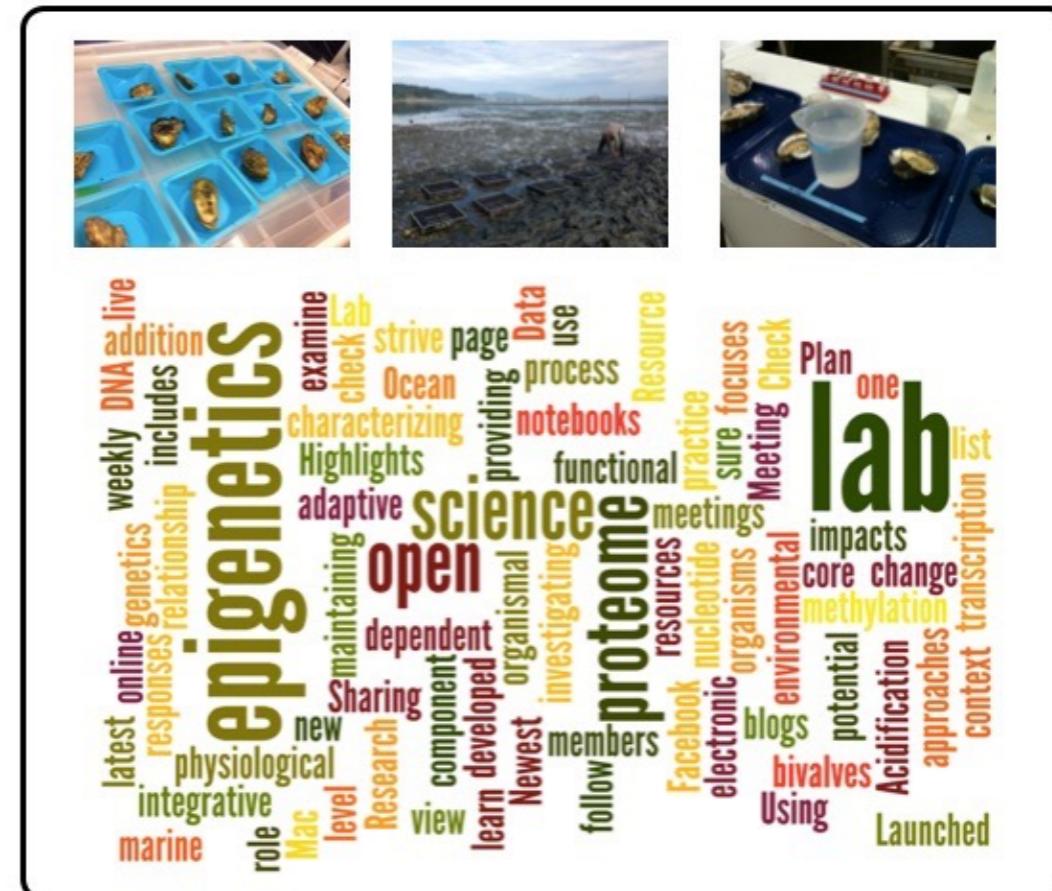


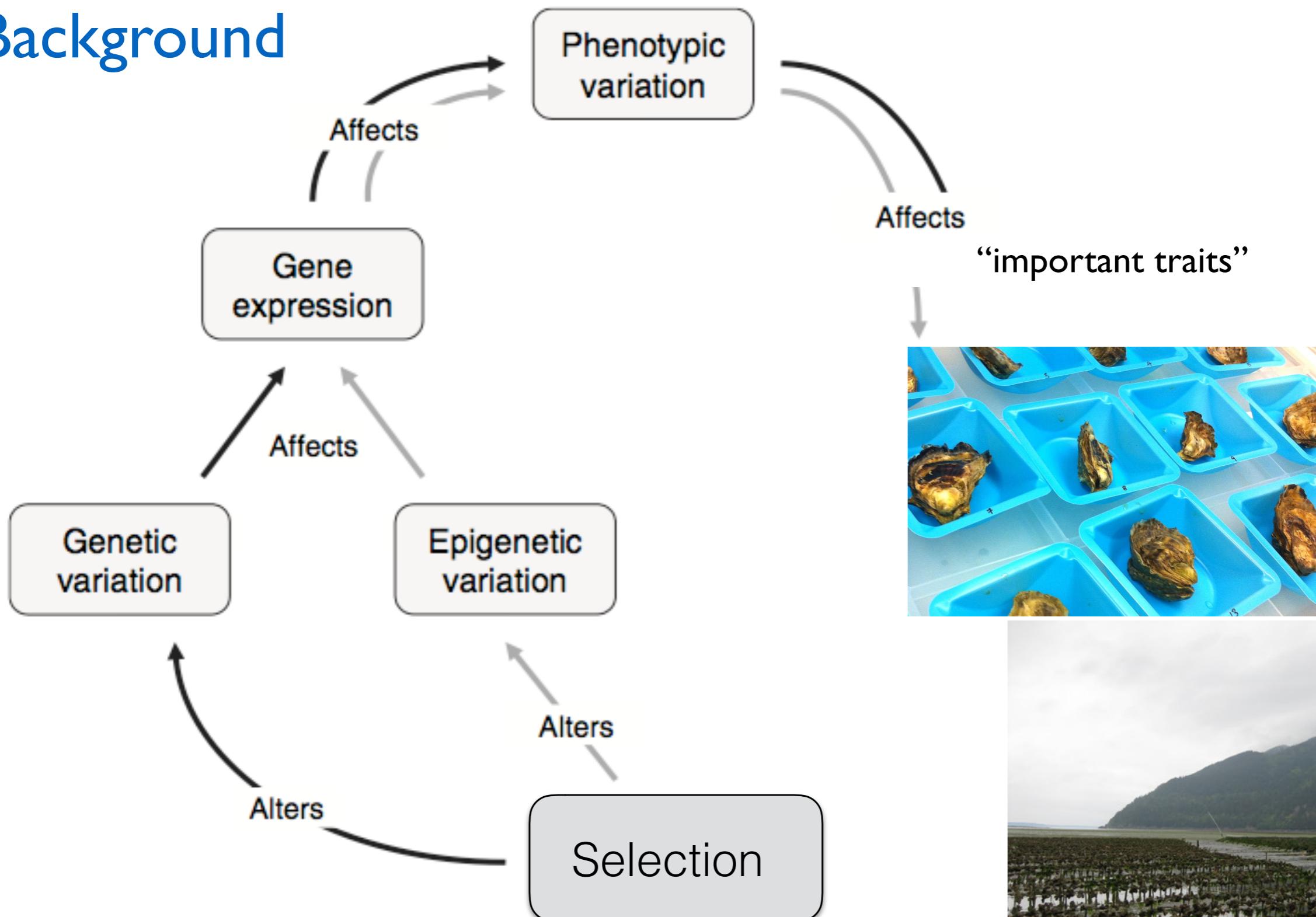
Epigenetic variation in oysters and implications for aquaculture

Steven Roberts
Kenneth K. Chew Endowed Professor
University of Washington
School of Aquatic and Fishery Sciences
Seattle, Washington, United States

robertslab.info
@sr320



Background



Ecology Letters, (2008) 11: 106–115

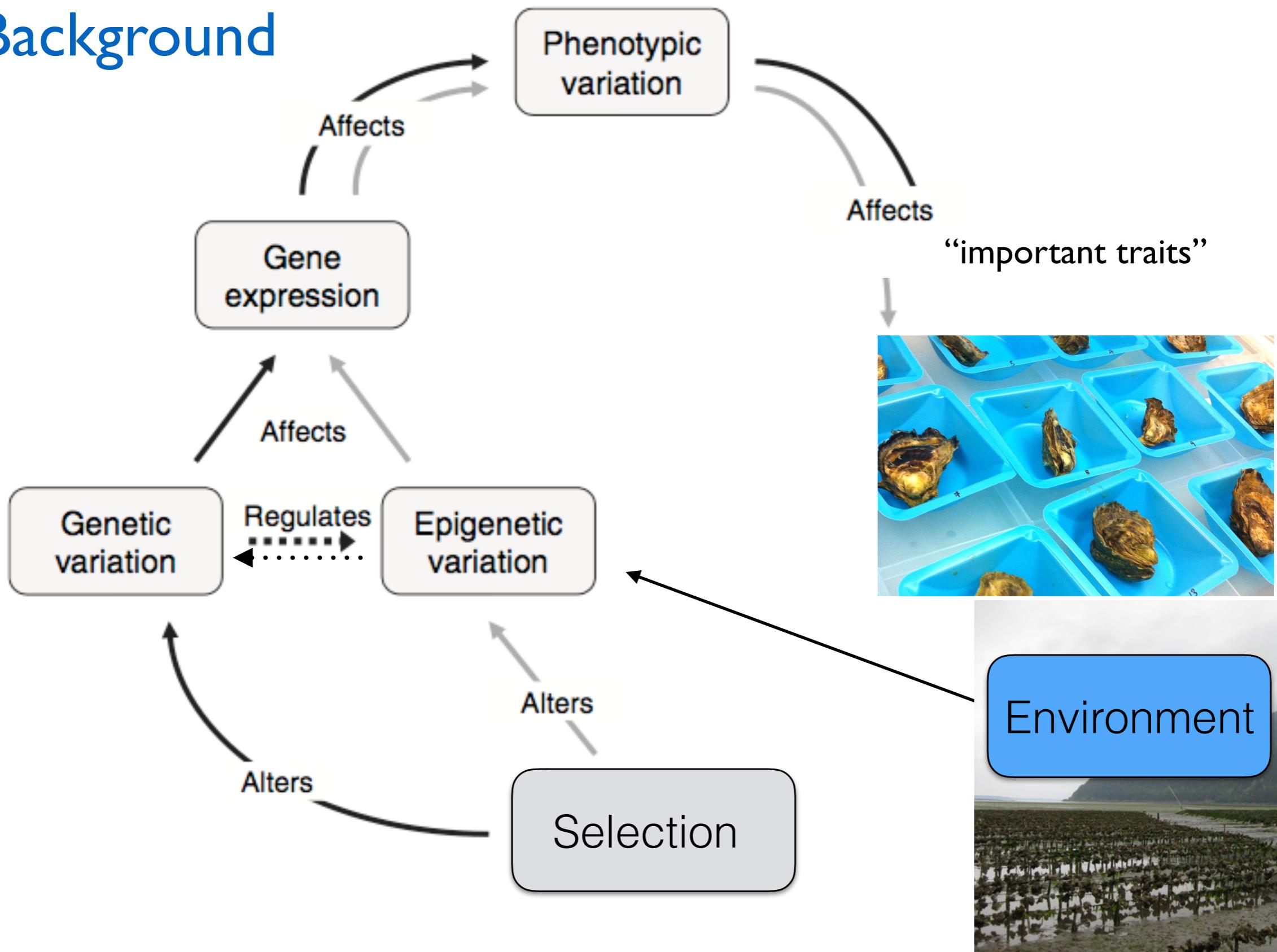
doi: 10.1111/j.1461-0248.2007.01130.x

modified from

IDEA AND
PERSPECTIVE

Epigenetics for ecologists

Background



Ecology Letters, (2008) 11: 106–115

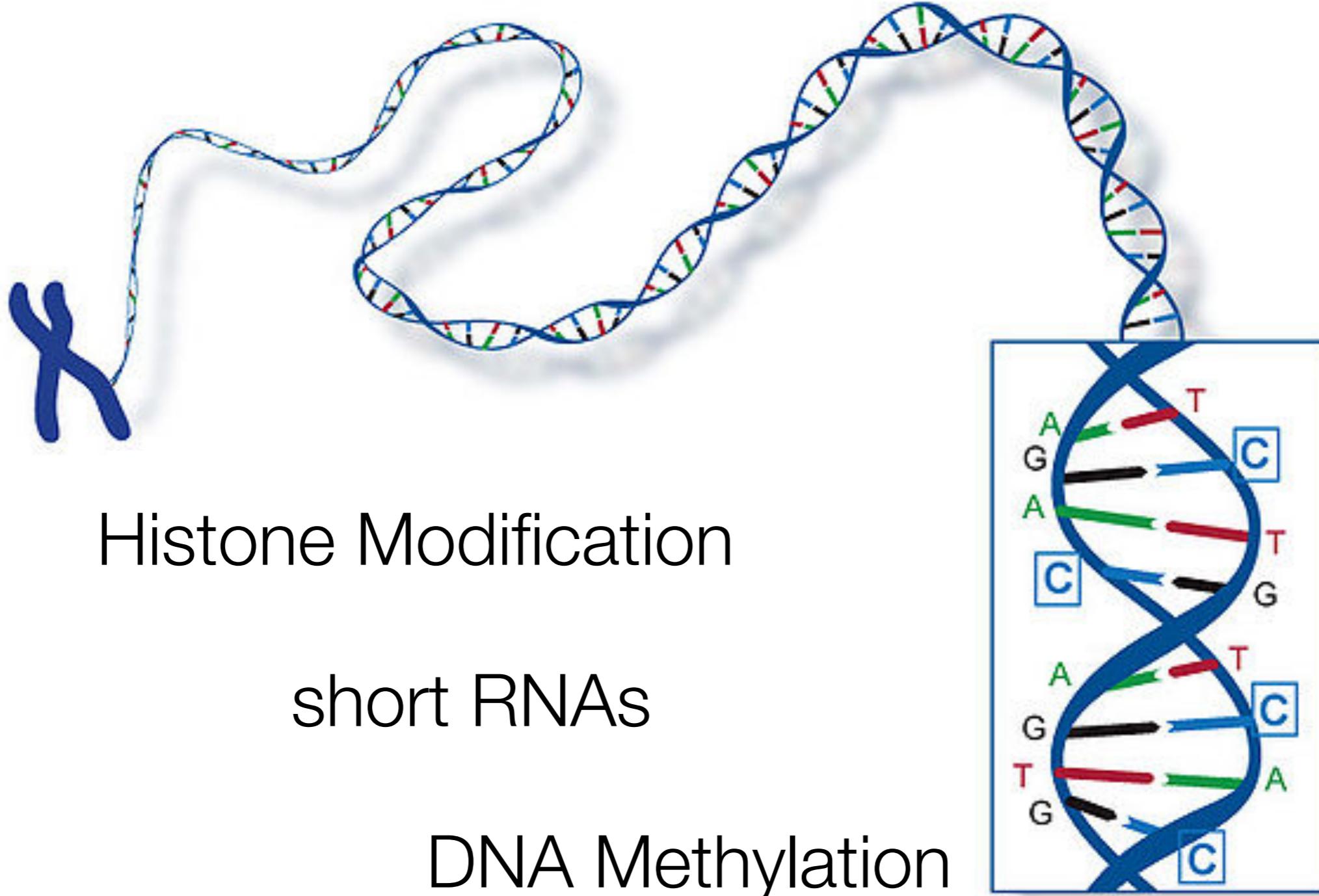
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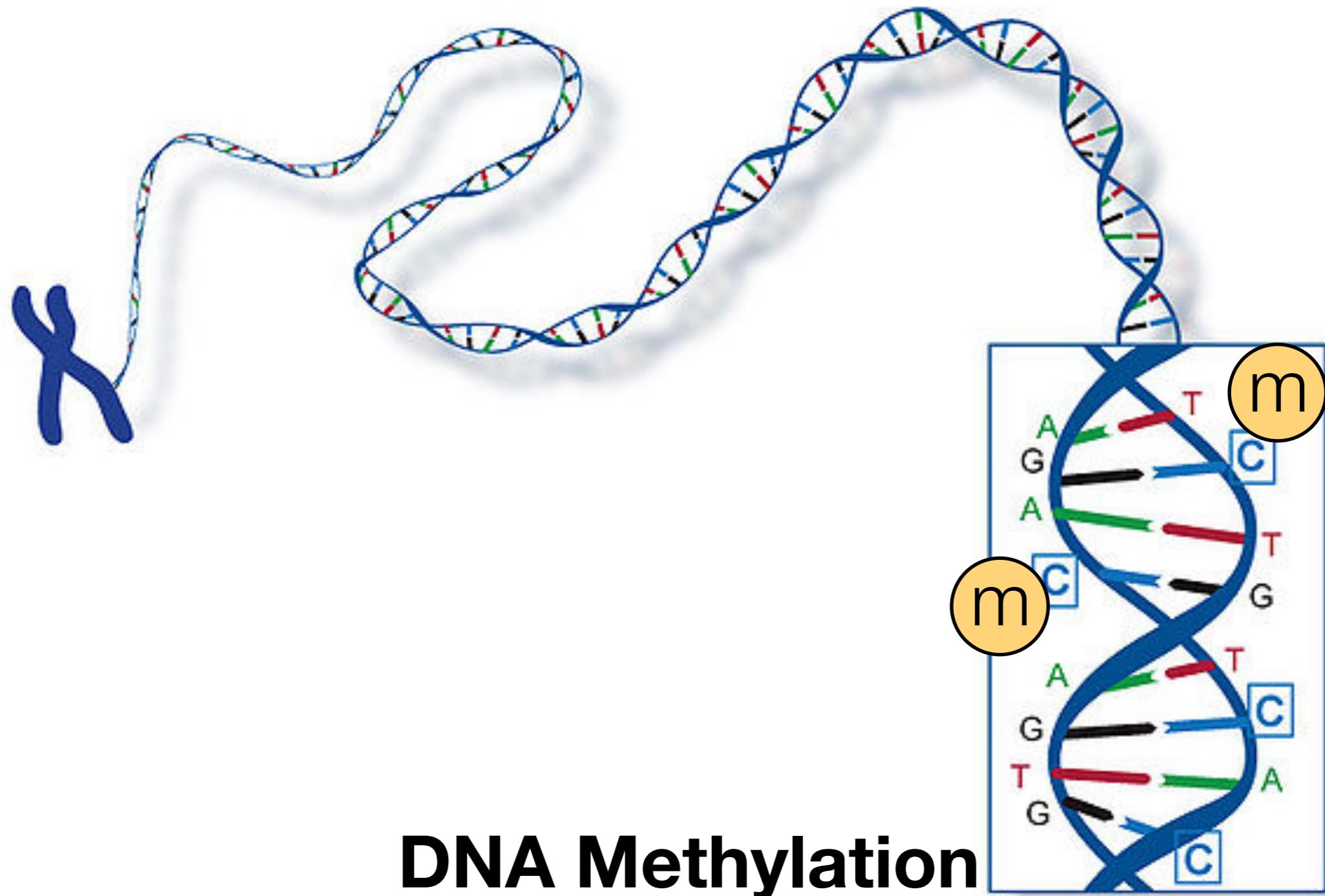
modified from

IDEA AND
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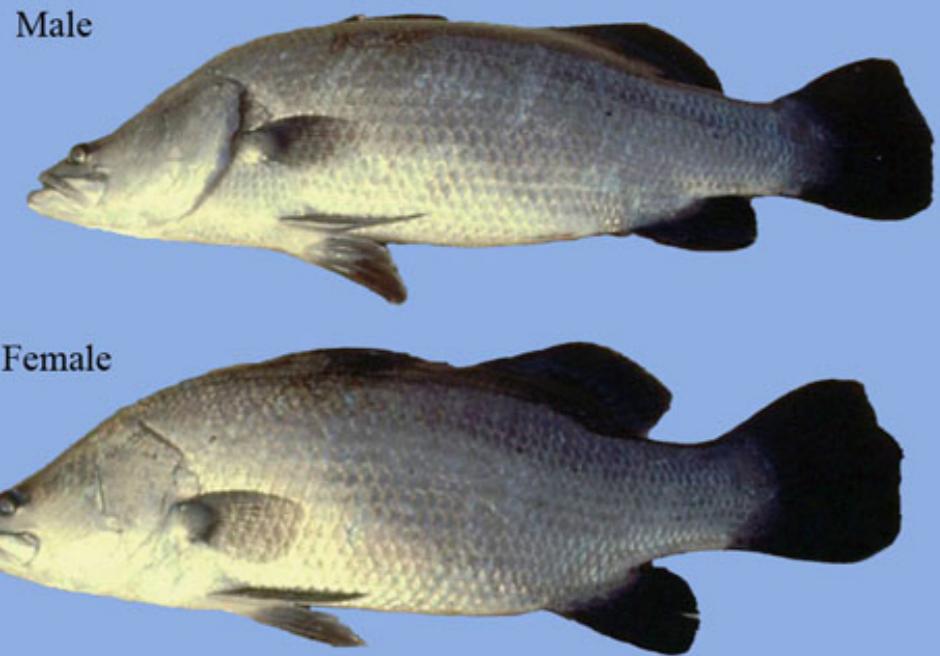
Epigenetics for ecologists

Epigenetics





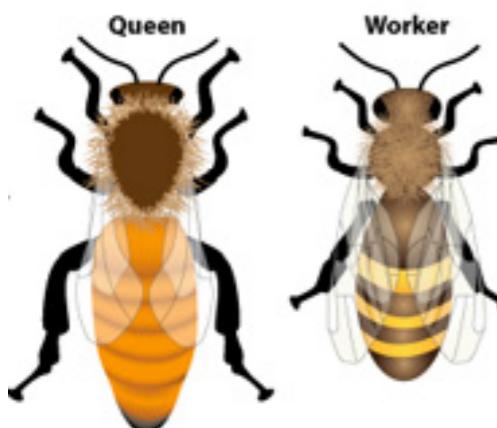
Male



Male and female *Lates calcarifer*



Queen Bee Larvae: Queens are raised in specially constructed cells called "queen cups," which are filled with royal jelly.



These Two Mice are Genetically Identical and the Same Age



While pregnant, both of their mothers were fed Bisphenol A (BPA) but DIFFERENT DIETS:

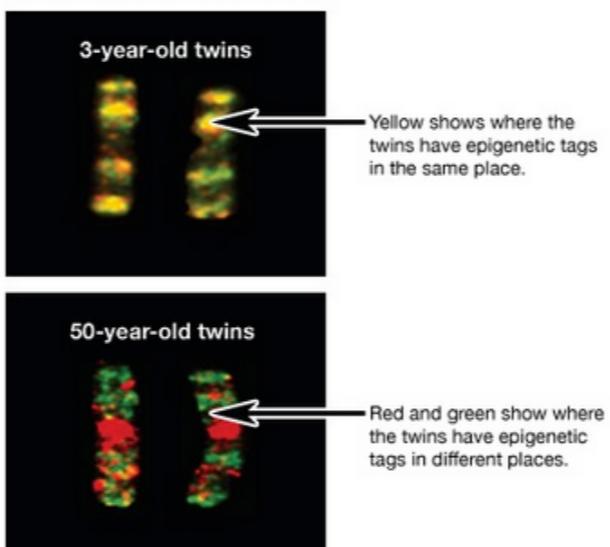
The mother of this mouse received a **normal mouse diet**

The mother of this mouse received a diet **supplemented** with choline, folic acid, betaine and vitamin B12

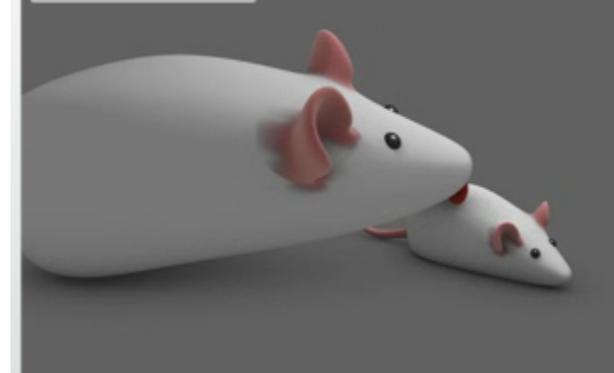
Nature AND Nurture

Chromosome 3 Pairs

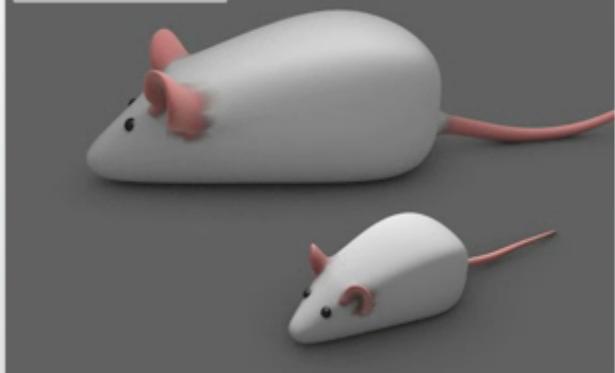
3-year old twins vs. 50-year-old twins



High Nurtured



Low Nurtured



These mothers come from a long line of inbred rats, so their genomes are highly similar. But they care for their pups very differently.

AUDIO

Applications in Aquaculture

Epigenetic Selection

Identifying individuals by attributing trait to epigenotype

Adults



Environmental Manipulation

Influencing offspring phenotype by altering environmental conditions of broodstock

Larvae



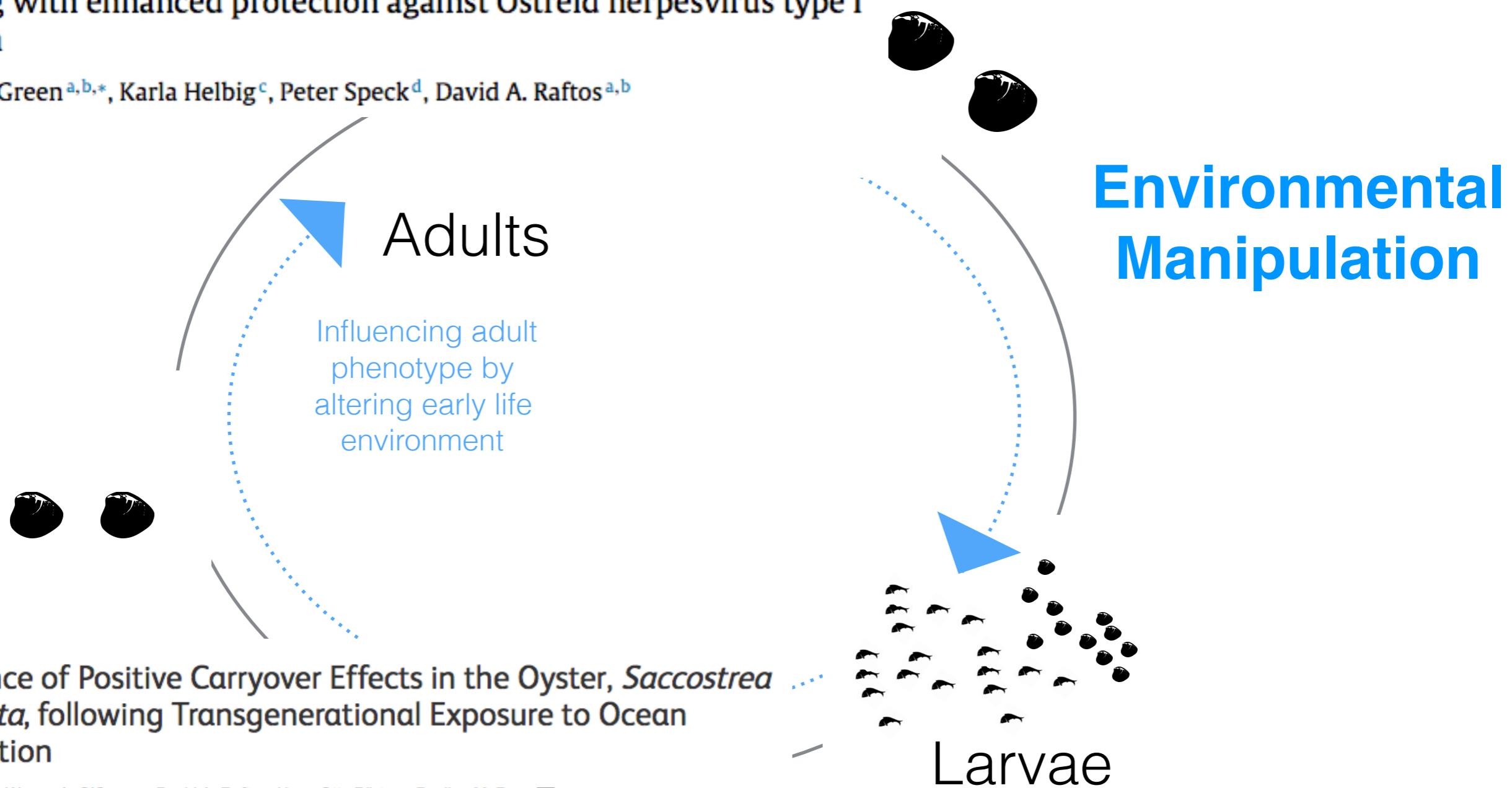
Influencing adult phenotype by altering early life environment



Applications in Aquaculture

Primed for success: Oyster parents treated with poly(I:C) produce offspring with enhanced protection against Ostreid herpesvirus type I infection

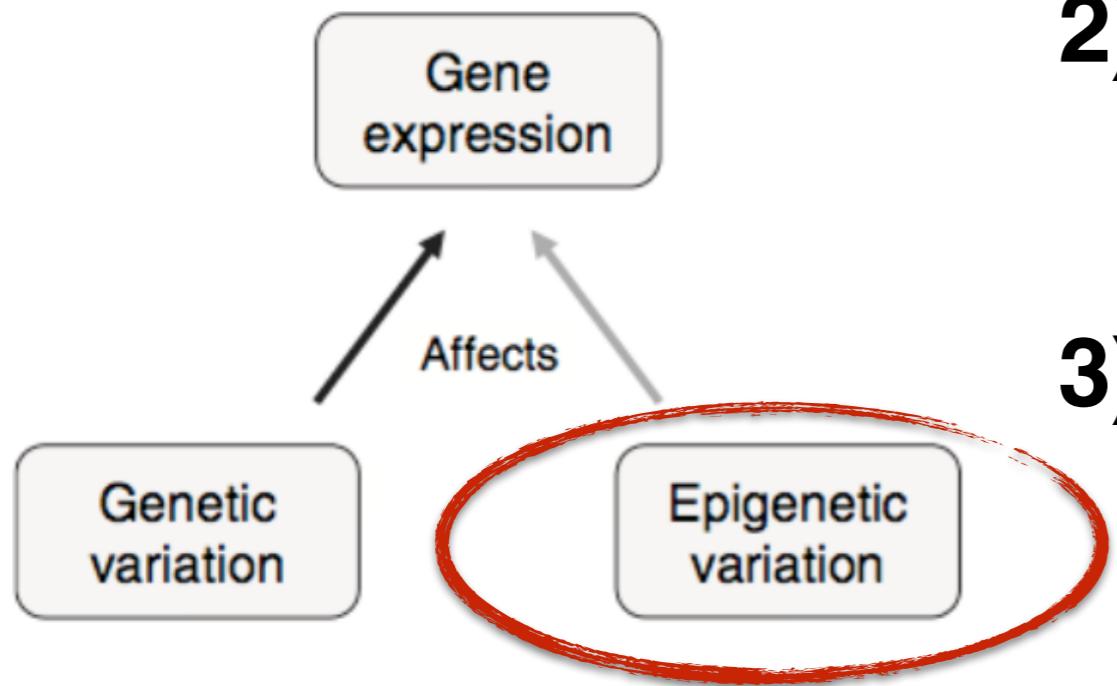
Timothy J. Green^{a,b,*}, Karla Helbig^c, Peter Speck^d, David A. Raftos^{a,b}



Laura M. Parker, Wayne A. O'Connor, David A. Raftos, Hans-Otto Pörtner, Pauline M. Ross

Published: July 6, 2015 • <http://dx.doi.org/10.1371/journal.pone.0132276>

Big Questions



- 1) What is the function of DNA methylation in marine invertebrates?**
- 2) To what degree is epigenetic variation heritable?**
- 3) Is epigenetic variation independent of genetic variation?**
- 4) How do environmental conditions influence epigenetic variation?**

Outline

Methylation landscape

Population studies

Environmental change

- 1) What is the function of DNA methylation in marine invertebrates?
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Methylation landscape

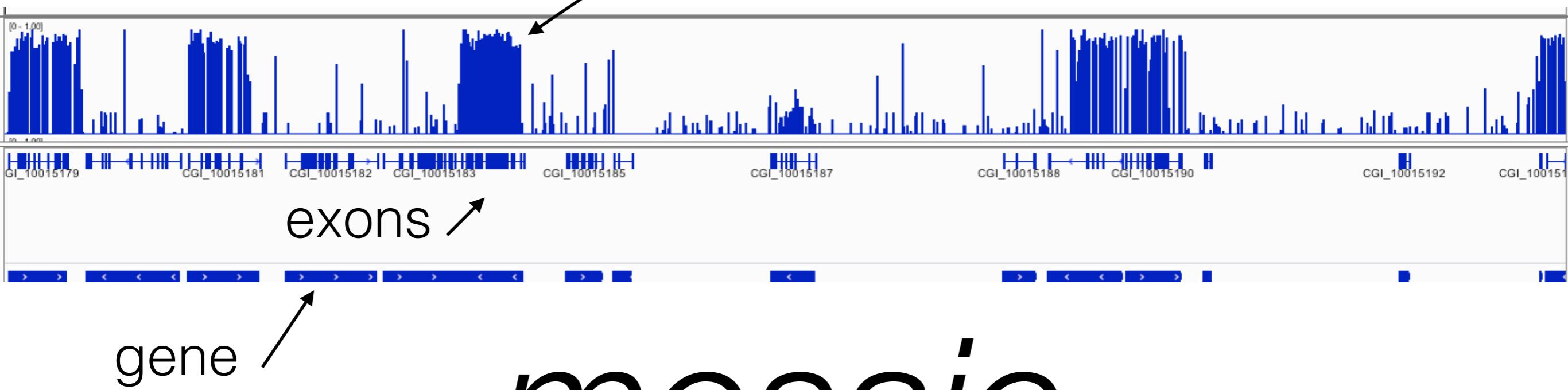
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Methylation landscape

DNA methylation level (0-100%) @ cytosines

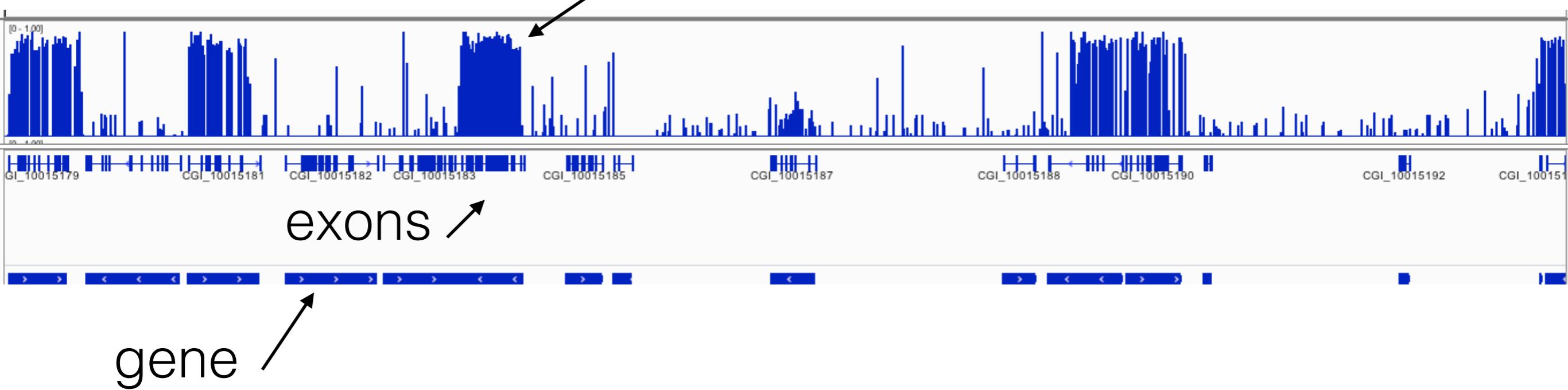


mosaic

associated with gene bodies

Methylation landscape

DNA methylation level (0-100%) @ cytosines



[PLoS One](#). 2017; 12(9): e0185224.

Published online 2017 Sep 25. doi: [10.1371/journal.pone.0185224](https://doi.org/10.1371/journal.pone.0185224)

PMCID: PMC5612690

PMID: [28945769](#)

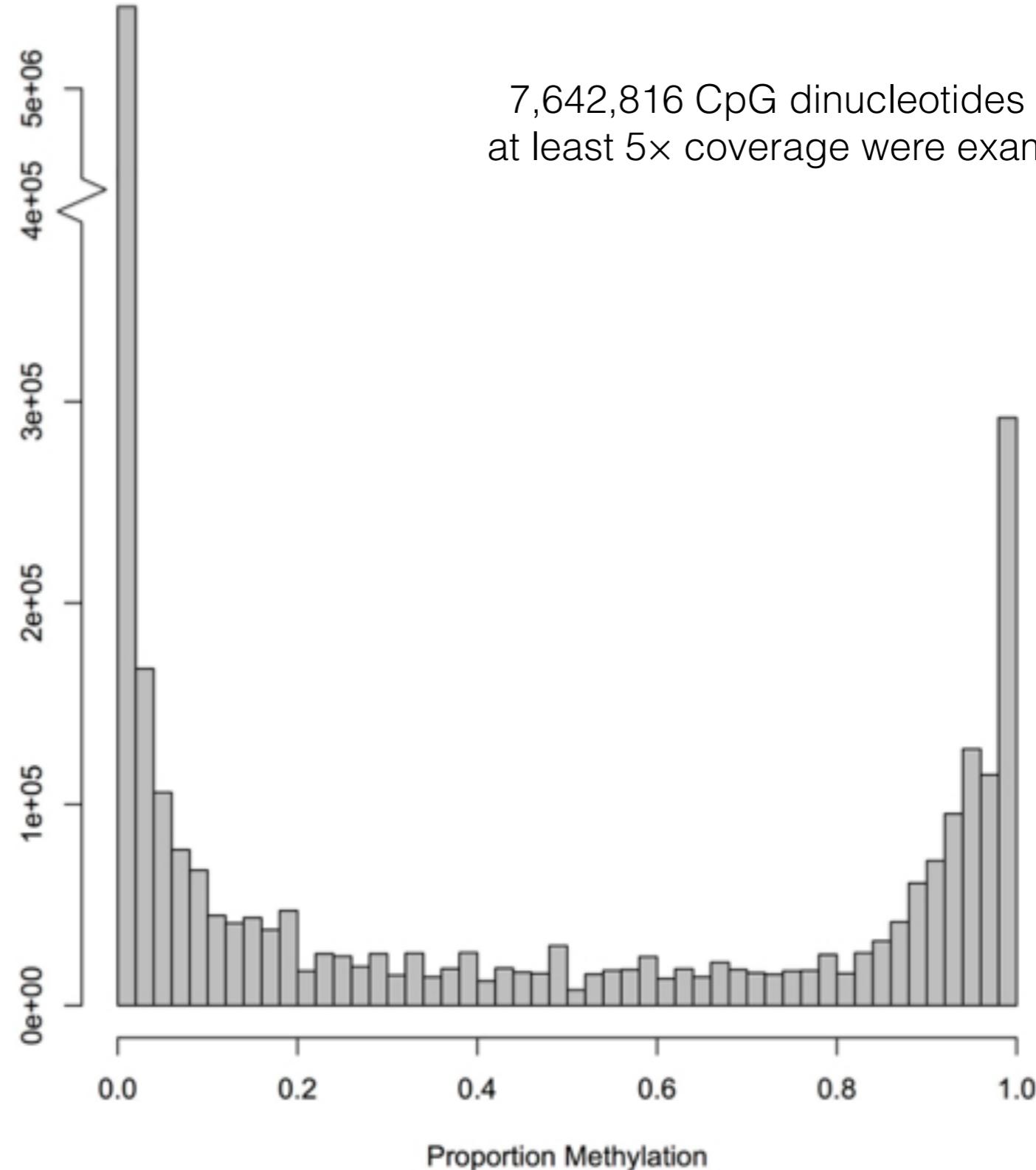
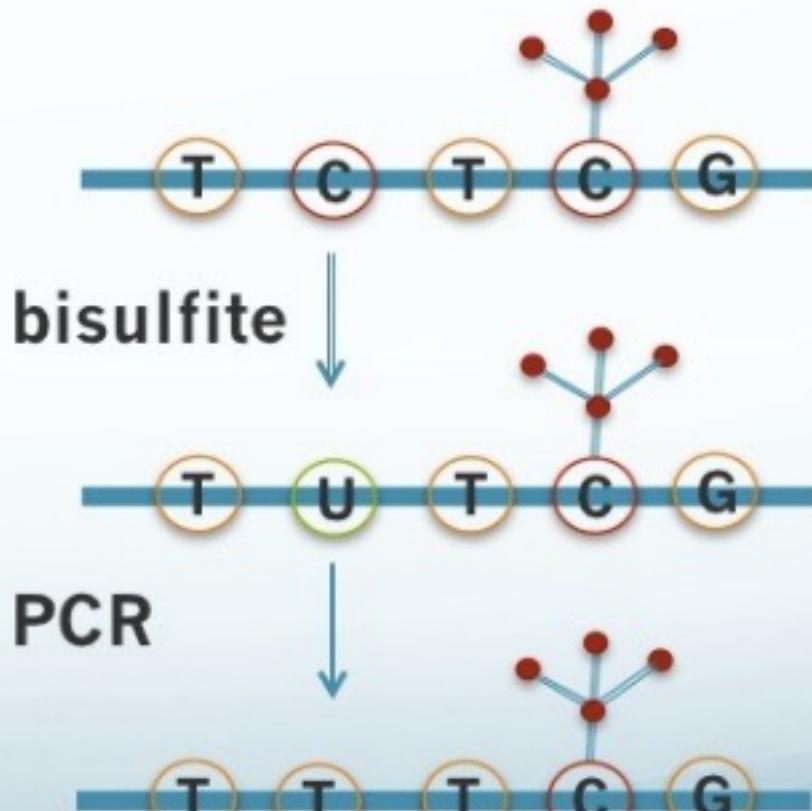
The association between DNA methylation and exon expression in the Pacific oyster *Crassostrea gigas*

[Kai Song](#), Conceptualization, Data curation, Formal analysis, Investigation, Methodology,^{1,2,3} [Li Li](#), Conceptualization, Validation,^{1,2,3,*} and [Guofan Zhang](#), Conceptualization, Funding acquisition, Validation^{1,3,4,*}

Methylation landscape

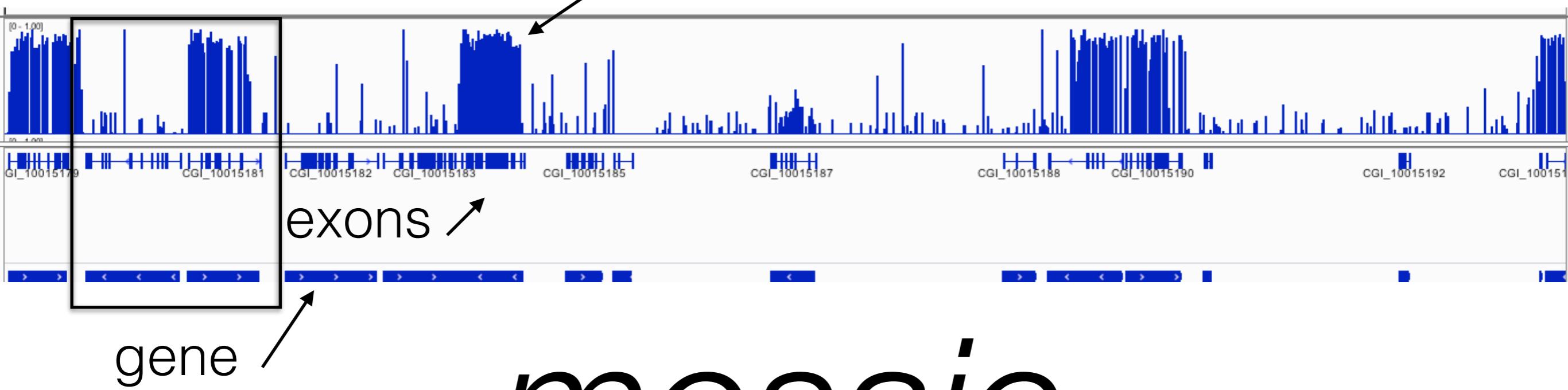
7,642,816 CpG dinucleotides with at least 5x coverage were examined

- Bisulfite conversion



Methylation landscape

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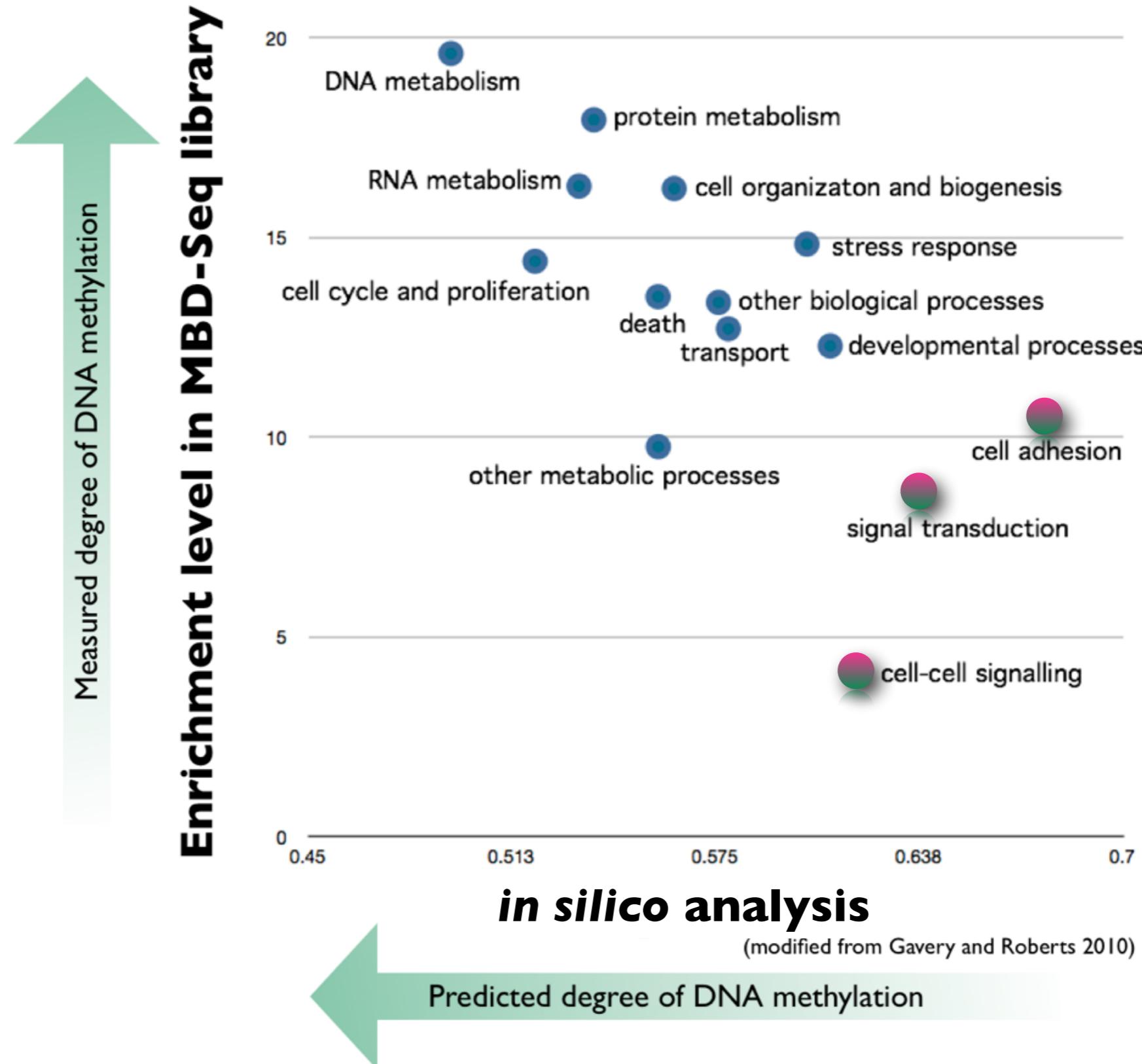


mosaic

Why are only a subset of genes methylated?

associated with gene bodies

Methylation landscape

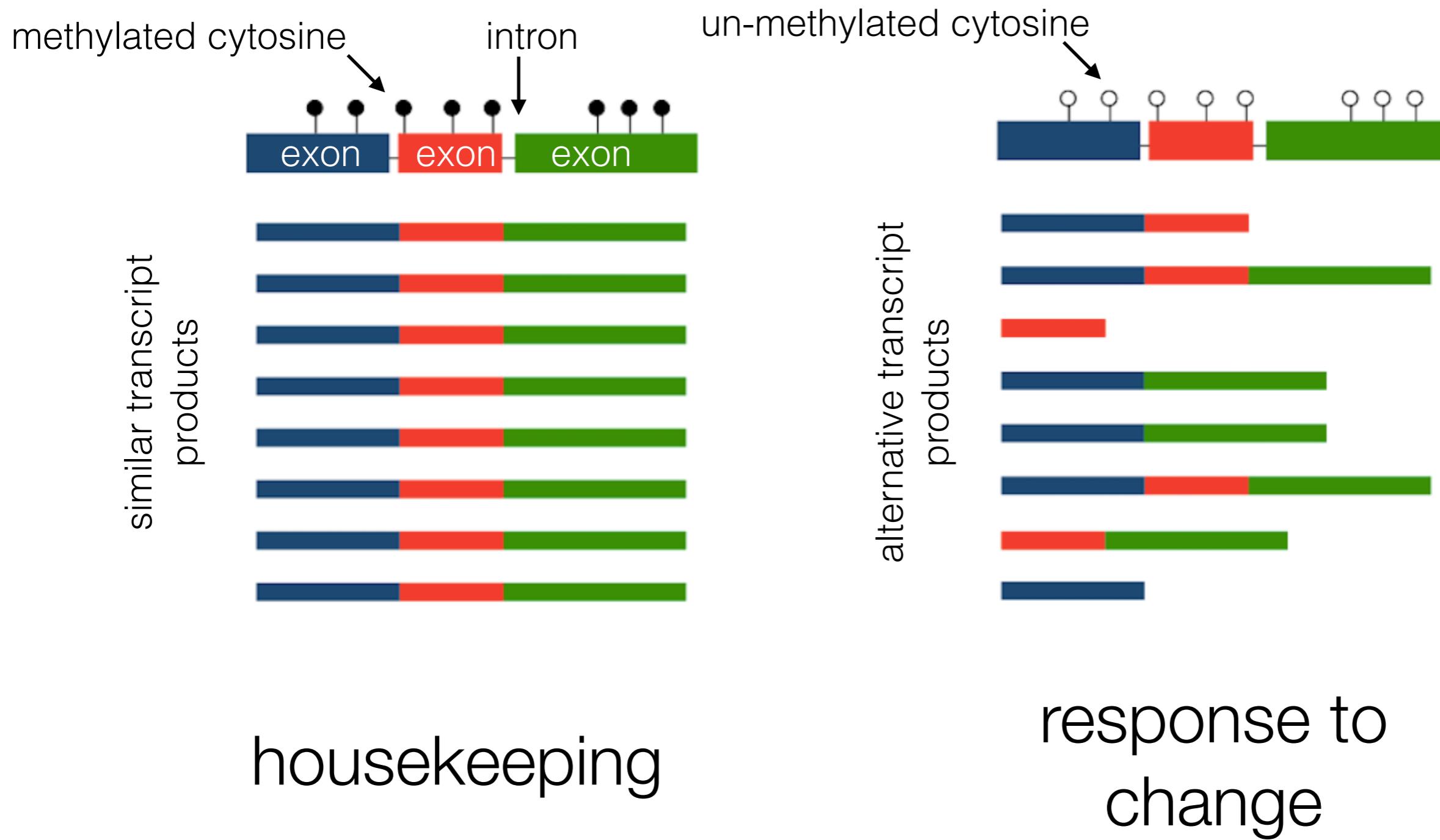


Stochastic Variation

A context dependent role for DNA methylation in bivalves

Mackenzie R. Gavery and Steven B. Roberts

Advance Access publication date 7 January 2014



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Population studies



Reciprocal Transplant Experiment



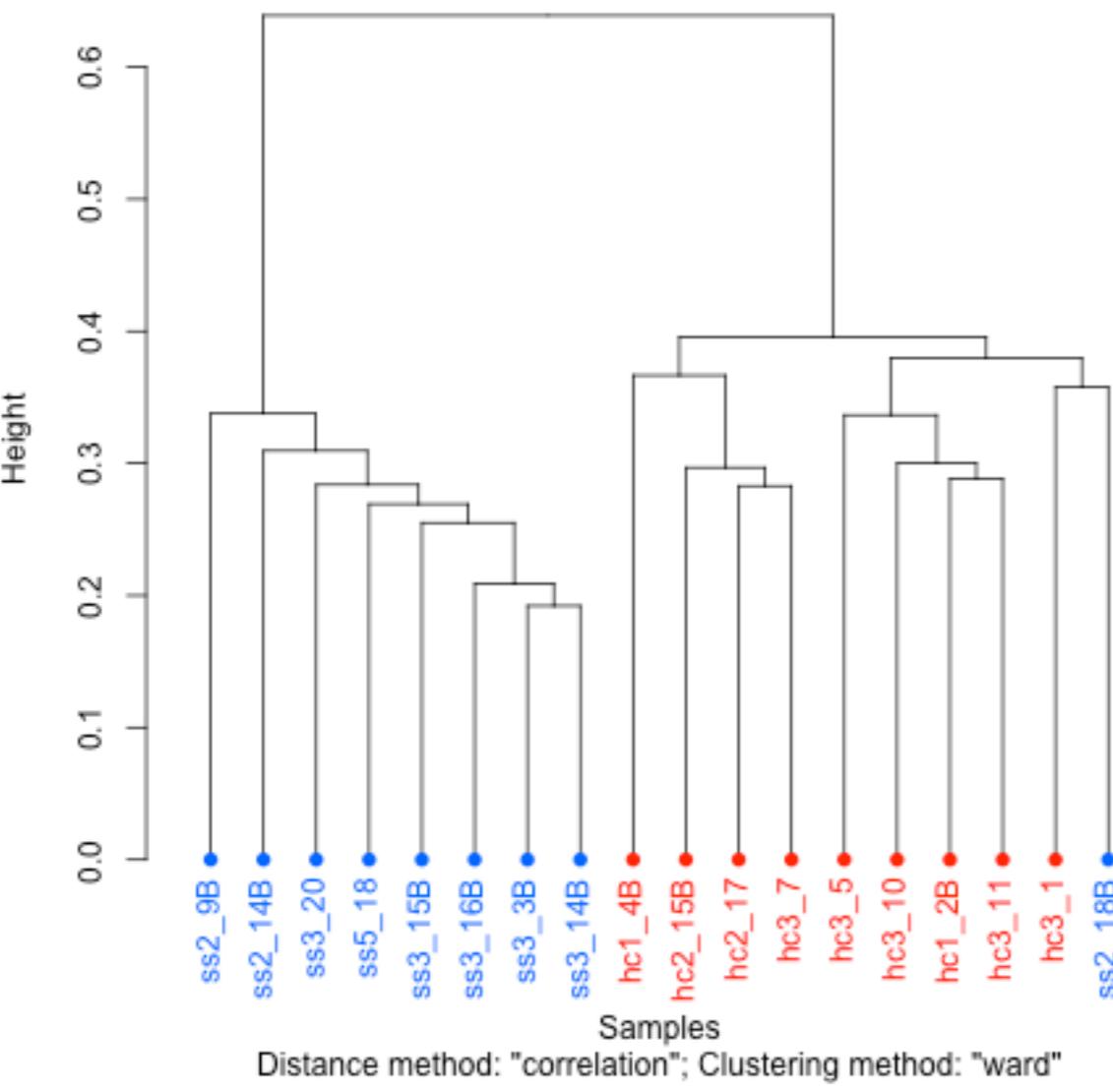
Manchester

Population studies



Reciprocal Transplant Experiment

CpG methylation clustering



Manchester

Population studies



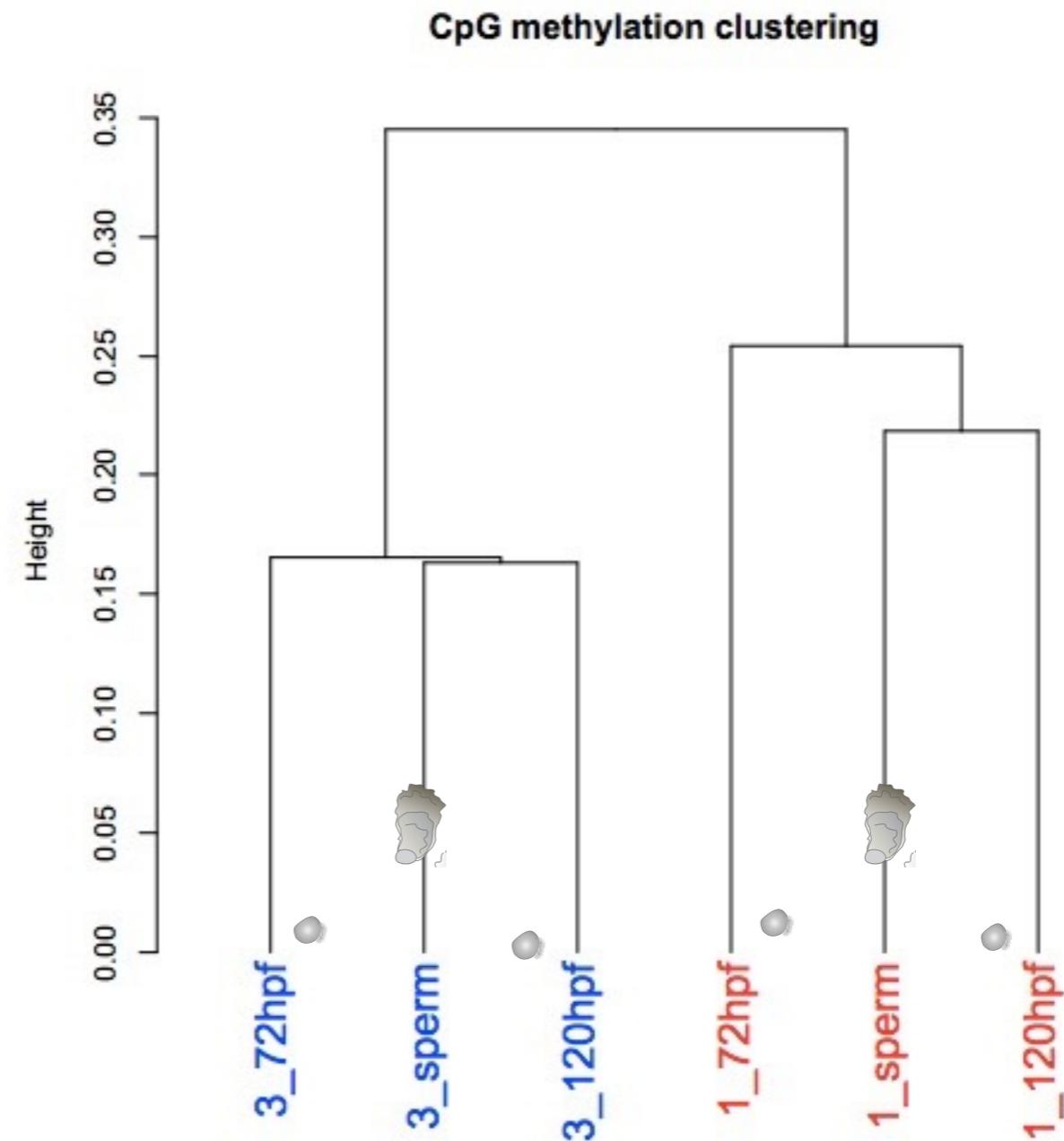
bioRxiv
beta
THE PREPRINT SERVER FOR BIOLOGY

New Results

Indication of family-specific DNA methylation patterns in developing oysters

Claire E. Olson , Steven B. Roberts

doi: <http://dx.doi.org/10.1101/012831>



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[Genes & Genomics](#)

... November 2017, Volume 39, [Issue 11](#), pp 1173–1181 | [Cite as](#)

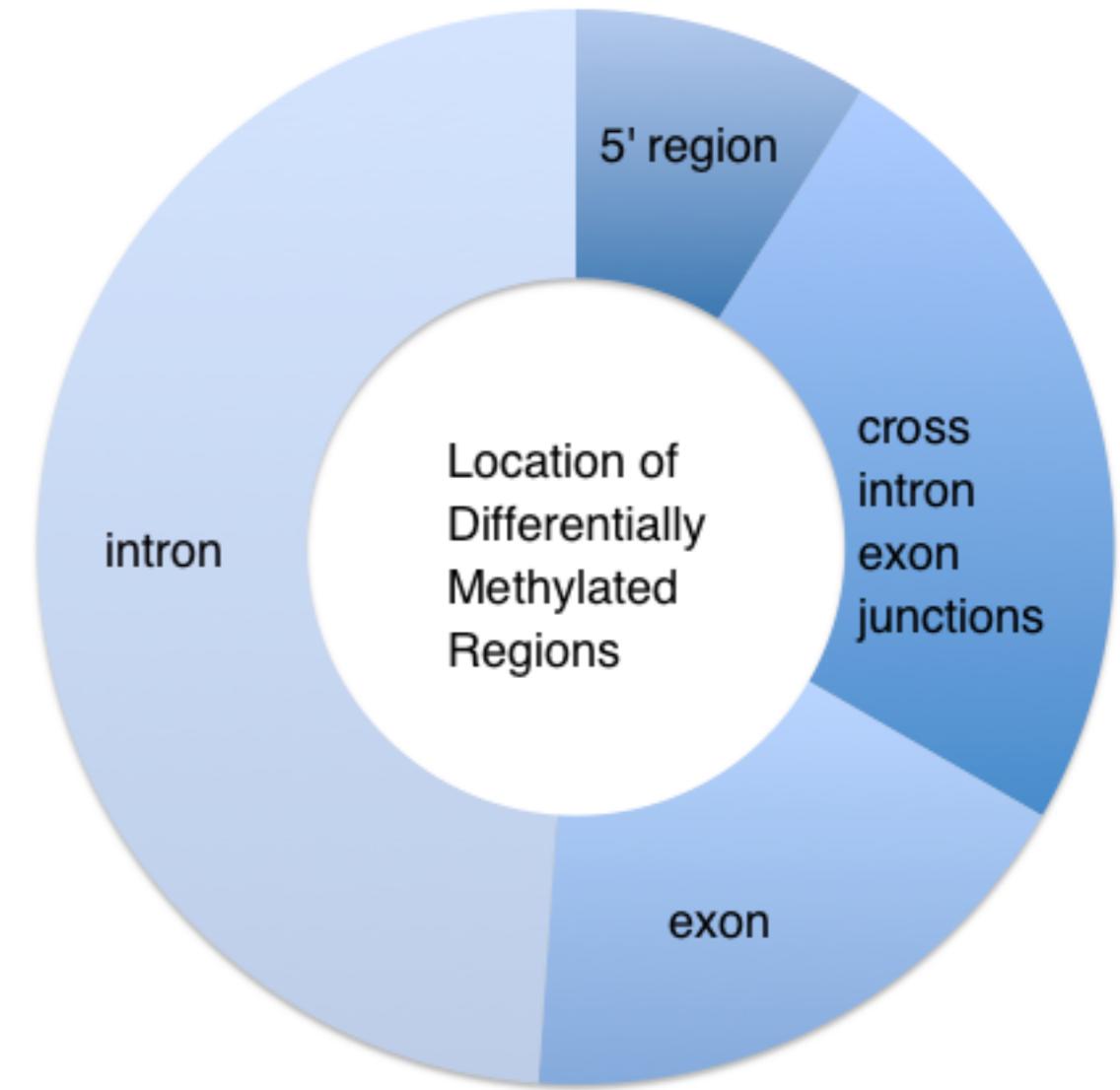
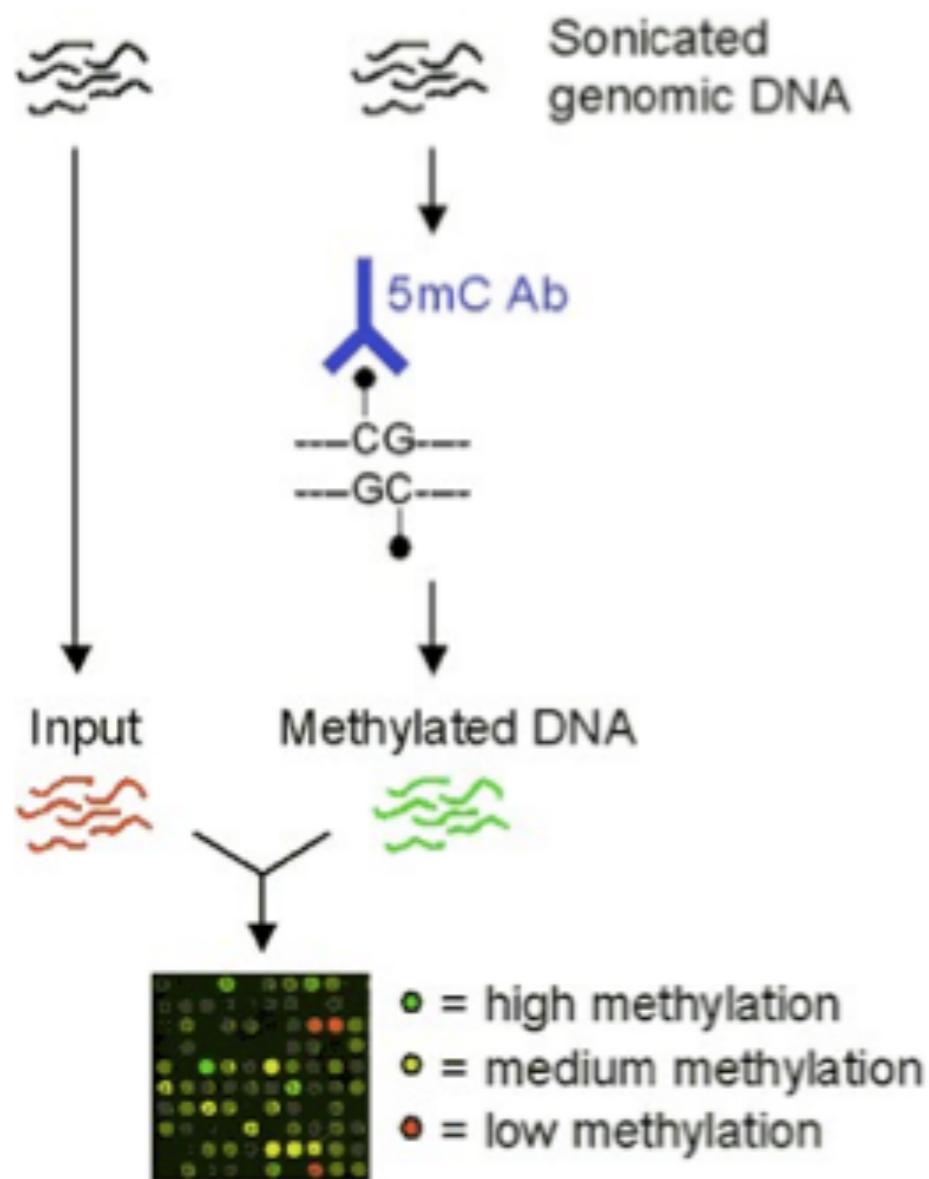
DNA methylation changes detected by methylation-sensitive amplified polymorphism in the Pacific oyster (*Crassostrea gigas*) in response to salinity stress

Xin Zhang, Qi Li , Lingfeng Kong, Hong Yu

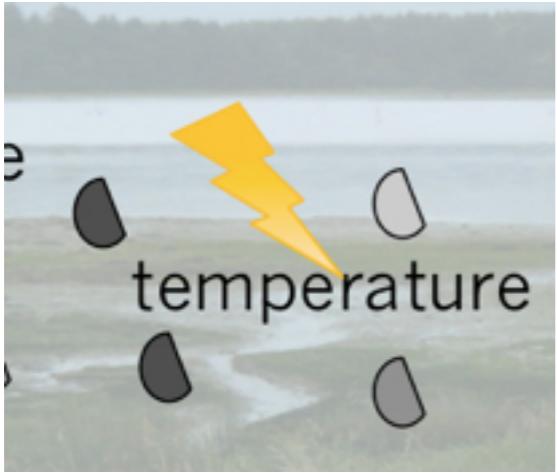
Key Laboratory of Mariculture, Ministry of Education, Ocean University of China, Qingdao, China

Laboratory for Marine Fisheries Science and Food Production Processes, Qingdao National Laboratory for Marine Science and Technology, Qingdao, China

Environmental change



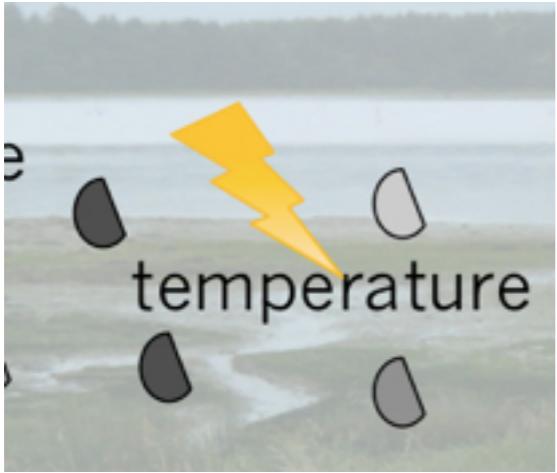
Environmental change



stochastic or targeted?

| Oyster | Hypo-methylated | Hyper-methylated |
|--------|-----------------|------------------|
| 2 | 7224 | 2803 |
| 4 | 6560 | 3587 |
| 6 | 7645 | 4044 |

Environmental change



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No obvious association
with genome feature
including *differentially
expressed
genes*

Environmental change

Very new data

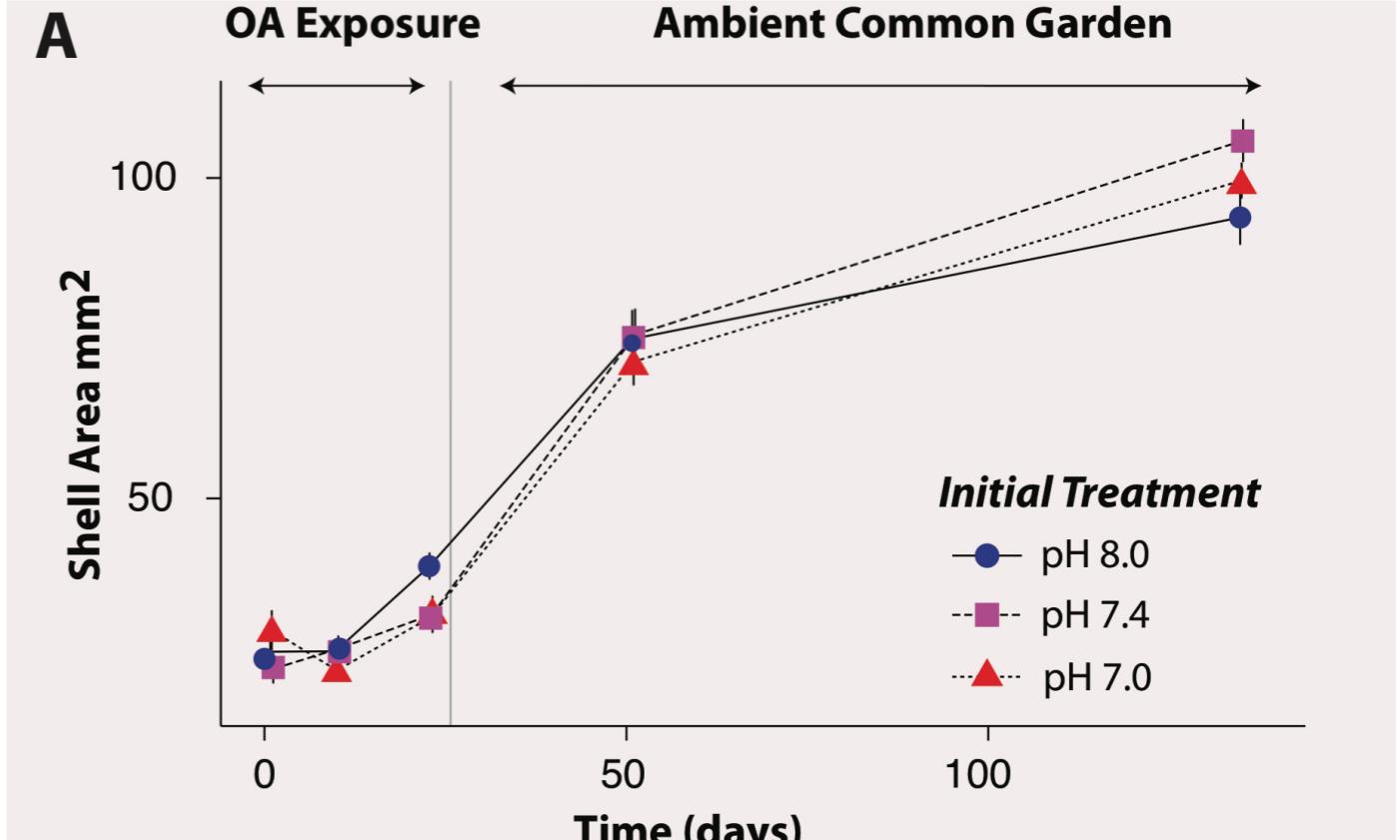
Ocean Acidification



Environmental change

Very new data

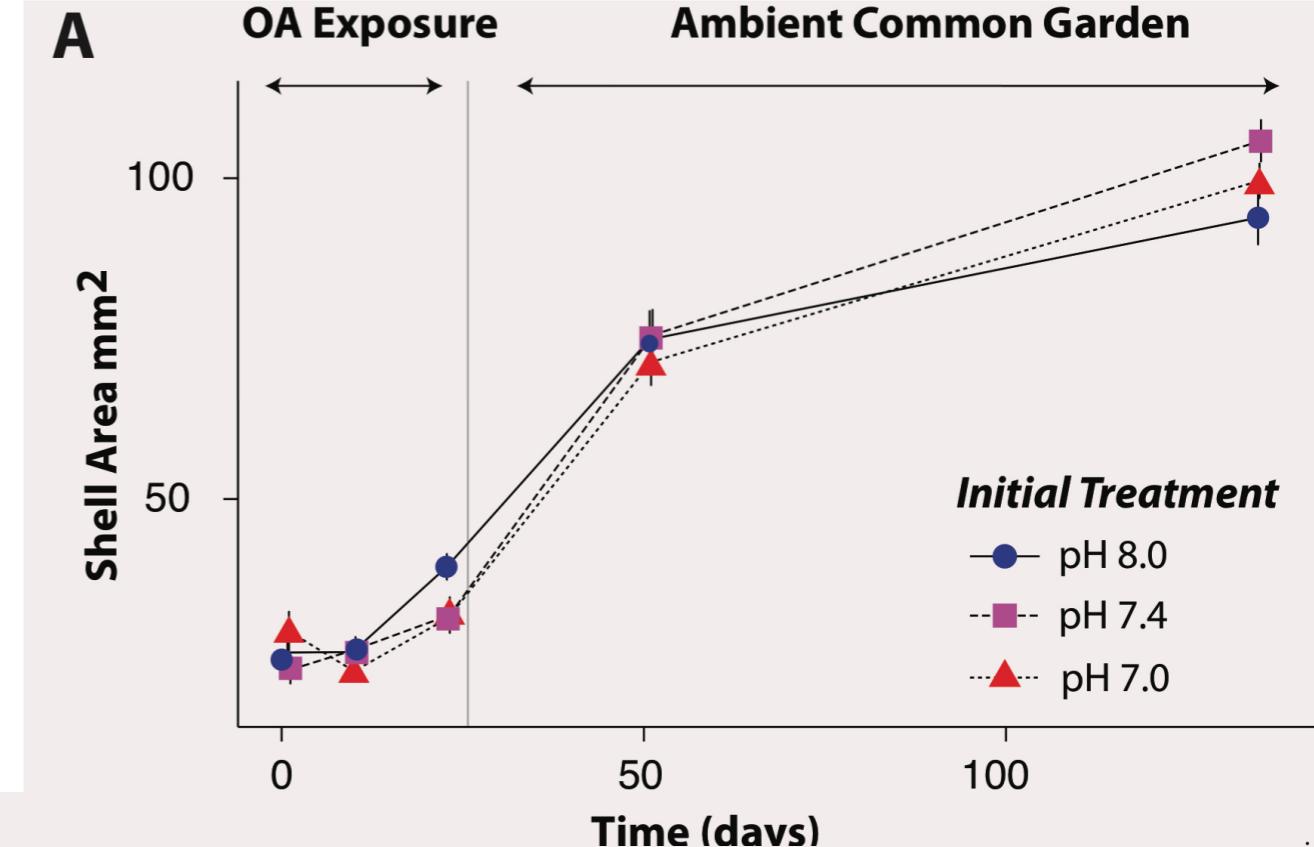
Ocean Acidification



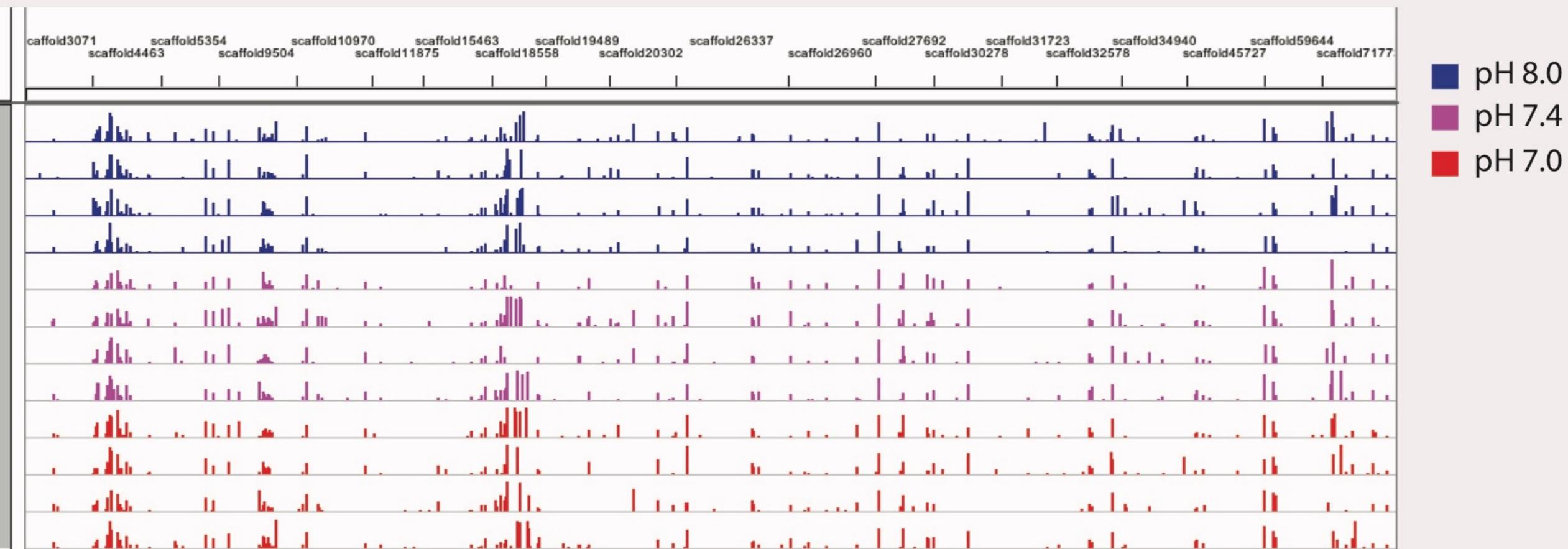
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Day 10 DNA methylation patterns



Applications in Aquaculture

Epigenetic Selection

Identifying individuals by attributing trait to epigenotype

Adults



Influencing adult phenotype by altering early life environment

Environmental Manipulation

Influencing offspring phenotype by altering environmental conditions of broodstock

Larvae



Applications in Aquaculture

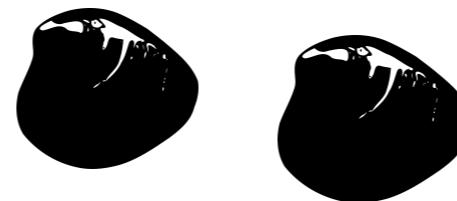
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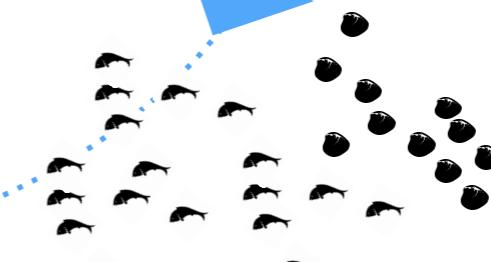


Influencing adult phenotype by altering early life environment

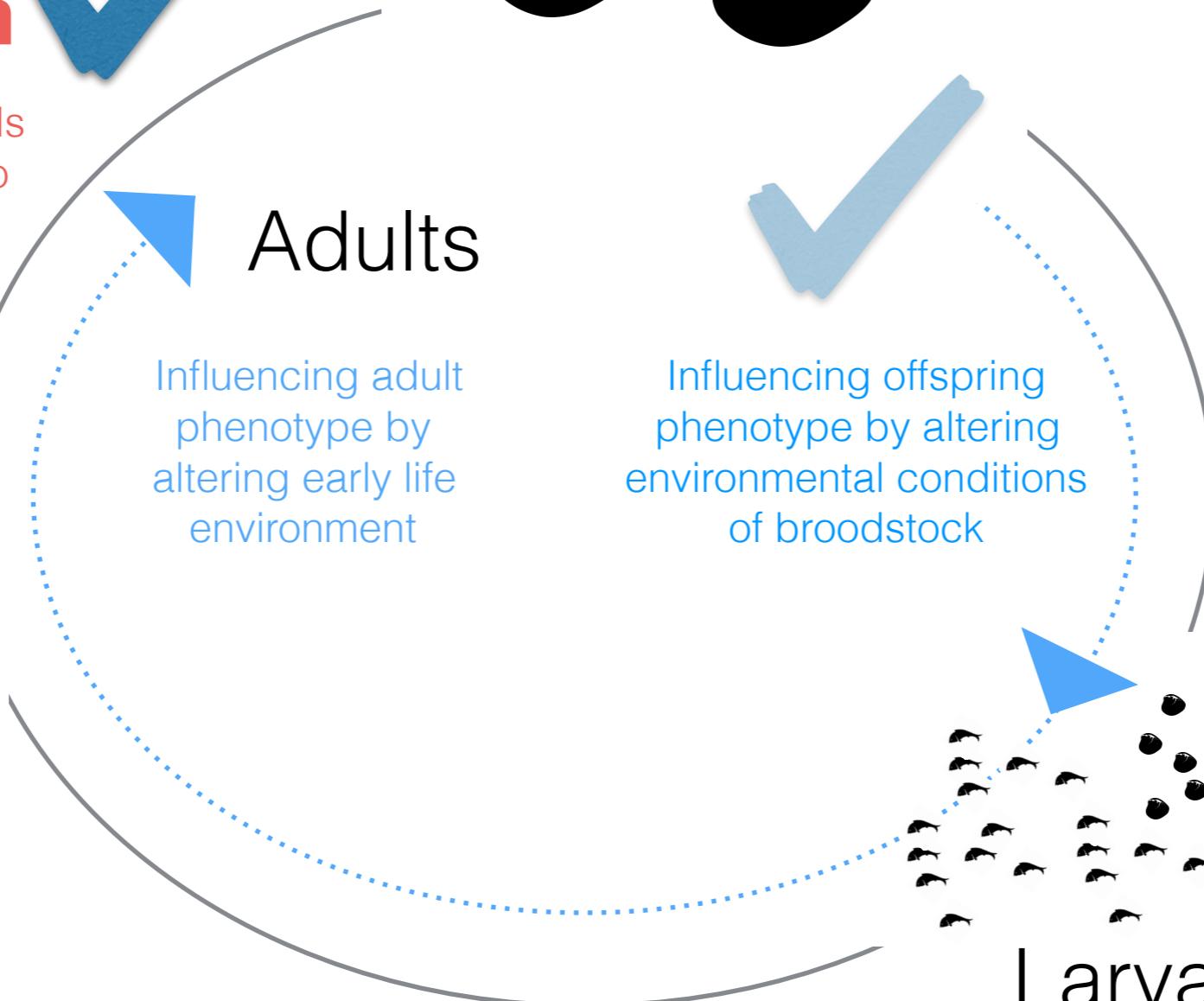


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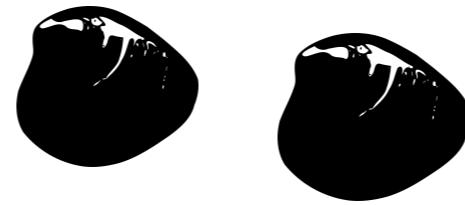
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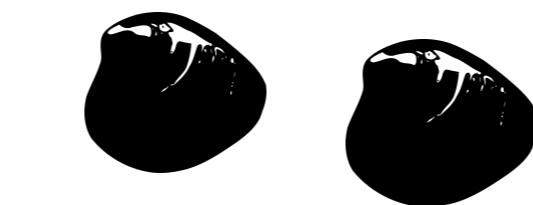
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Summary

Particularly in *shellfish*, epigenetics should be given considerable attention in understanding and optimizing phenotype.

Considerations in Aquaculture

1. Epigenetics is an attractive lens through which to consider manipulation of traits through environmental memory or selection.
2. Epigenetics may also function to disrupt predictable phenotypes through the creation of unexpected variation.

Acknowledgements

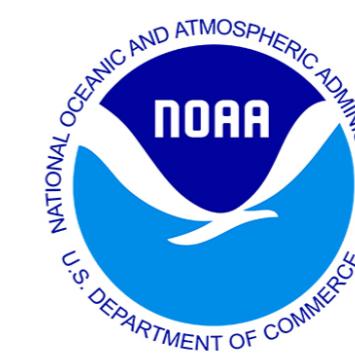
Mackenzie Gavery

Claire Olson

Sam White

Brent Vadopalas

Hollie Putnam



slides, data & more @

<https://github.com/sr320/talk-Rushan-2018>