

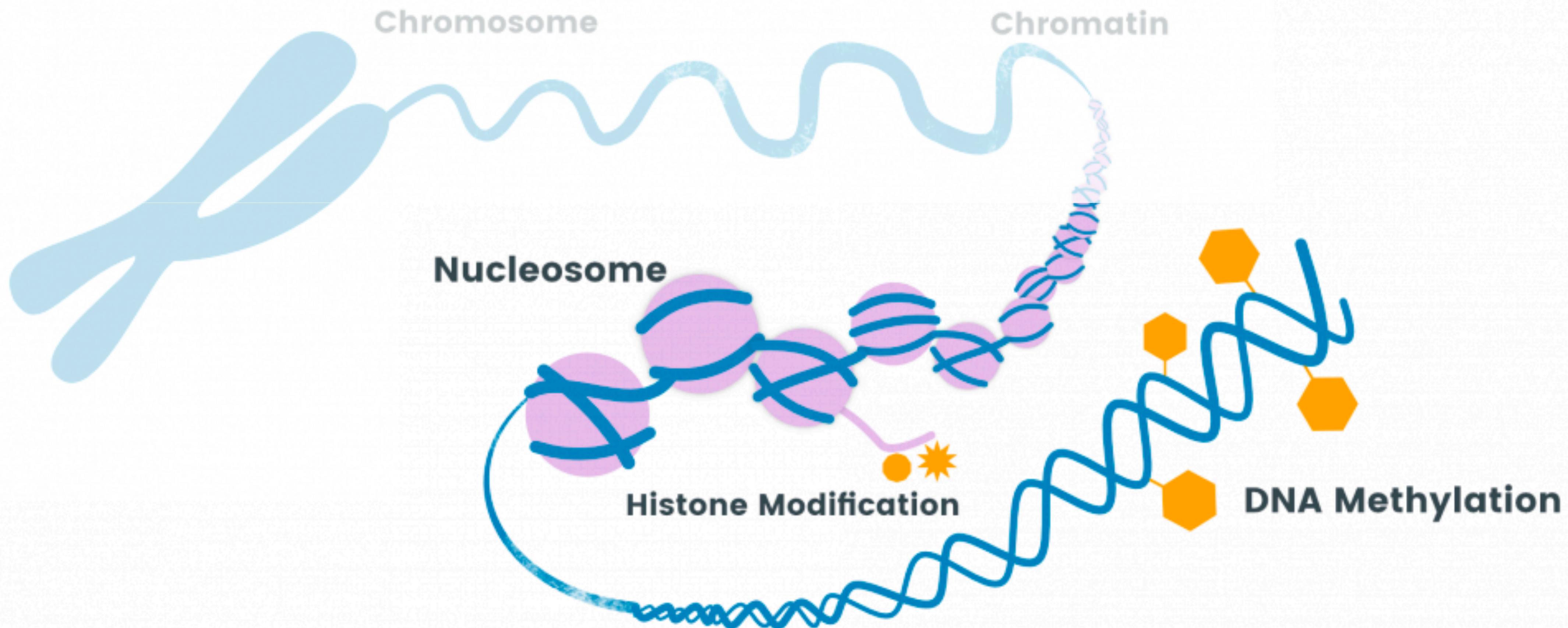


STEVEN ROBERTS
SCHOOL OF AQUATIC AND FISHERY SCIENCES
UNIVERSITY OF WASHINGTON

**EPIGENETIC MECHANISMS
IN MARINE INVERTEBRATES:
PERSPECTIVES AND
APPLICATIONS**

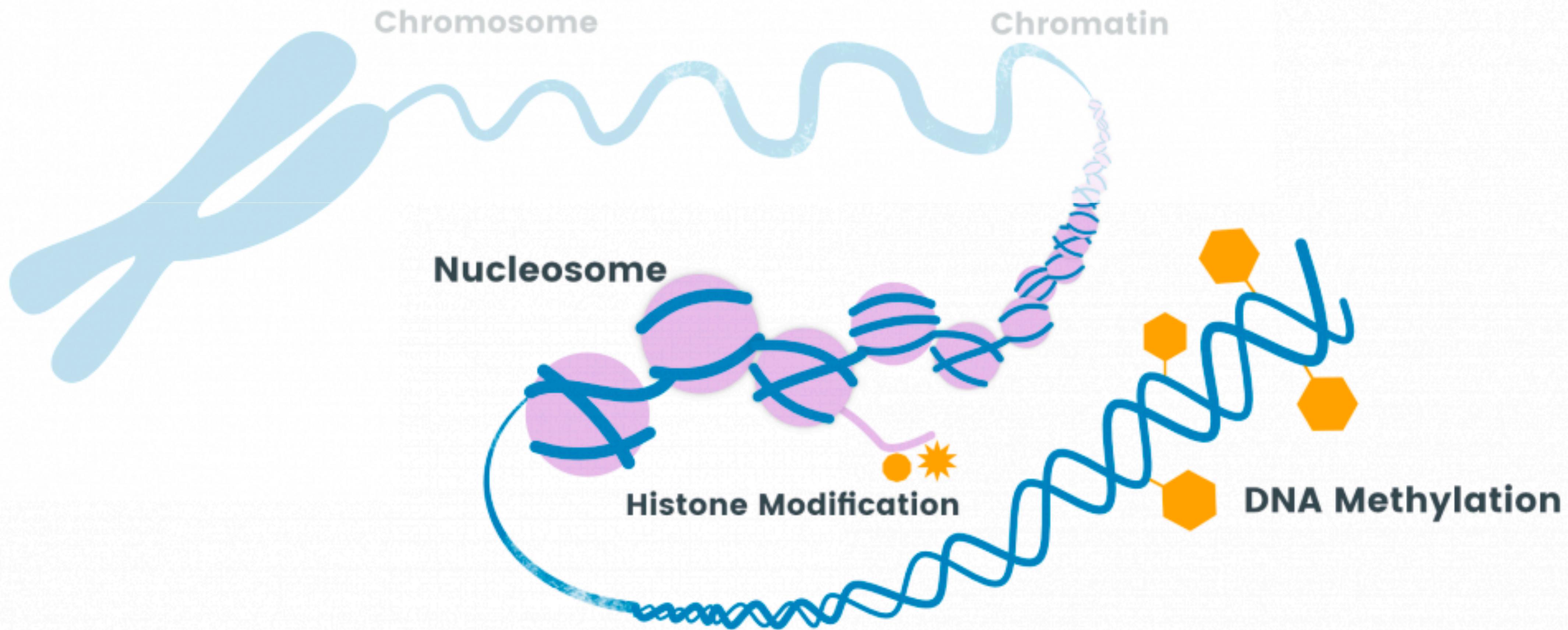
WHAT IS EPIGENETICS?

ALTERS THE PHENOTYPE (WITHOUT CHANGING DNA CODE); HERITABLE



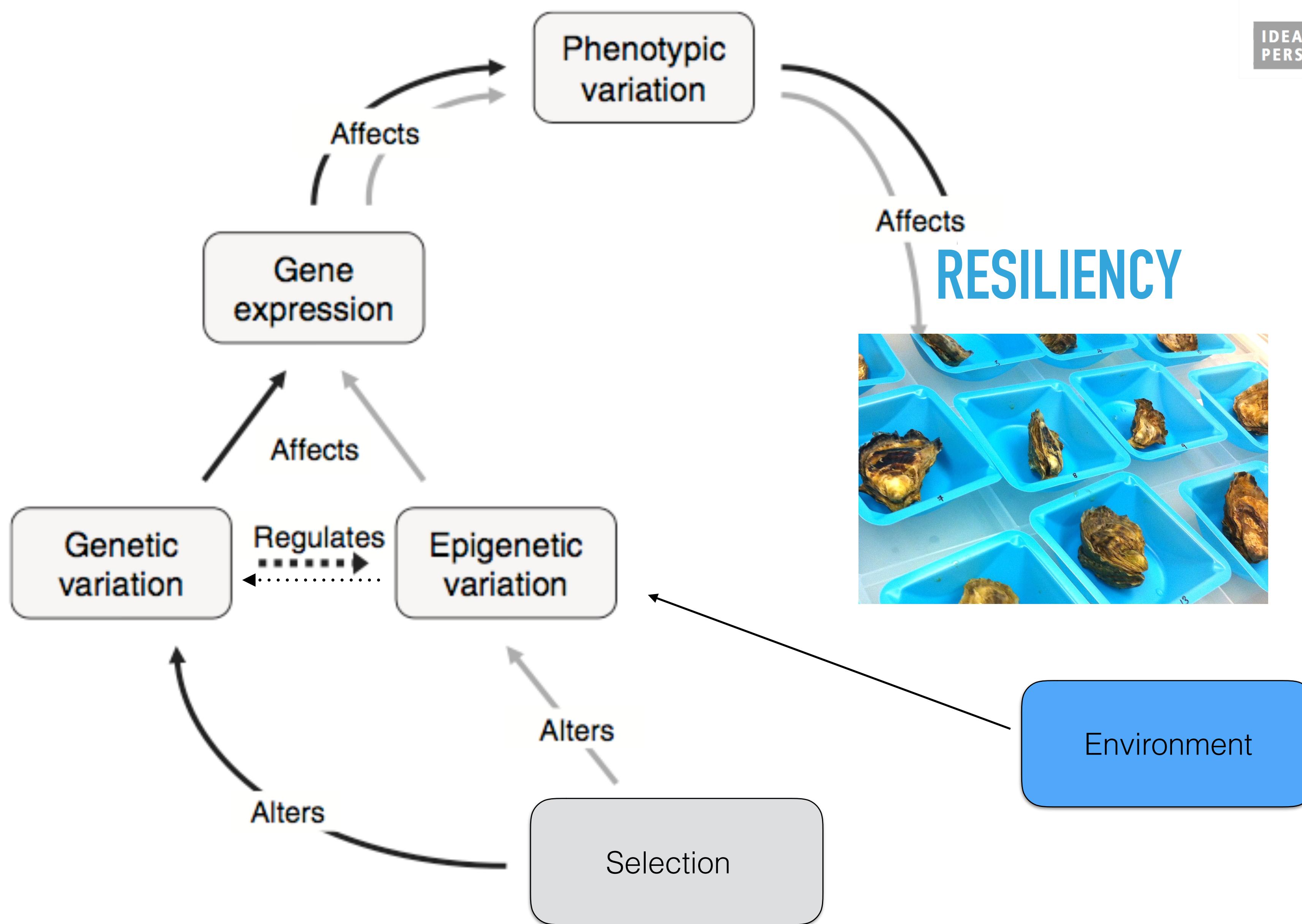
WHAT IS EPIGENETICS?

ALTERS THE PHENOTYPE (WITHOUT CHANGING DNA CODE); HERITABLE



CAN BE INDUCED WITH THROUGH ENVIRONMENTAL ALTERATION

ECOLOGICAL EPIGENETICS



Ecology Letters, (2008) 11: 106–115

doi: 10.1111/j.1461-0248.2007.01130.x

IDEA AND
PERSPECTIVE

Epigenetics for ecologists

O Bossdorf, CL Richards, M Pigliucci



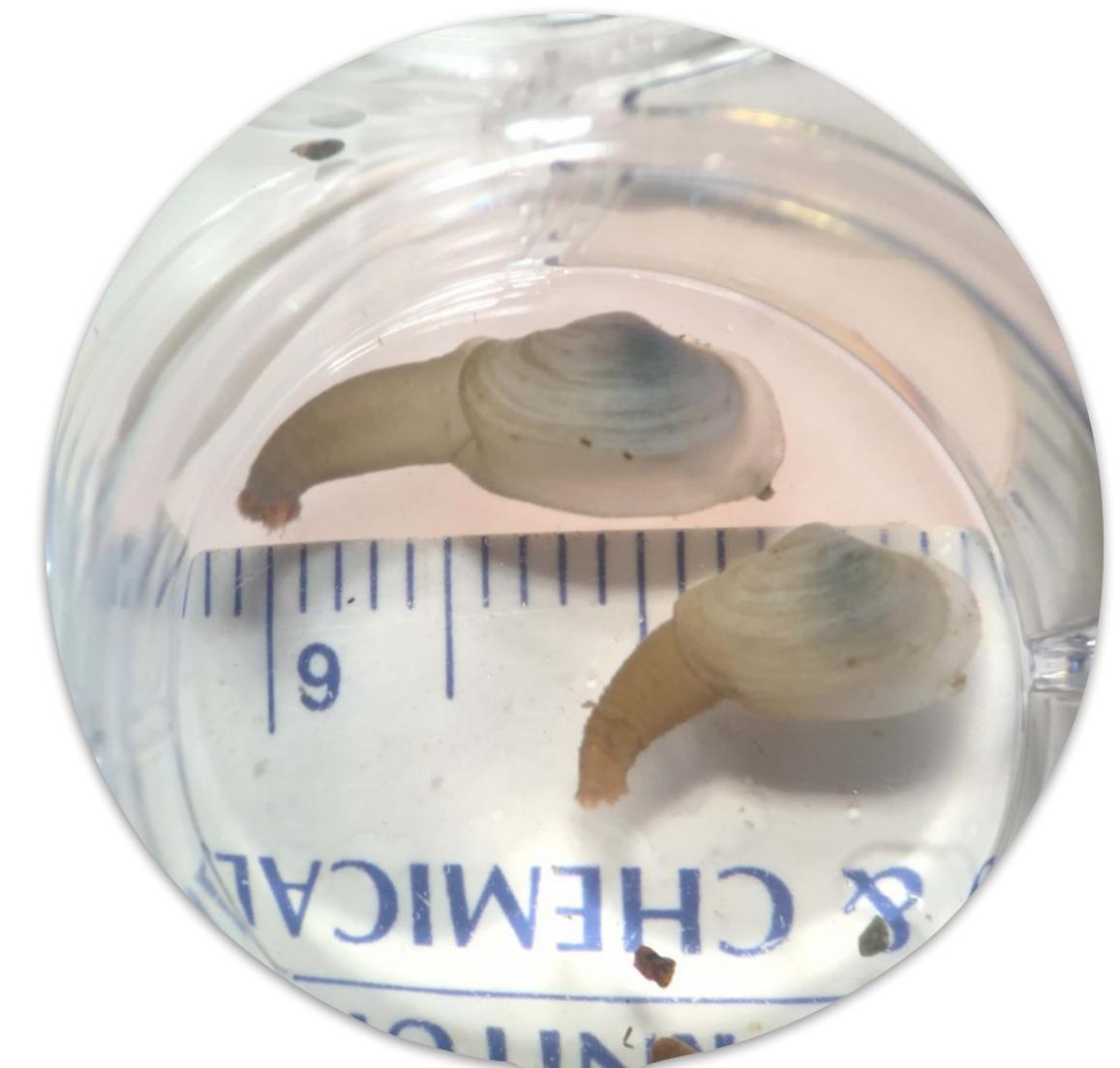
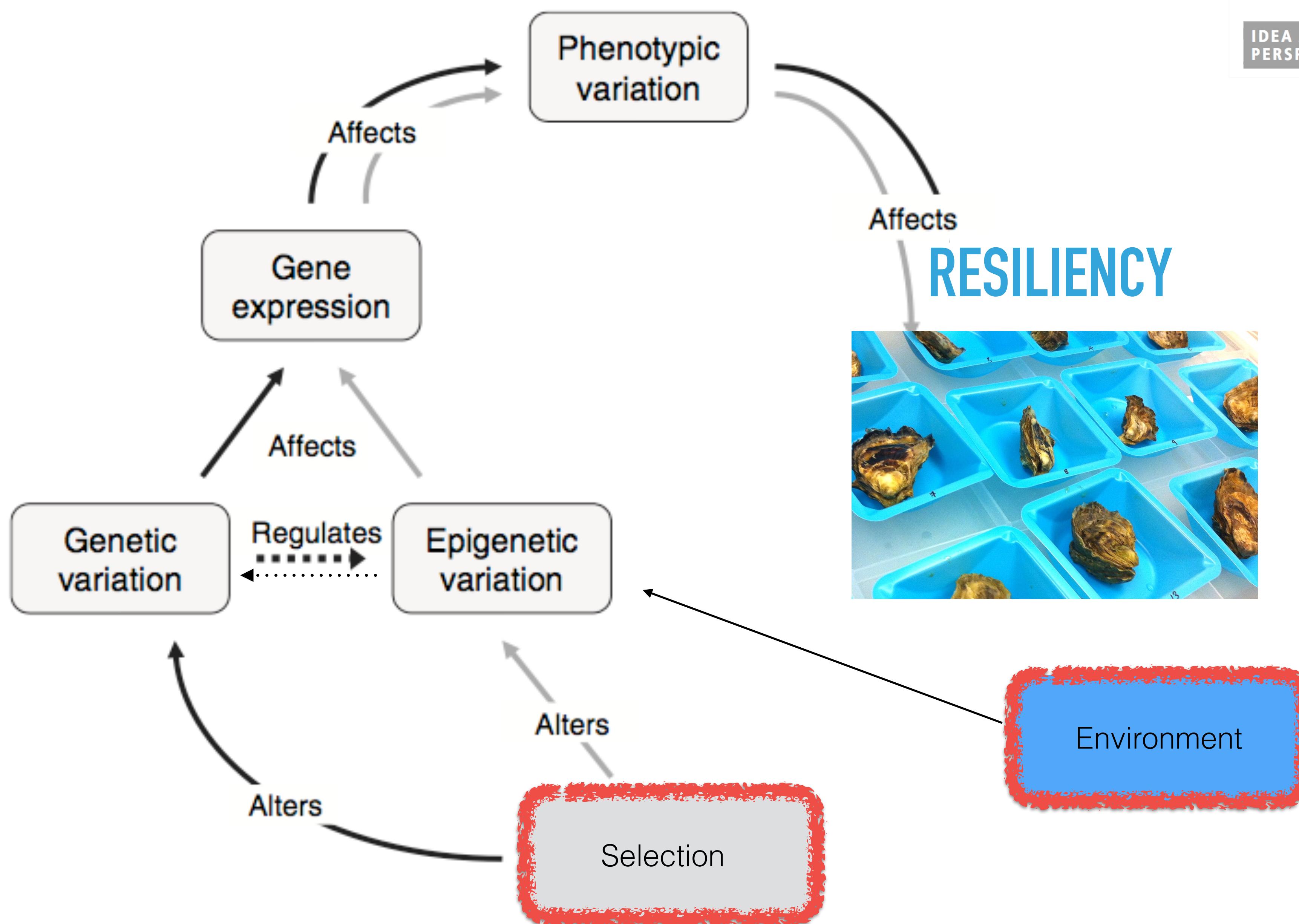
ECOLOGICAL EPIGENETICS

Ecology Letters, (2008) 11: 106–115

doi: 10.1111/j.1461-0248.2007.01130.x

IDEA AND
PERSPECTIVE

Epigenetics for ecologists



Epigenetics



Photo credit: Flickr, Creative Commons, he-boden



Epigenetics

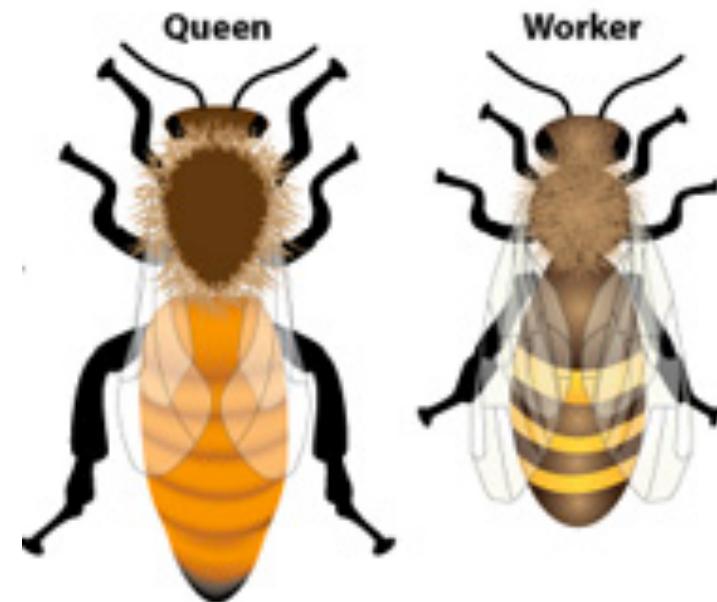
DNA METHYLATION



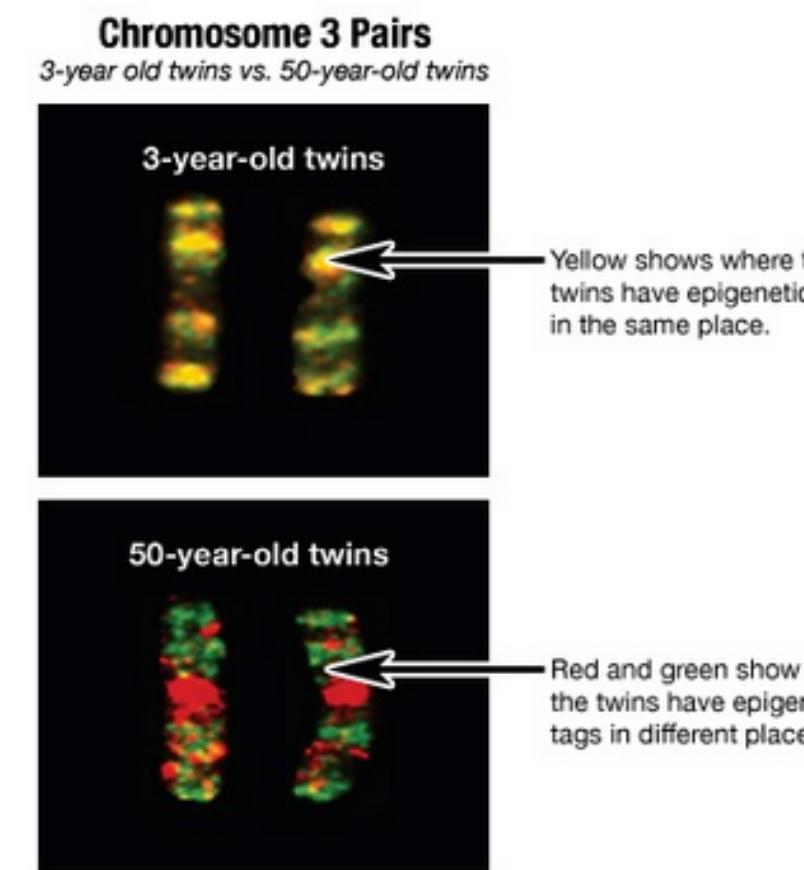
Male and female *Lates calcarifer*



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



Nature AND Nurture



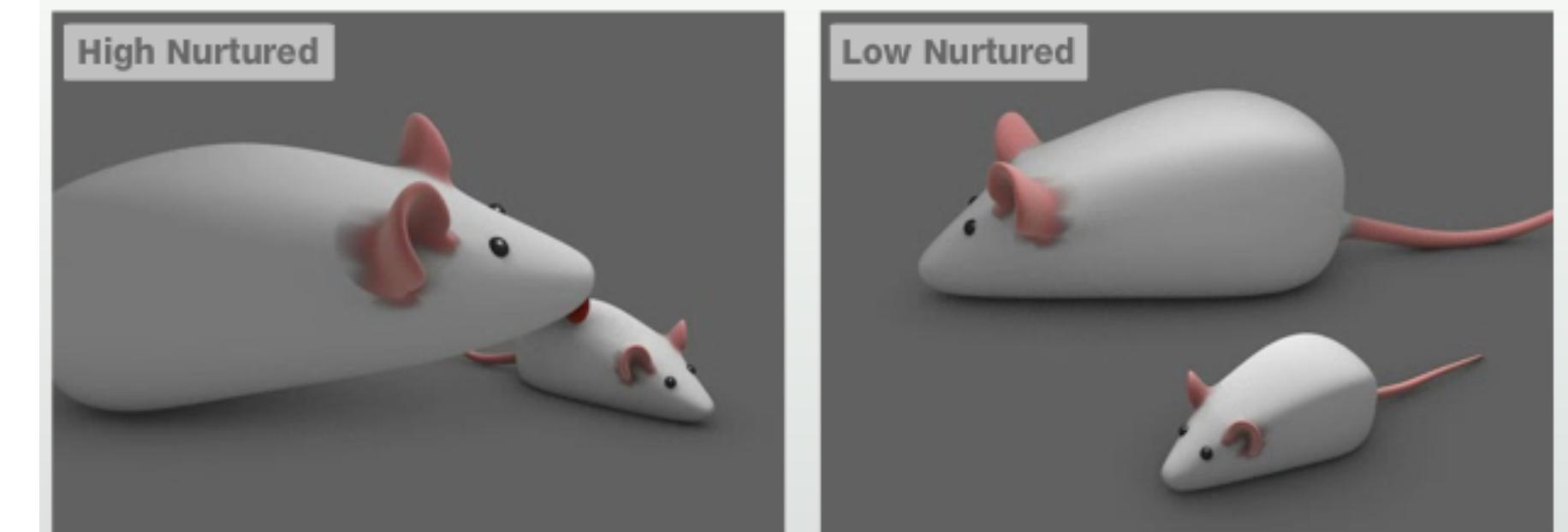
These Two Mice are Genetically Identical and the Same Age



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



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

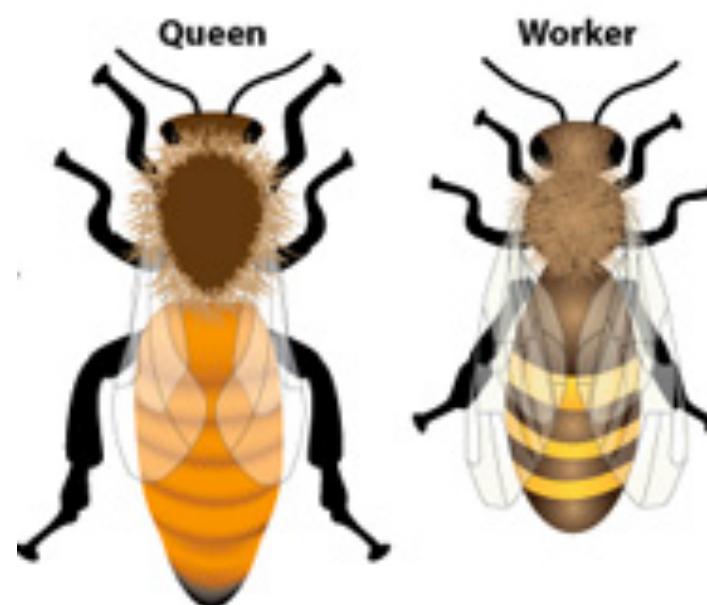
DNA METHYLATION



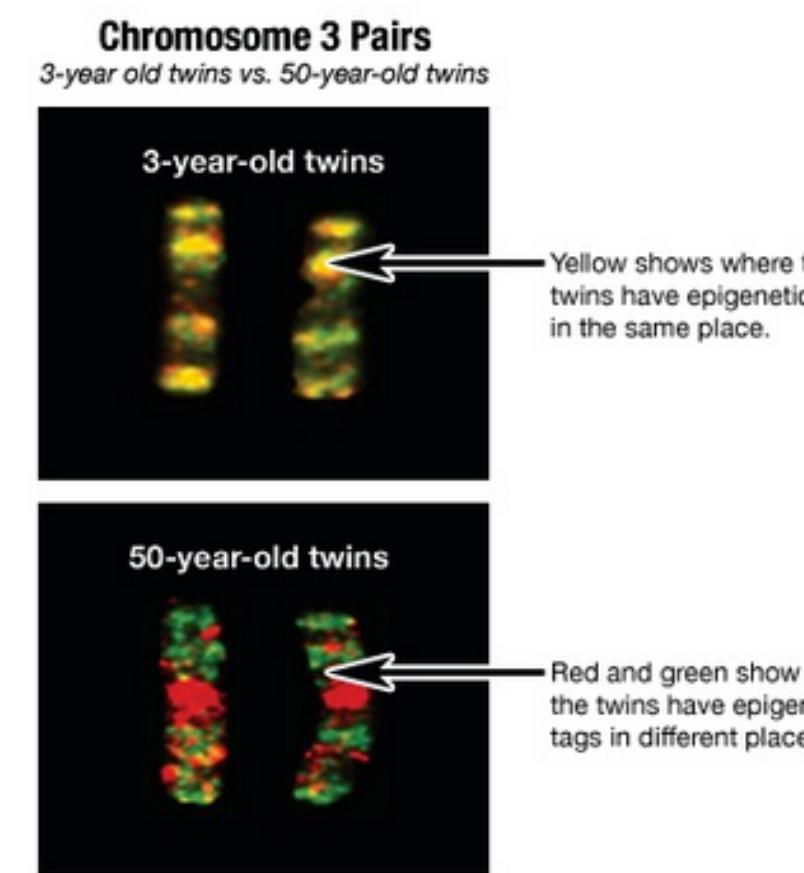
Male and female *Lates calcarifer*



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



Nature AND Nurture



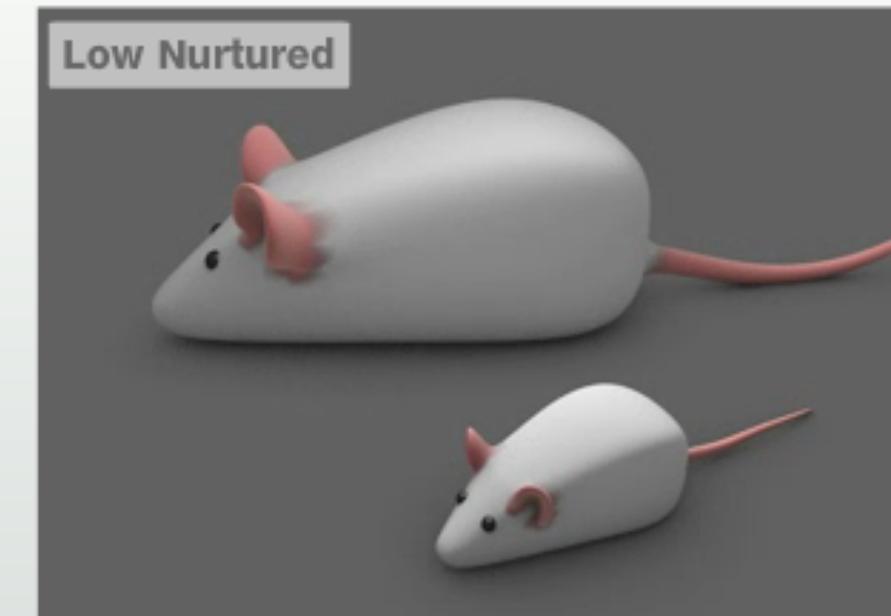
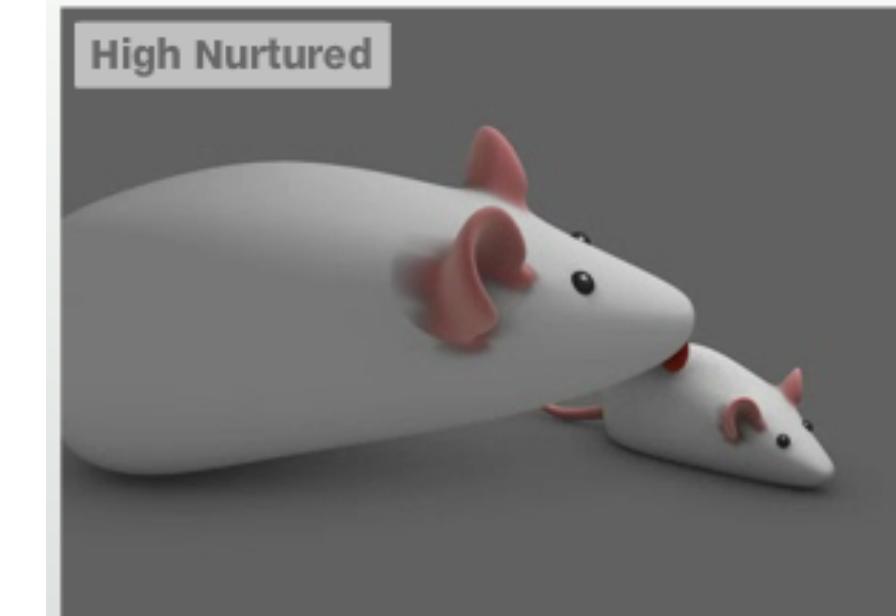
These Two Mice are Genetically Identical and the Same Age



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



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

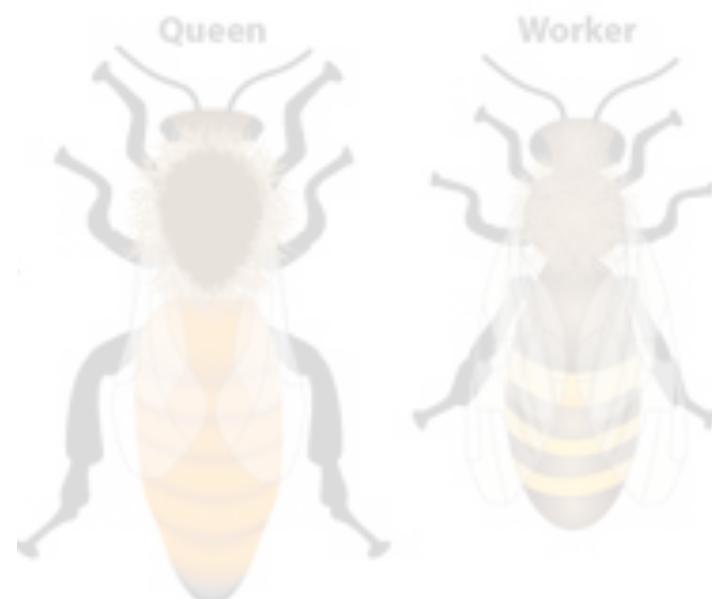
DNA METHYLATION



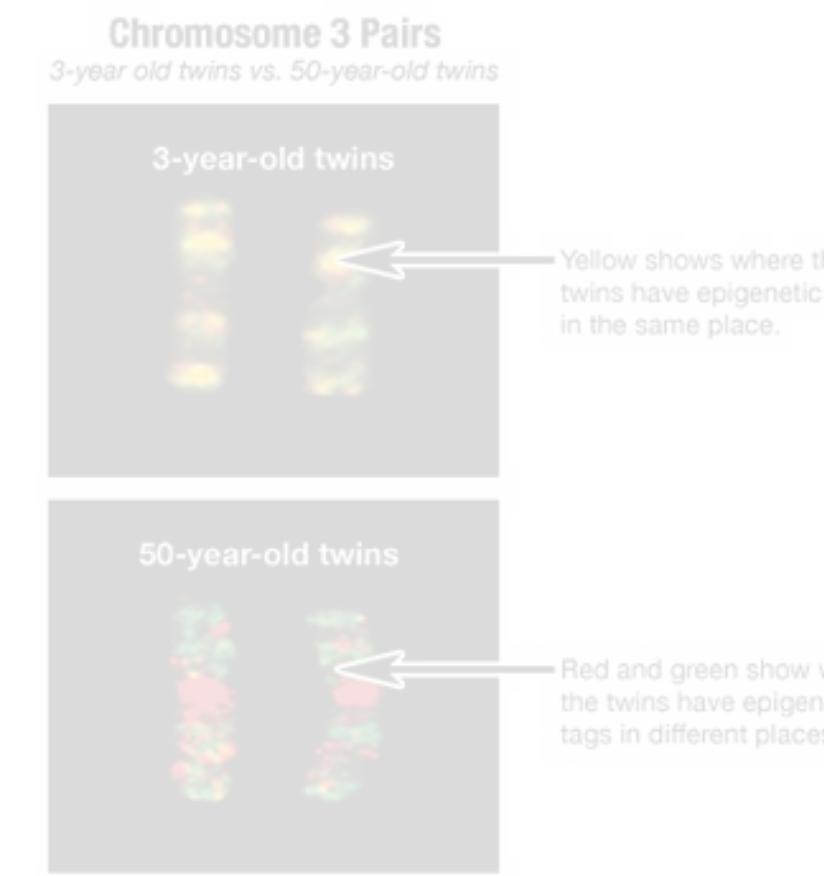
Male and female *Lates calcarifer*



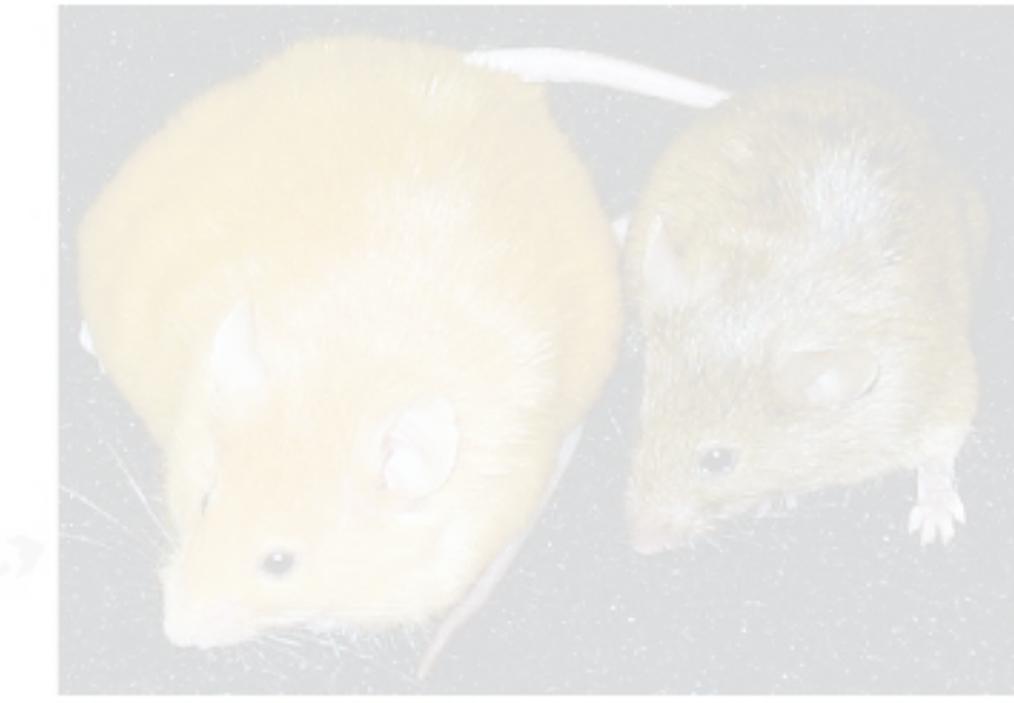
Queen Bee Larvae: Queens are raised in specially constructed cells called "queen cups," which are filled with royal jelly.



Nature AND Nurture



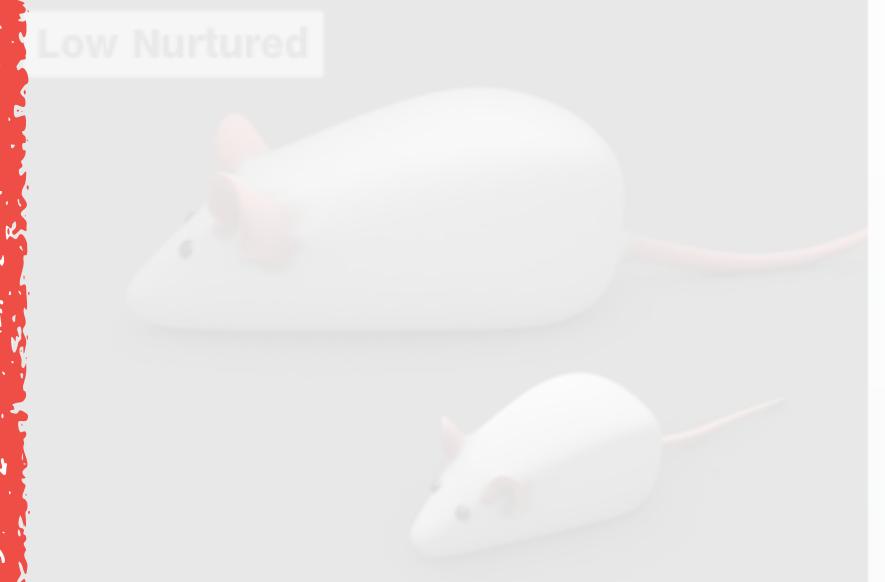
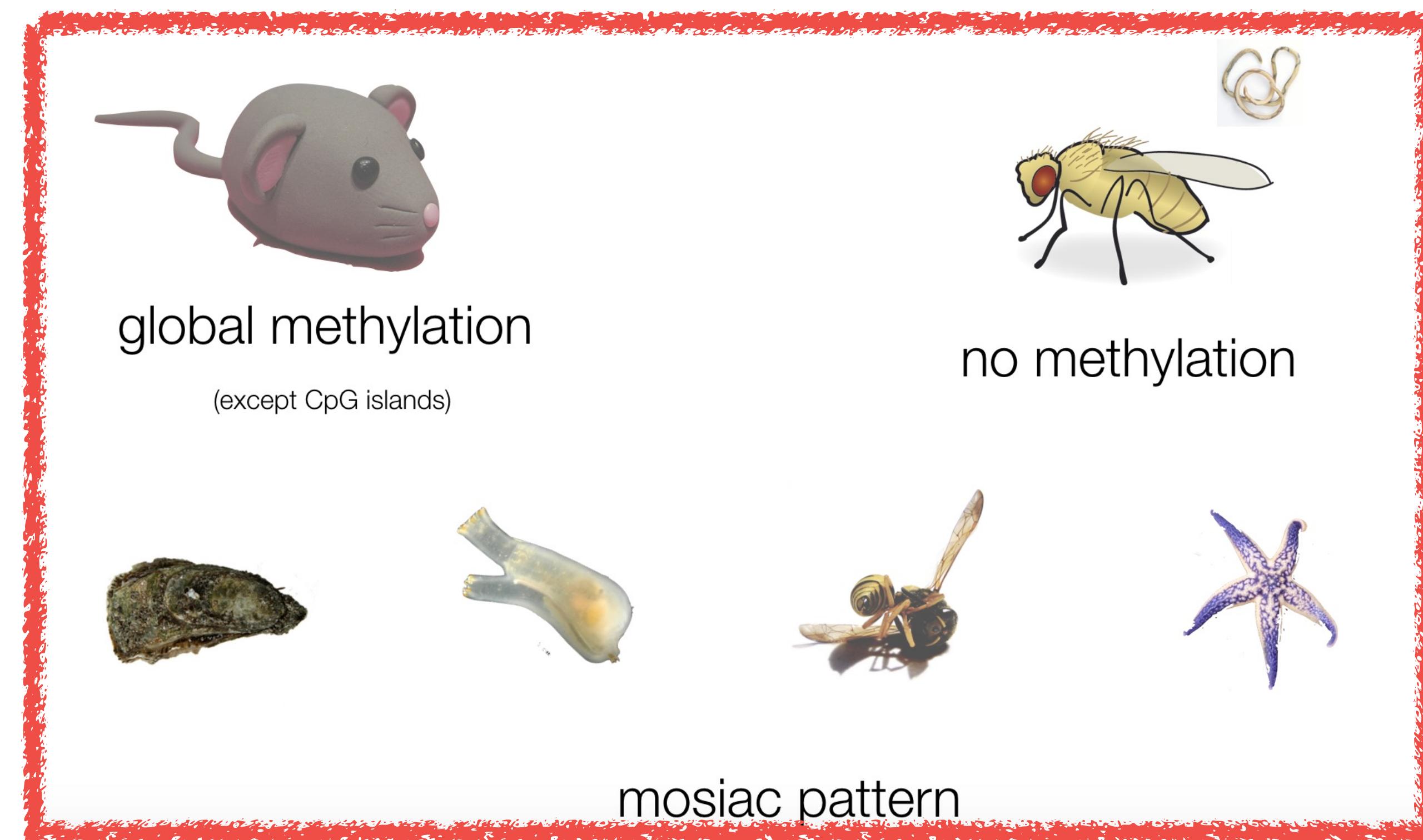
These Two Mice are Genetically Identical and the Same Age



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



so their genomes are highly

AUDIO

Non- Vertebrates?

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

ALTERS THE PHENOTYPE (WITHOUT CHANGING DNA CODE); HERITABLE



CAN BE INDUCED WITH THROUGH ENVIRONMENTAL ALTERATION

ALTERS THE PHENOTYPE (WITHOUT CHANGING DNA CODE); HERITABLE



ALTERS THE PHENOTYPE (WITHOUT CHANGING DNA CODE); HERITABLE

3

1 Function

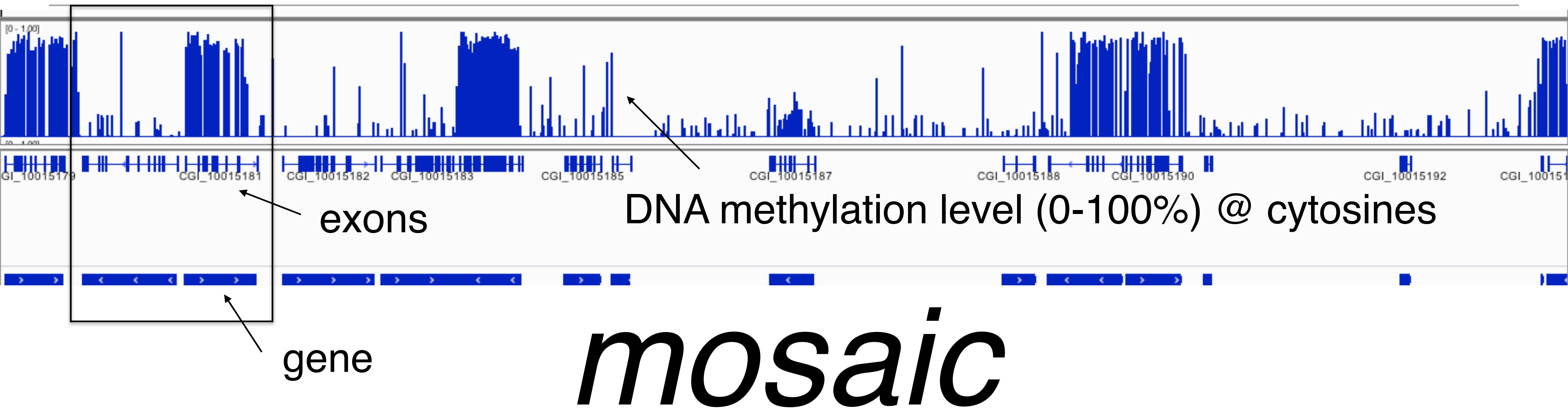
DNA Methylation

2

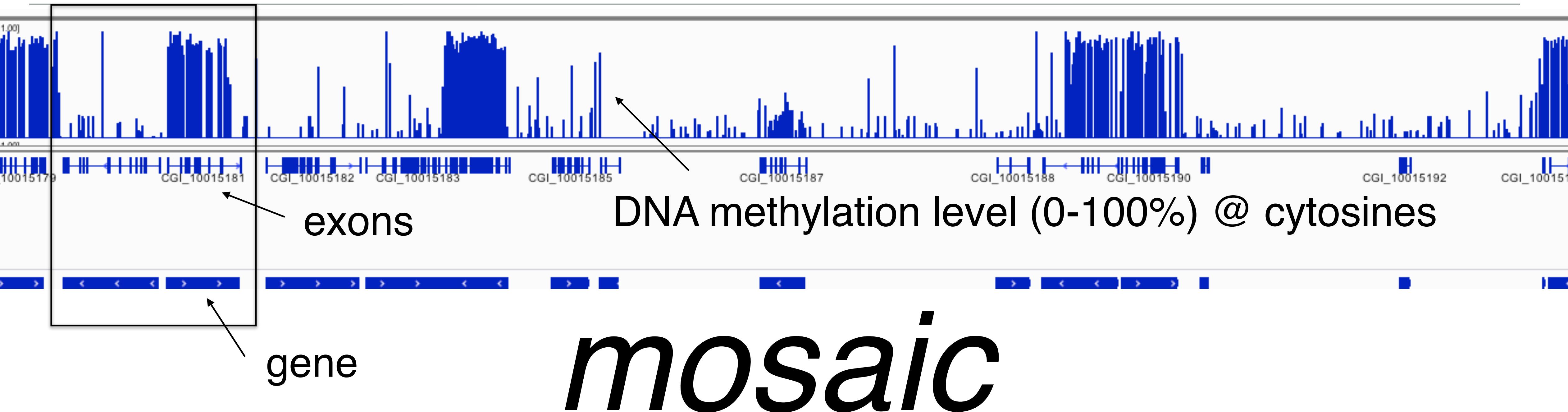
CAN BE INDUCED WITH THROUGH ENVIRONMENTAL ALTERATION



METHYLATION LANDSCAPE IN MARINE INVERTEBRATES



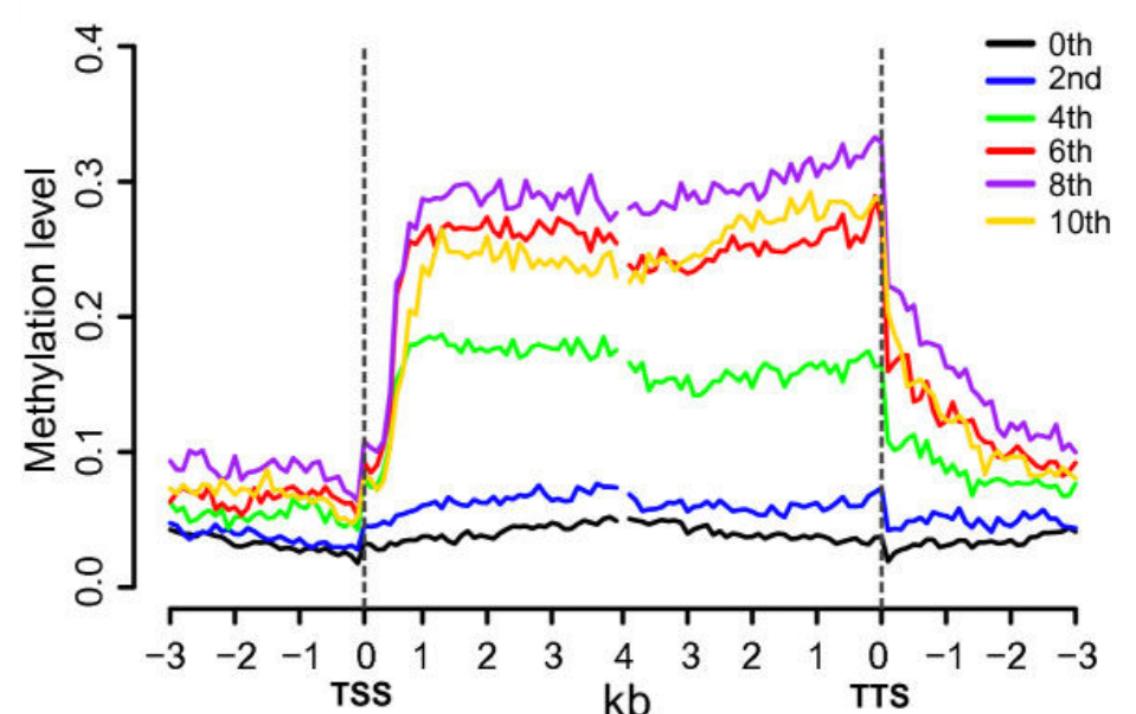
METHYLATION LANDSCAPE IN MARINE INVERTEBRATES



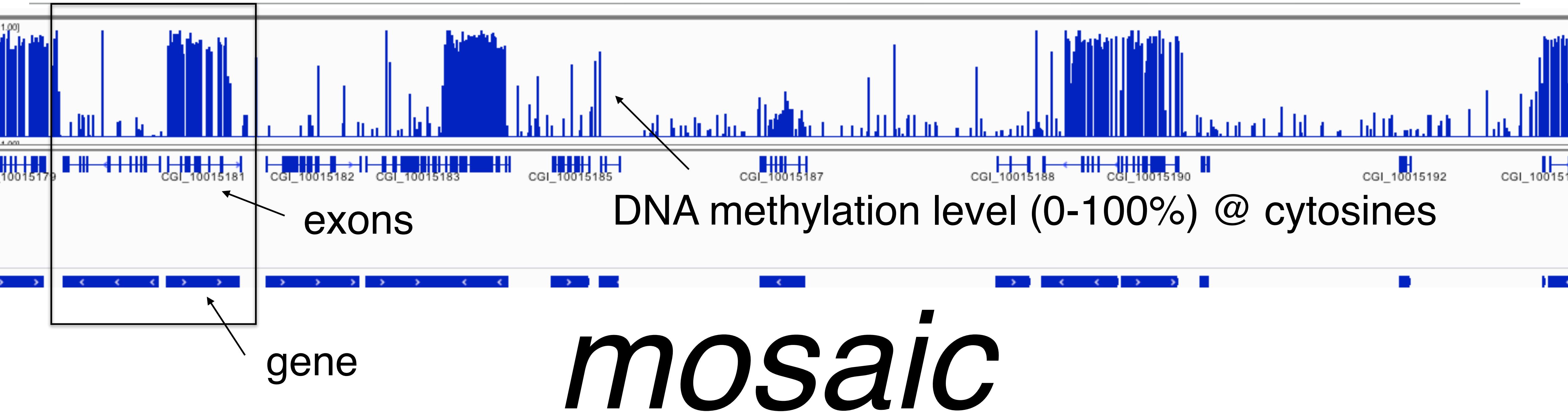
associated with gene bodies

Genome-wide and single-base resolution
DNA methylomes of the Pacific oyster
Crassostrea gigas provide insight into the
evolution of invertebrate CpG methylation

Xiaotong Wang [†], Qiye Li [†], Jinmin Lian [†], Li Li [†], Lijun Jin, Huimin Cai, Fei Xu, Haigang Qi,
Linlin Zhang, Fucun Wu, Jie Meng, Huayong Que, Xiaodong Fang, Ximing Guo and
Guofan Zhang



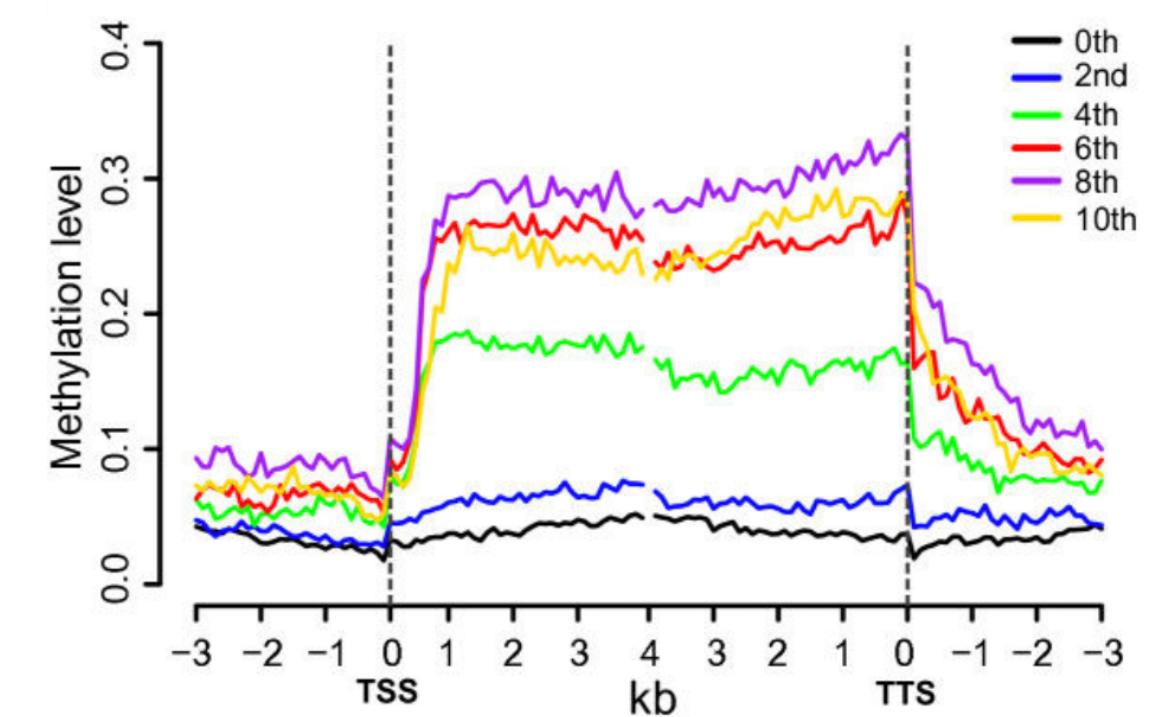
METHYLATION LANDSCAPE IN MARINE INVERTEBRATES



associated with gene bodies

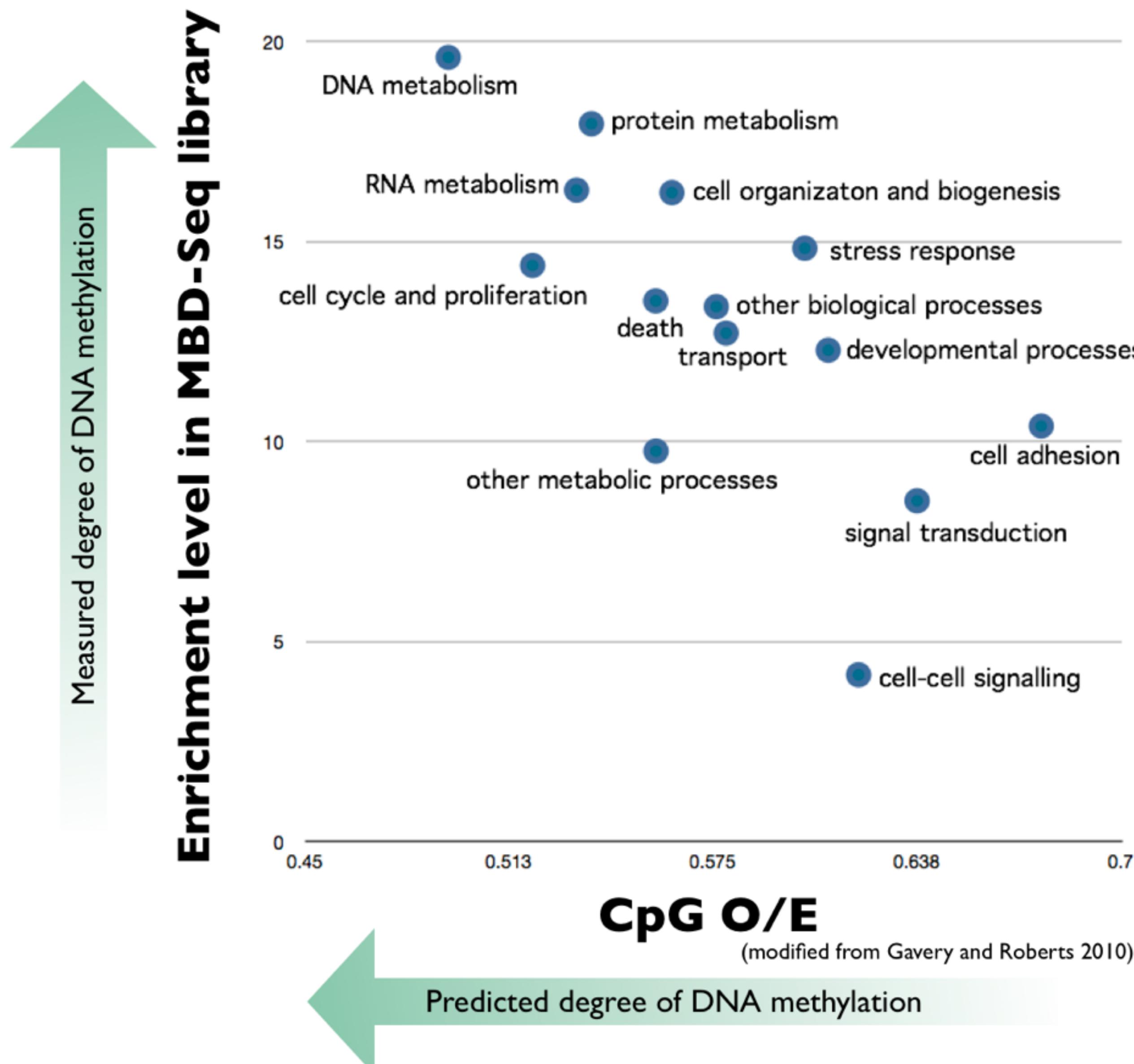
Genome-wide and single-base resolution
DNA methylomes of the Pacific oyster
Crassostrea gigas provide insight into the
evolution of invertebrate CpG methylation

Xiaotong Wang [†], Qiye Li [†], Jinmin Lian [†], Li Li [†], Lijun Jin, Huimin Cai, Fei Xu, Haigang Qi,
Linlin Zhang, Fucun Wu, Jie Meng, Huayong Que, Xiaodong Fang, Ximing Guo and
Guofan Zhang



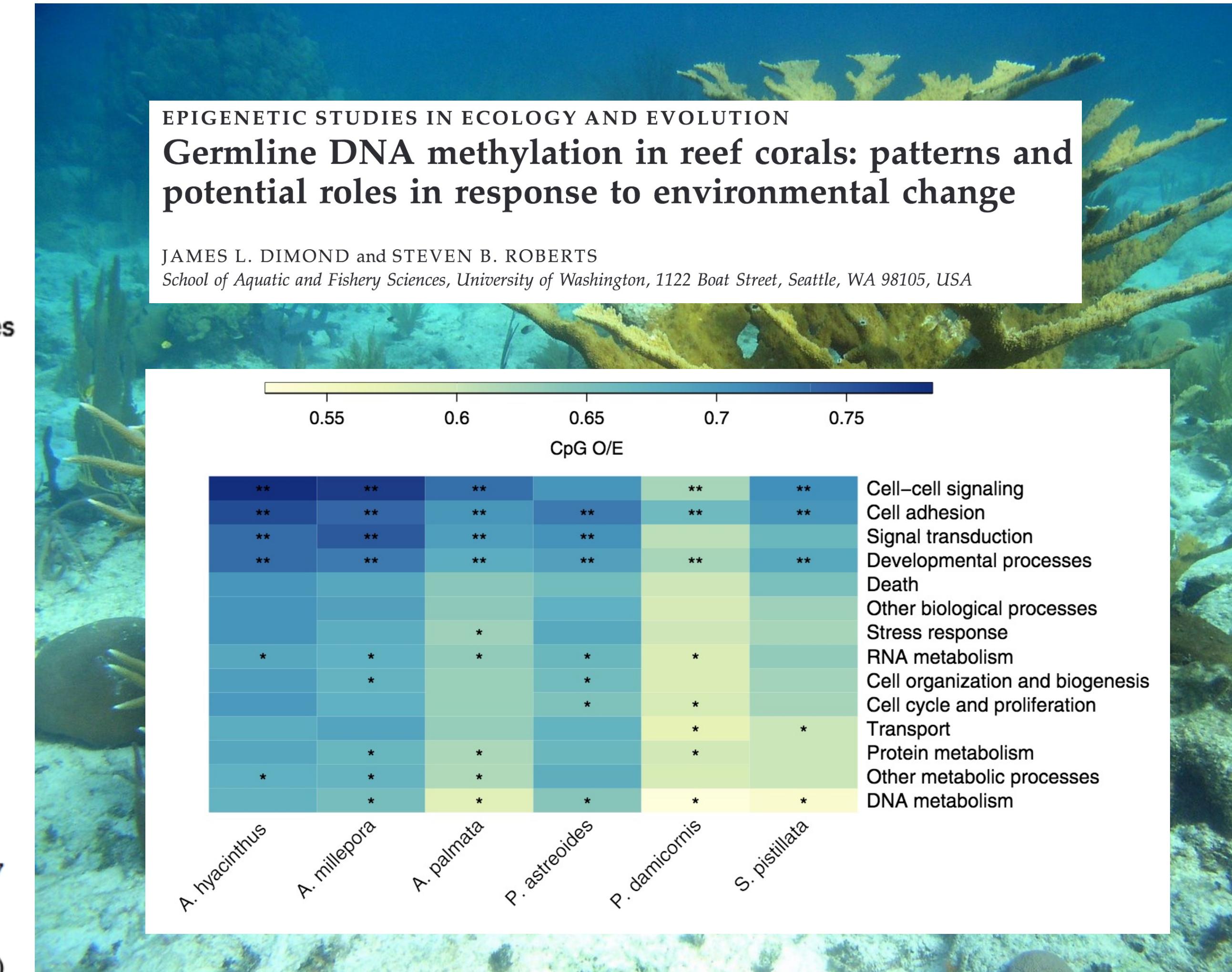
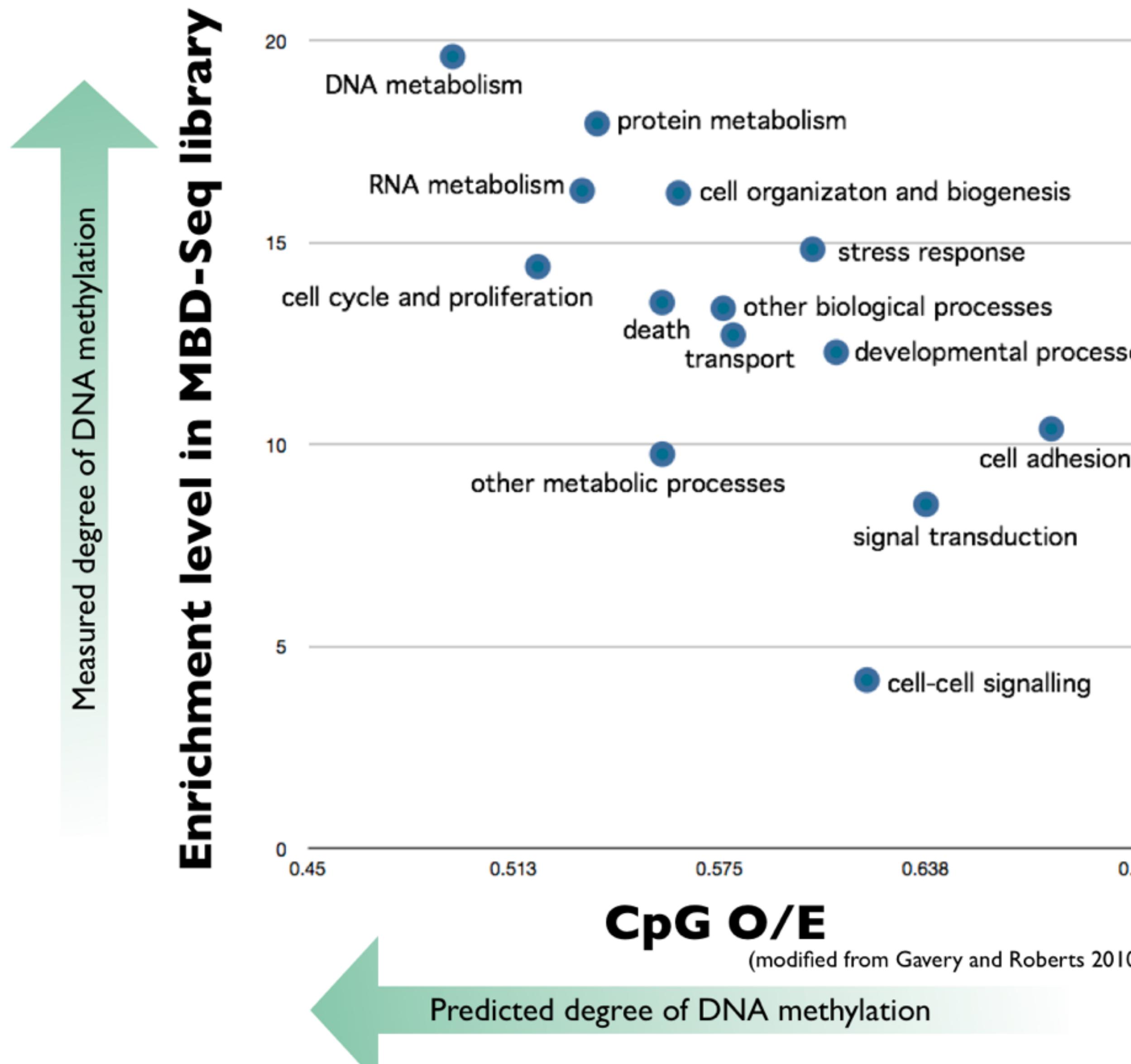
Why are only a subset of genes methylated?

METHYLATION LANDSCAPE IN MARINE INVERTEBRATES

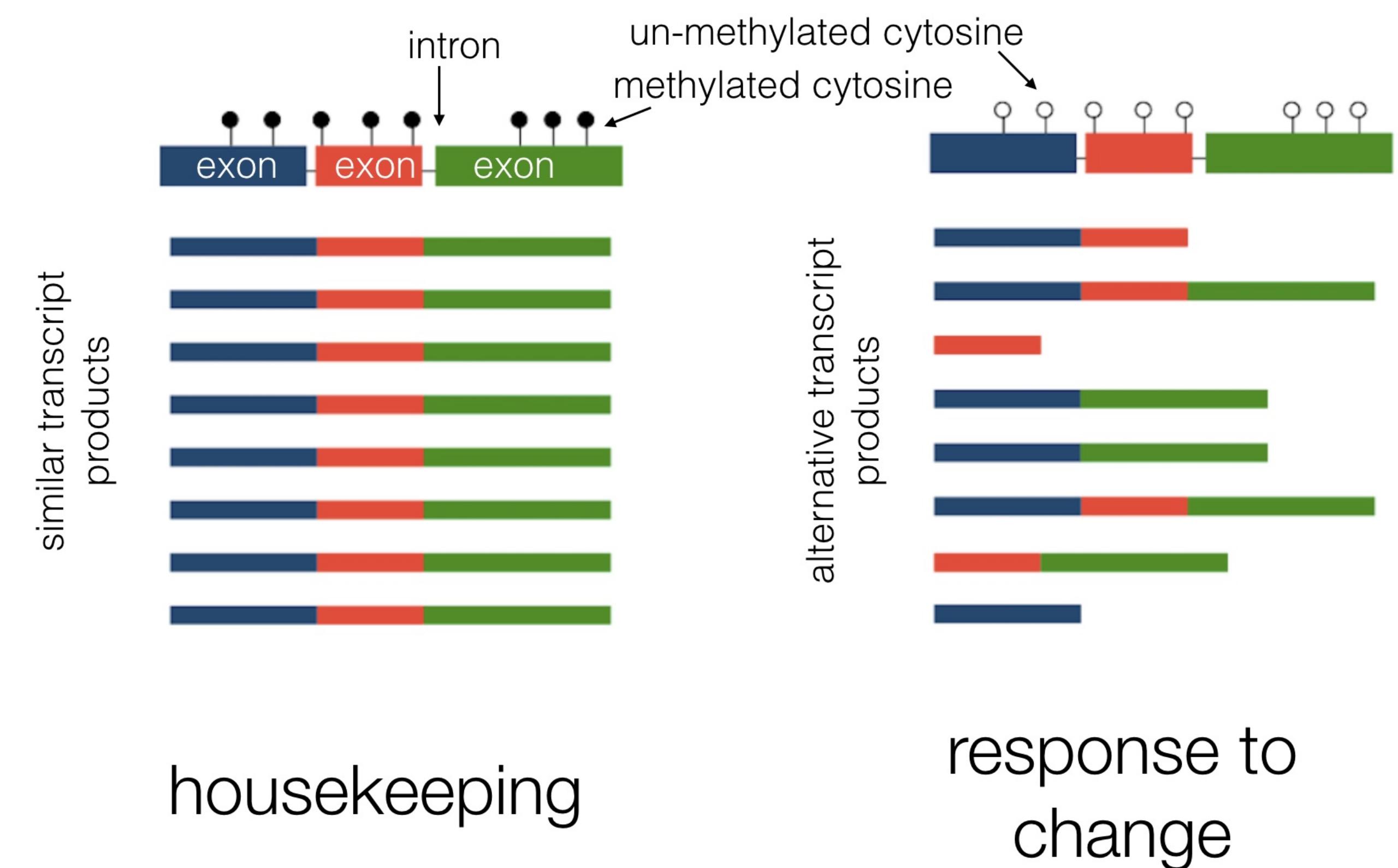
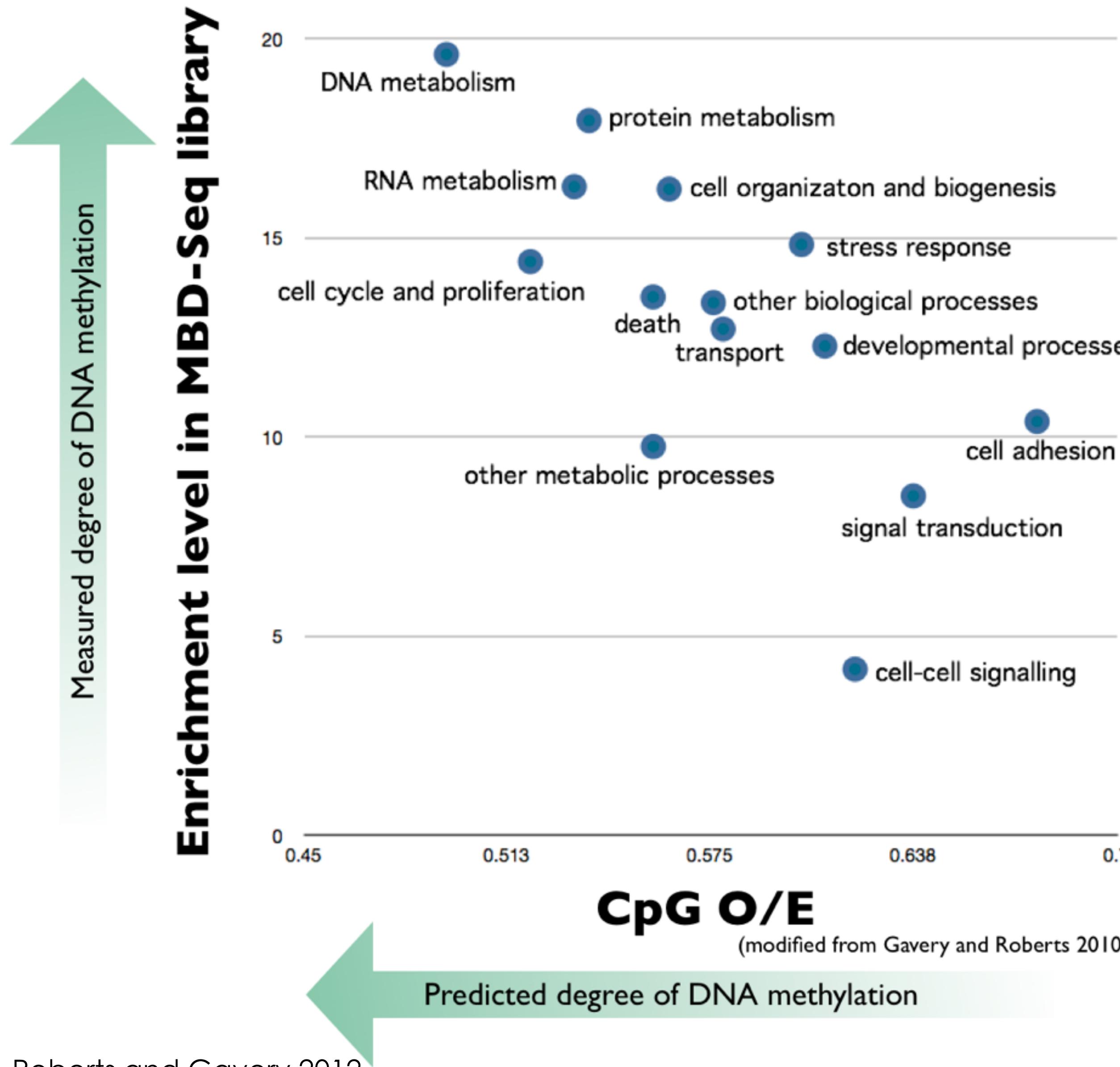


METHYLATION LANDSCAPE IN MARINE INVERTEBRATES

Jay Dimond



METHYLATION LANDSCAPE IN MARINE INVERTEBRATES



A context dependent role for DNA methylation in bivalves

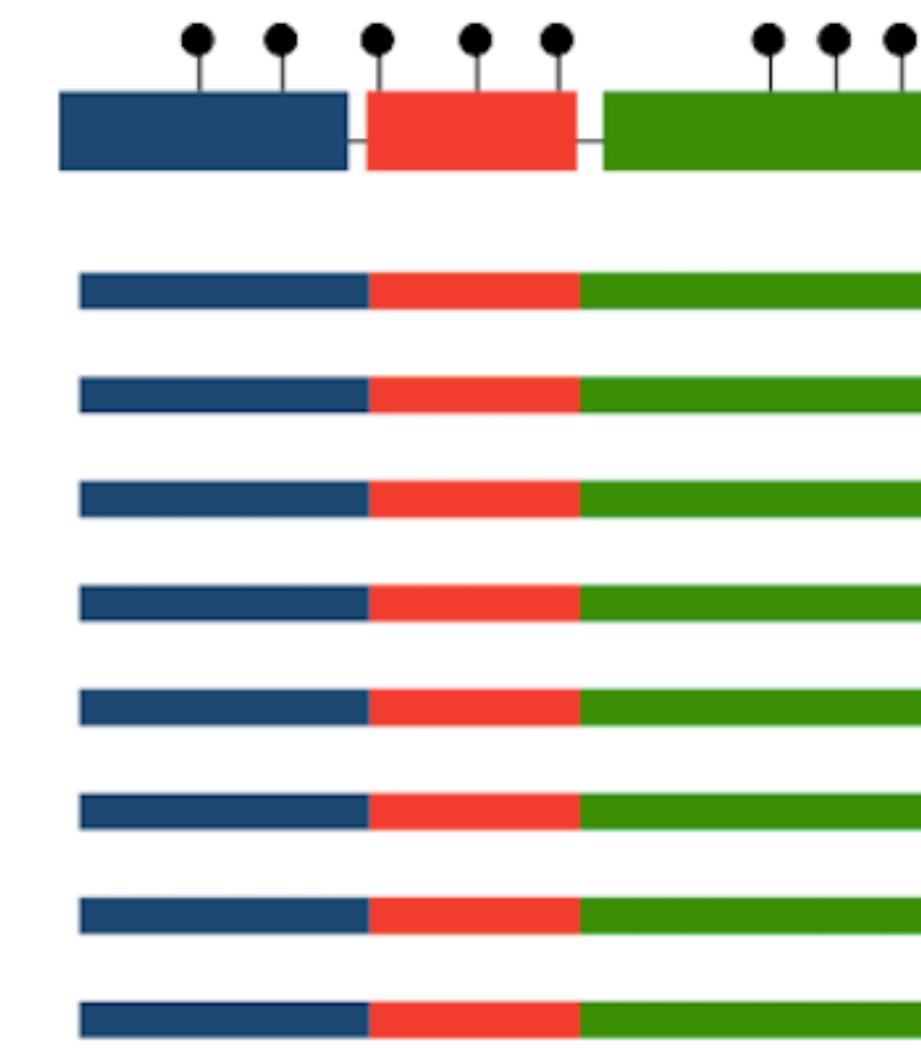
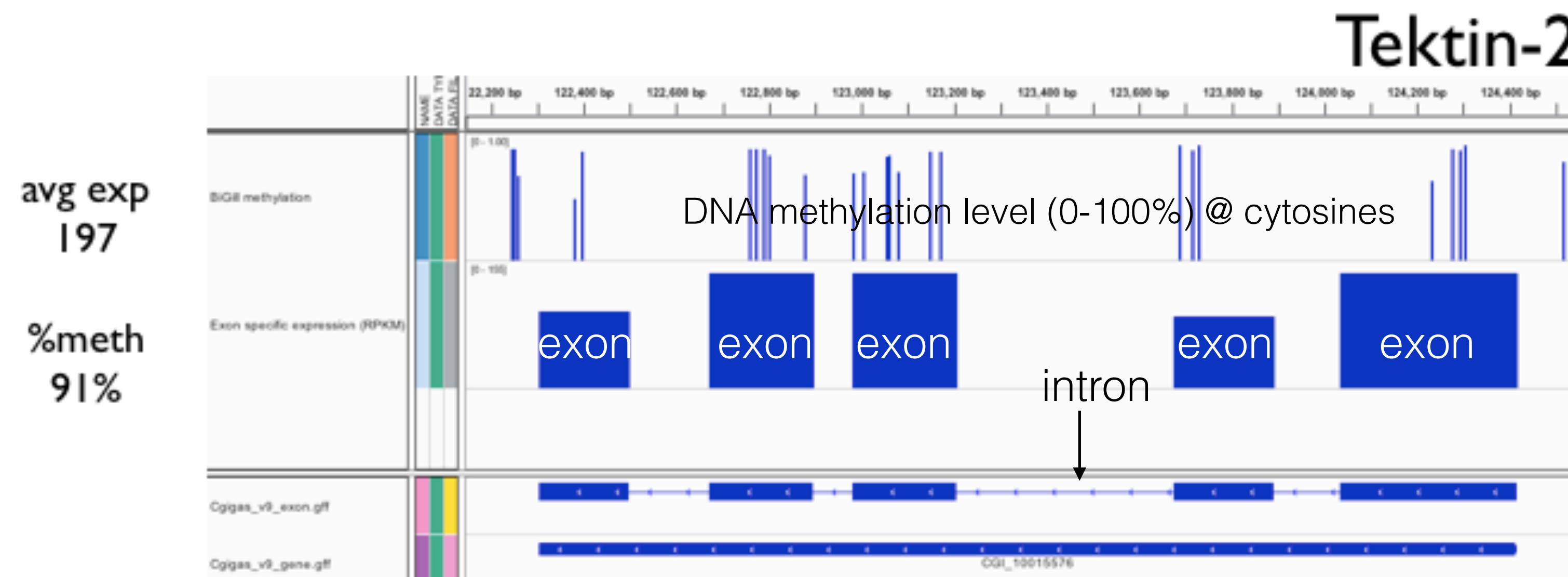
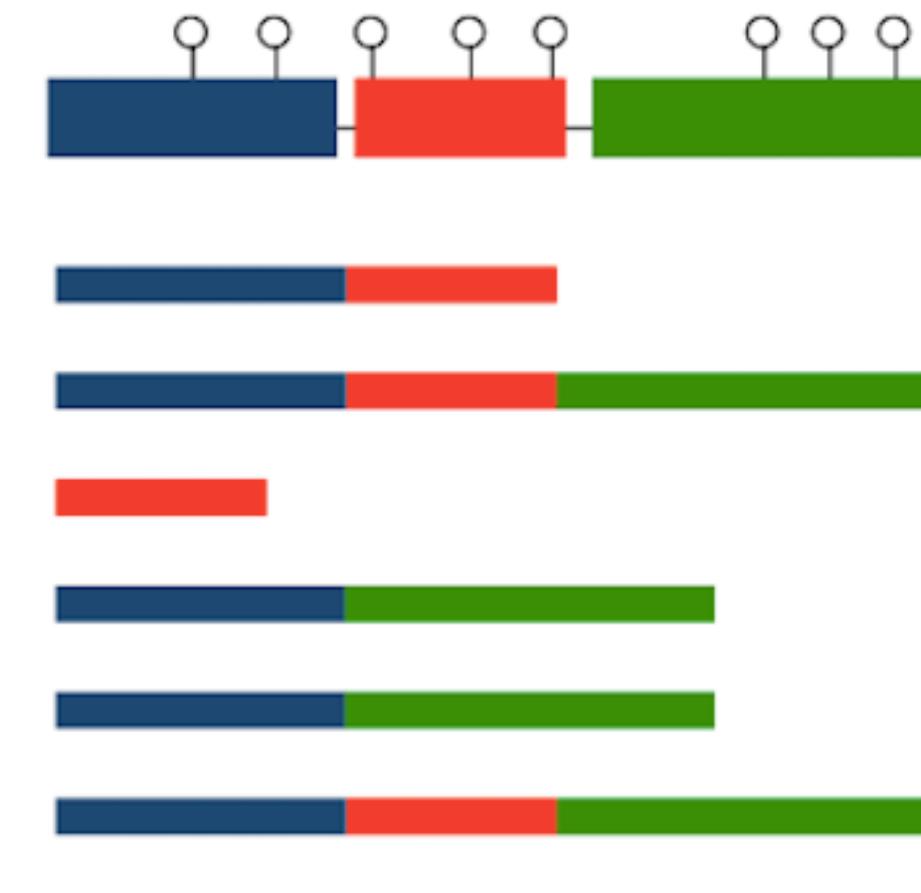
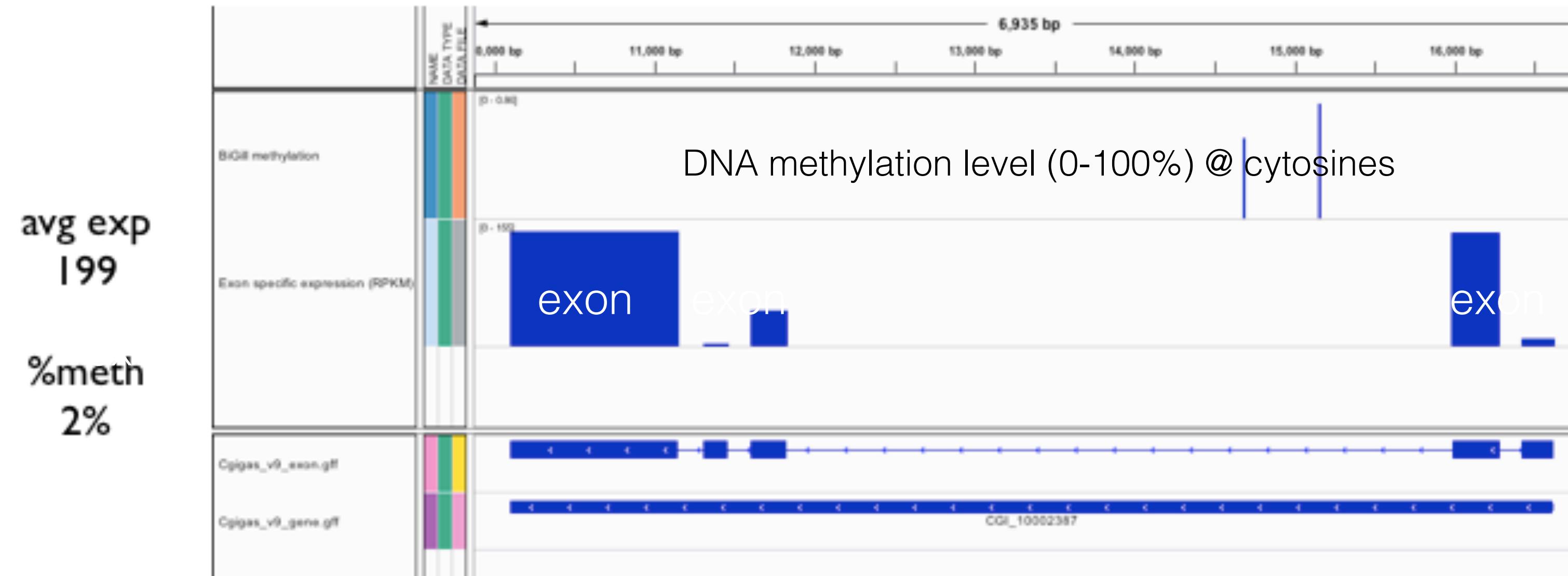
Mackenzie R. Gavery, Steven B. Roberts

Briefings in Functional Genomics, Volume 13, Issue 3, May 2014, Pages 217–222,

<https://doi.org/10.1093/bfgp/elt054>

Could STOCHASTIC VARIATION contribute to ACCLIMATIZATION and ADAPTATION?

Heat shock 70 kDa protein 12A





In species that experience a diverse range of environmental conditions, processes have evolved to increase the number of potential phenotypes in a population in order to improve the chances for an individual's survival.



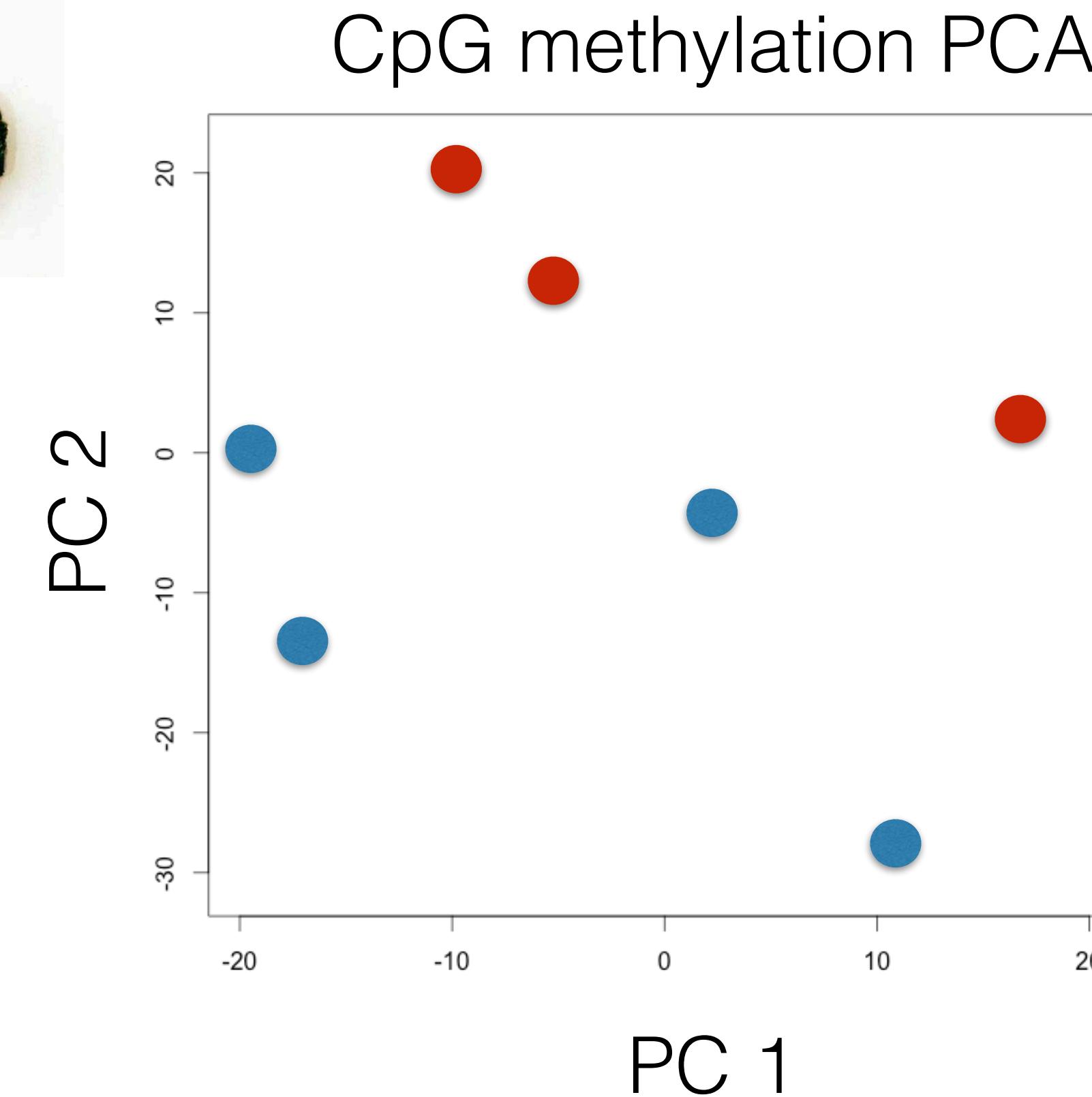
ALTERS THE PHENOTYPE (WITHOUT CHANGING DNA CODE); HERITABLE



2

CAN BE INDUCED WITH THROUGH ENVIRONMENTAL ALTERATION

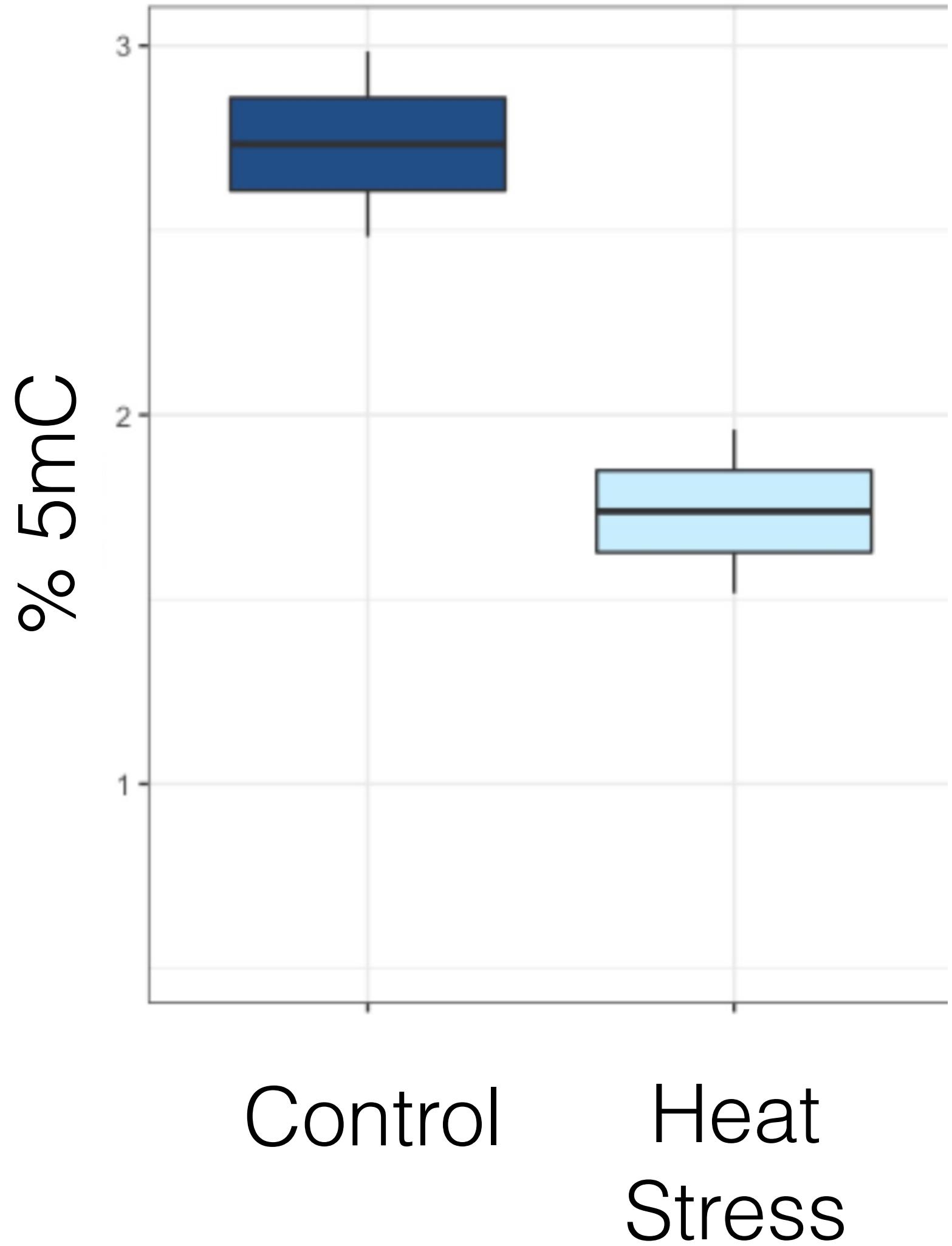
Local Environmental Differences Influence DNA Methylation Patterns



MBD-BS Sequencing



Temperature and Desiccation Decreases Global DNA Methylation

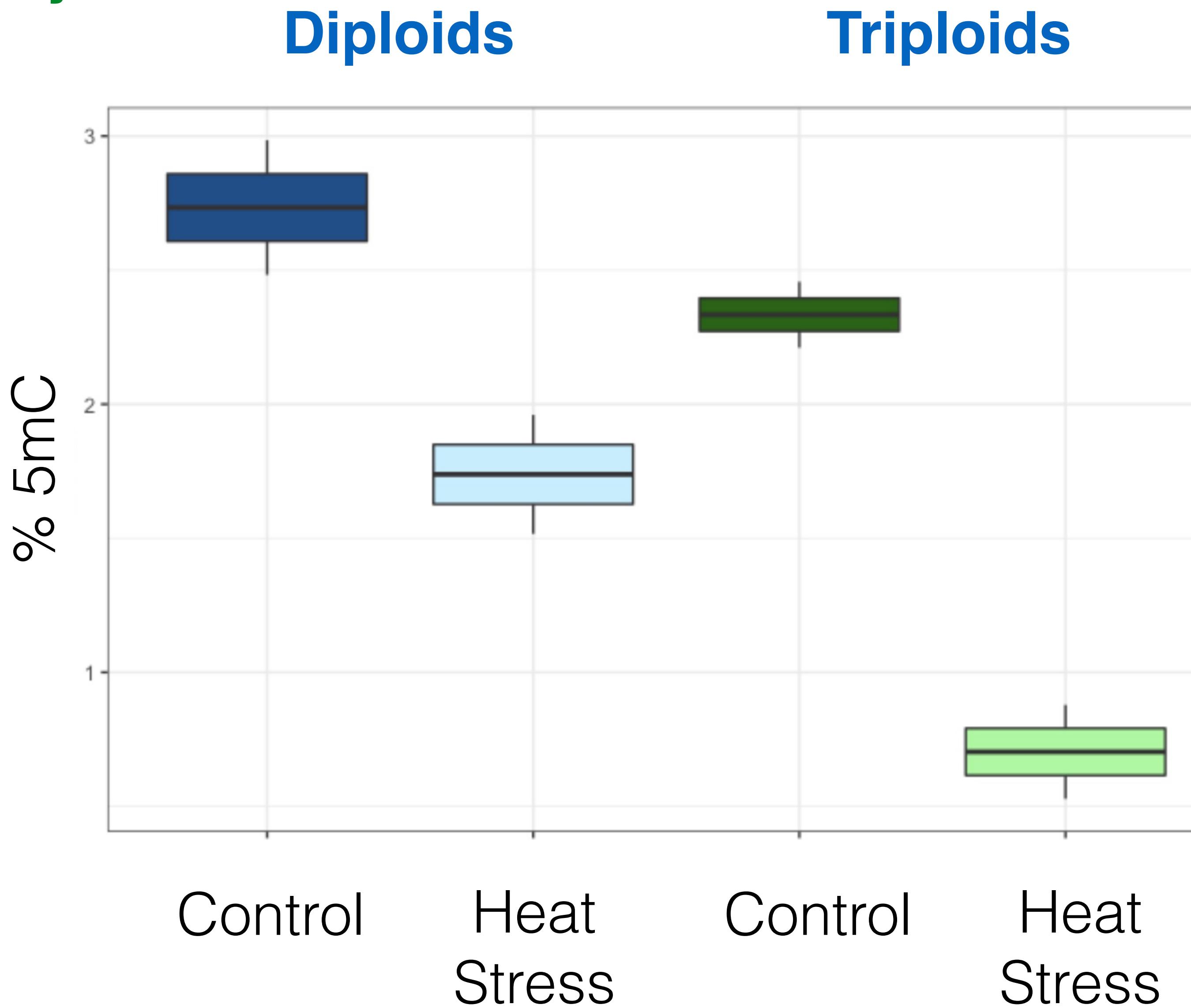


DNA Methylation ELISA

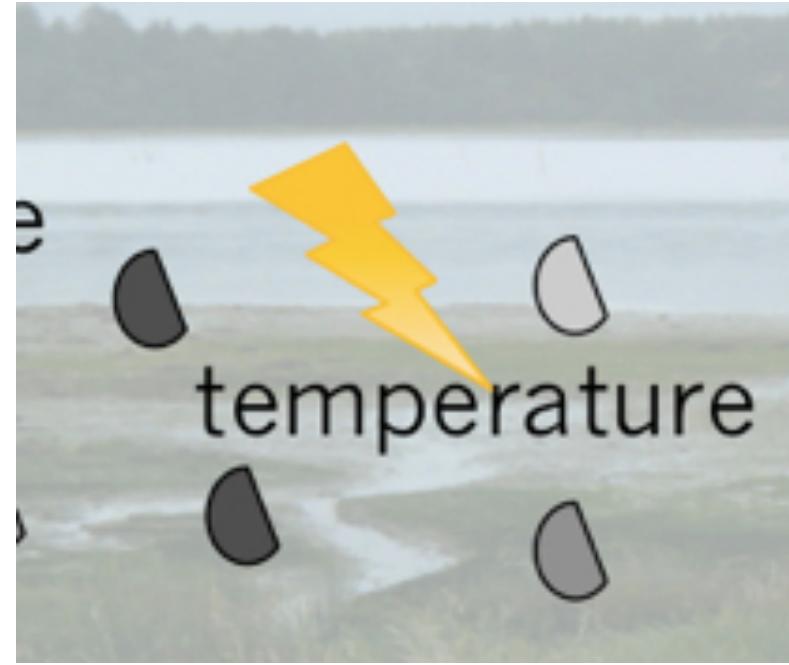
Temperature and Desiccation Decreases Global DNA Methylation



DNA Methylation ELISA



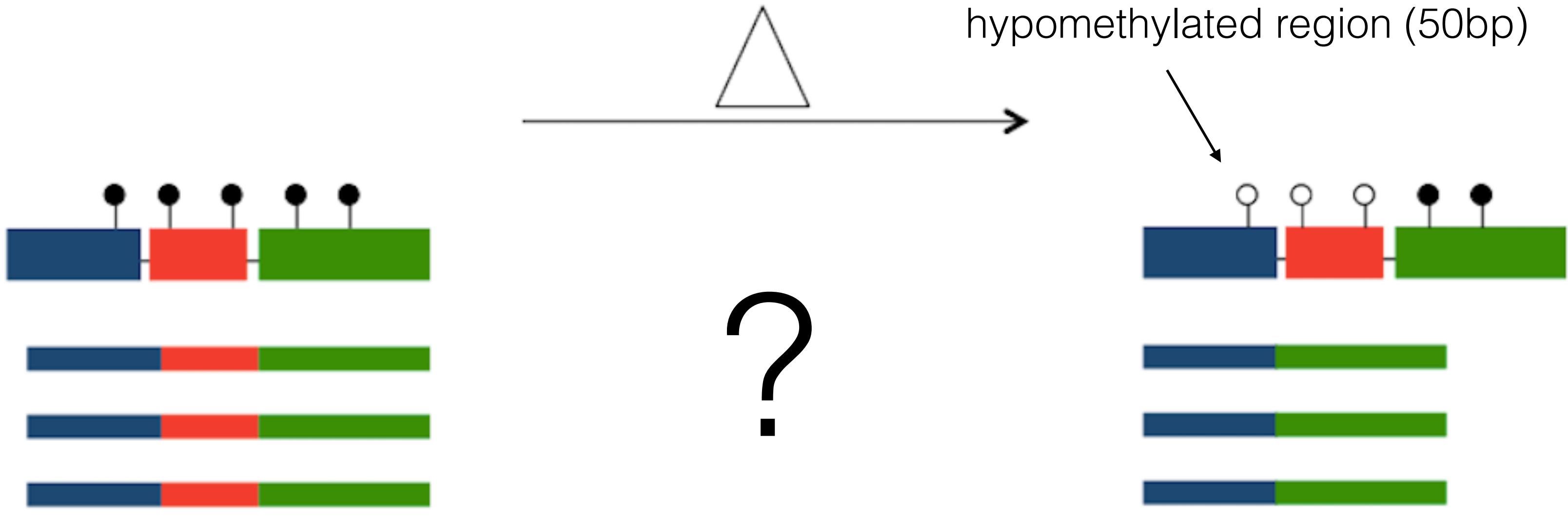
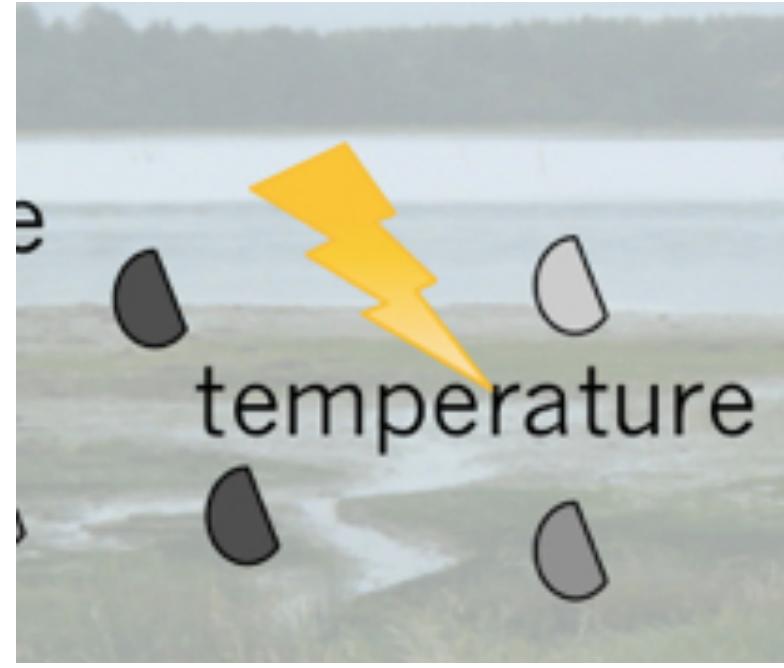
Temperature Alters CpG Methylation



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

MBD-Array

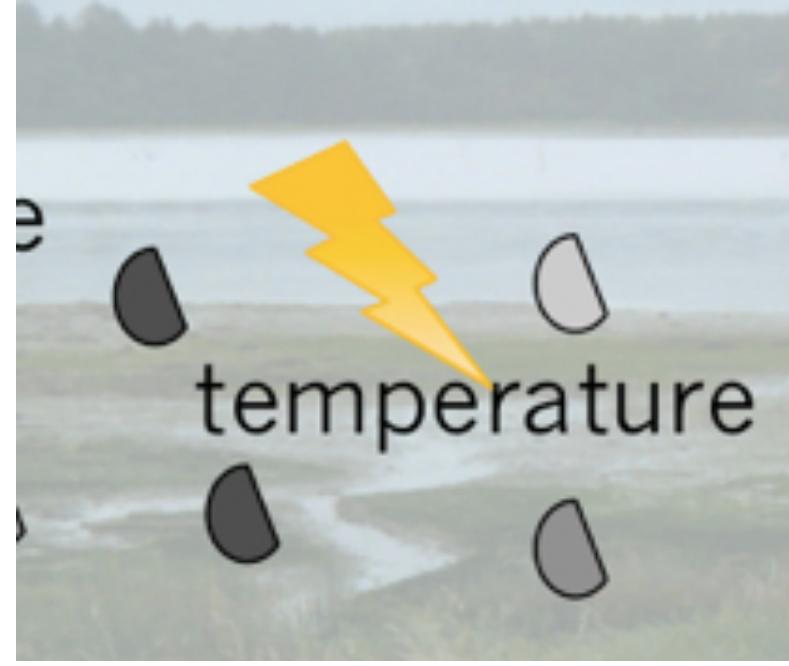
Temperature Alters CpG Methylation



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

MBD-Array

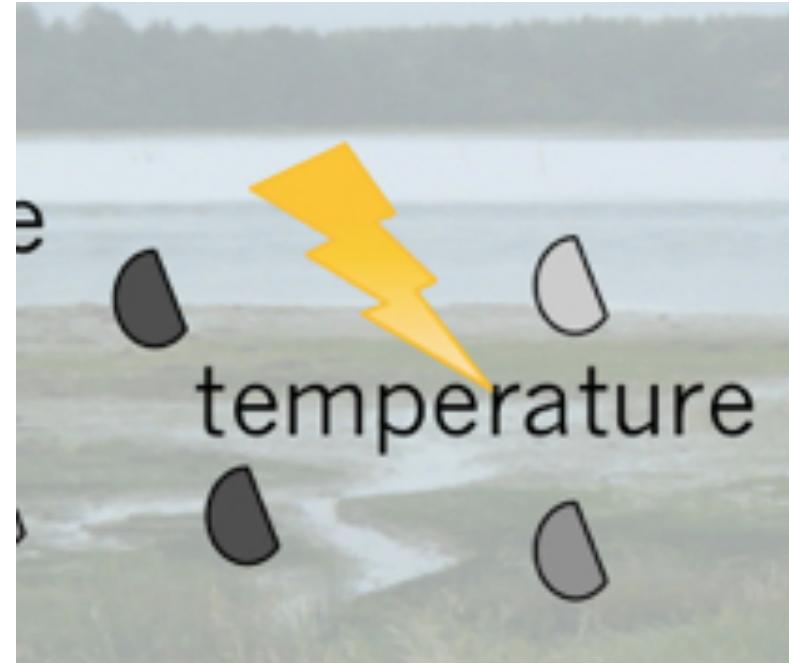
Temperature Alters CpG Methylation



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

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

Temperature Alters CpG Methylation



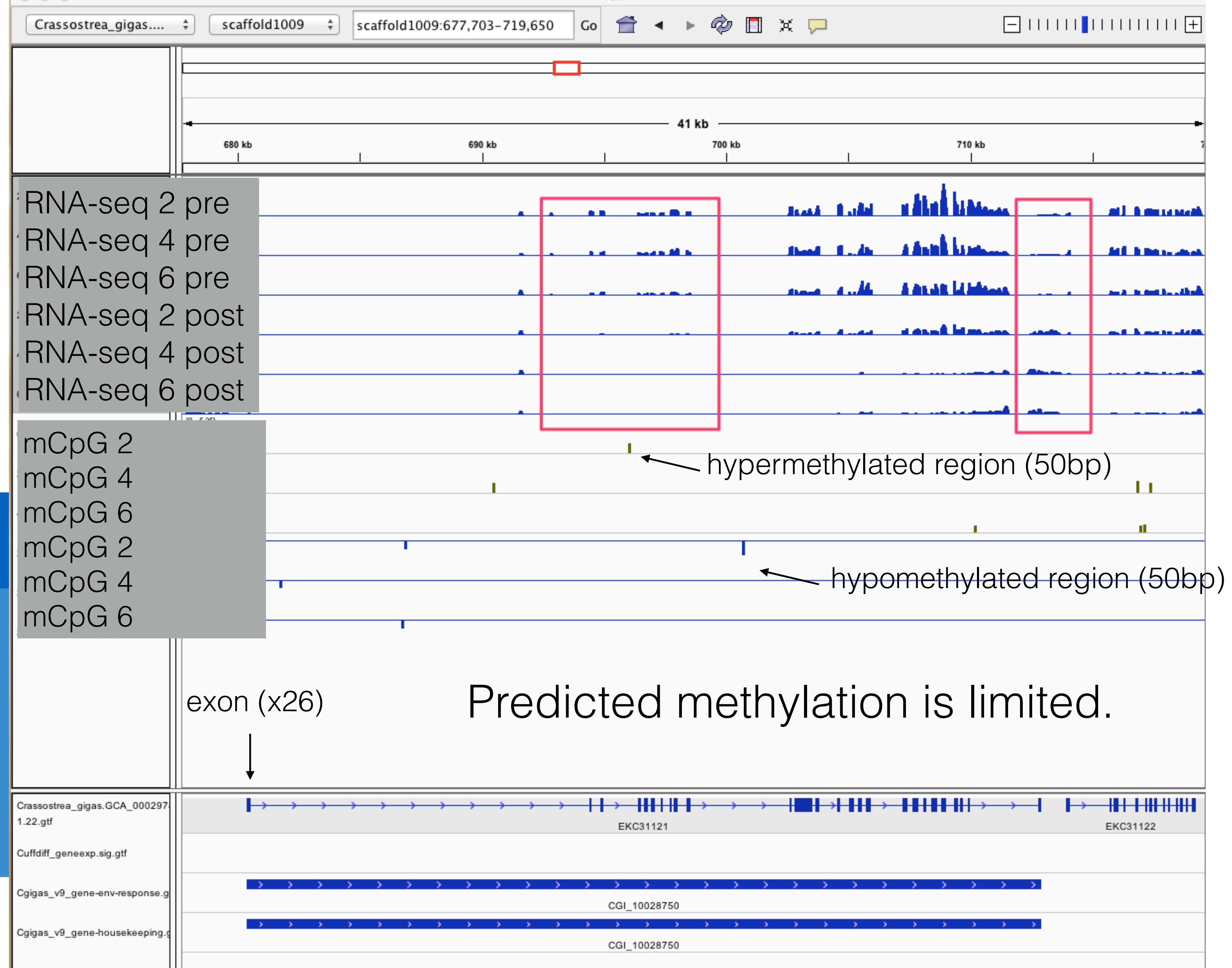
Oyster

2

4

6

MBD-Array



ALTERS THE PHENOTYPE (WITHOUT CHANGING DNA CODE); HERITABLE

3



CAN BE INDUCED WITH THROUGH ENVIRONMENTAL ALTERATION

Family Specific DNA Methylation Patterns Exist



Cold
Spring
Harbor
Laboratory

bioRxiv
beta

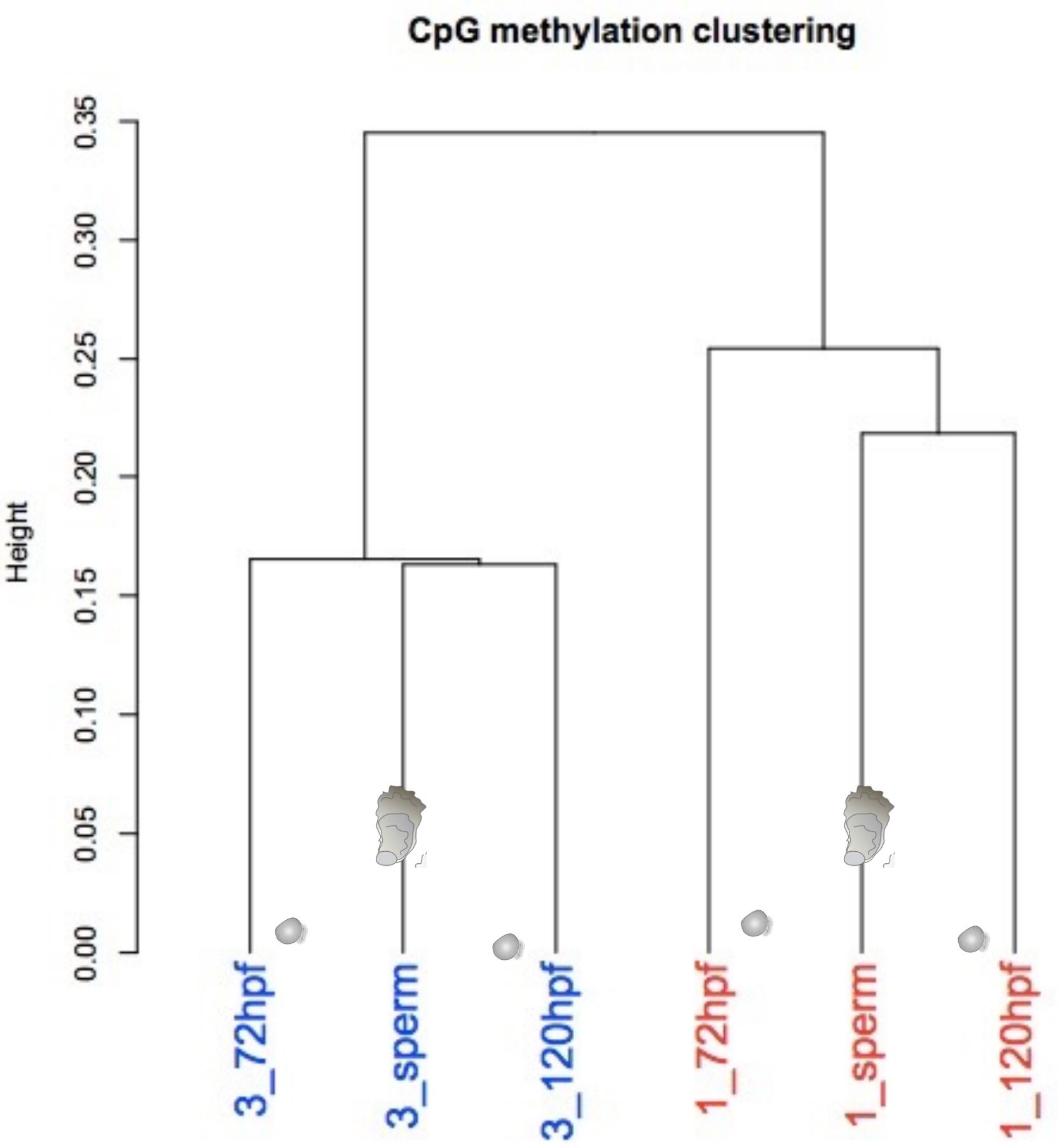
THE PREPRINT SERVER FOR BIOLOGY

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>

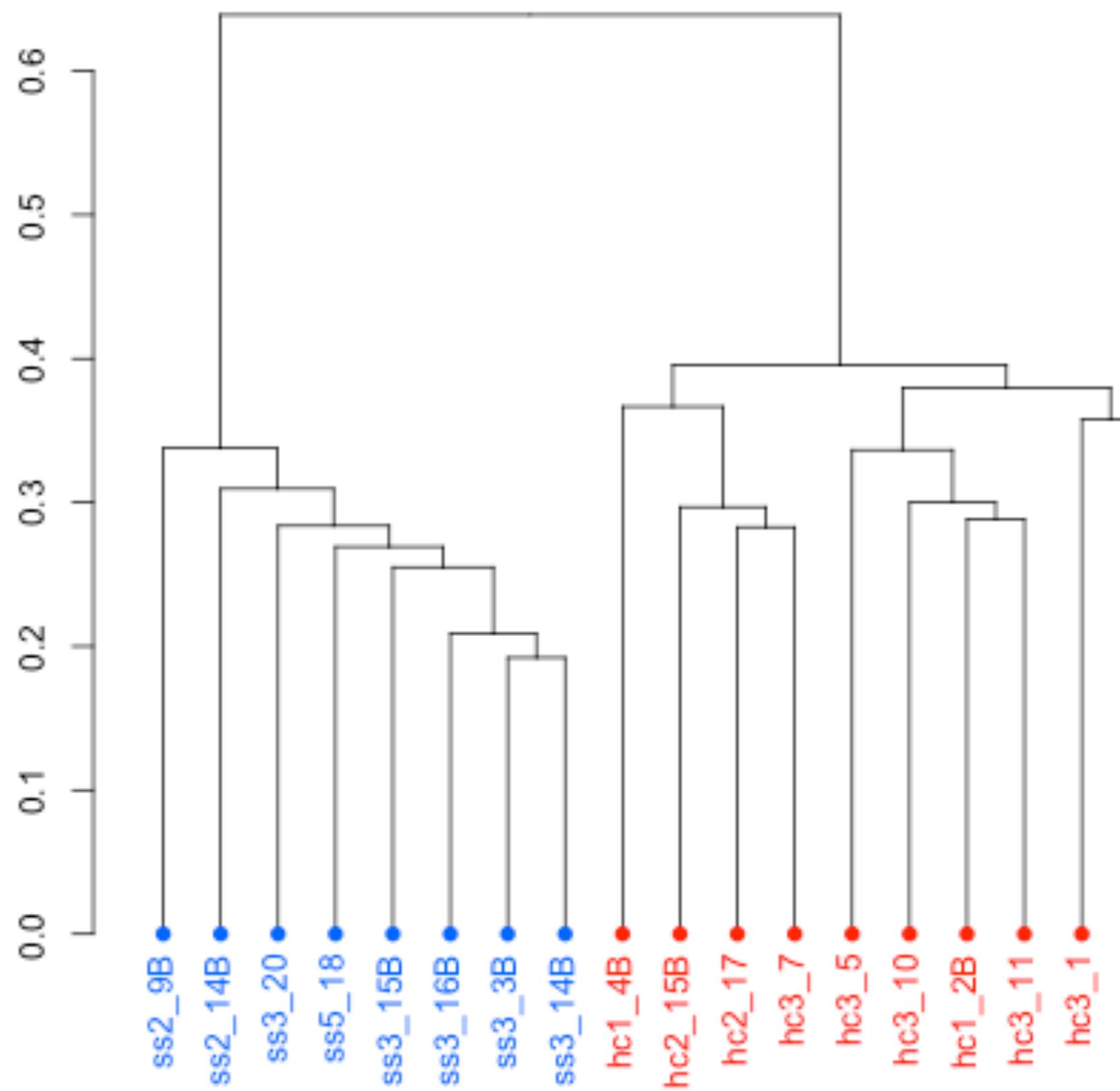


Population DNA Methylation Patterns Persist in Transplant Experiment



Population DNA Methylation Patterns Persist in Transplant Experiment

CpG methylation clustering



ALTERS THE PHENOTYPE (WITHOUT CHANGING DNA CODE); HERITABLE

3

What about within generation? Priming?

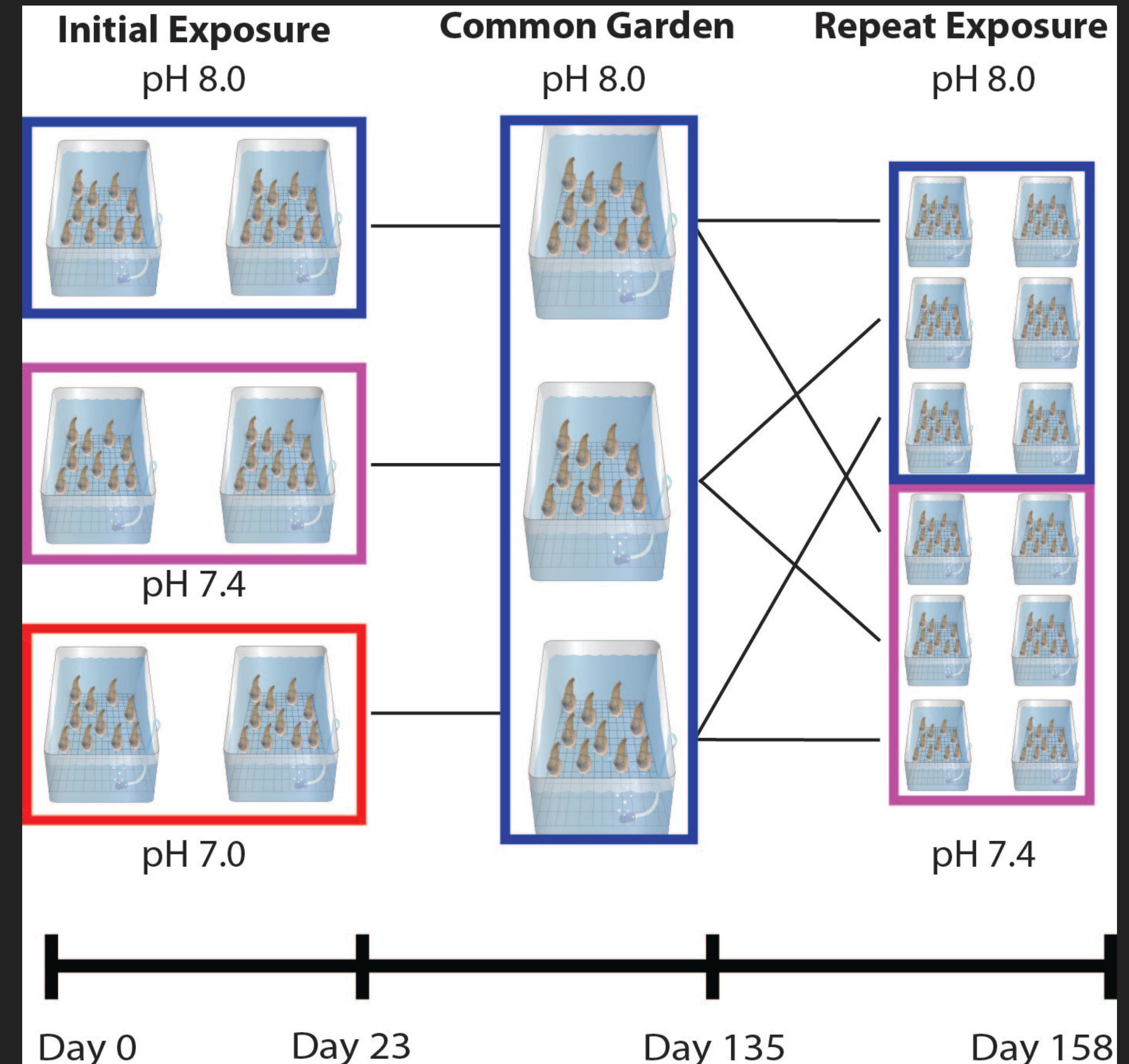


CAN BE INDUCED WITH THROUGH ENVIRONMENTAL ALTERATION

GEODUCKS AND OA

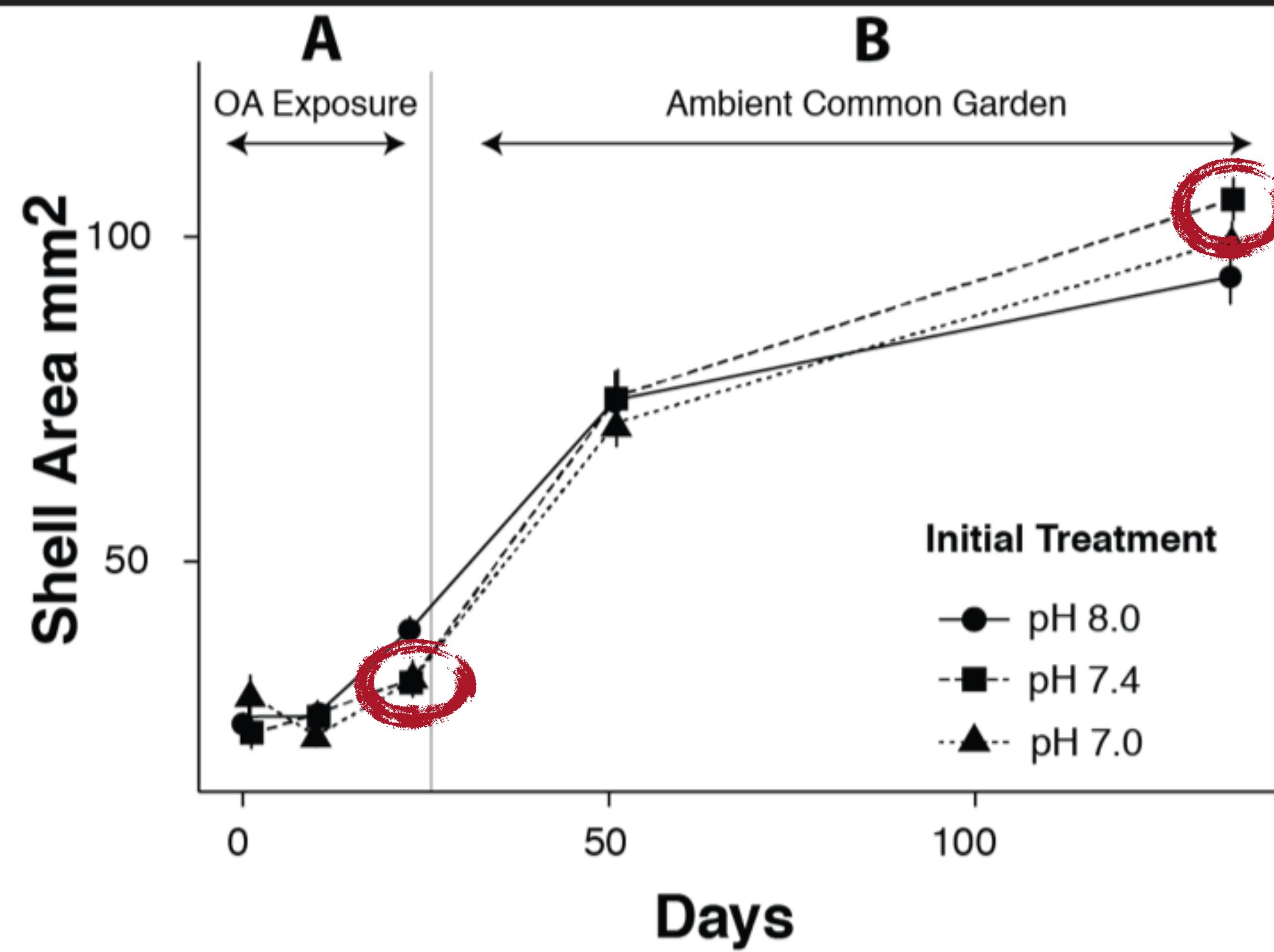


- ▶ Does conditioning to low pH confer tolerance within a generation?



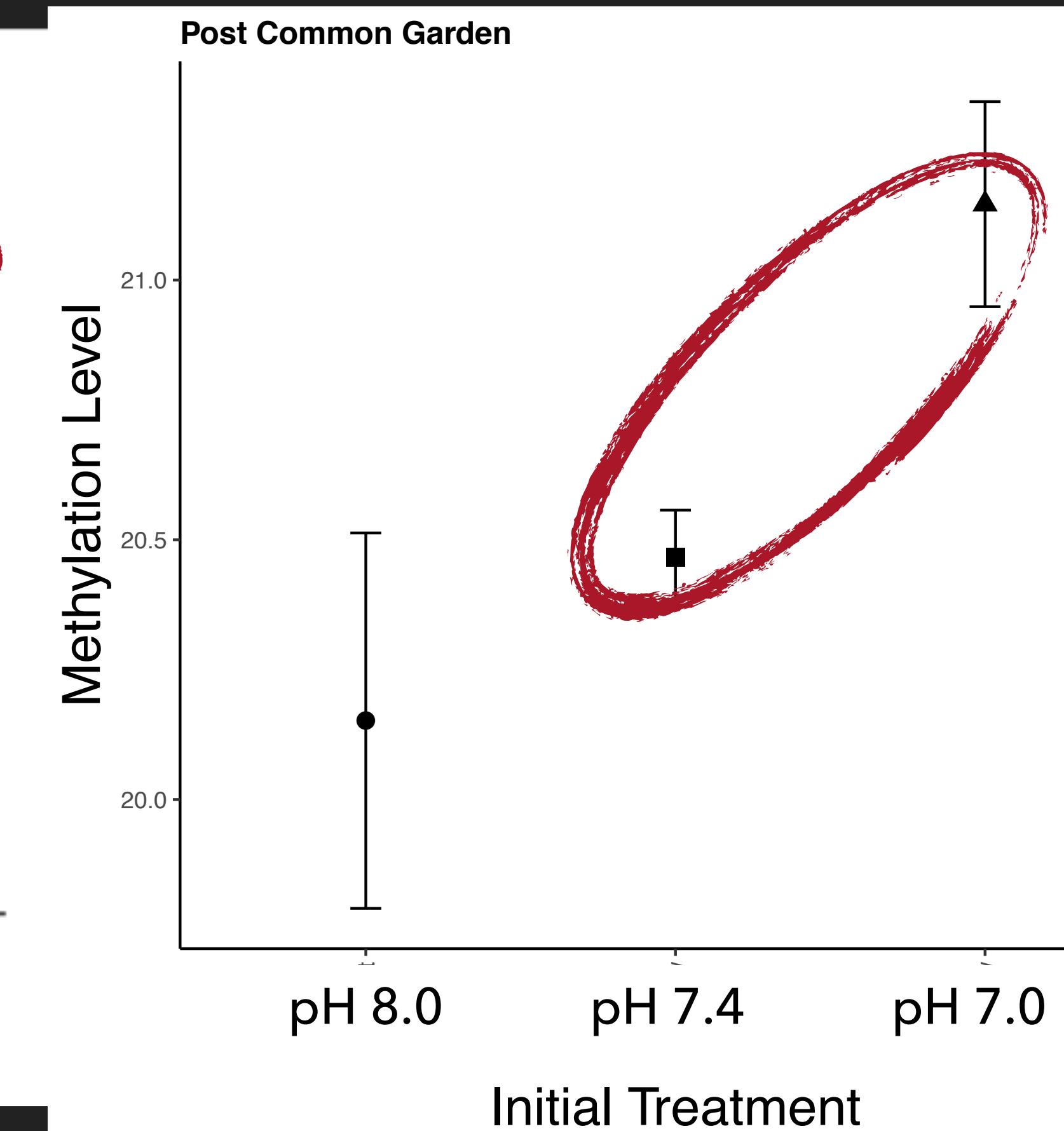
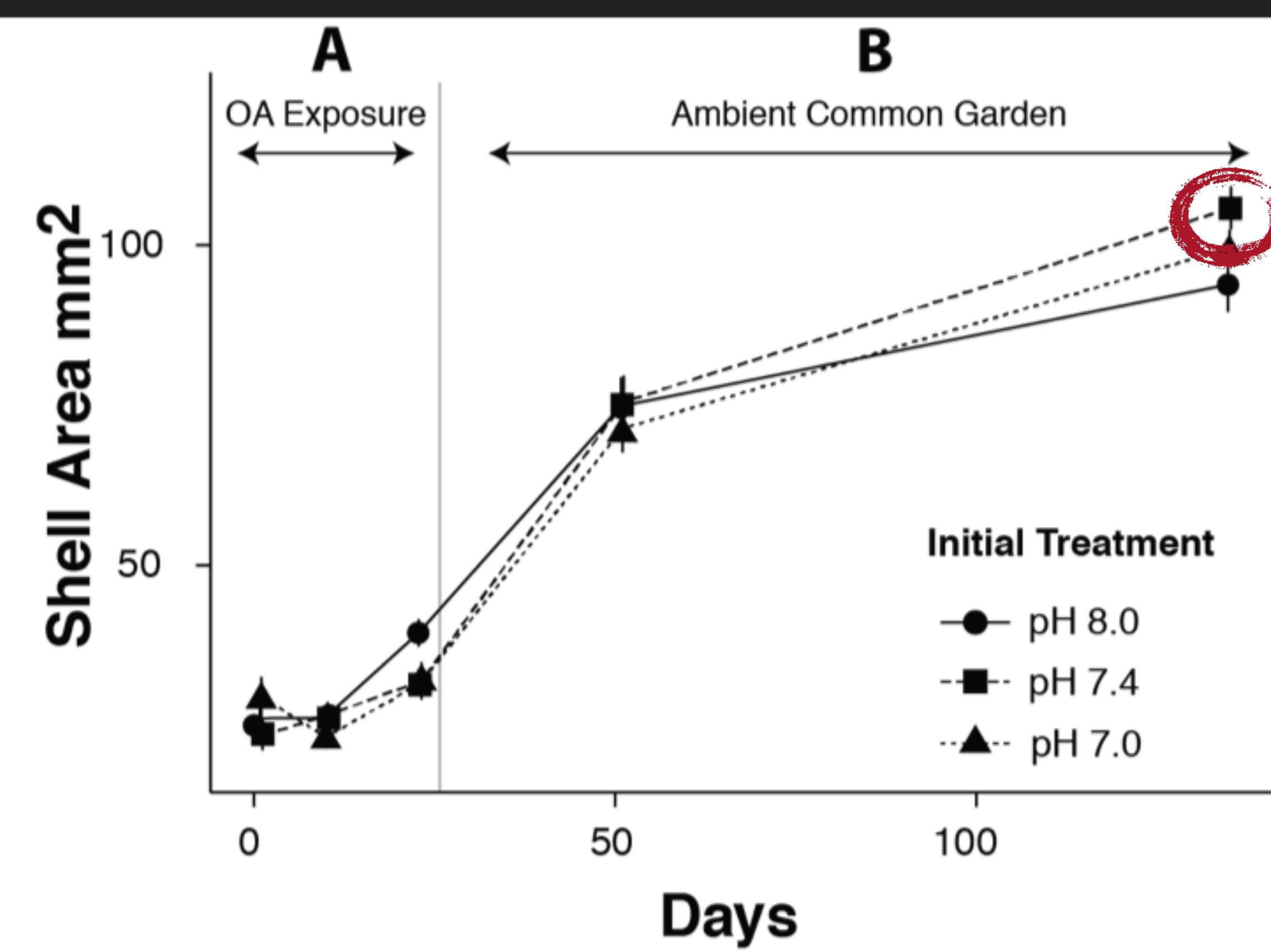
GEODUCKS AND OA

- ▶ Does conditioning to low pH confer tolerance within a generation?



GEODUCKS AND OA

DNA METHYLATION



SUMMARY

1. There is a lot we still do not understand with regard to the functional role of DNA methylation in marine invertebrates. (*If in fact one exists*)
2. We have just begun to look at epigenetic phenomenon in marine invertebrates.
3. Based on numerous within and across generation studies in marine invertebrates (ie. priming, transgenerational plasticity) there are exciting possibilities to explore on how species can effectively respond to environmental change.

ACKNOWLEDGEMENTS

- ▶ Mackenzie Gavery, Claire Olson, Sam White, Brent Vadopalas, Kaitlyn Mitchell, Shelly Trigg, Hollie Putnam, Laura Spencer, Yaamini Venkataraman, James Dimond
- ▶ Kenneth K. Chew Center for Shellfish Research and Restoration



FFAR



GITHUB.COM/SR320/TALK-GRC-2019