



Response of DNA methylation to environmental change in the reef coral *Porites astreoides* and its associated *Symbiodinium*

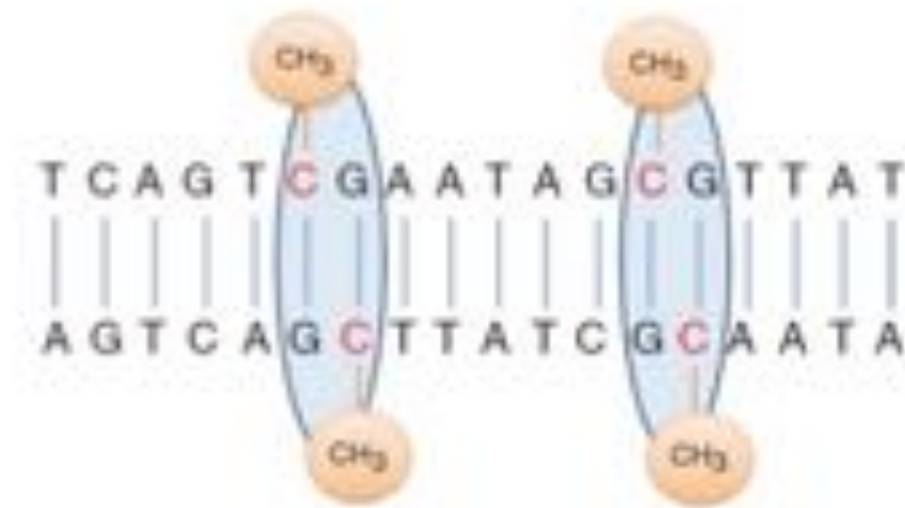
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CpG methylation

5-methylcytosine (5mC)



Schroeder et al. (2011)

Evidence for:

- Environmental induction
- Heritability
- Influence on transcription & phenotype

Context important

- Evolutionary
- Genomic

DNA methylation in invertebrates

Genomes less methylated than vertebrates

Methylation mostly in gene bodies

Function of gene body methylation not fully understood



Why corals?

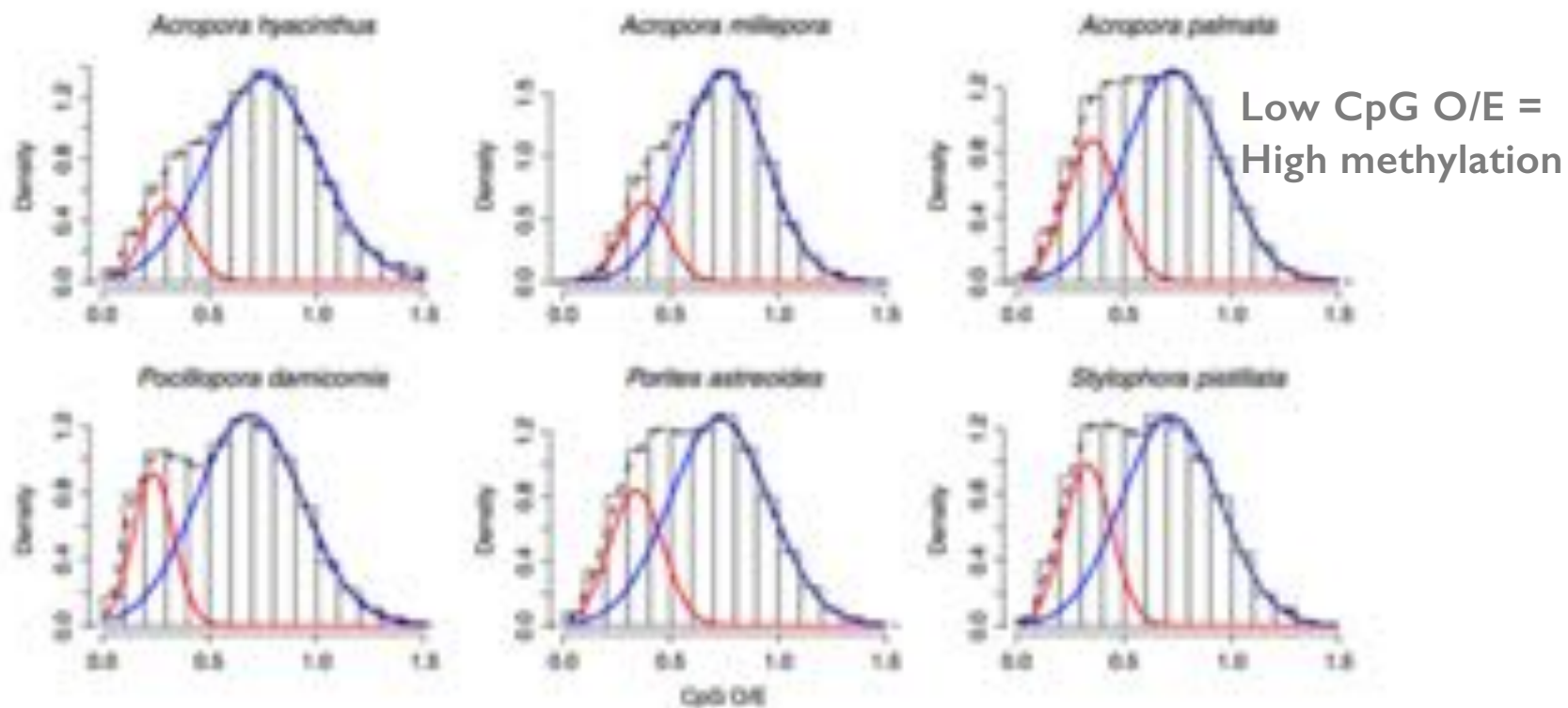
In decline globally

Need to understand mechanisms
of adaptation & acclimatization

Sessile and very reliant on
phenotypic plasticity



Corals, like other invertebrates, have distinct fractions of genes with high and low levels of methylation



Dimond & Roberts (2016)



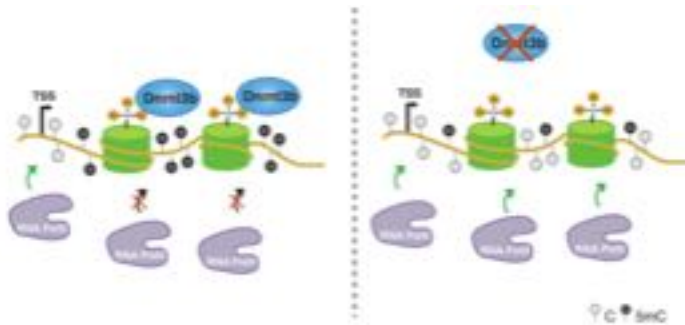
Hypermethylated genes

Tend to be housekeeping genes
Essential, conserved functions



5mC promotes optimal codon usage (Dixon et al. 2016)

5mC prevents spurious transcription (Neri et al. 2017)



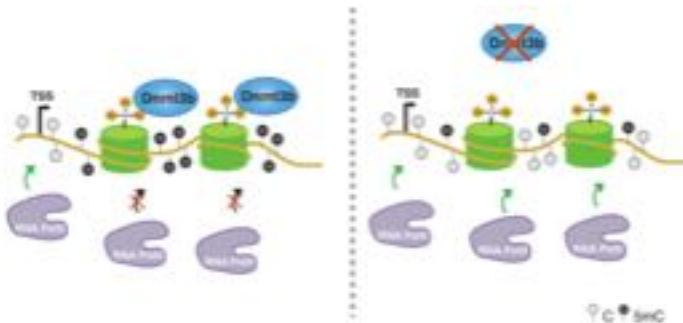
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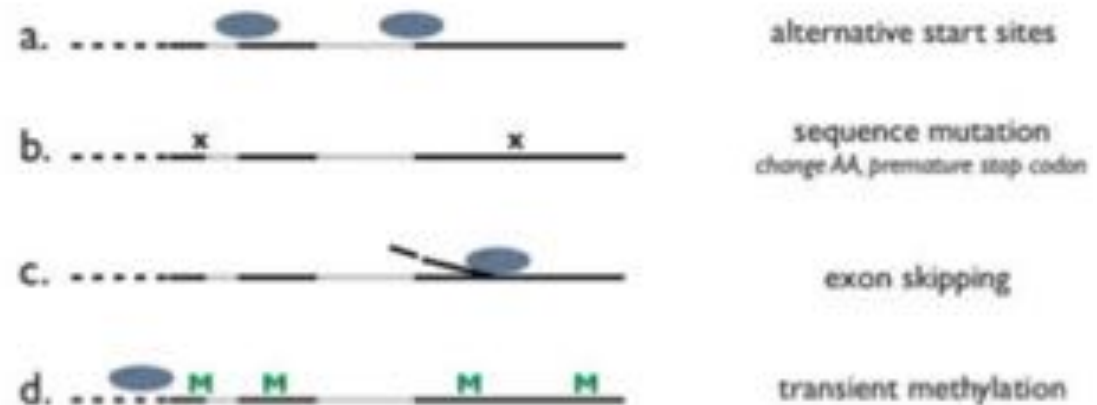


Hypomethylated genes

Tend to be inducible genes
Associated with environmental change & exhibit plasticity



Increased transcriptional opportunities?



Roberts and Gavery (2012)

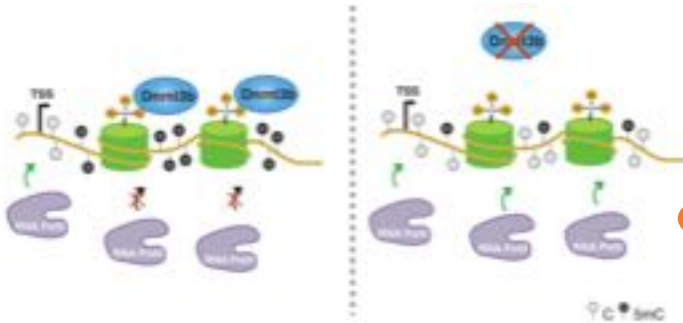
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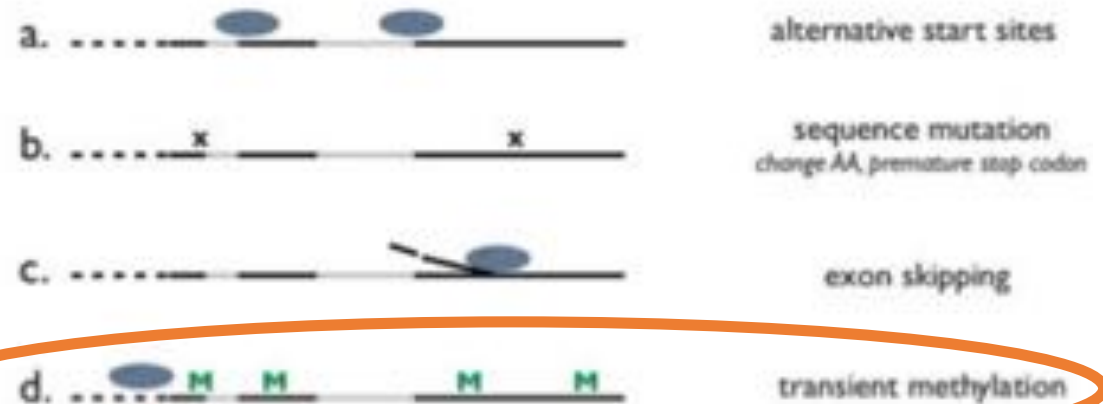


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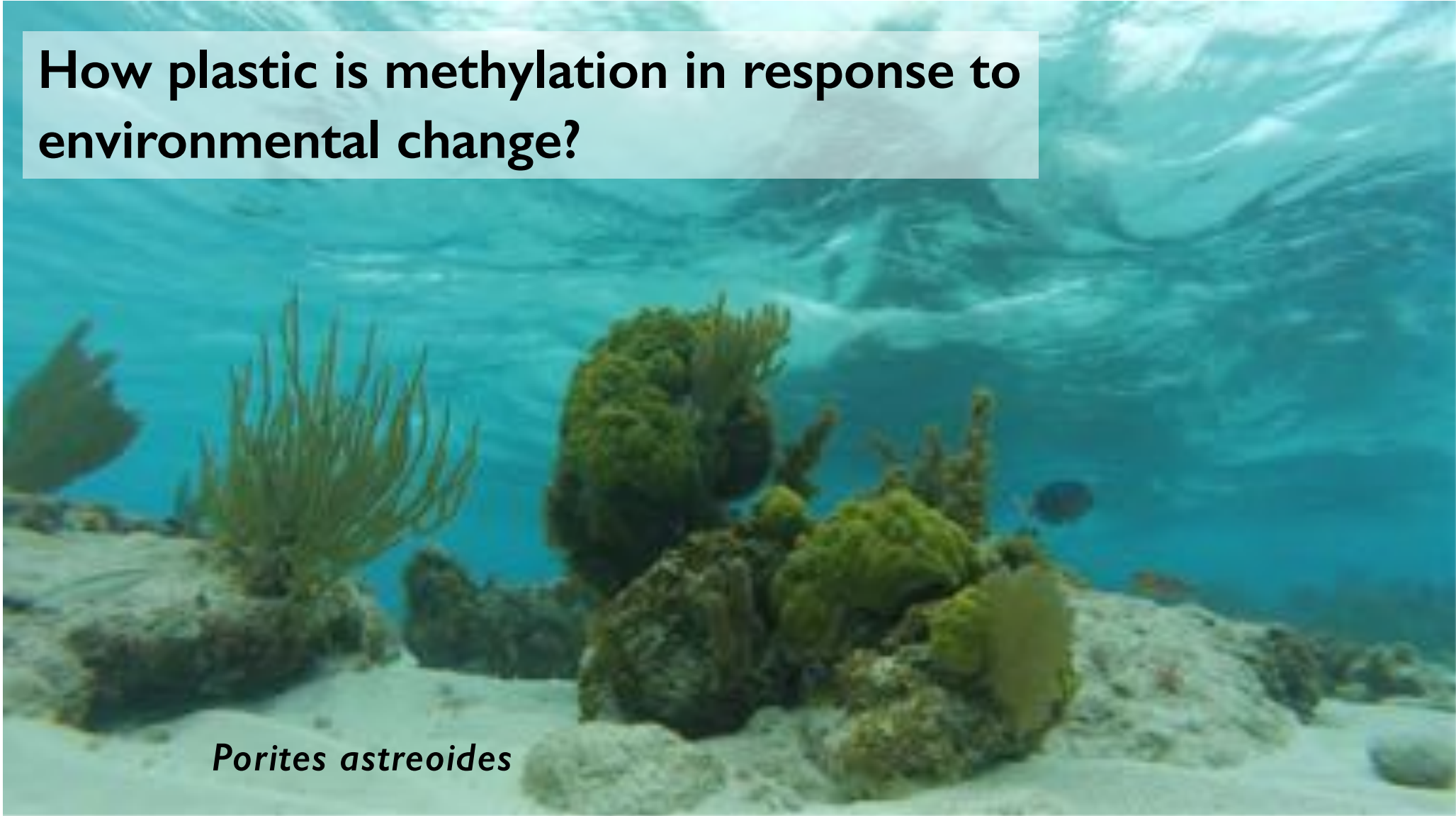
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Roberts and Gavery (2012)

How plastic is methylation in response to environmental change?

Porites astreoides



Methods

One-year common garden transplantation experiment on Belize Barrier Reef

- colonies moved to common garden from 10-20 km away

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ddRADseq coupled with EpiRADseq (ddRAD variant) to assess methylation

- EpiRADseq uses methylation-sensitive restriction enzyme
- Methylation estimated by read counts
 - Reads low/absent in EpiRADseq library = methylated

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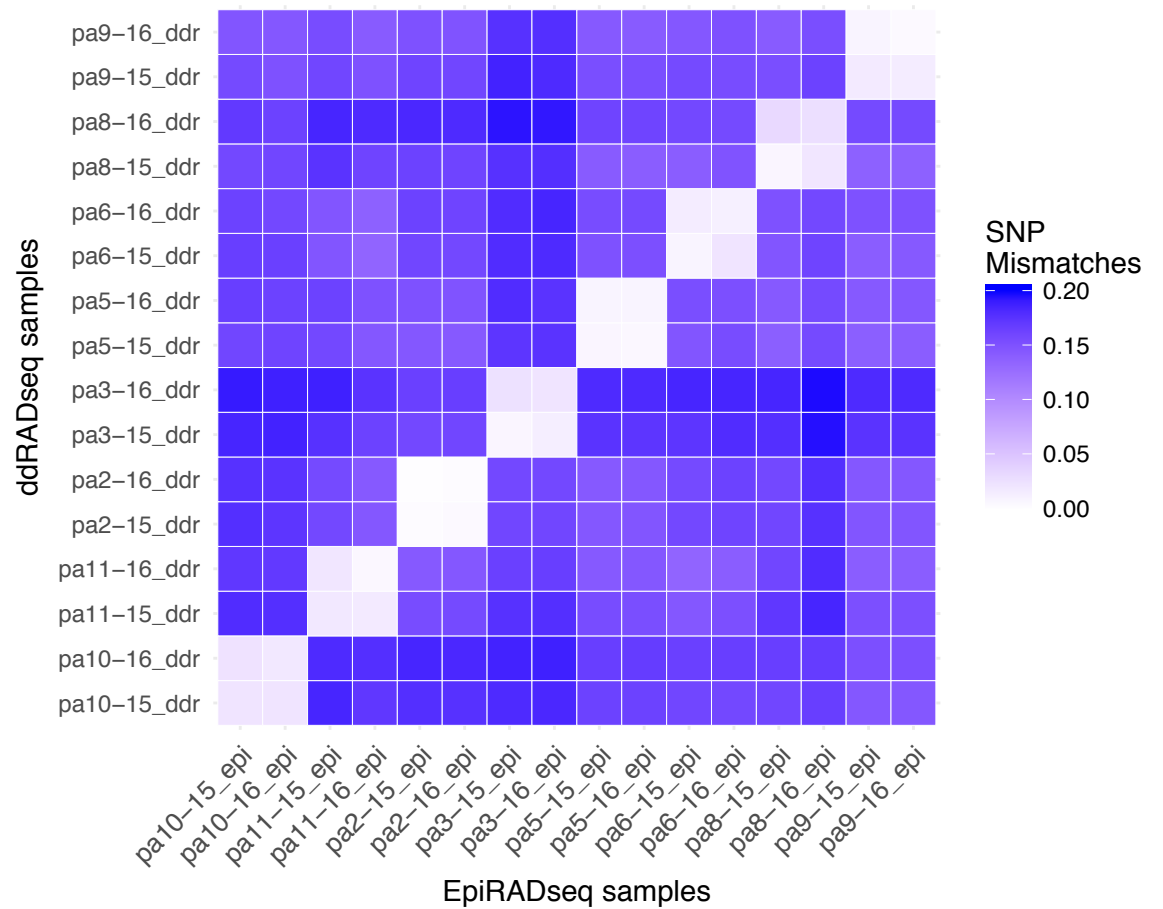
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Genome-independent assembly using iPyrad

- *Symbiodinium* Clade A genome used to remove symbiont reads

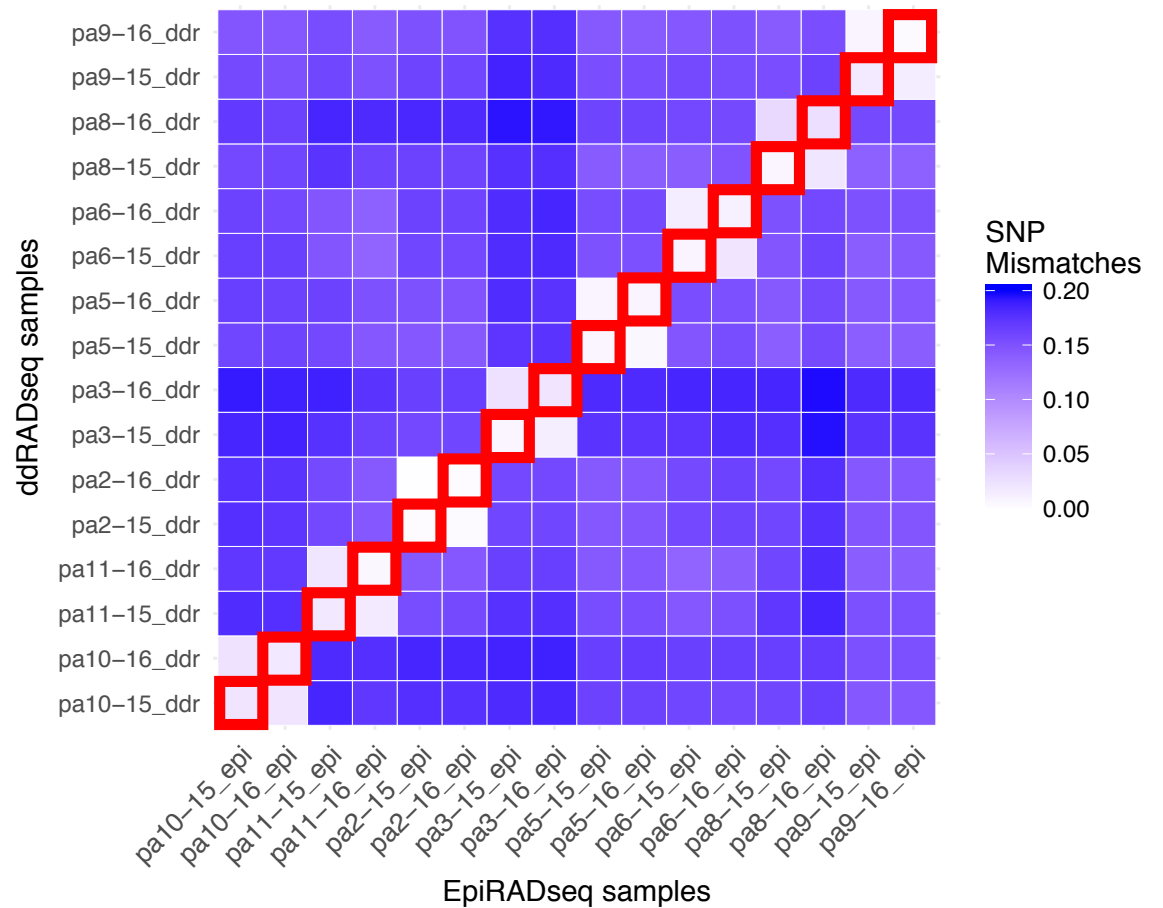
n = 8 colonies x 2 years

Technical replicates
and repeated sampling
indicate low error



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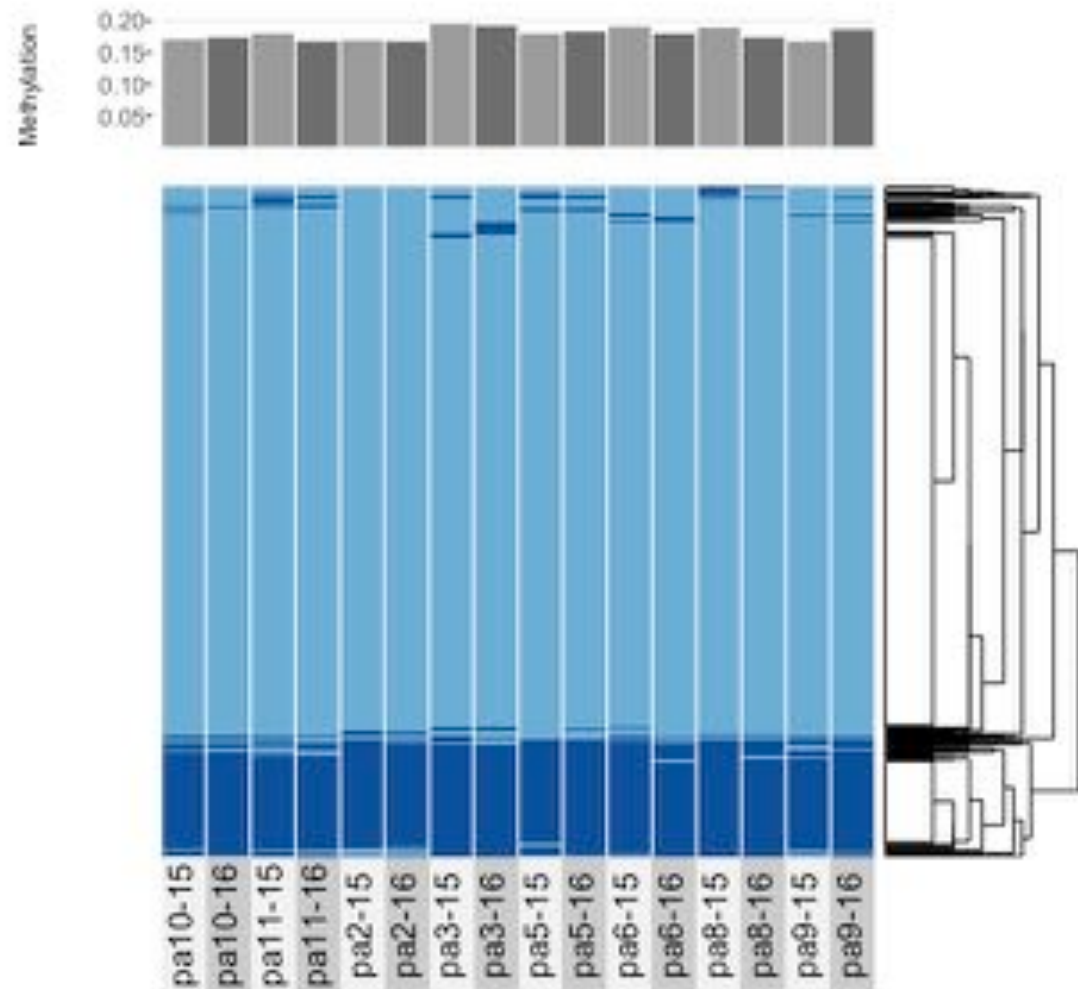
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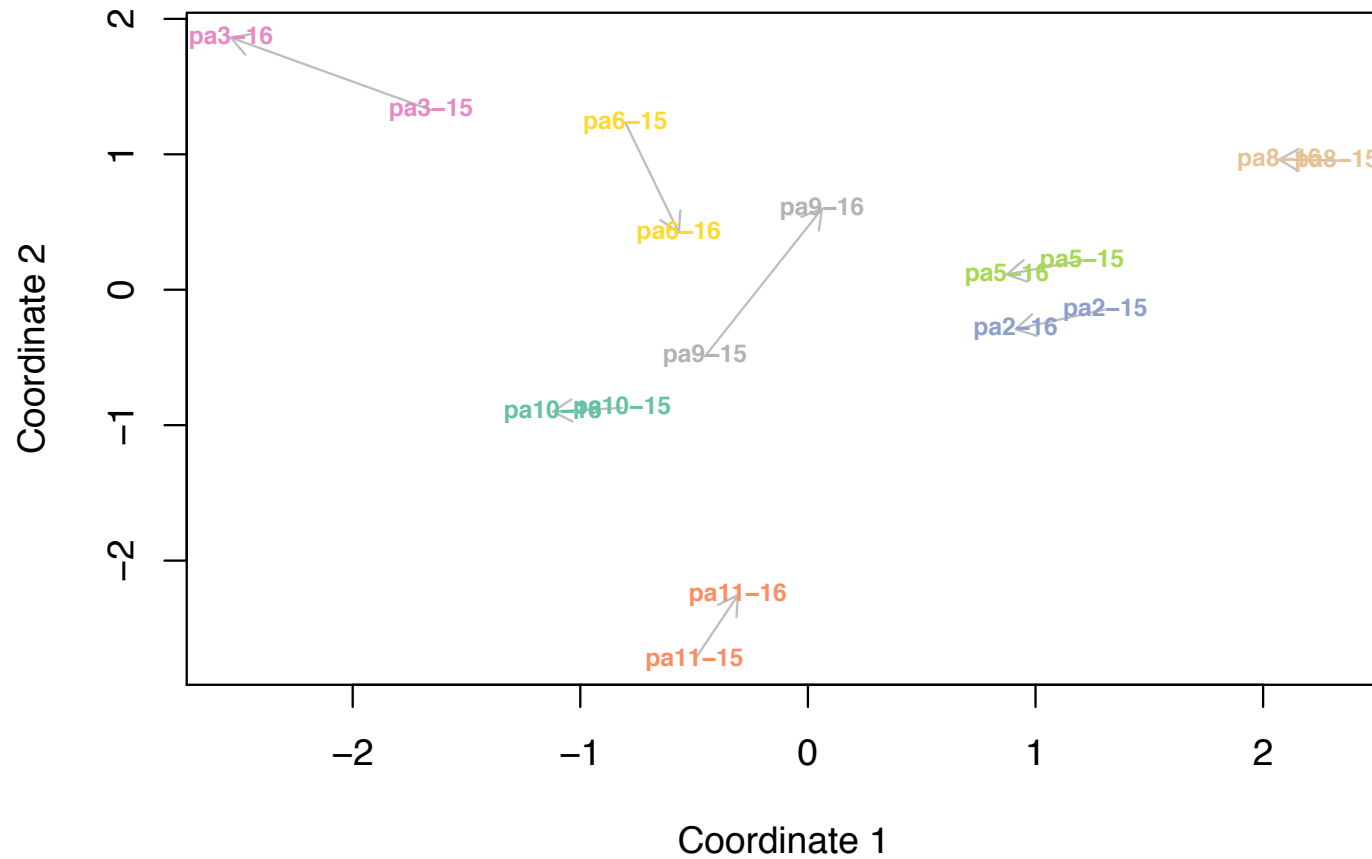
649 shared loci

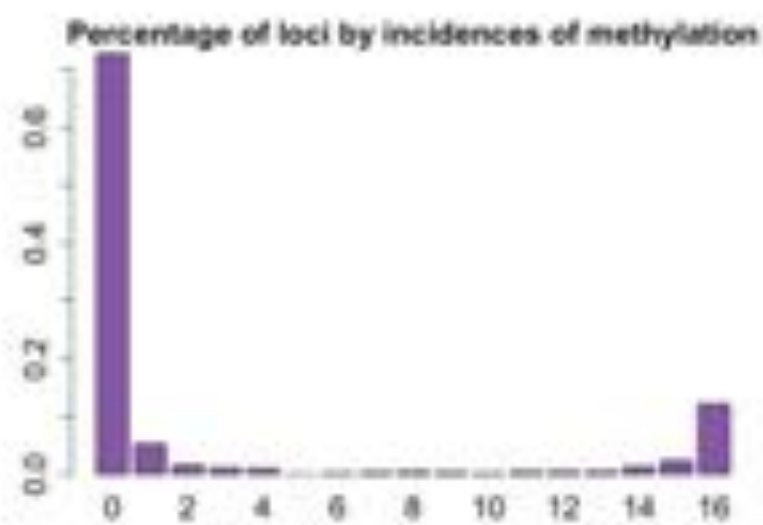
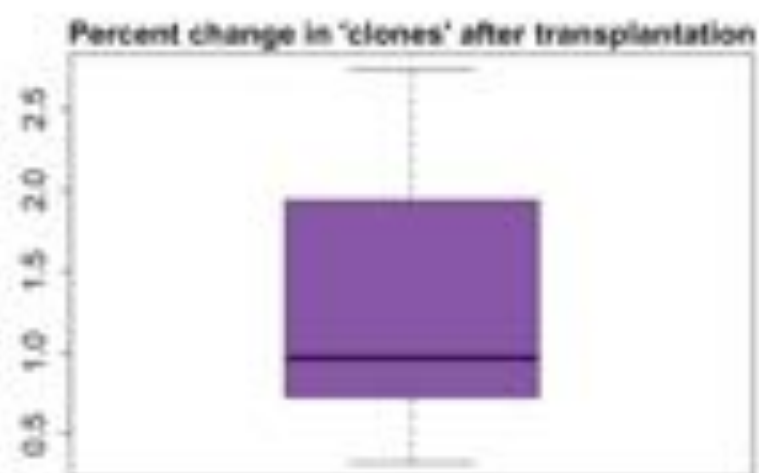
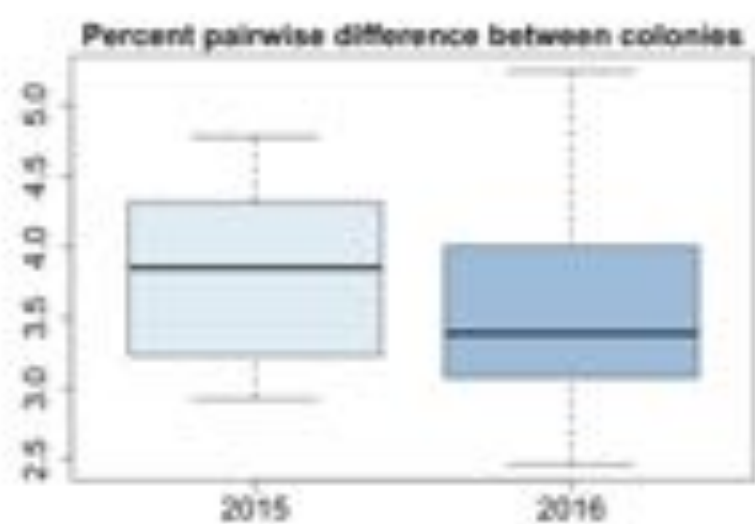
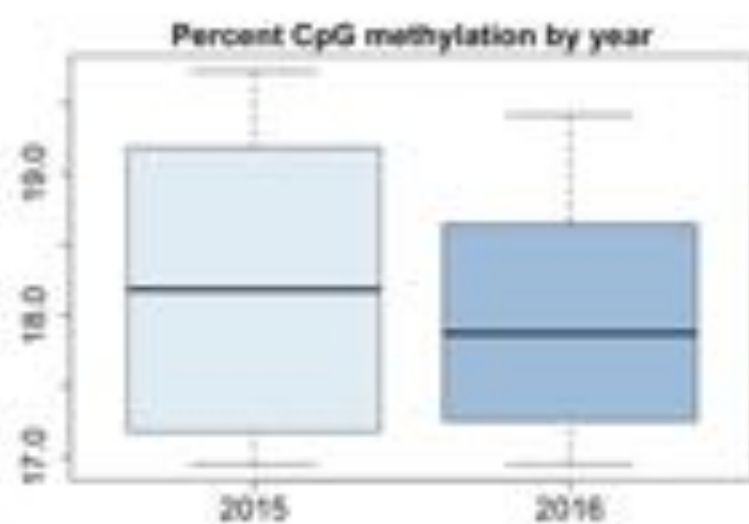
Most loci either
constitutively
unmethylated or
methylated

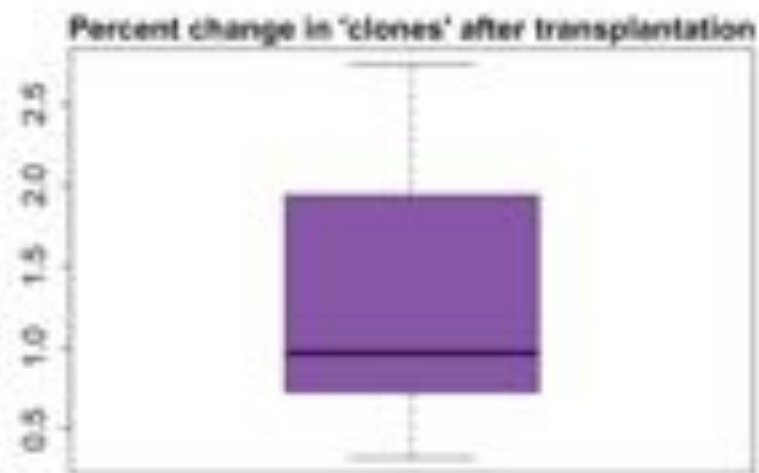
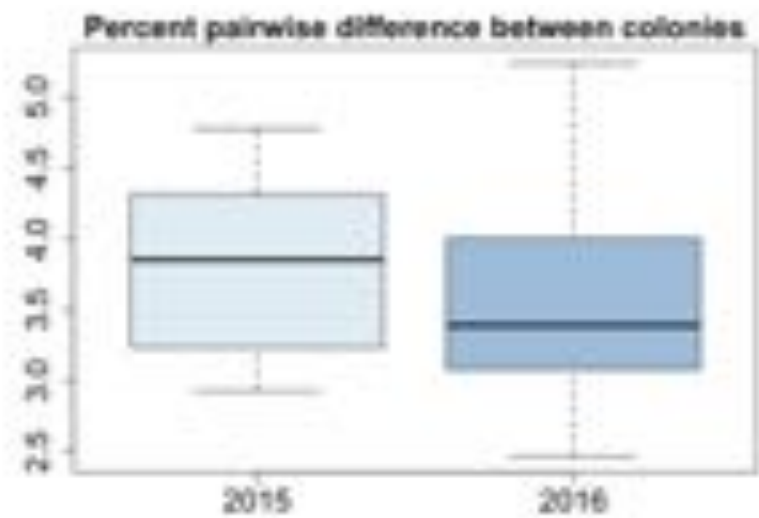
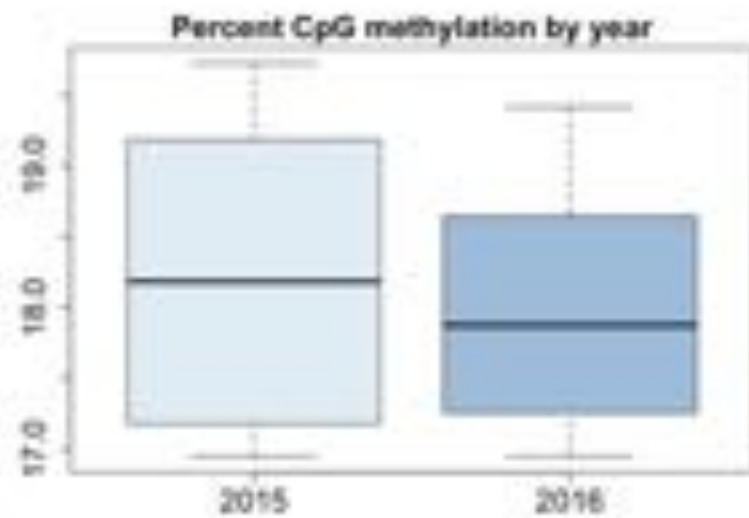
Little change over one
year

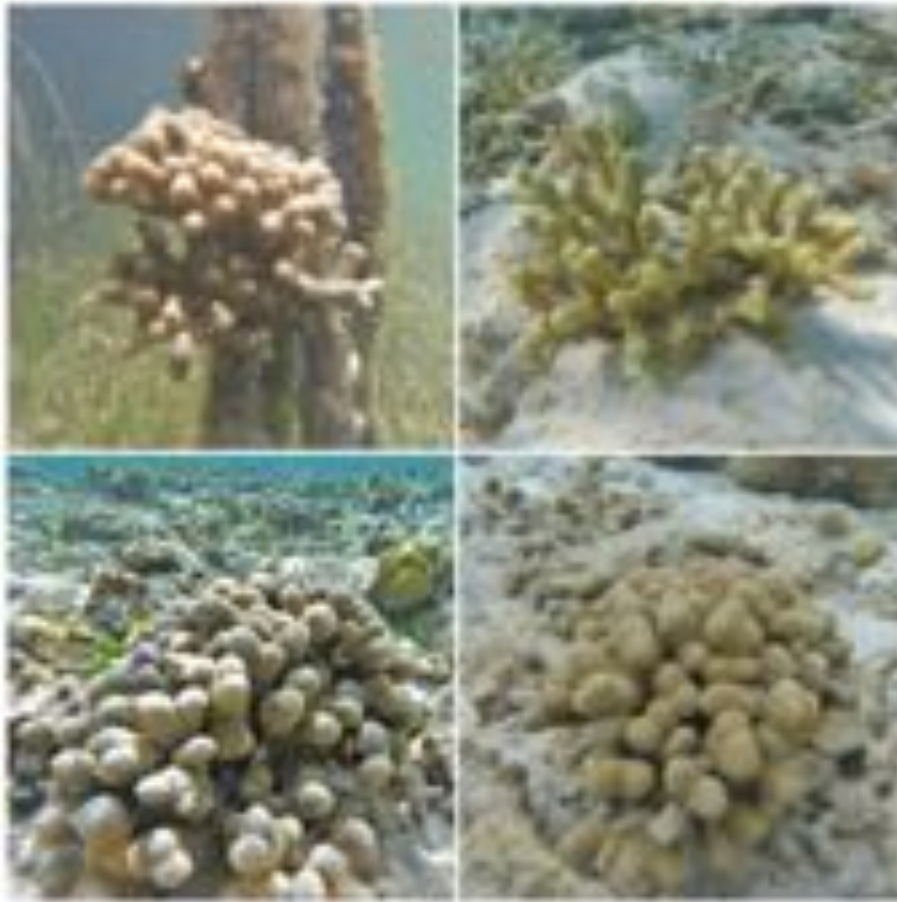


Little change over a year; individuals tend to cluster together









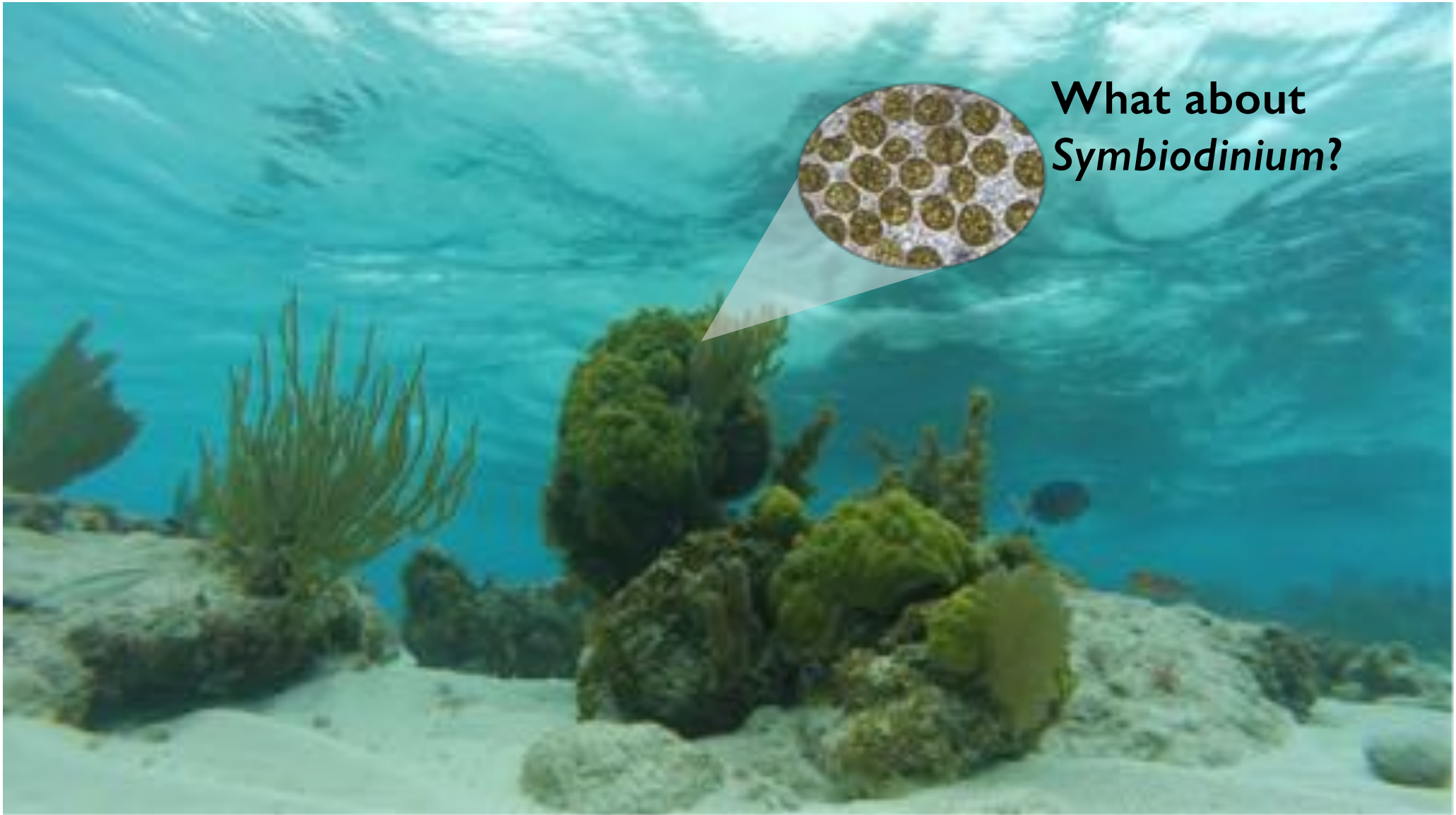
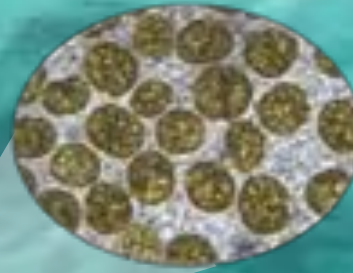
Dimond et al. (2017)

For comparison:
***Porites porites* complex**

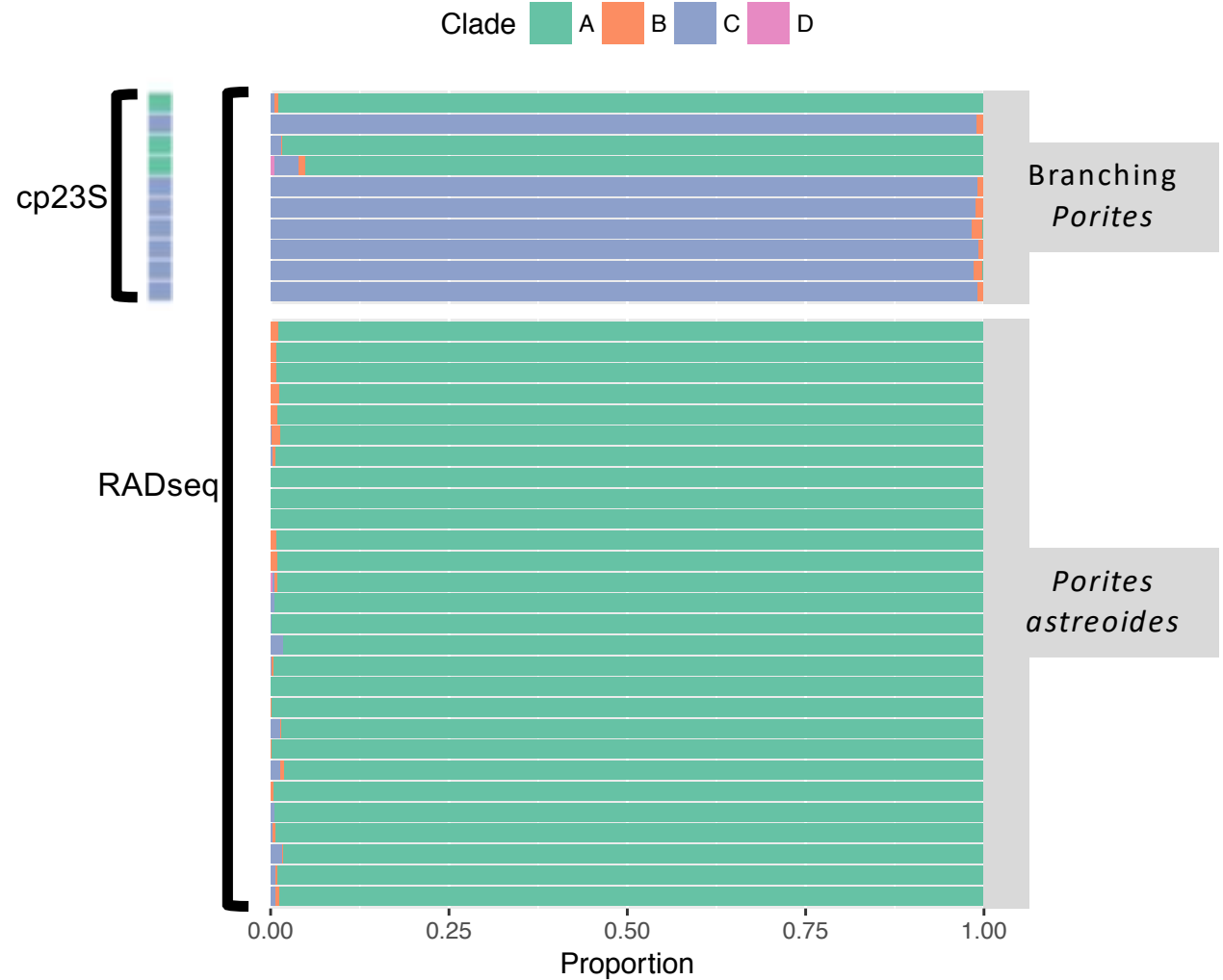
18% of CpGs methylated

**15% differentially methylated
among colonies (n = 27)**

**What about
Symbiodinium?**

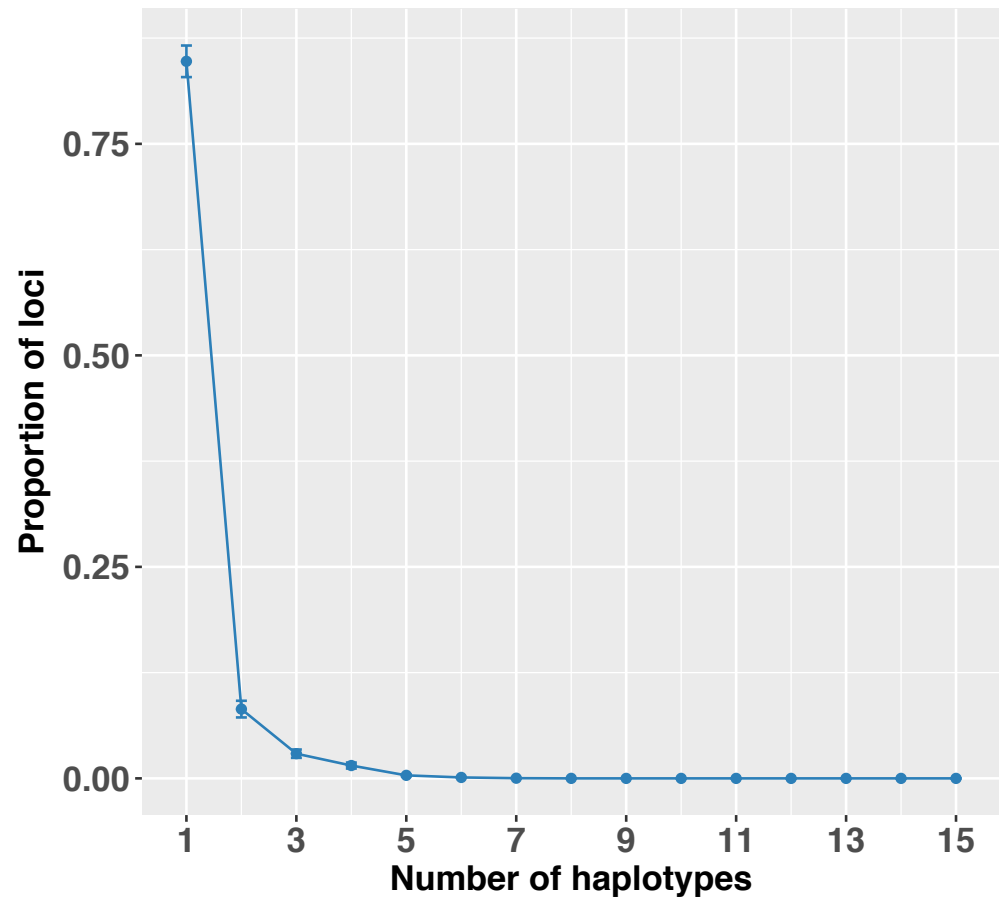


**All *P. astreoides* hosted
>98% Clade A**

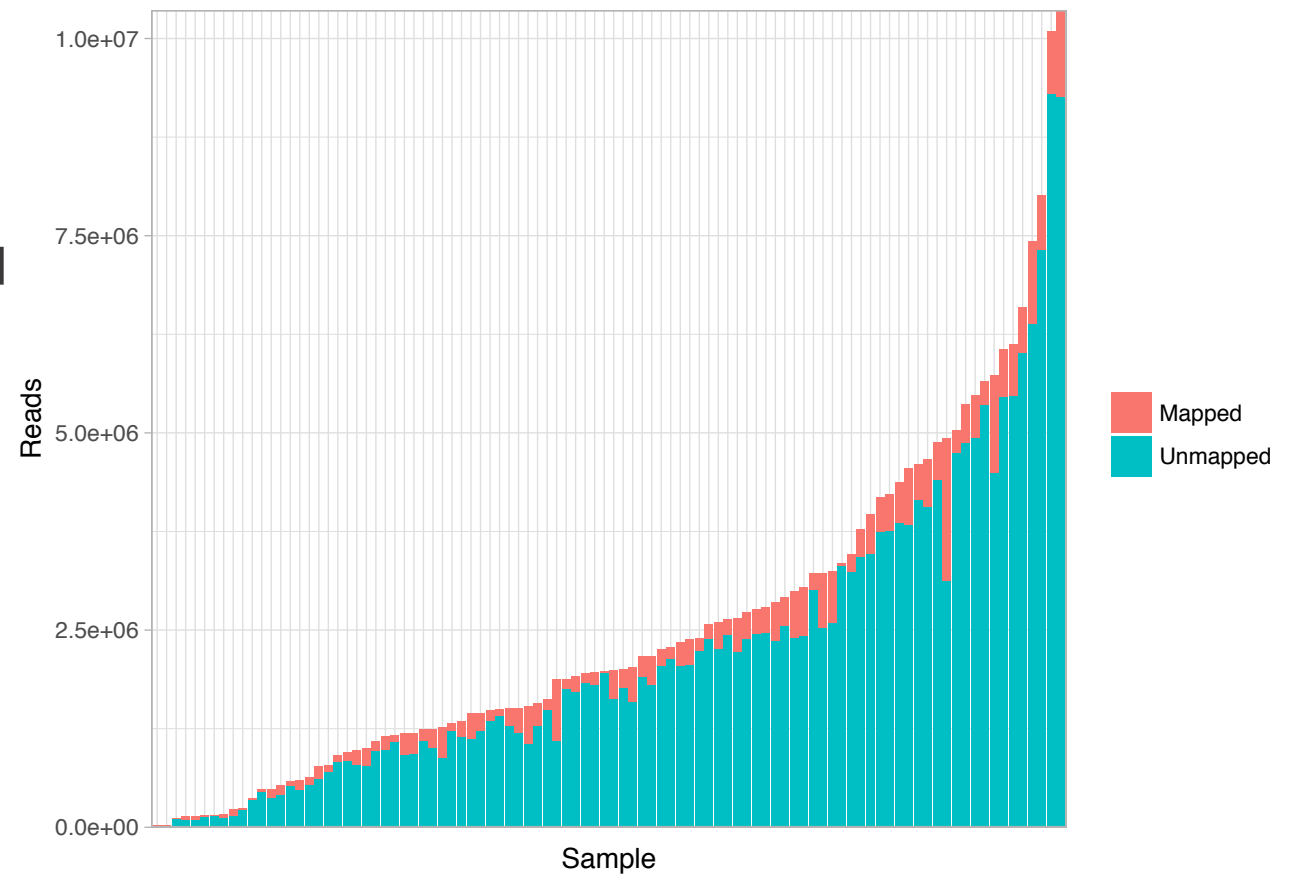


**Low haplotype
diversity:**

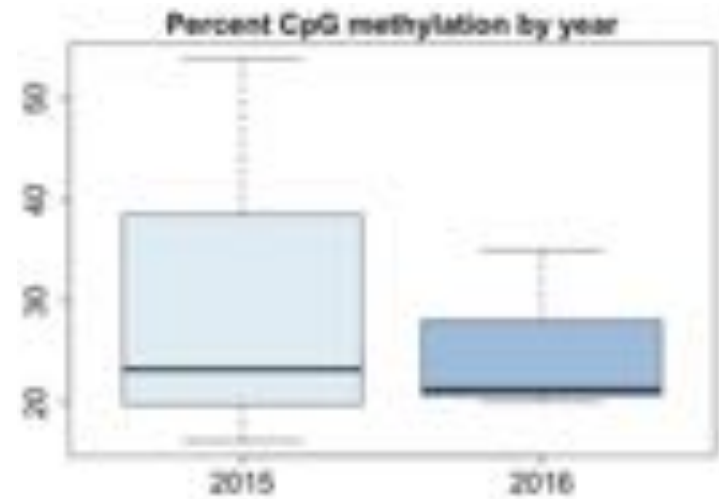
**A single haplotype was
observed in ~83% of
RADseq loci**



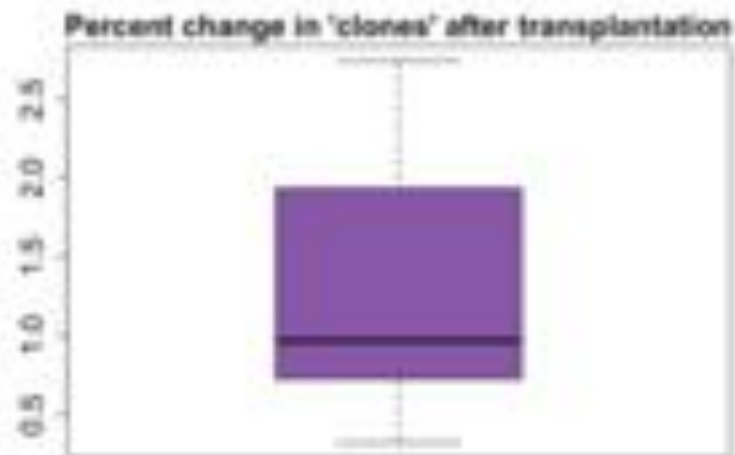
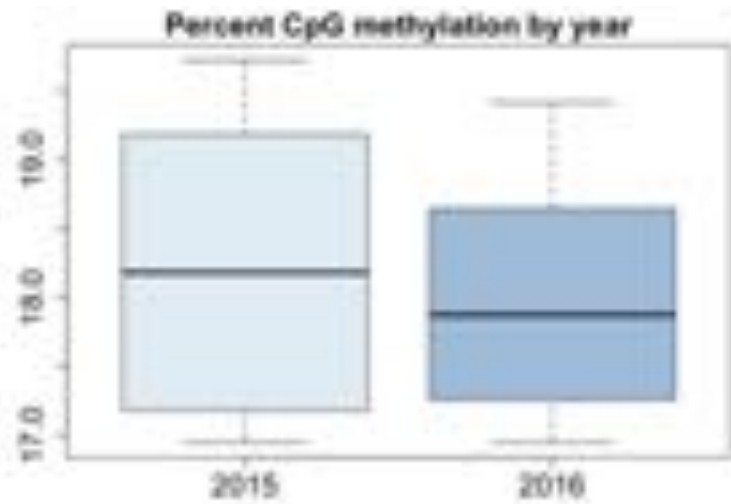
Only ~14% of loci mapped
to the *S. microadriaticum*
(Clade A) genome



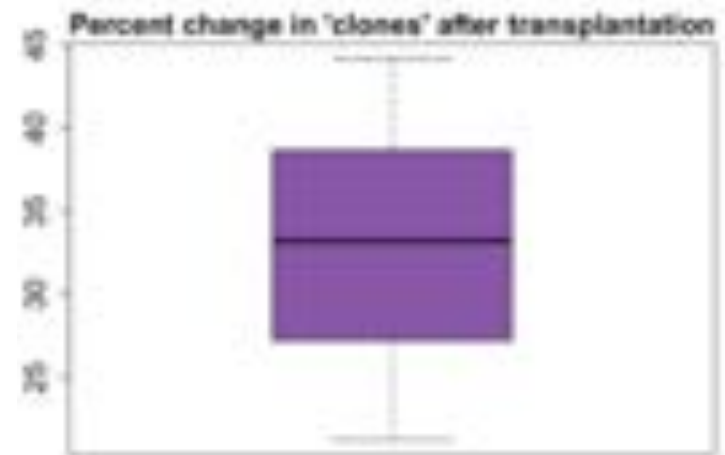
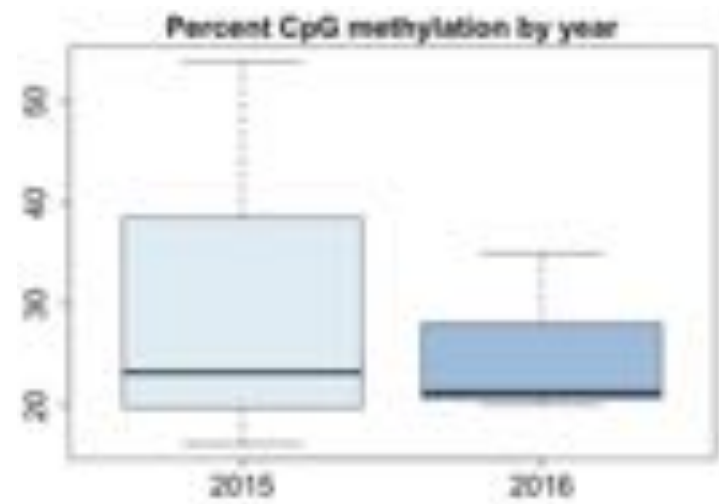
Symbiont



Host



Symbiont



J. Phycol. **34**, 152–159 (1998)

HYPERMETHYLATION AT CPG-MOTIFS IN THE DINOFLAGELLATES *AMPHIDINIUM CARTERAE* (DINOPHYCEAE) AND *SYMBIODINIUM MICROADRIATICUM* (DINOPHYCEAE): EVIDENCE FROM RESTRICTION ANALYSES, 5-AZACYTIDINE AND ETHIONINE TREATMENT¹

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Townsville, Queensland 4811, Australia

Plant Physiol. (1998) **117**, 1384–1390

Light-Regulated Transcription of Genes Encoding Peridinin Chlorophyll *a* Proteins and the Major Intrinsic Light-Harvesting Complex Proteins in the Dinoflagellate *Amphidinium carterae* Hulburt (Dinophyceae)¹

Changes in Cytosine Methylation Accompany Photoadaptation

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Townsville, Queensland 4811, Australia

Conclusions

Coral methylation shows limited plasticity after a year in a novel environment

- corroborates results of Dixon et al. (preprint) in GBR *Acropora*

Symbiont methylation appears to be more abundant and dynamic

- corroborates earlier studies by ten Lohuis & Miller (1998)

Methylation may play a relatively larger role in *Symbiodinium* biology

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Scott Jones
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