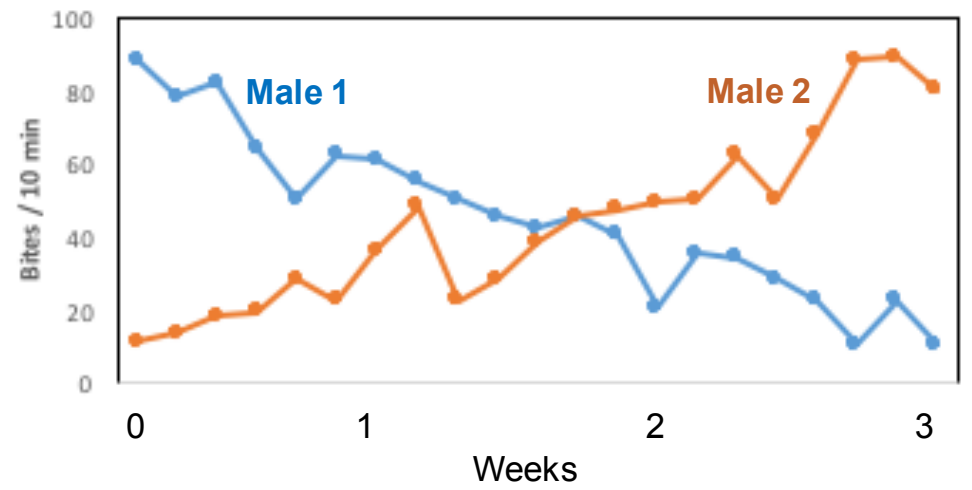


Choose Fonts and sizes appropriately

### Aggression Level in 2 male fish

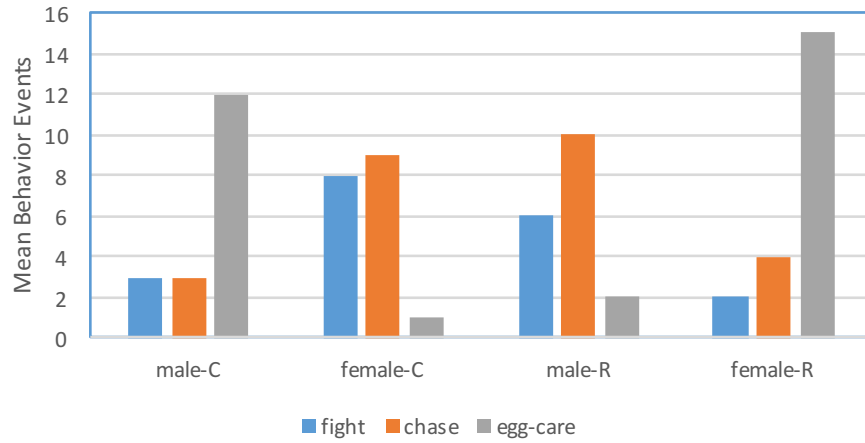


### Males Switch Aggression Level in 3 weeks

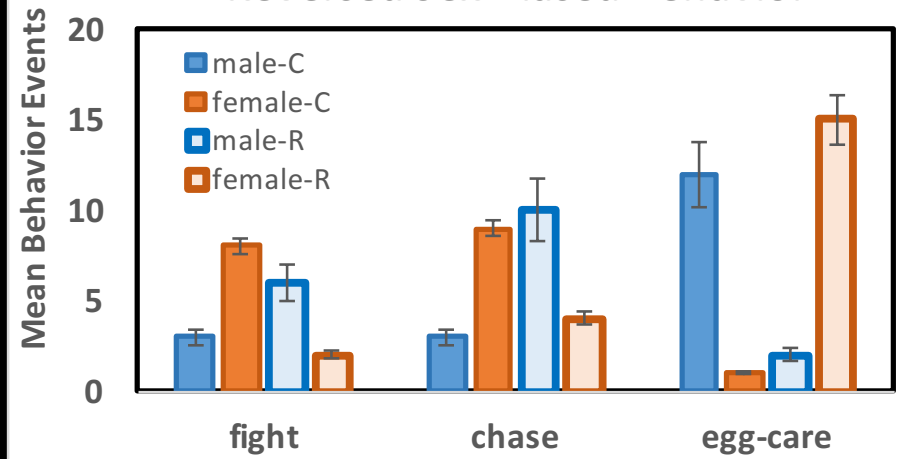




Behavior in 2 species



Reversed Sex-Biased Behavior







**Abstracts :: due date Dec 8th.**

An abstract (~7 sentences) with a descriptive (fun) title and the authors names.

This should describe:

- the "Big Question"
- the specific area of research
- the general technique or approach applied,
- the major results found and conclusion that can be drawn.

**Please post to Moodle by 5:00**

**Poster Presentation :: Dec 11<sup>th</sup> 9:00 AM**

Tips for making and Presenting a Poster [template1](#), [template2](#), on website. During the poster session, students will be required to visit several posters and to formally evaluate at least two posters using the standard evaluation forms that will be provided in class and handed in at the end of class.

**Please post a .pdf copy to Moodle**

**Turn in Lab Notebooks at Poster Session**

**Self Assessment :: Dec 12th**

Each student will **individually** assess his/her own effort & success.

See Moodle for worksheet. **Please post to Moodle by 5:00**