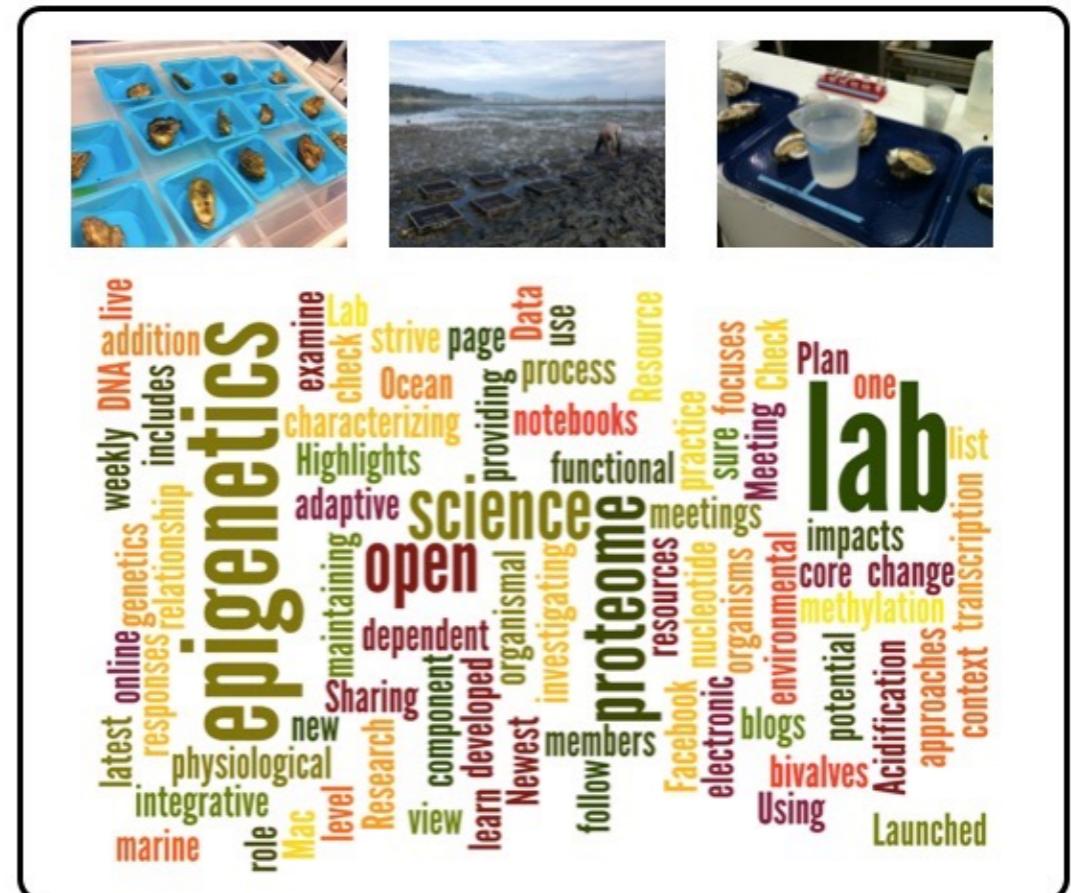


Epigenetic mechanisms in marine invertebrates: perspectives and applications

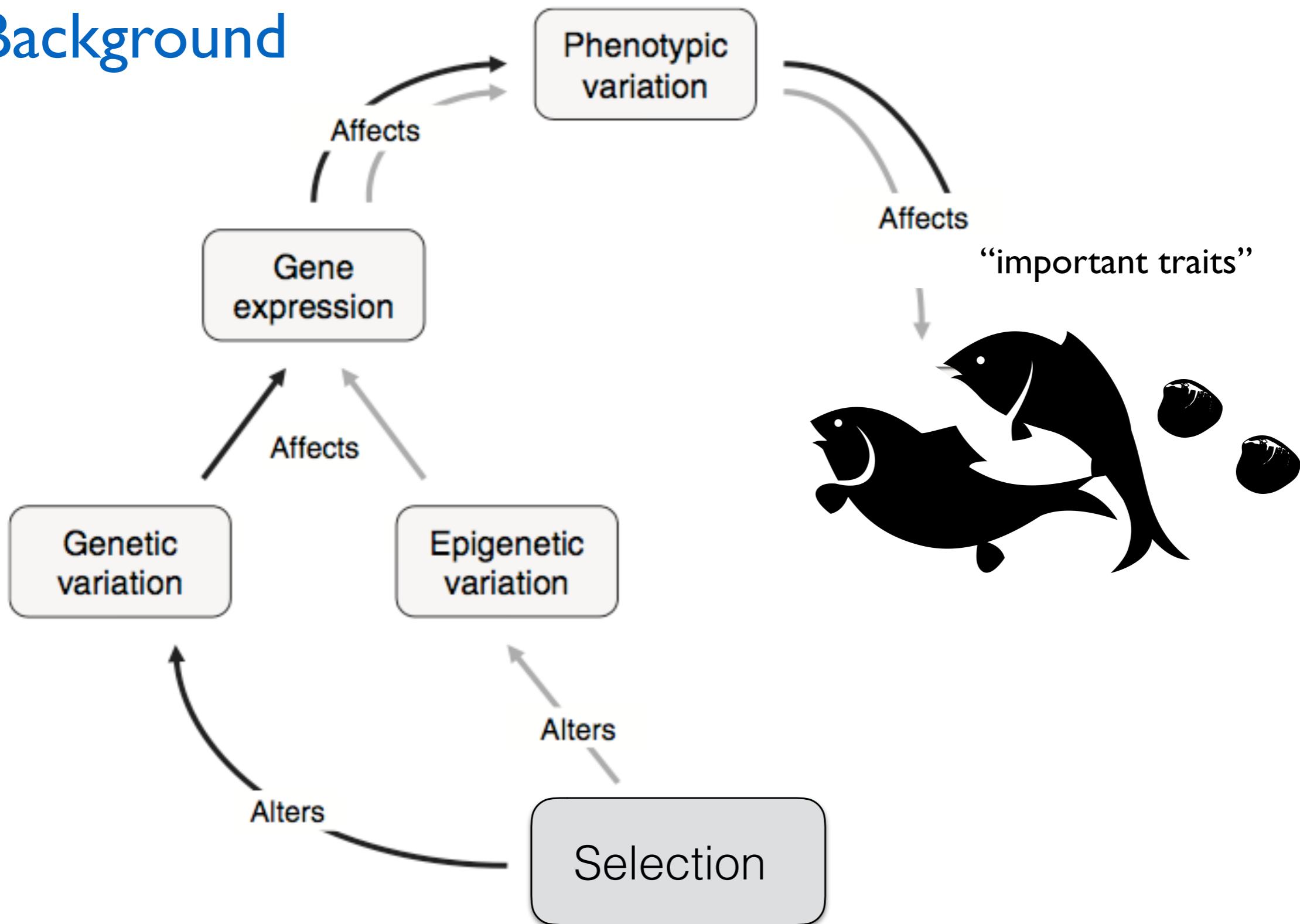
Steven Roberts

Kenneth K. Chew Endowed Professor
University of Washington
School of Aquatic and Fishery Sciences
robertslab.info

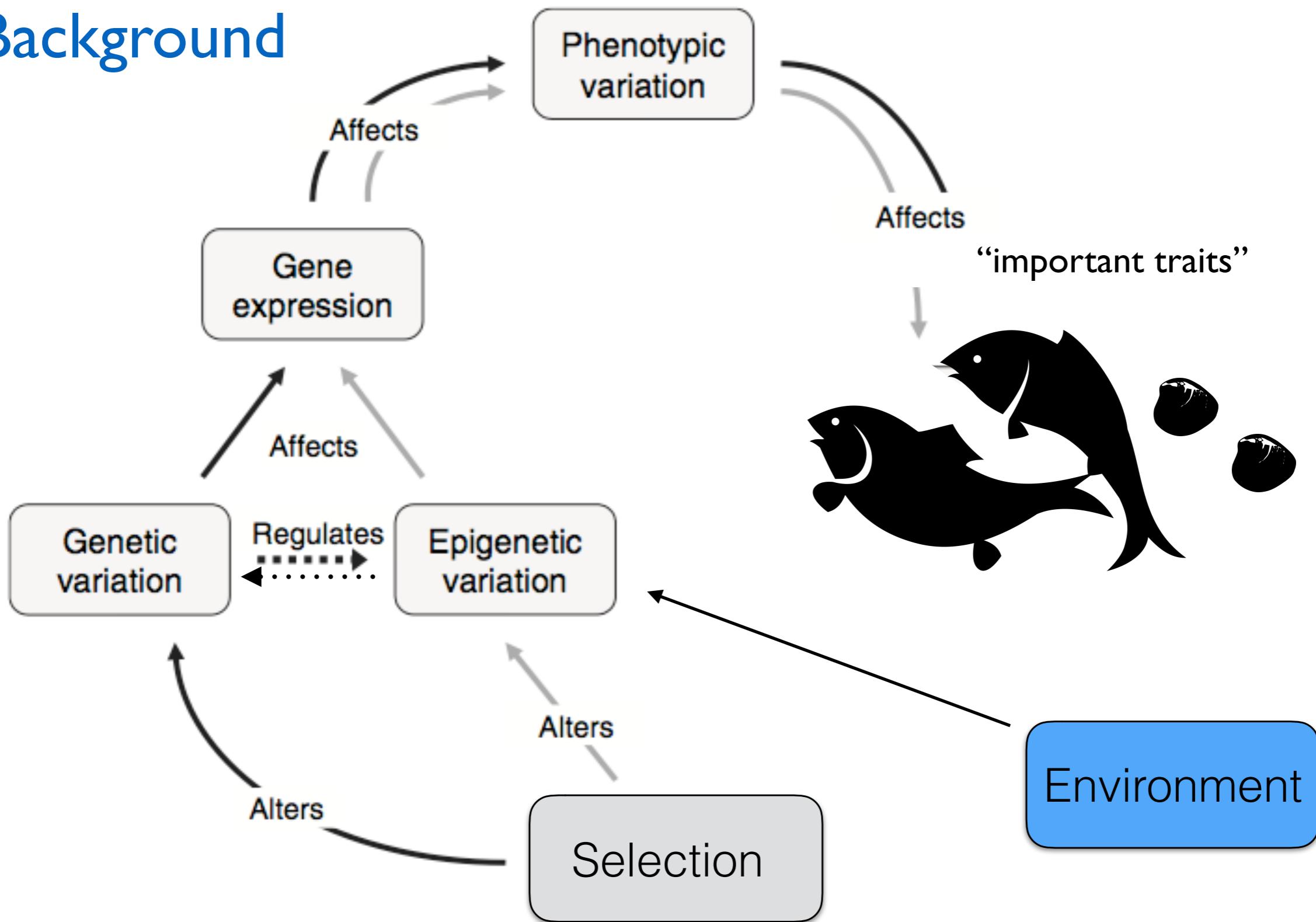
@sr320



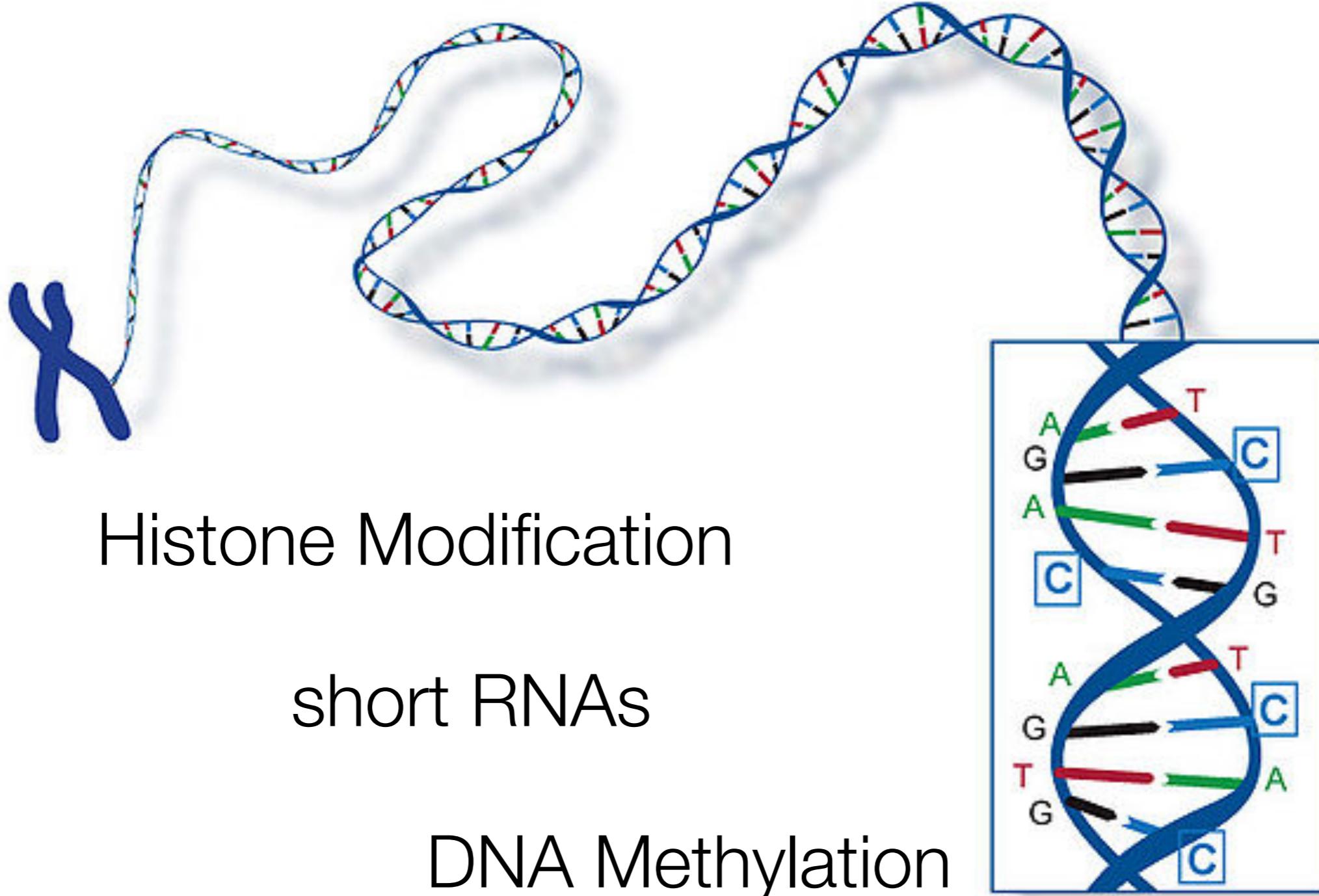
Background

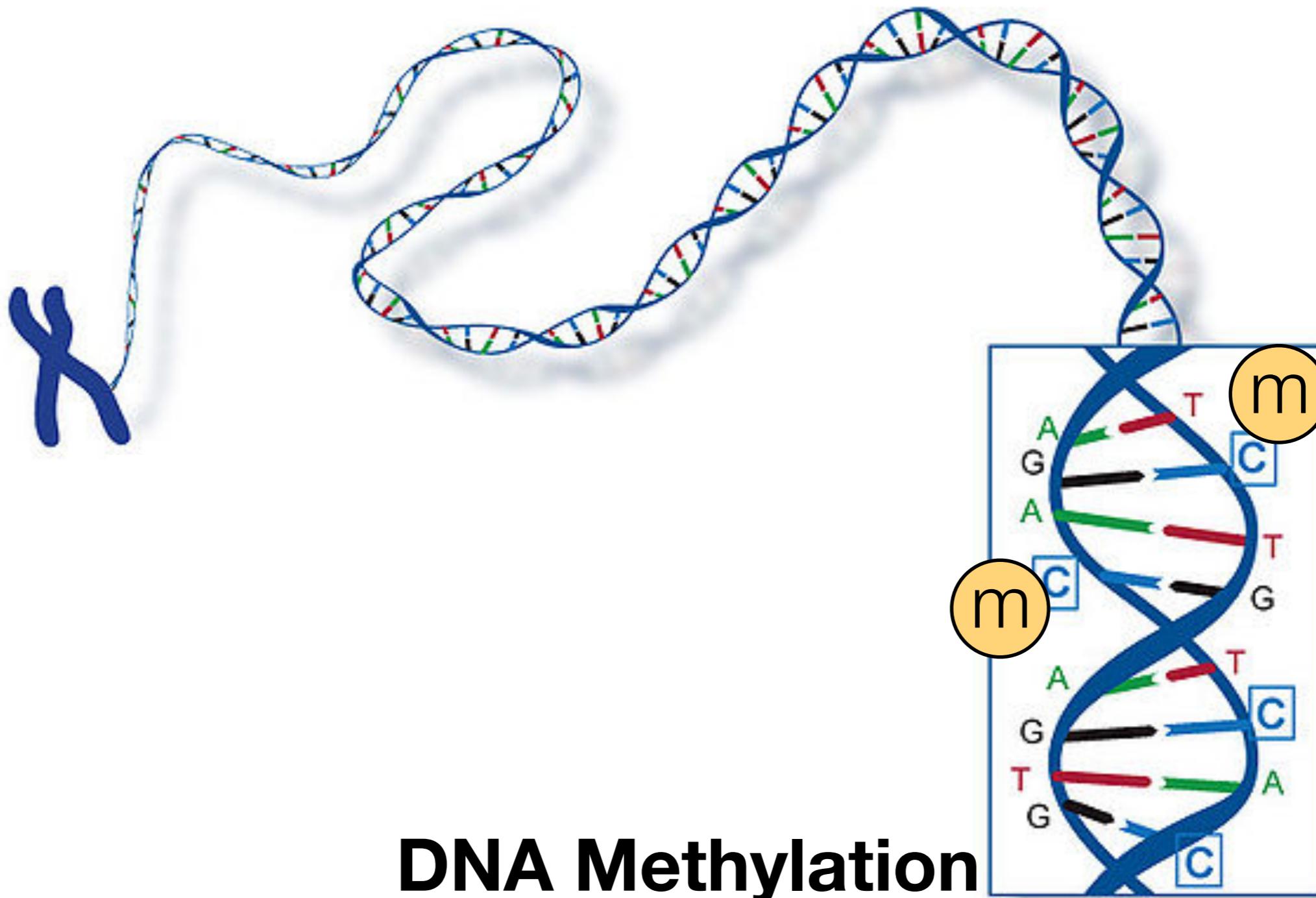


Background



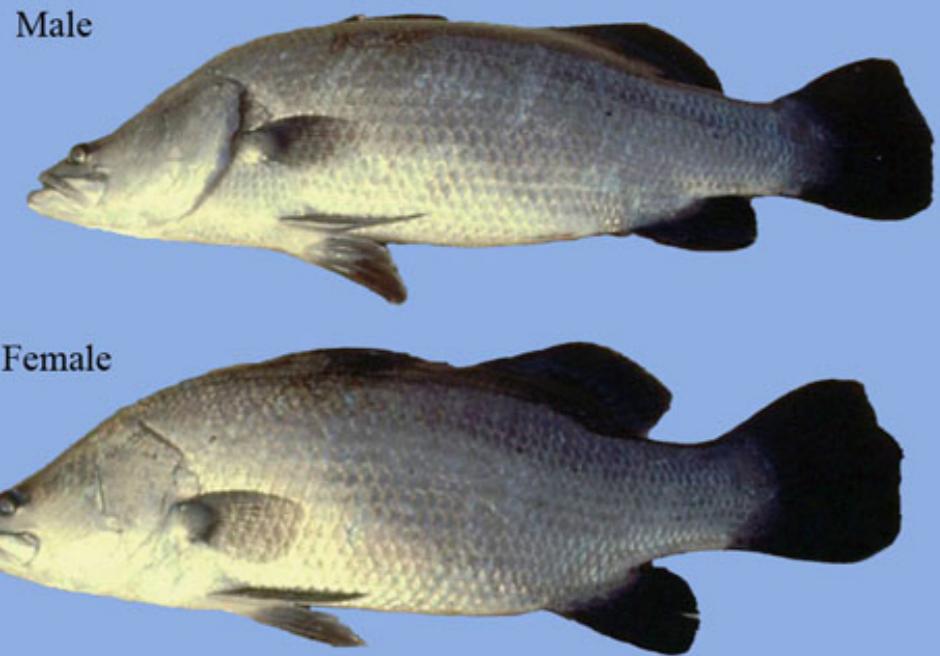
Epigenetics





DNA Methylation

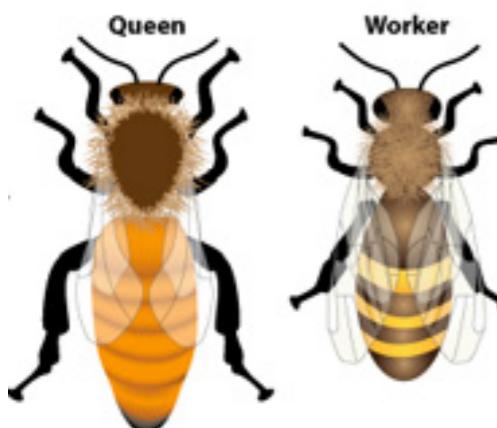
Male



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:

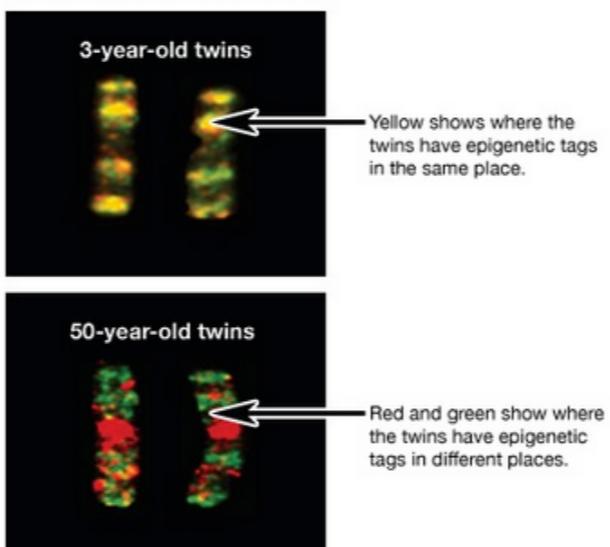
The mother of this mouse received a **normal mouse diet**

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

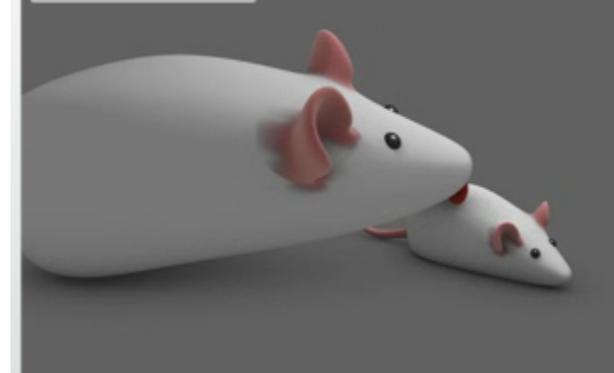
Nature AND Nurture

Chromosome 3 Pairs

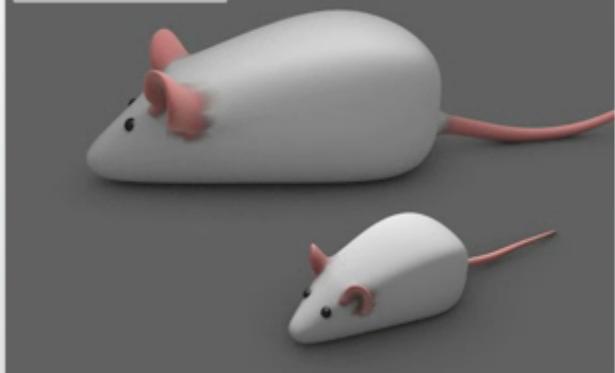
3-year old twins vs. 50-year-old twins



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

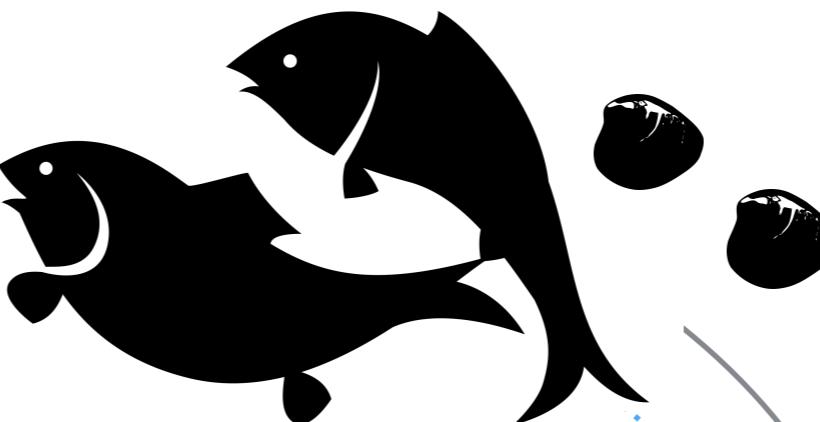
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Identifying individuals by attributing trait to epigenotype

Adults

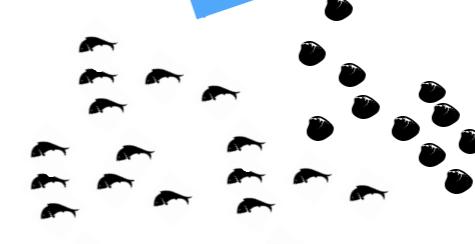


Influencing adult phenotype by altering early life environment



Environmental Manipulation

Influencing offspring phenotype by altering environmental conditions of broodstock

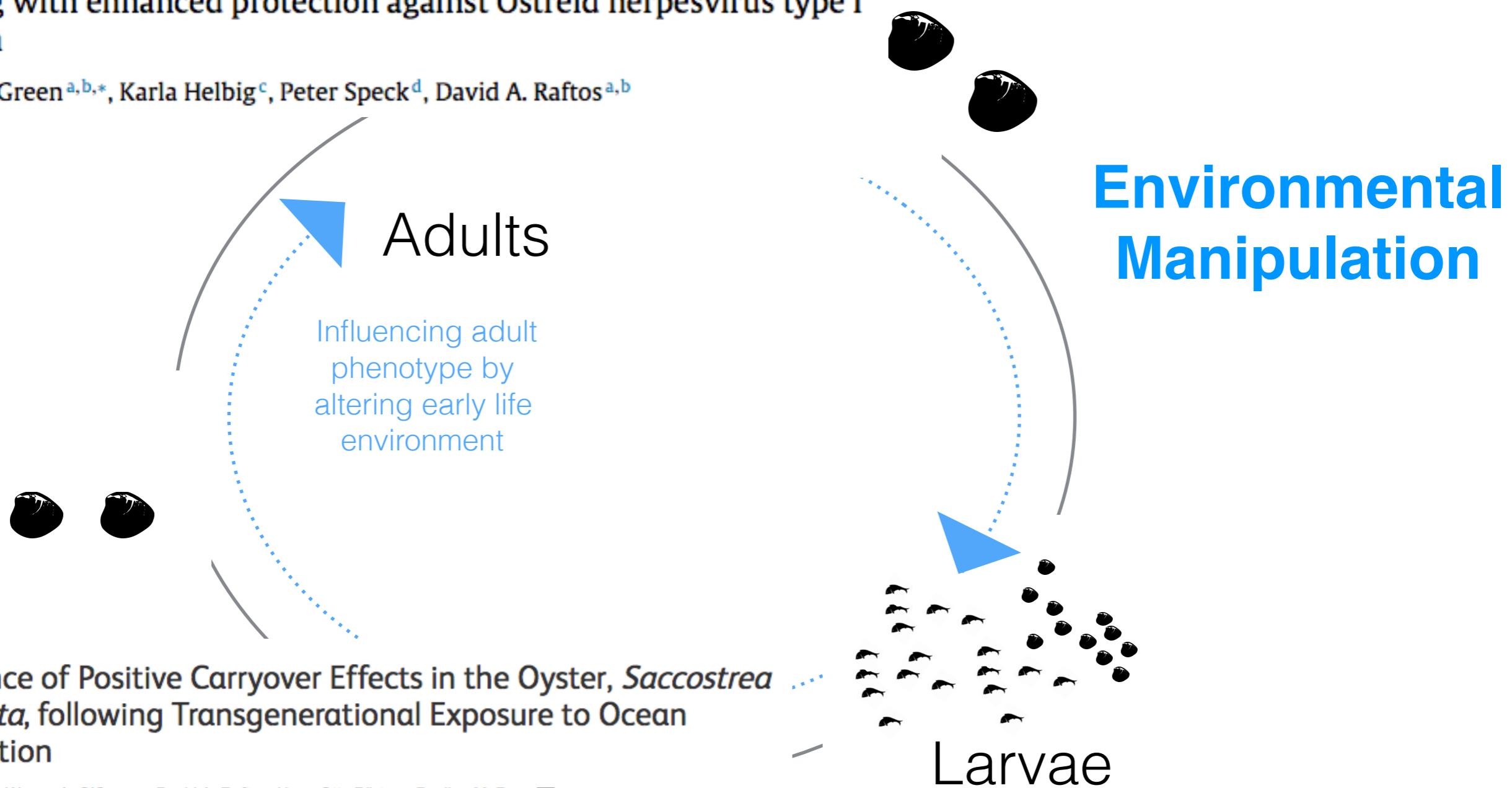


Larvae

Applications in Aquaculture

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

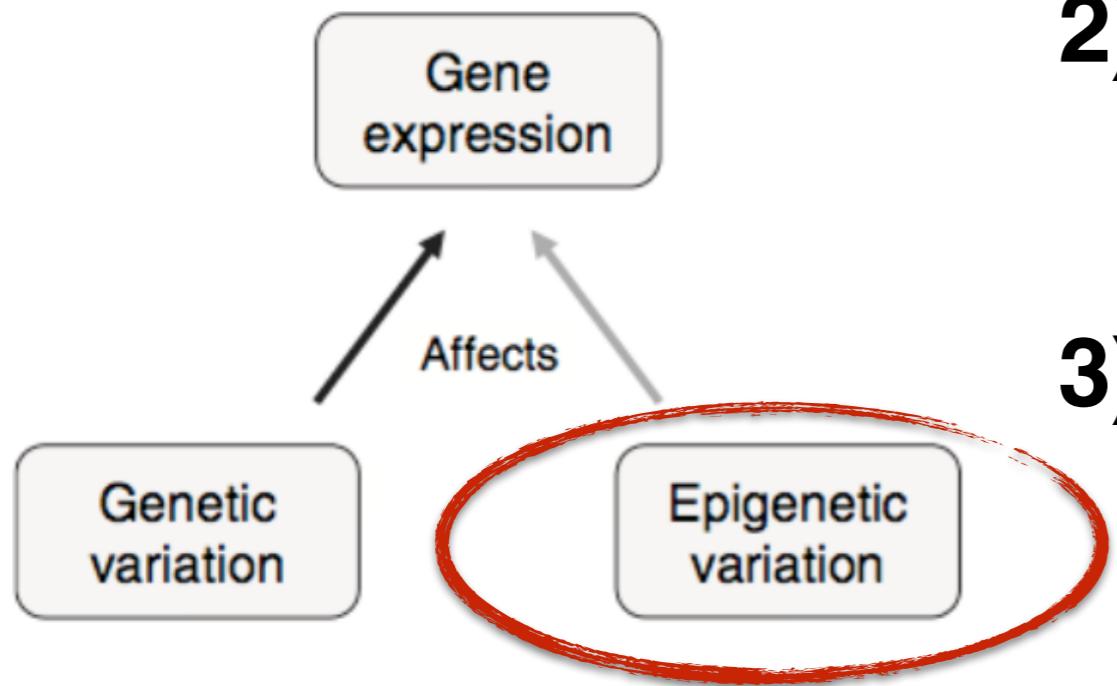
Timothy J. Green^{a,b,*}, Karla Helbig^c, Peter Speck^d, David A. Raftos^{a,b}



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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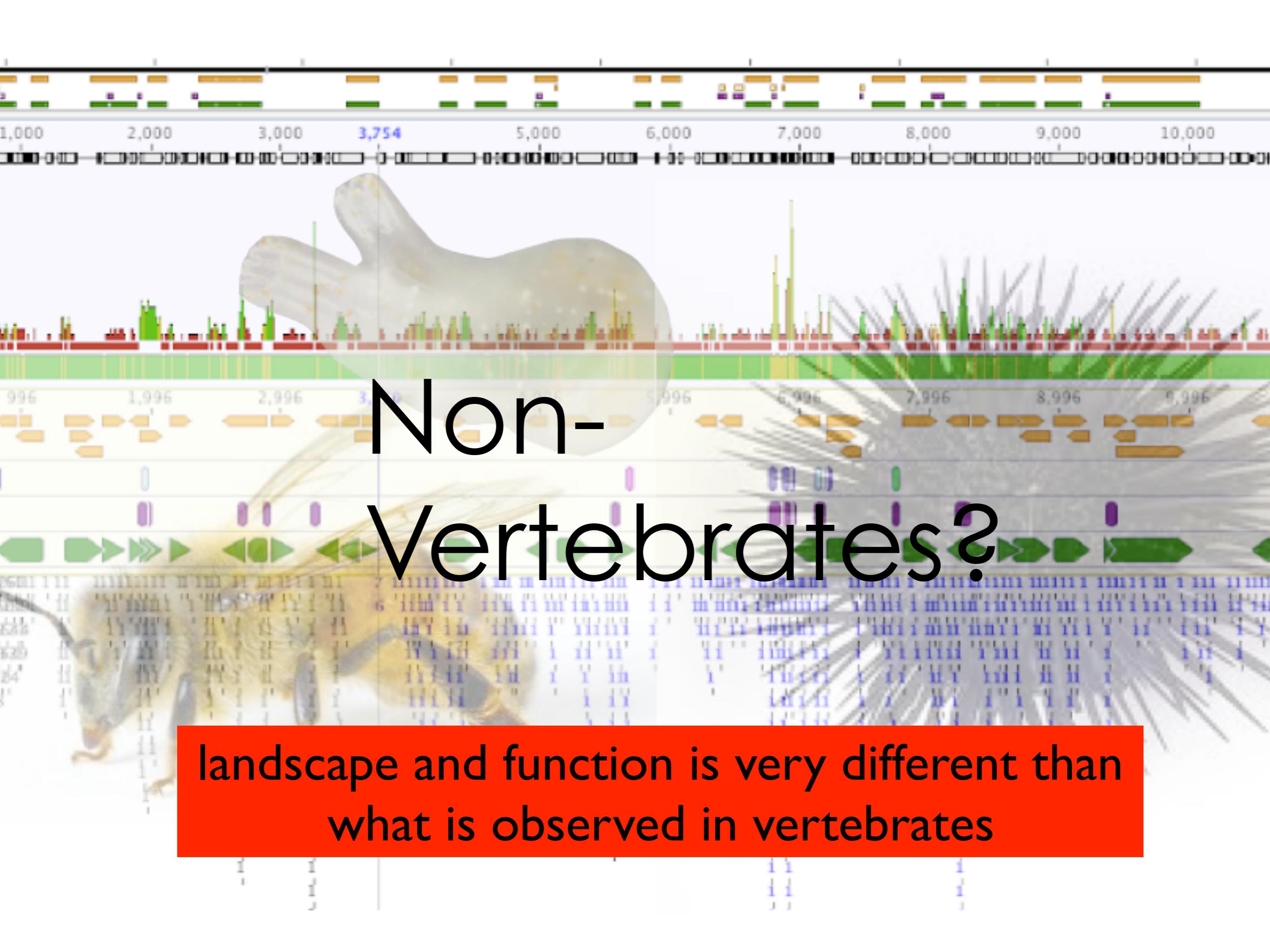
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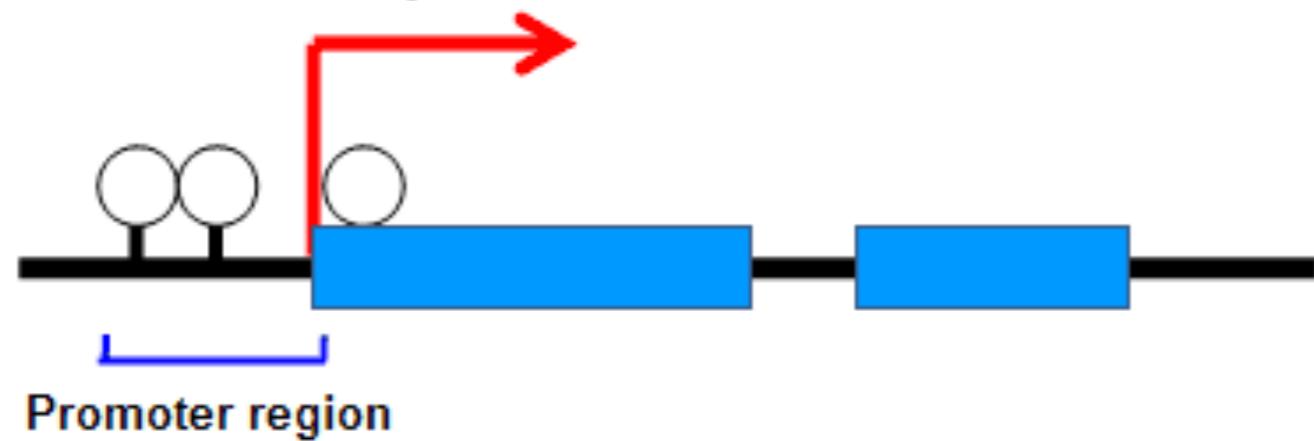


Non- Vertebrates?

landscape and function is very different than
what is observed in vertebrates

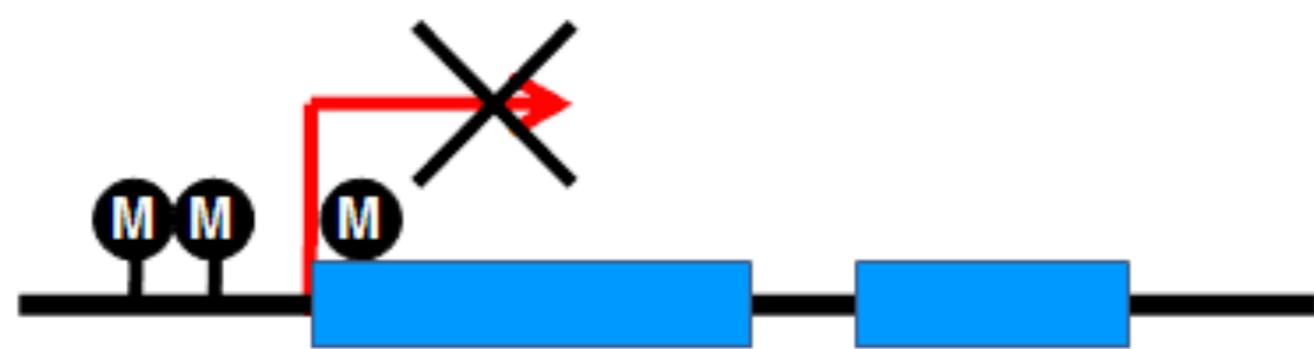
Low temp.

Genes that can be expressed



High temp.

Genes inactivated by DNA methylation

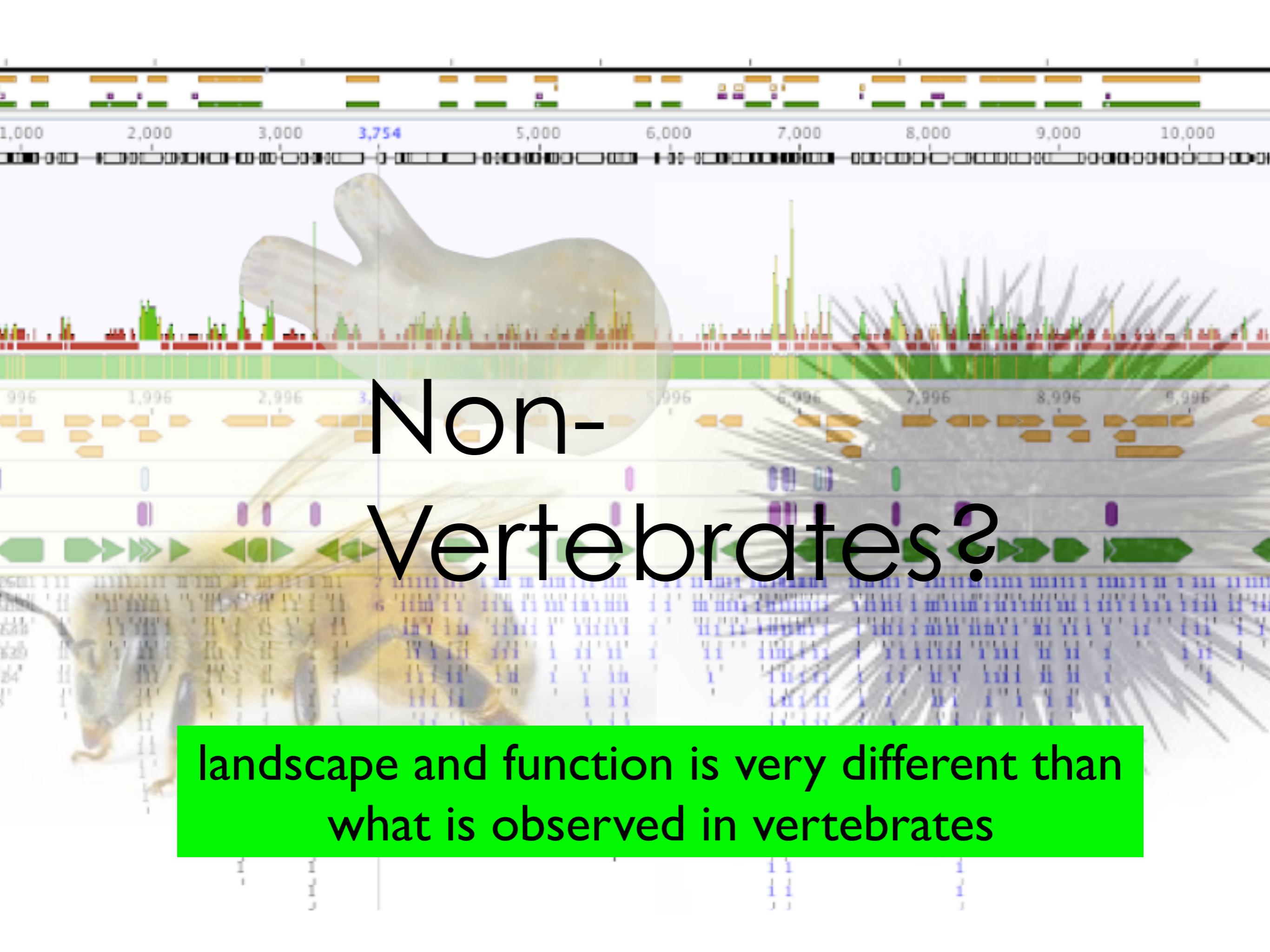


Methylated

Unmethylated



Male and female *Lates calcarifer*

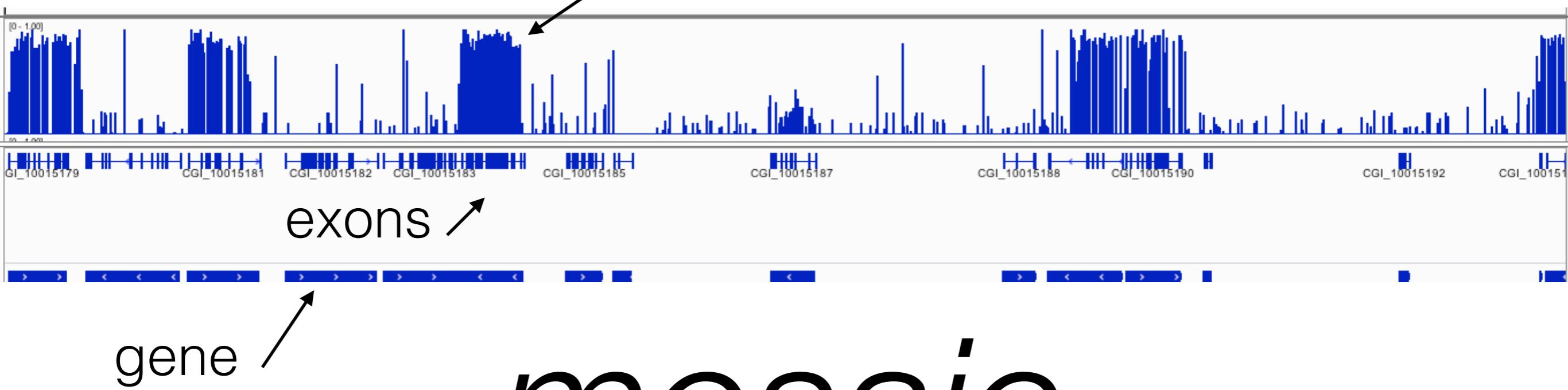


Non- Vertebrates?

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Methylation landscape

DNA methylation level (0-100%) @ cytosines



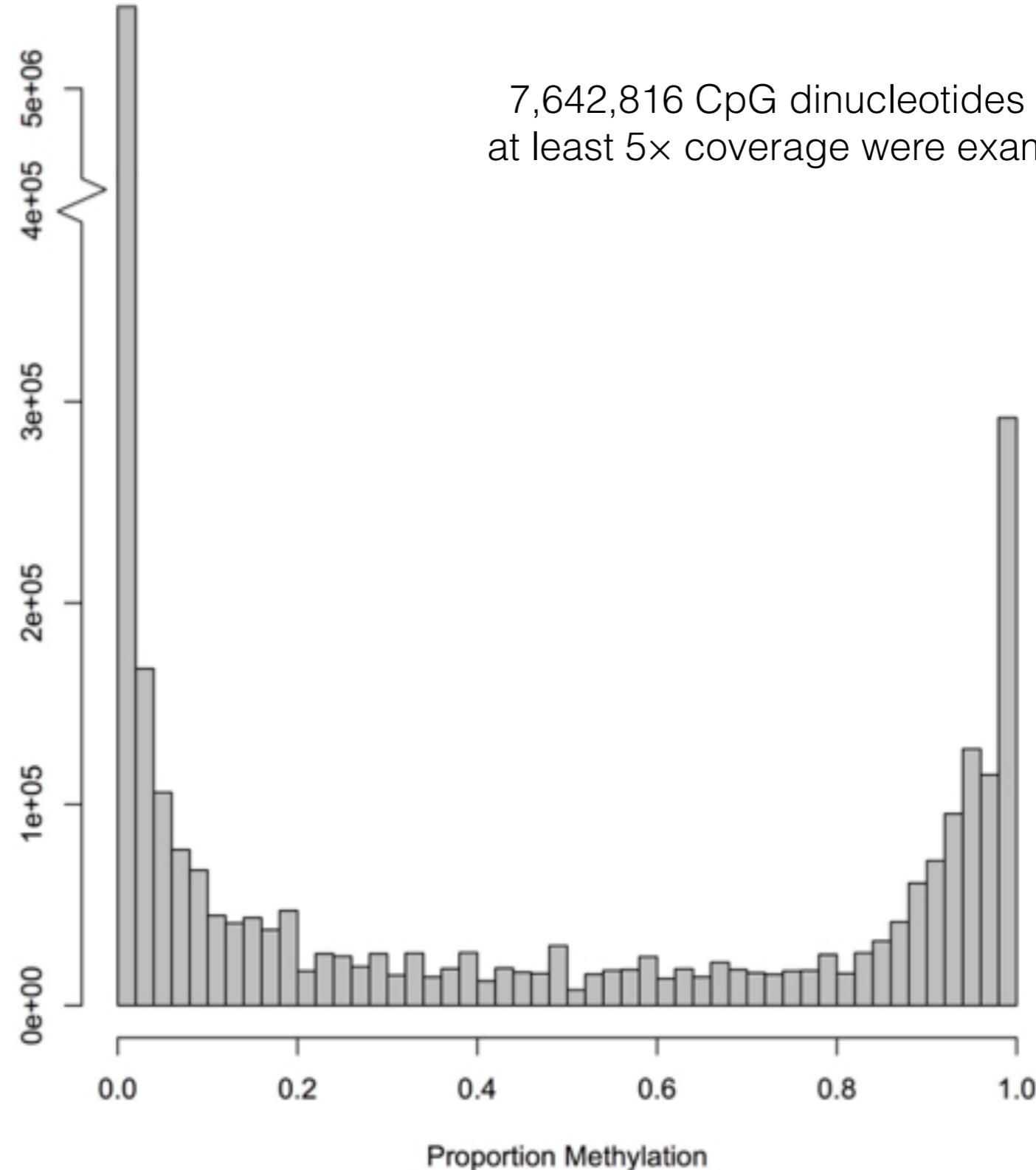
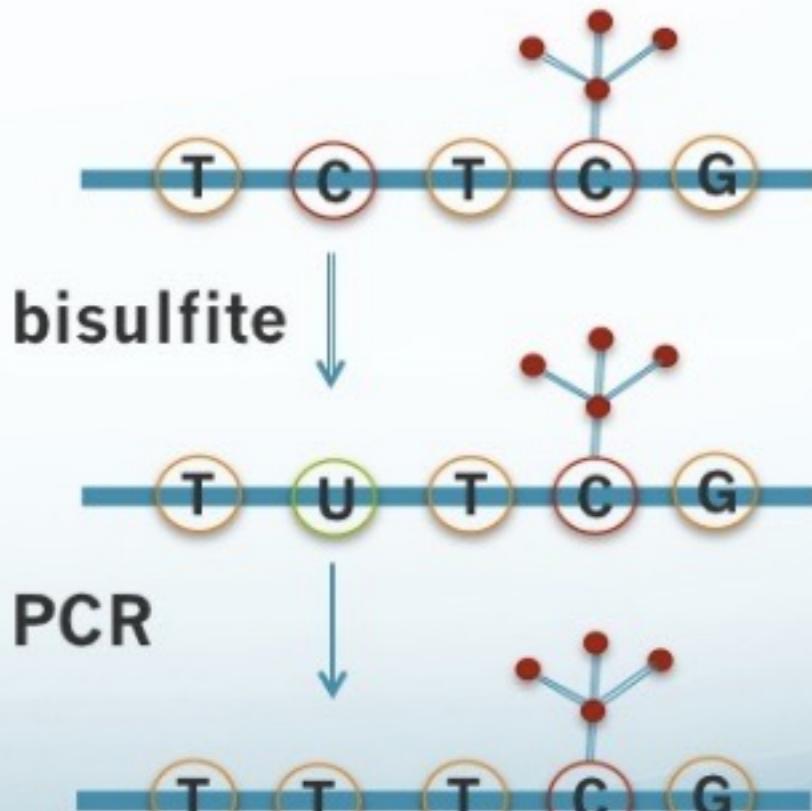
mosaic

associated with gene bodies

Methylation landscape

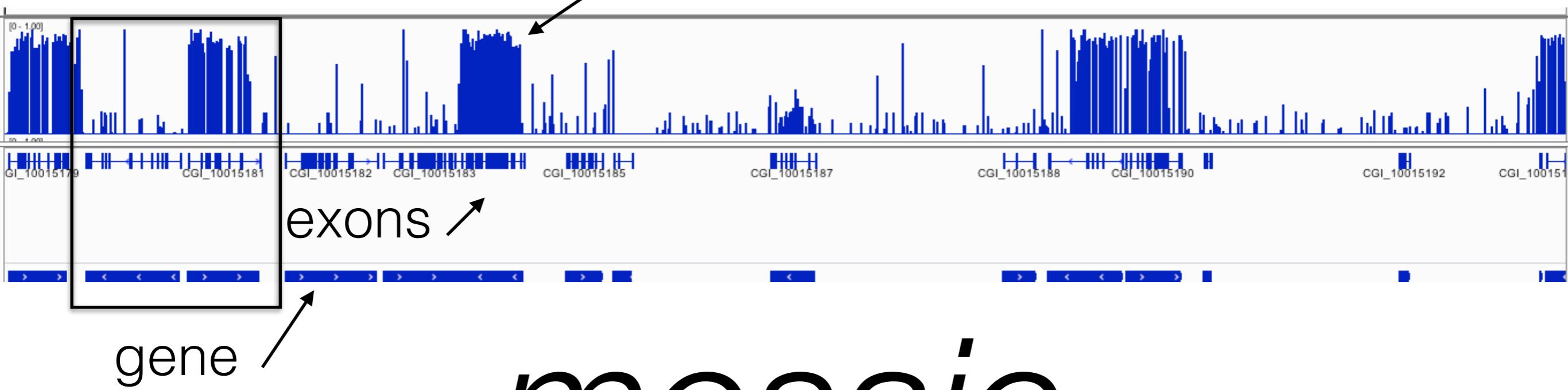
7,642,816 CpG dinucleotides with at least 5x coverage were examined

- Bisulfite conversion



Methylation landscape

DNA methylation level (0-100%) @ cytosines

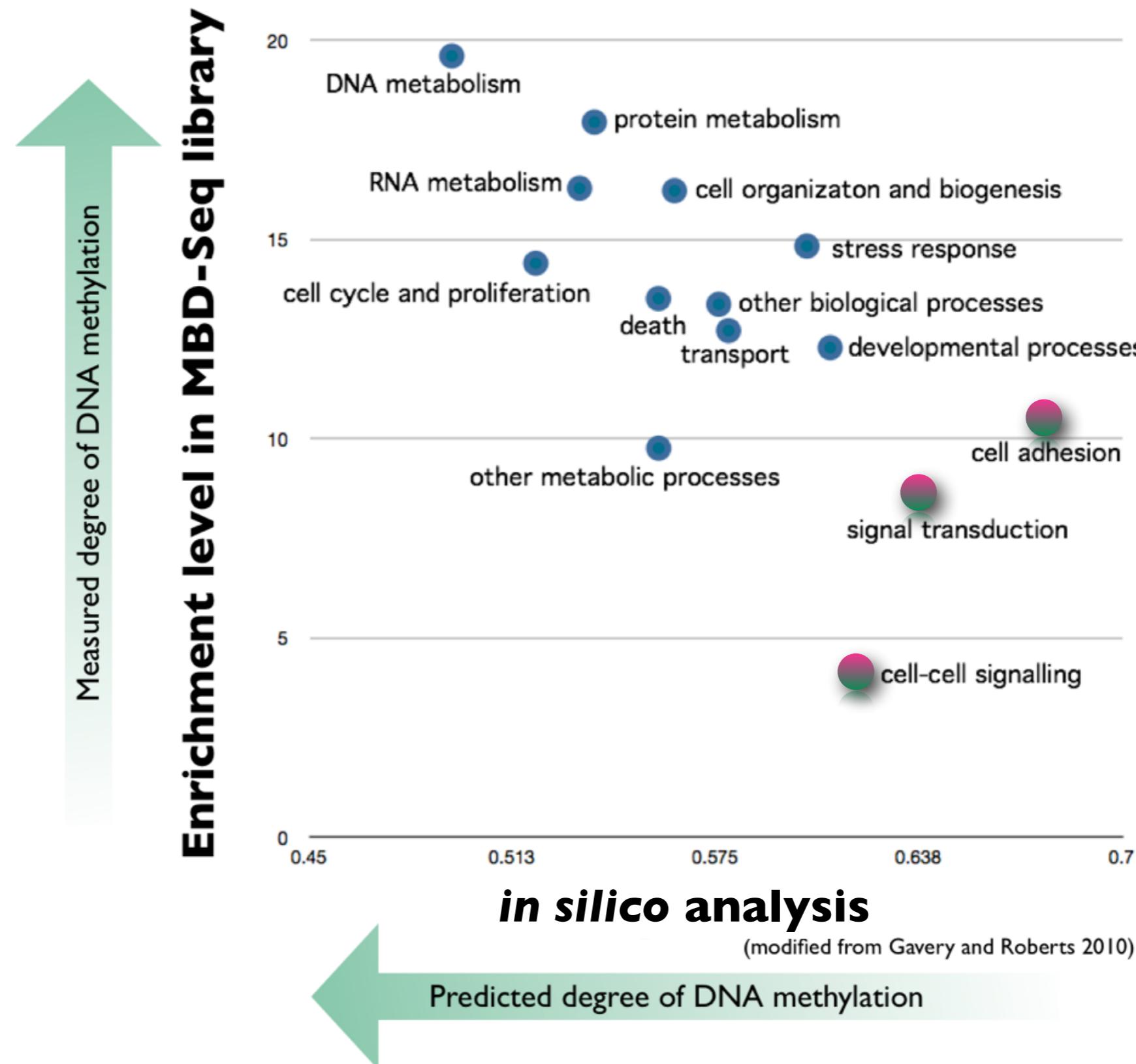


mosaic

Why are only a subset of genes methylated?

associated with gene bodies

Methylation landscape

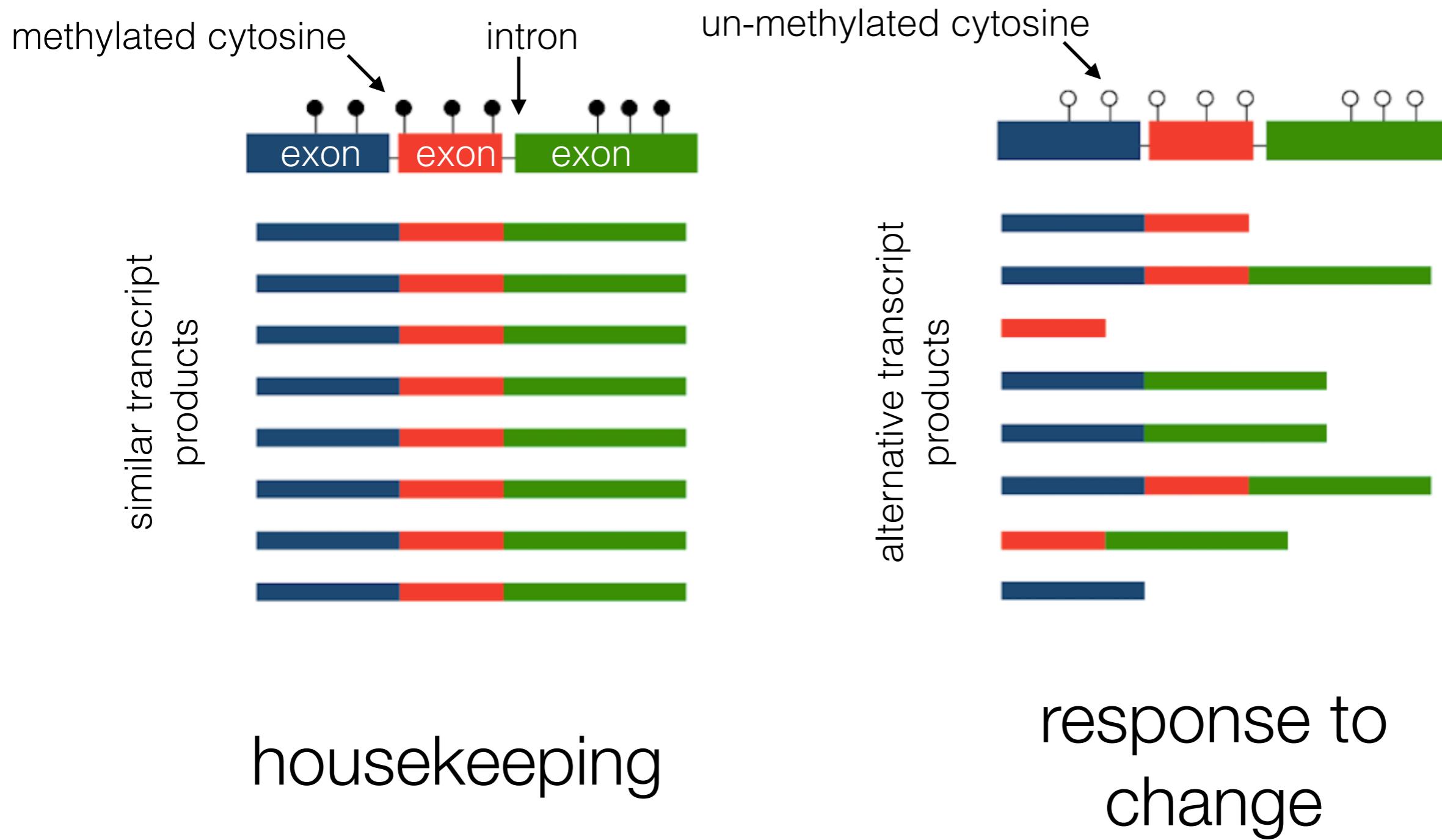


Stochastic Variation

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



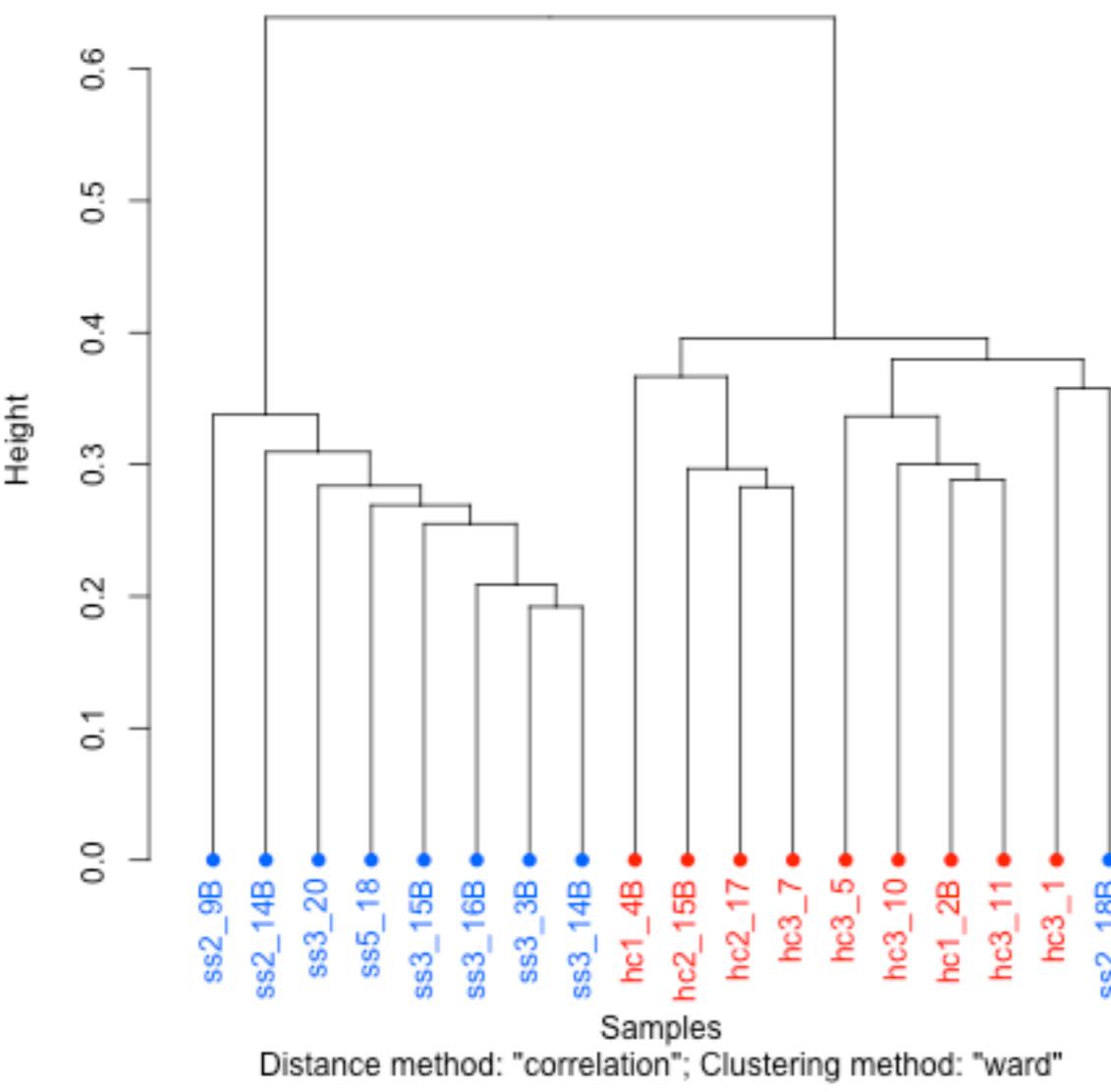
Manchester

Population studies



Reciprocal Transplant Experiment

CpG methylation clustering



Population studies



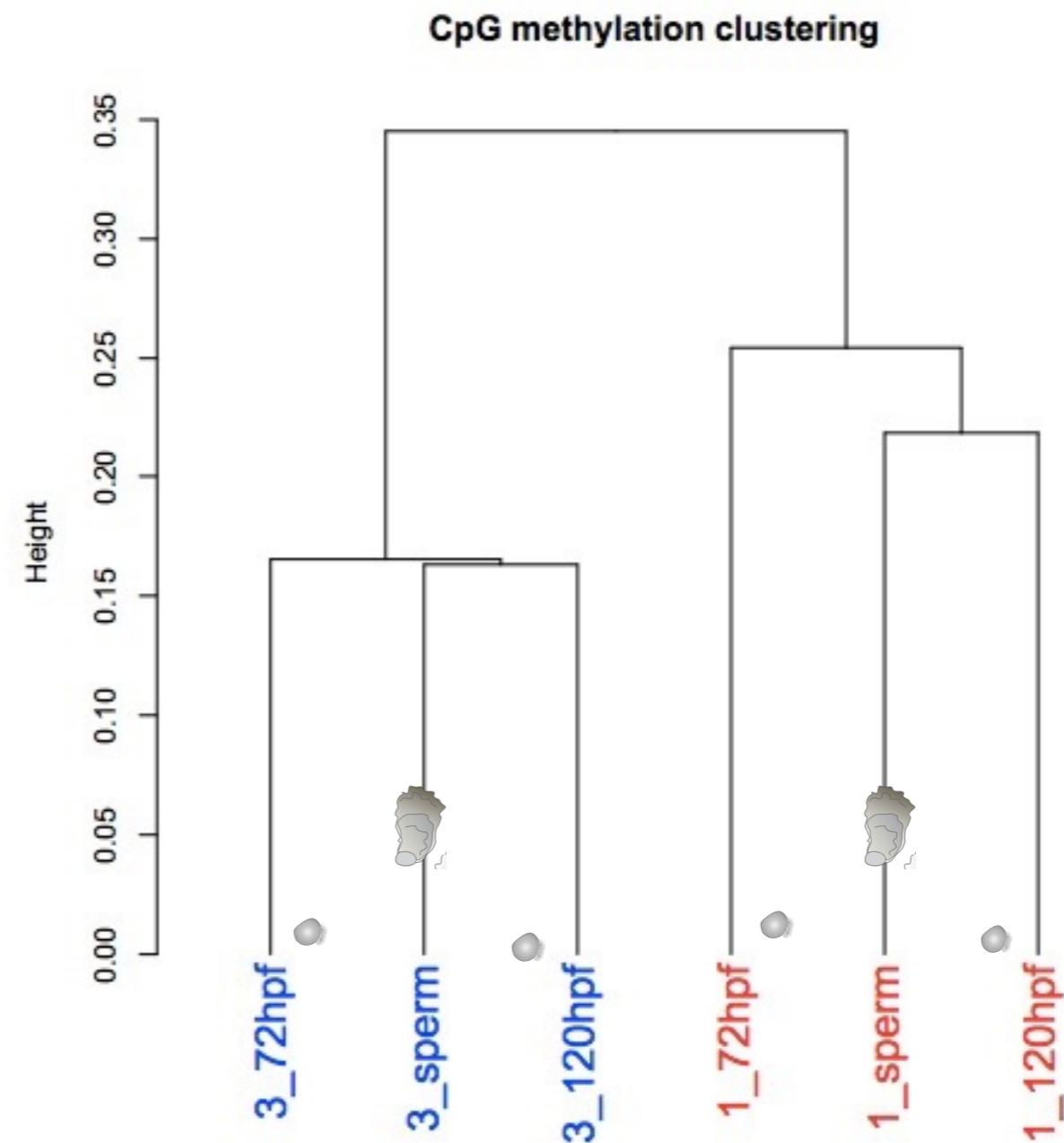
bioRxiv
beta
THE PREPRINT SERVER FOR BIOLOGY

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>



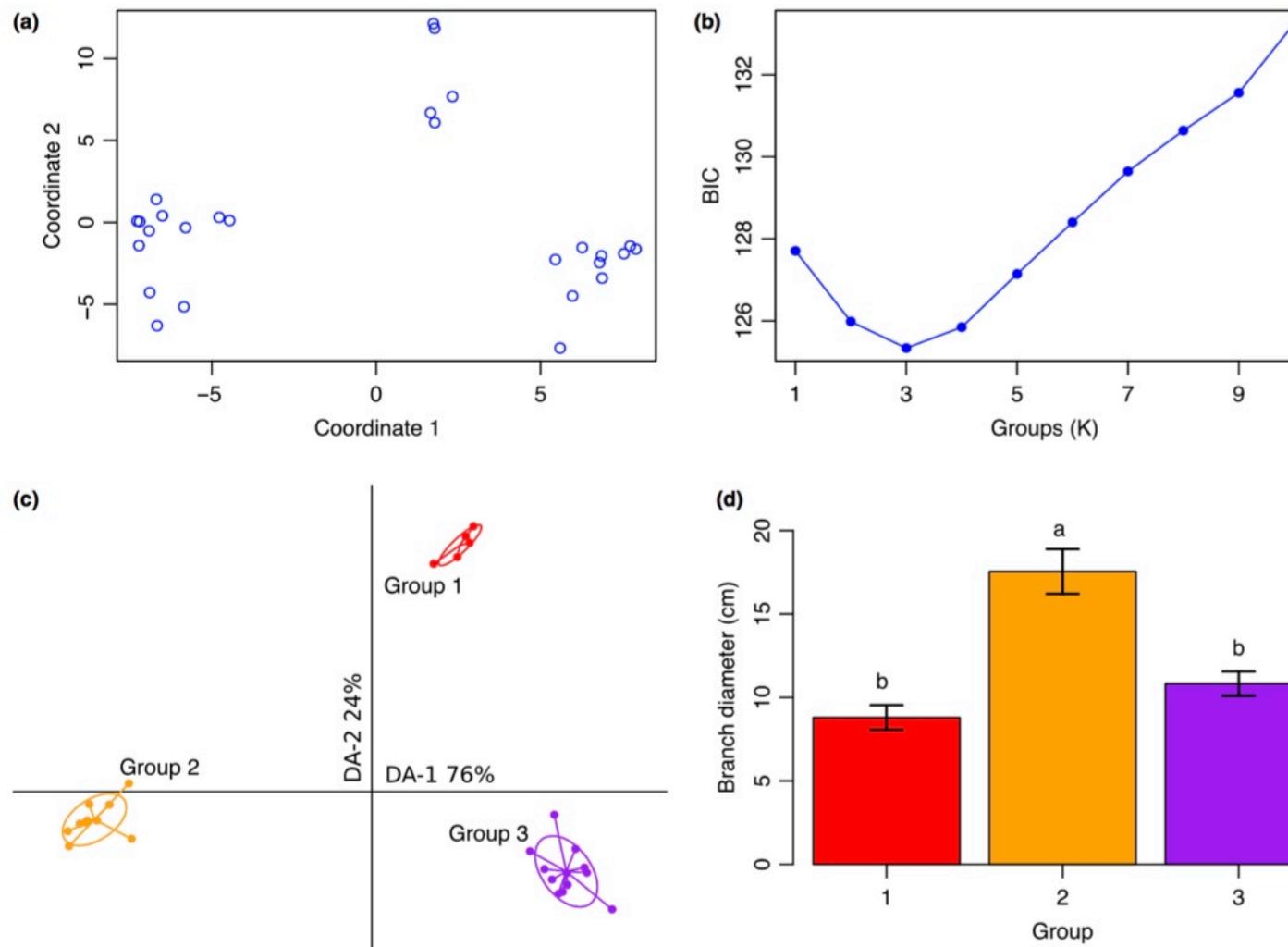
Population studies

ORIGINAL ARTICLE

WILEY MOLECULAR ECOLOGY

Genetic and epigenetic insight into morphospecies in a reef coral

James L. Dimond^{1,2} | Sanoosh K. Gamblewood² | Steven B. Roberts¹



SNP analysis detected 3 groups

Evidence for phenotypic differentiation between genetic groups

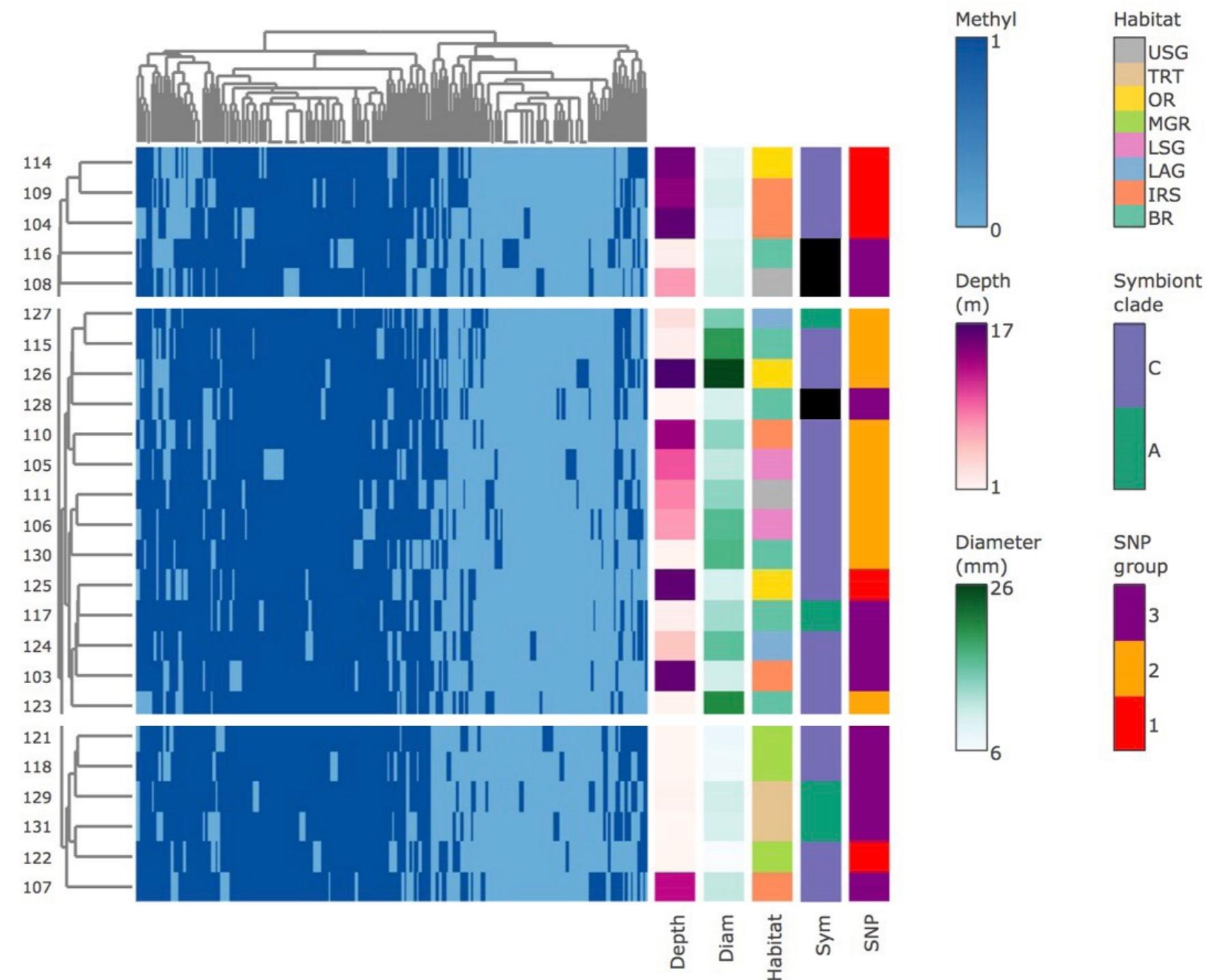
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Environmental Epigenetics, 2017, 1–13

doi: 10.1093/eep/dvx004
Research article

RESEARCH ARTICLE

Effects of a parental exposure to diuron on Pacific oyster spat methylome

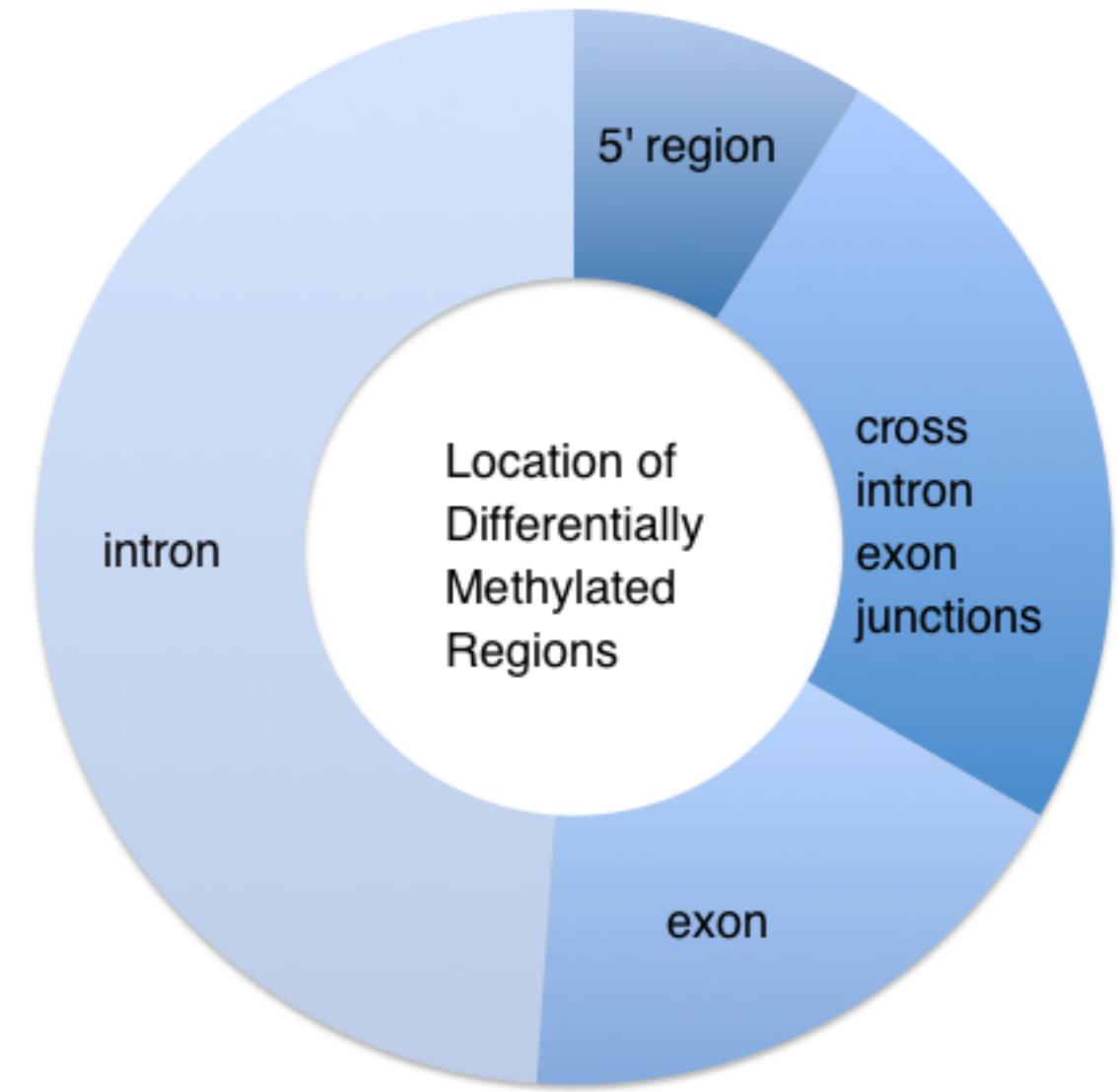
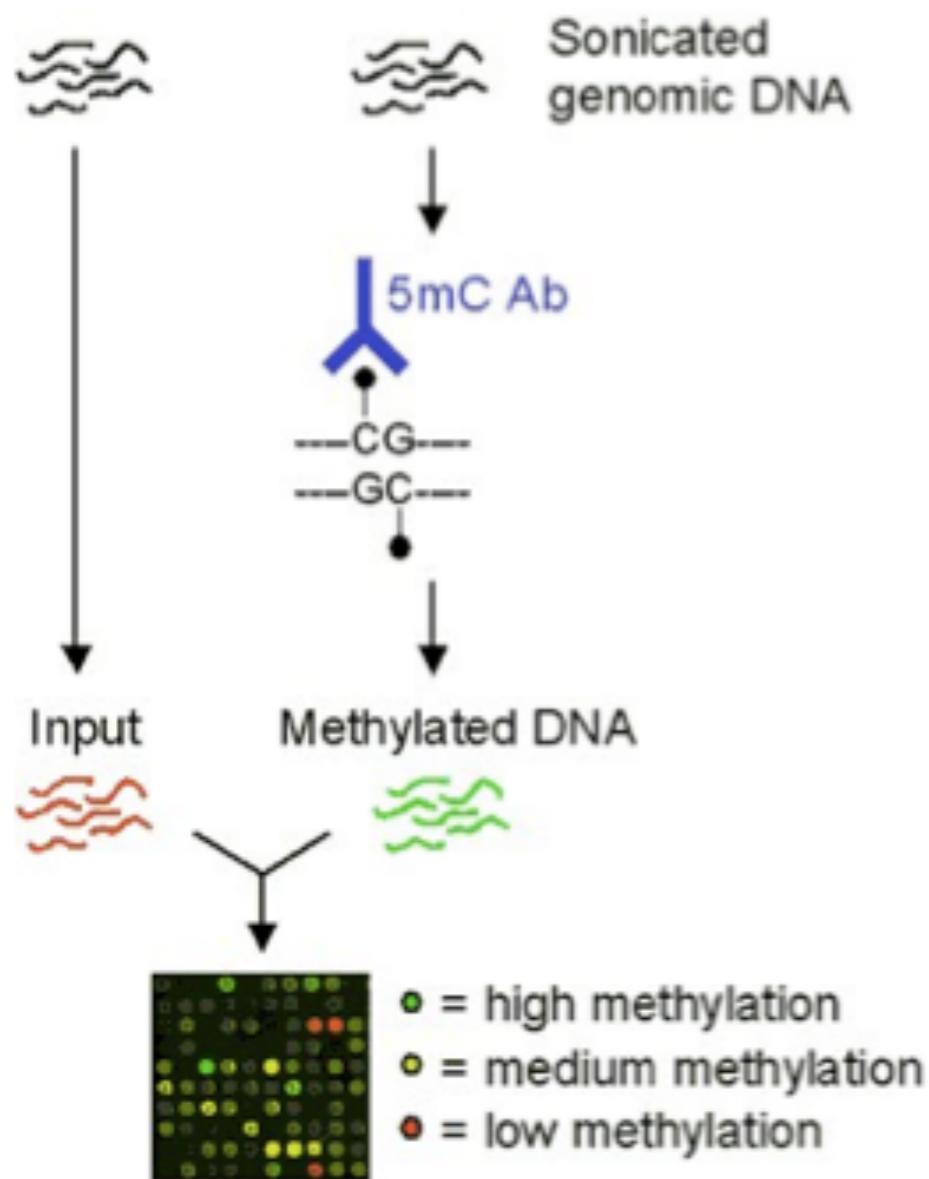
Rodolfo Rondon^{1,2}, Christoph Grunau², Manon Fallet², Nicolas Charlemagne³, Rossana Sussarellu³, Cristian Chaparro², Caroline Montagnani¹, Guillaume Mitta², Evelyne Bachère¹, Farida Akcha³ and Céline Cosseau^{2,*}

¹Ifremer, IHPE UMR 5244, Univ. Perpignan Via Domitia, CNRS, Univ. Montpellier, F-34095 Montpellier, France

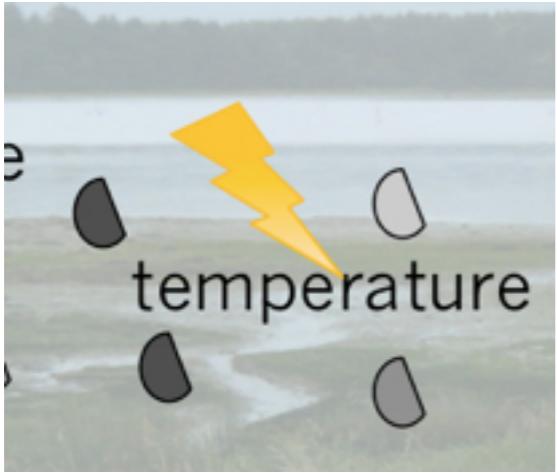
²Univ. Perpignan Via Domitia, IHPE UMR 5244, CNRS, IFREMER, Univ. Montpellier, F-66860 Perpignan, France

and ³Ifremer, Department of Biogeochemistry and Ecotoxicology, Laboratory of Ecotoxicology, Rue de l'ile d'Yeu, BP 21105, 44311 Nantes Cedex 03, France

Environmental change



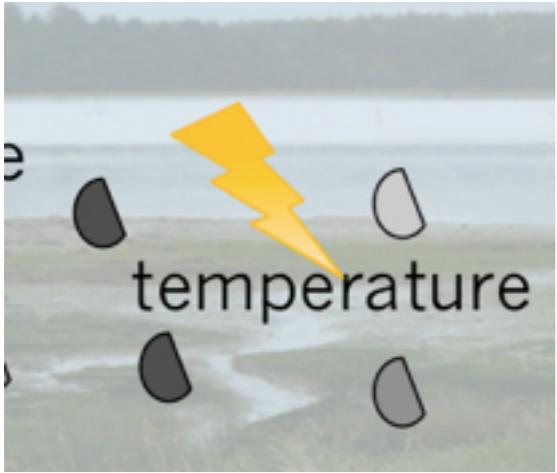
Environmental change



stochastic or targeted?

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

Environmental change



stochastic or targeted?

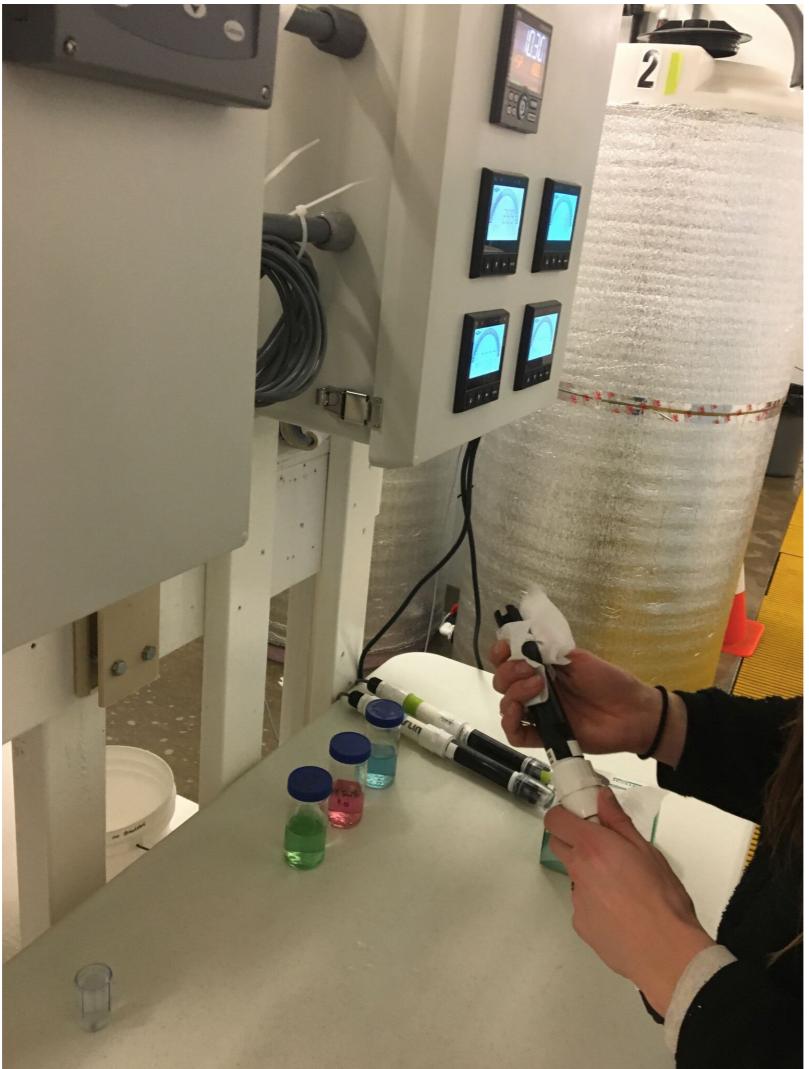
Oyster	Hypo-methylated	Hyper-methylated
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No obvious association
with genome feature
including *differentially
expressed
genes*

Environmental change

Very new data

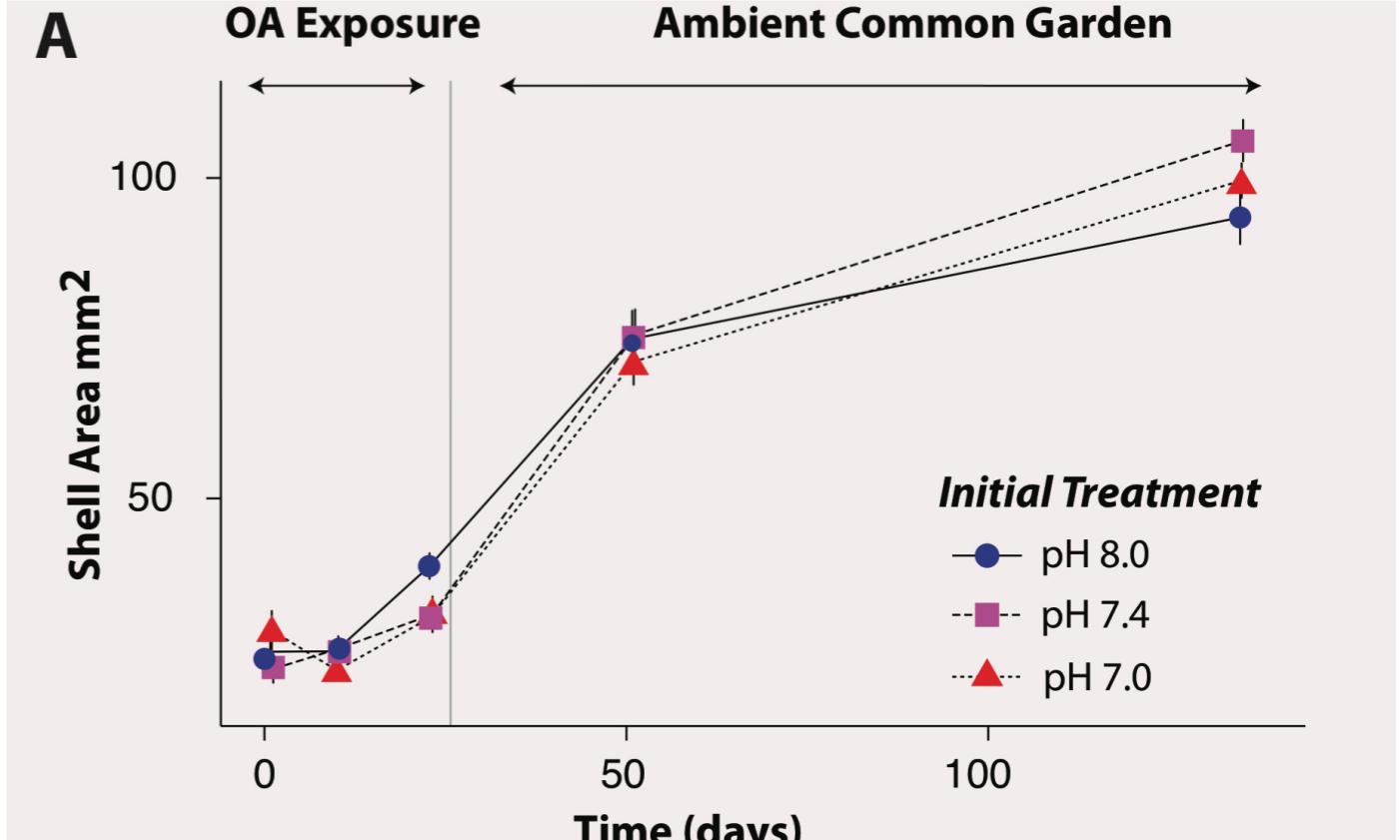
Ocean Acidification



Environmental change

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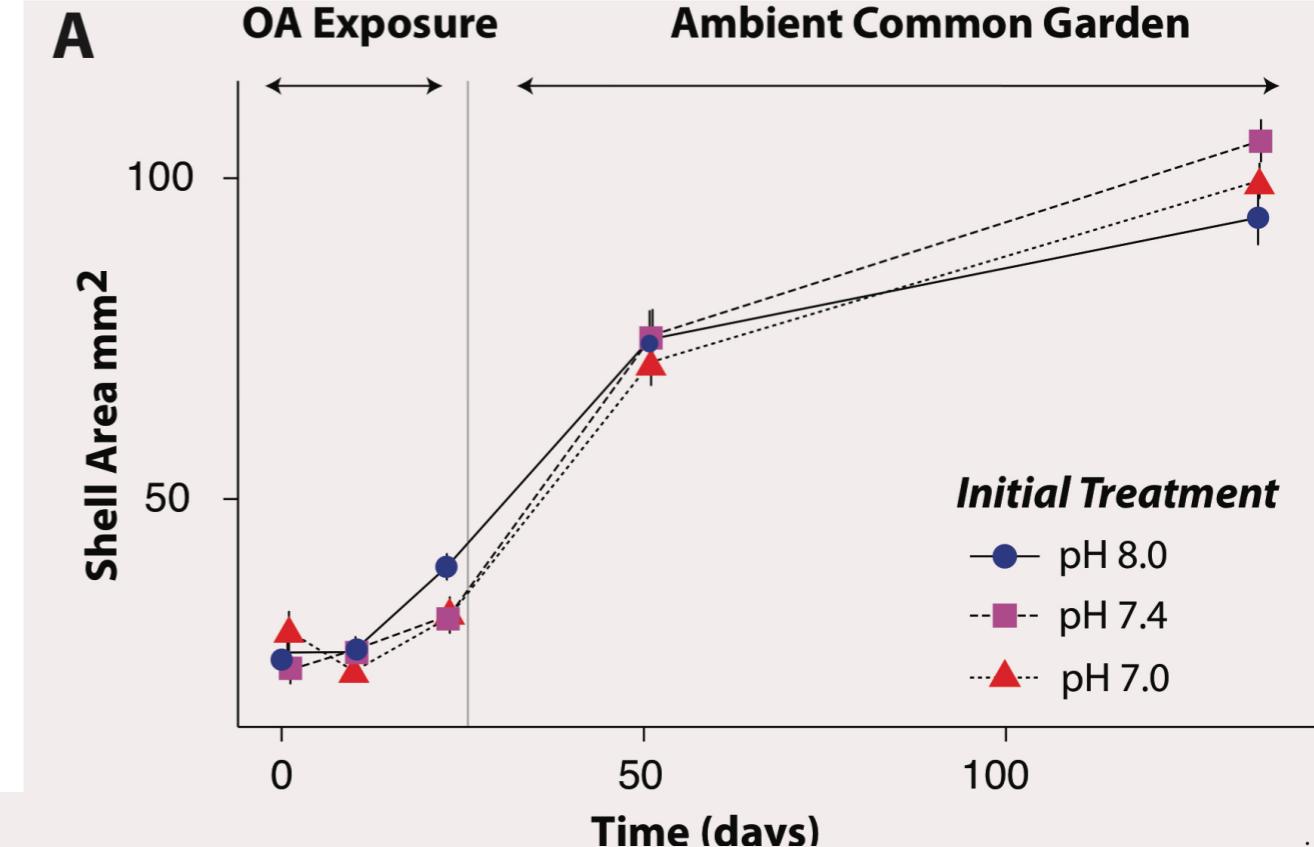
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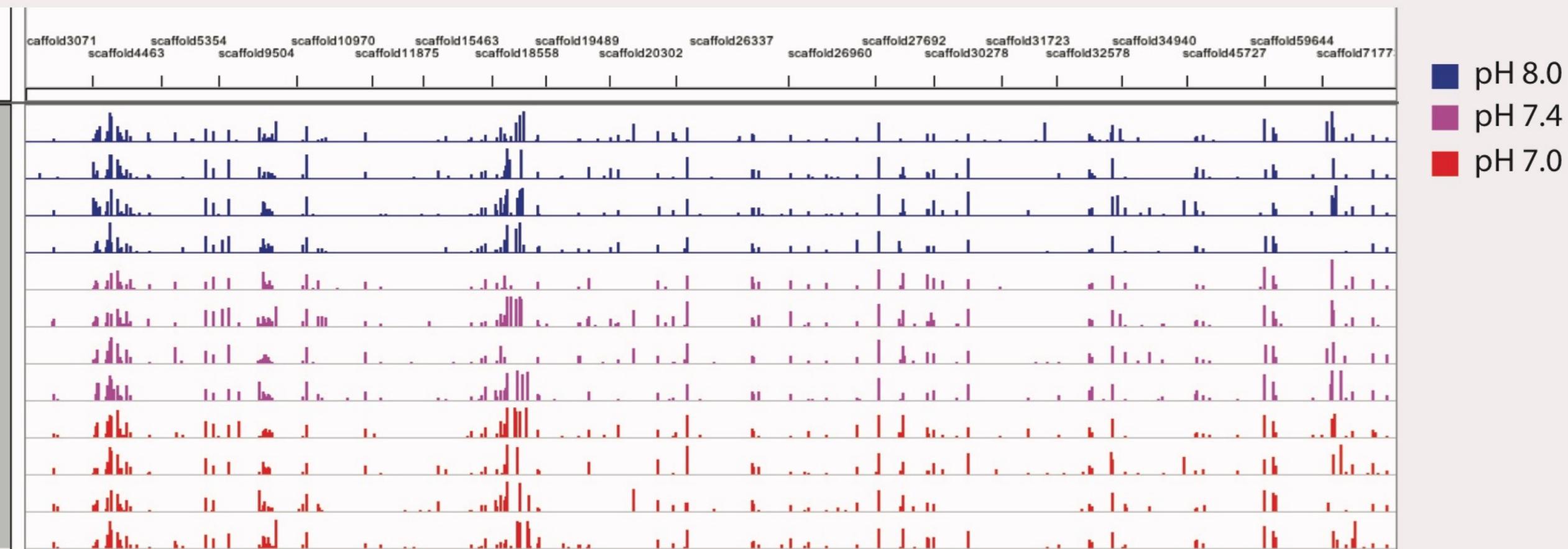
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Day 10 DNA methylation patterns



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



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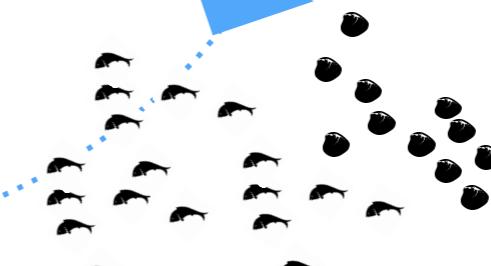


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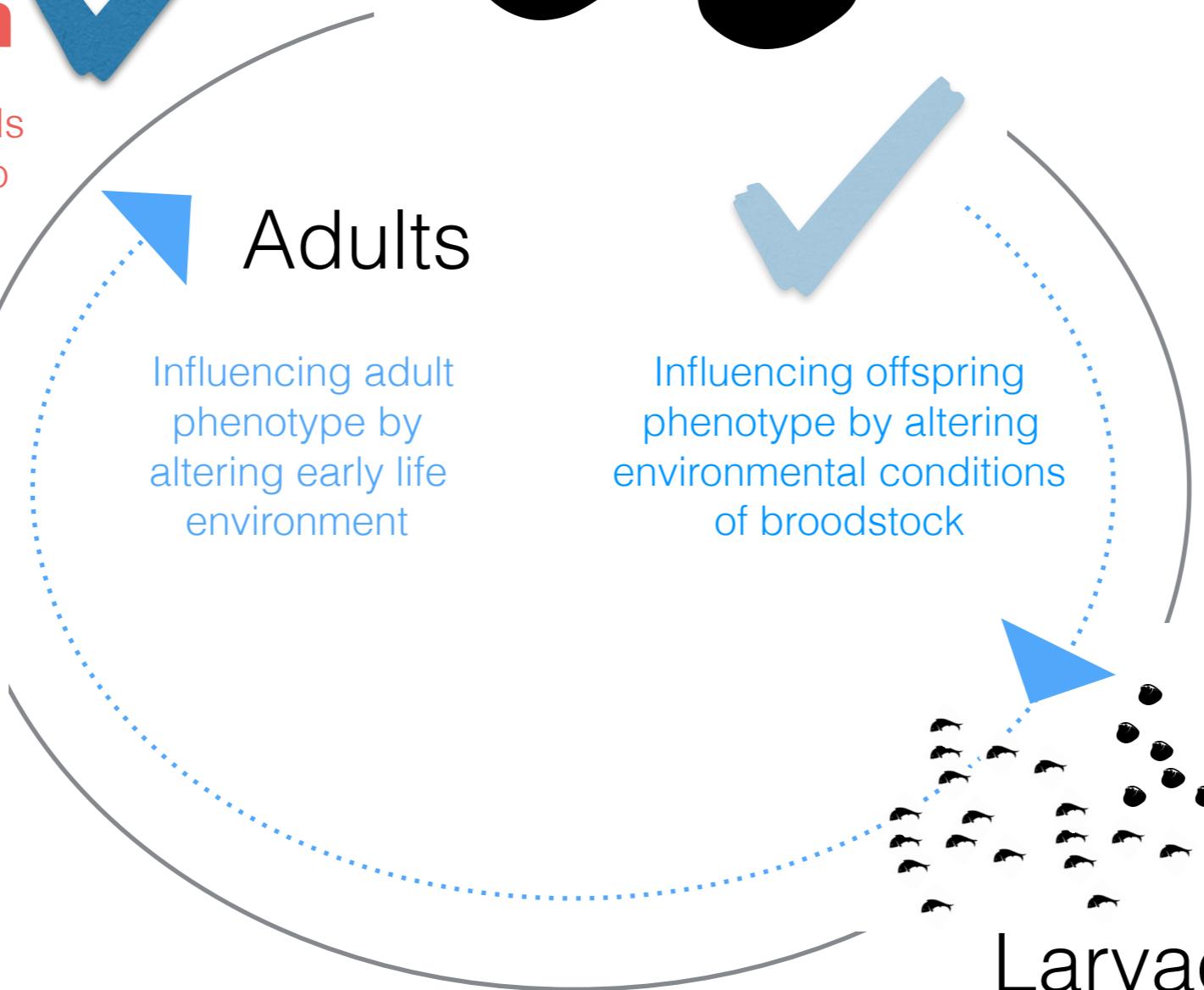


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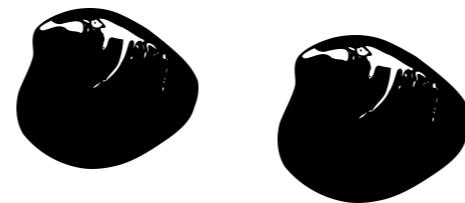
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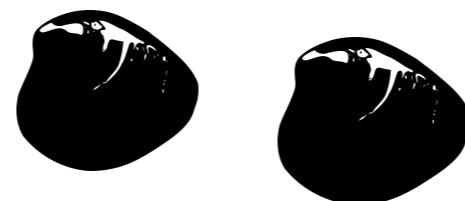
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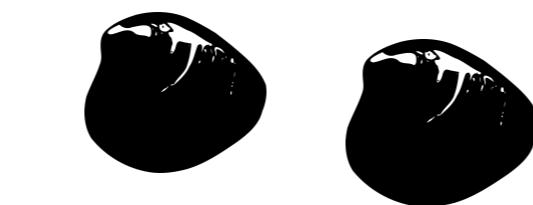
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Larvae

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

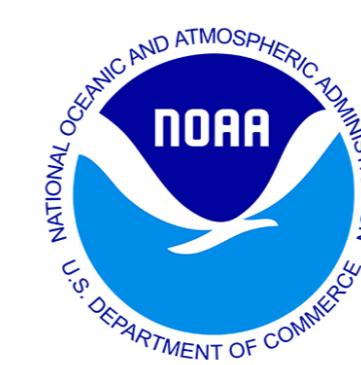
Claire Olson

Sam White

Brent Vadopalas

Hollie Putnam

Jay Dimond



slides, data & more @

<https://github.com/sr320/talk-bh-2017>