

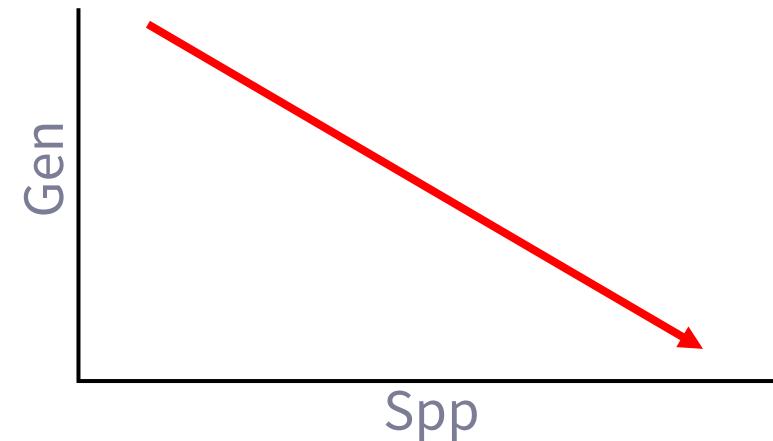
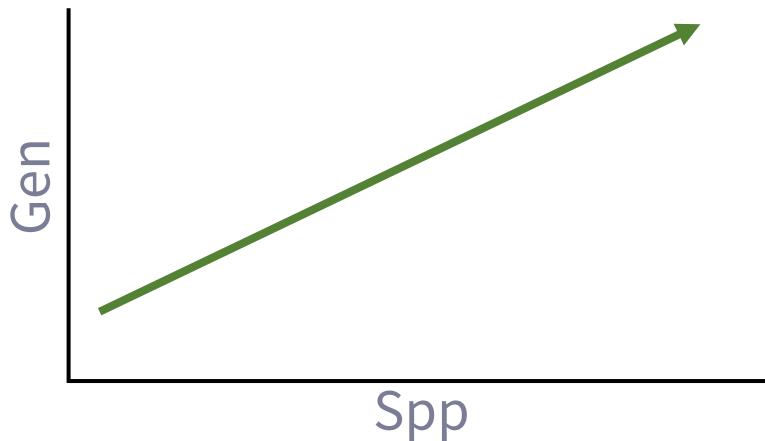
Linking invertebrate biodiversity and epigenetics in urban aquatic environments

Chaz Hyseni, Frank Johansson, & Jacob Höglund

Motivation

- Correlation between species (within communities) and genetic diversity (within species)

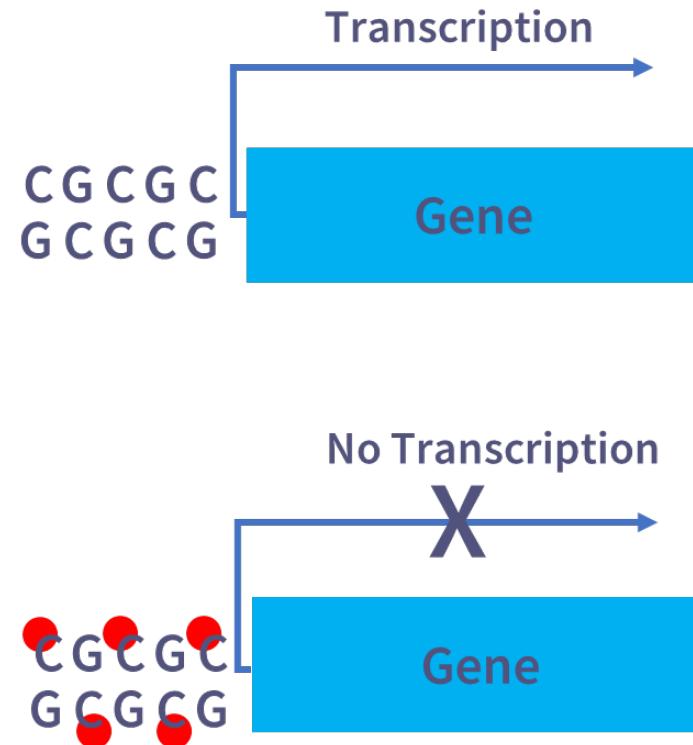
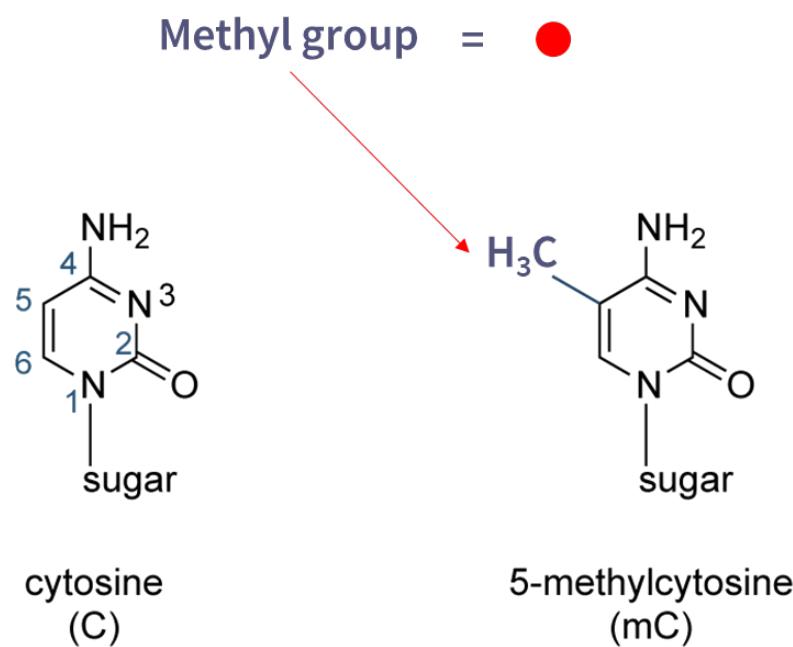
- Many (recent) studies have shown that this correlation is not always positive
- Negative correlation can be just as common



Motivation

- (Epi-)genetic diversity and covariance with (a)biotic factors

1. Epigenetic diversity (e.g., DNA methylation) tracks environment better than genetic diversity
2. Better candidate to examine covariance with (a)biotic factors (incl. spp. diversity)?

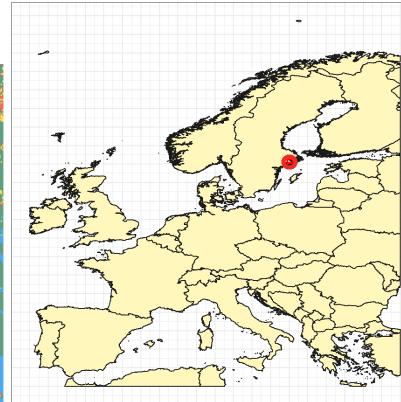
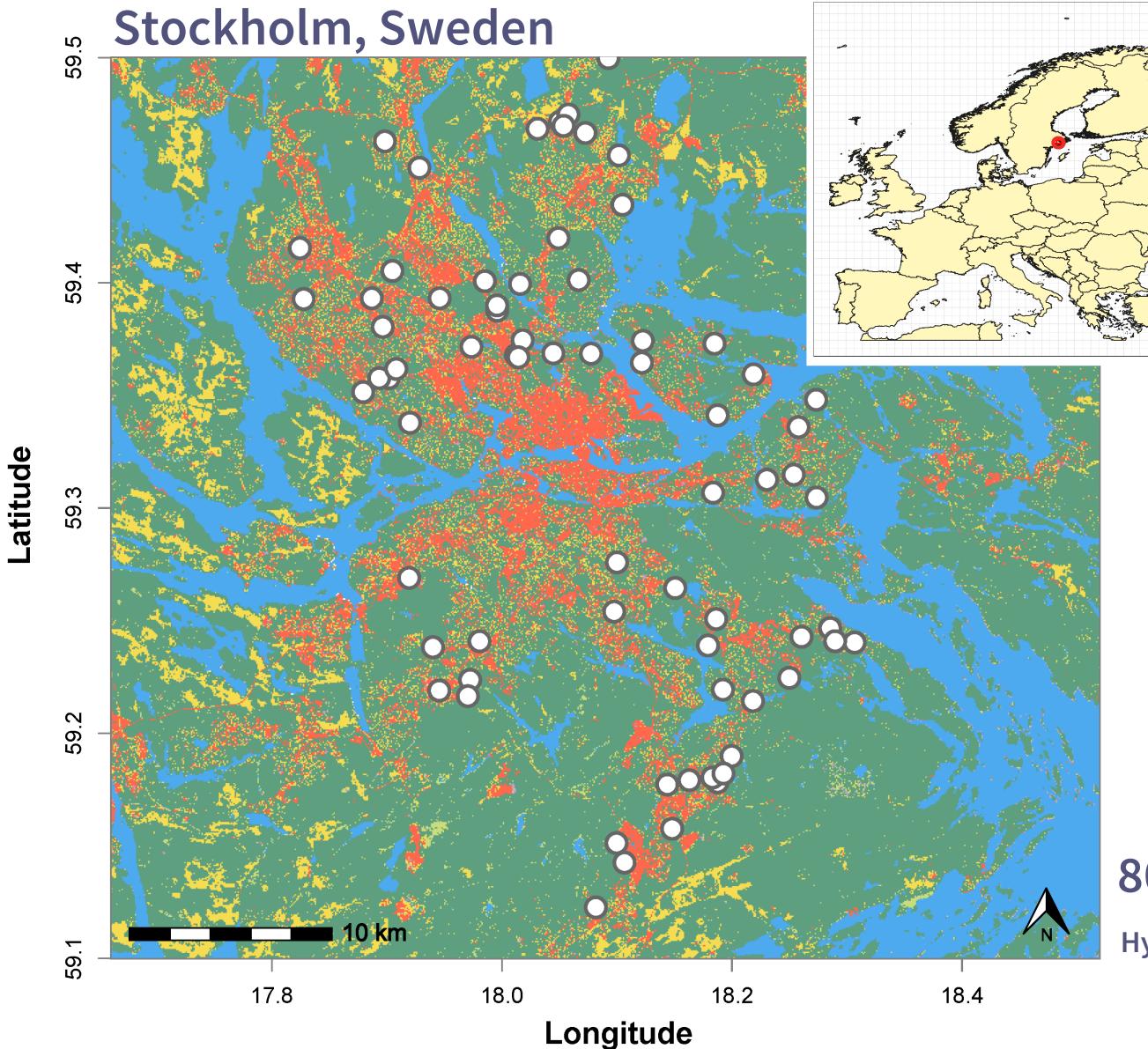


Questions

- **Species**-epigenetic diversity correlation
 - Positive or negative?
- Covariance of methylation w/ both **biotic** and **abiotic** factors
 - What are the abiotic/biotic factors influencing differential methylation?

Sampling: Pond Invertebrates (Biotic)

~160 species
~100 species (>1 site)

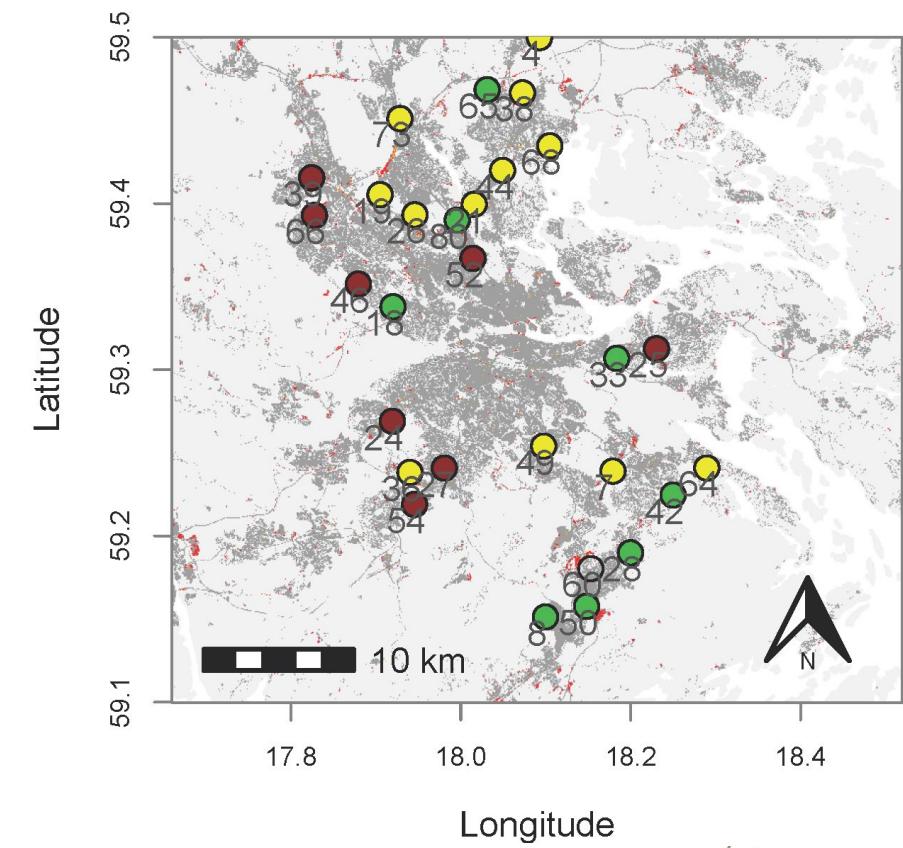


- Coleoptera (beetles)
- Hemiptera (true bugs)
- Odonata (damself- and dragonflies)
- Trichoptera (caddisflies)
- Gastropoda (freshwater snails)

Pond Environment (Abiotic)



Pond Environment (Abiotic)



	Cluster 1: Grassland	25%-75%	Cluster 2: Artif. Surf.	25%-75%	Cluster 3: Forest	25%-75%
Pond	Median	25%-75%	Median	25%-75%	Median	25%-75%
pond area	1105.0	[738.5-1973.5]	503.0	[206-1089.5]	2008.0	[640.5-4019]
pond depth	0.6	[0.4-0.8]	0.7	[0.4-0.9]	1.1	[0.6-1.5]
pH	7.4	[7.1-7.6]	7.3	[7-7.5]	7.2	[6.9-8]
float. veg.	2.0	[0-3]	2.8	[0-4.5]	2.0	[0.3-4.5]
emerg. veg.	3.2	[2-5.5]	3.0	[1.5-4.5]	2.0	[1-3]
bushes	2.0	[1-3]	3.0	[1-4]	2.5	[1-4]
bare ground	0.0	[0-1.3]	0.0	[0-5.5]	0.0	[0-0.8]
TOC	15.6	[12.2-20.7]	16.1	[10.2-18.6]	16.9	[13.1-20.7]
TN	1.3	[0.9-1.7]	0.9	[0.7-1.4]	1.0	[0.9-1.4]
TP	72.0	[30-148]	57.0	[21.9-148]	39.0	[25.8-76.5] µg/L
artif. surf.	10.4	[5.8-16]	39.3	[24-52.4]	4.6	[1.4-8.4]
cultiv. area.	9.8	[7-16.1]	11.4	[6.5-14.9]	3.5	[1.9-7.2]
forest	28.2	[18.8-43.1]	26.1	[17.7-40.5]	65.6	[59-75.9] %
grassland	41.5	[29.2-50.1]	13.7	[10.2-23.1]	13.0	[7.2-16.6]
wetland	1.5	[1-3.4]	1.1	[0.6-1.8]	3.3	[1.2-7.5]
nat. surf.	0.3	[0-0.8]	1.3	[0.8-2]	0.2	[0.1-0.6]
water	0.0	[0-0.7]	0.0	[0-0]	0.0	[0-0.6]



Focal species = *Asellus aquaticus* ("waterlouse"), a freshwater crustacean (isopod)

Restriction Digestion: Unmethylated

GENOME:



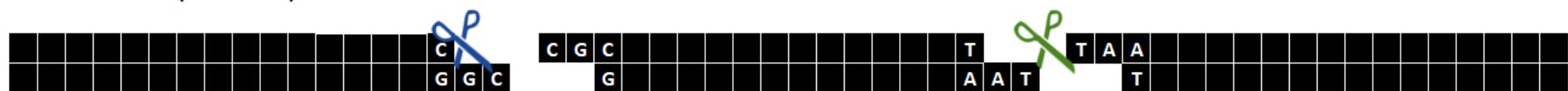
DIGESTION W/ RESTRICTION ENZYMES (PstI & MseI):



GENOME:



DIGESTION W/ RESTRICTION ENZYMES (Acil & MseI):



Restriction Enzymes: Acil PstI MseI

Methylation Content Sensitive Enzyme ddRAD (MCSeEd)

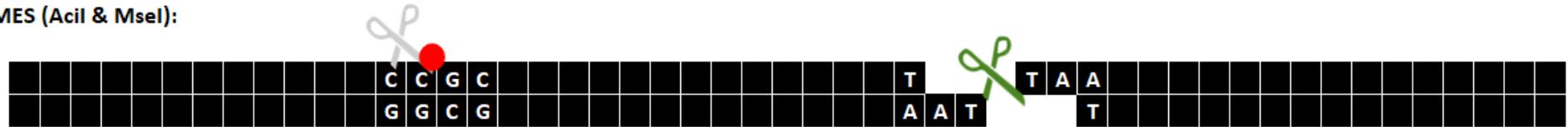
Pipeline modified from: Marconi et al. (2019). Scientific Reports

Restriction Digestion: Methylated

DIGESTION W/ RESTRICTION ENZYMES (PstI & MseI):



DIGESTION W/ RESTRICTION ENZYMES (AciI & MseI):



Restriction Enzymes: Acil PstI MseI

Methylation Content Sensitive Enzyme ddRAD (MCSeEd)

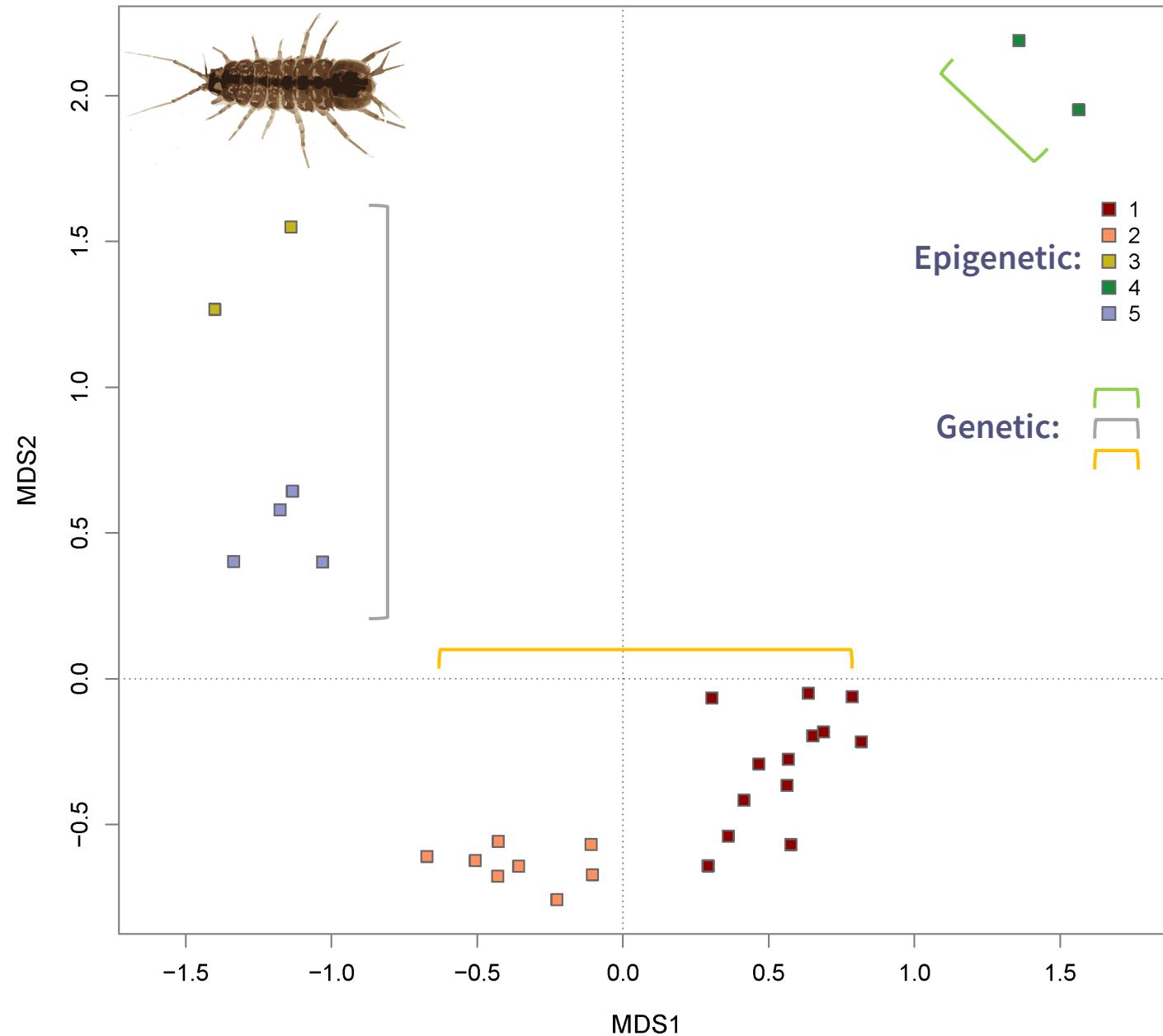
Pipeline modified from: Marconi et al. (2019). Scientific Reports

(Epi-)genetic Clusters

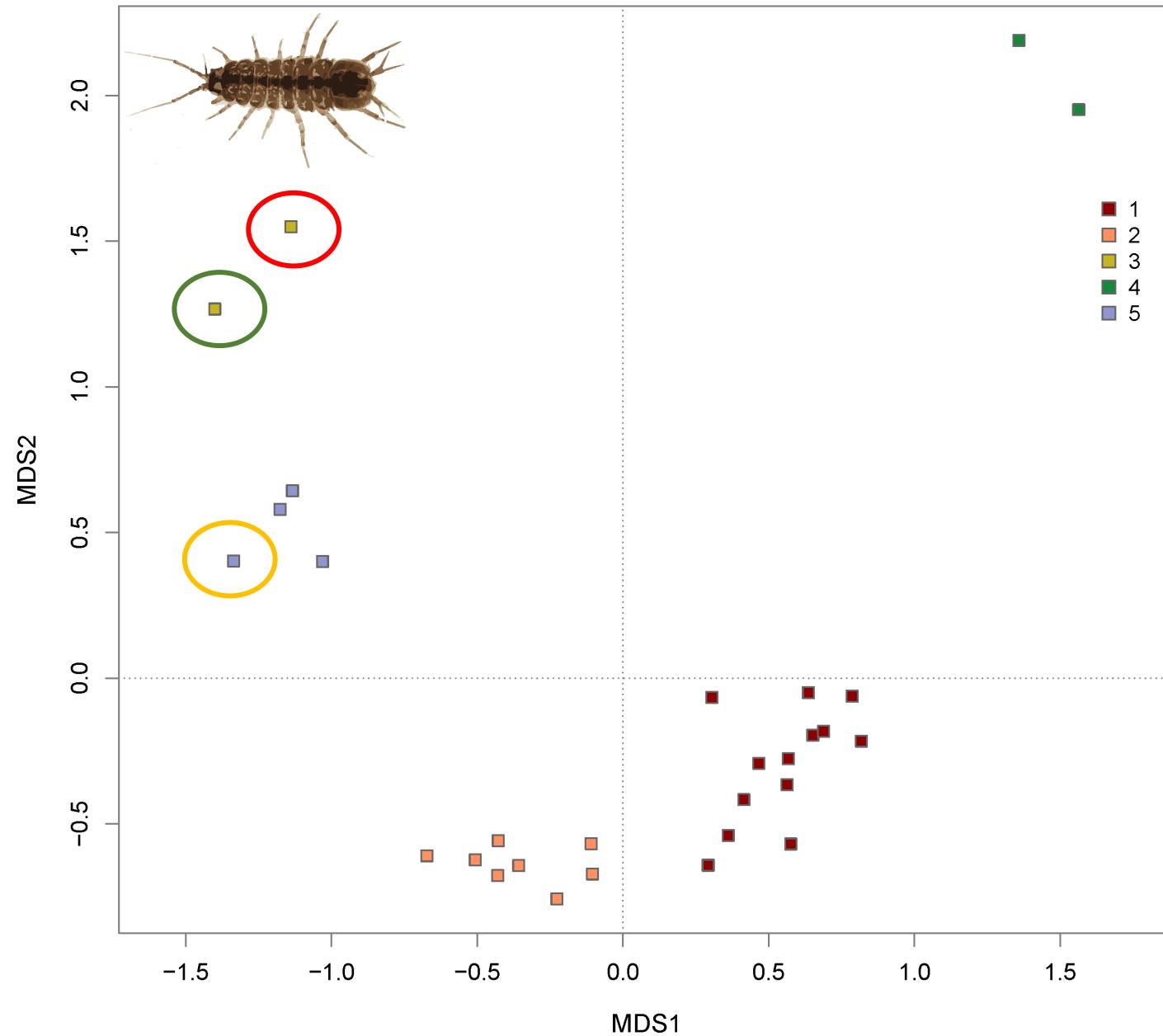
>500k loci

Results presented here:
random subset of
~23k loci

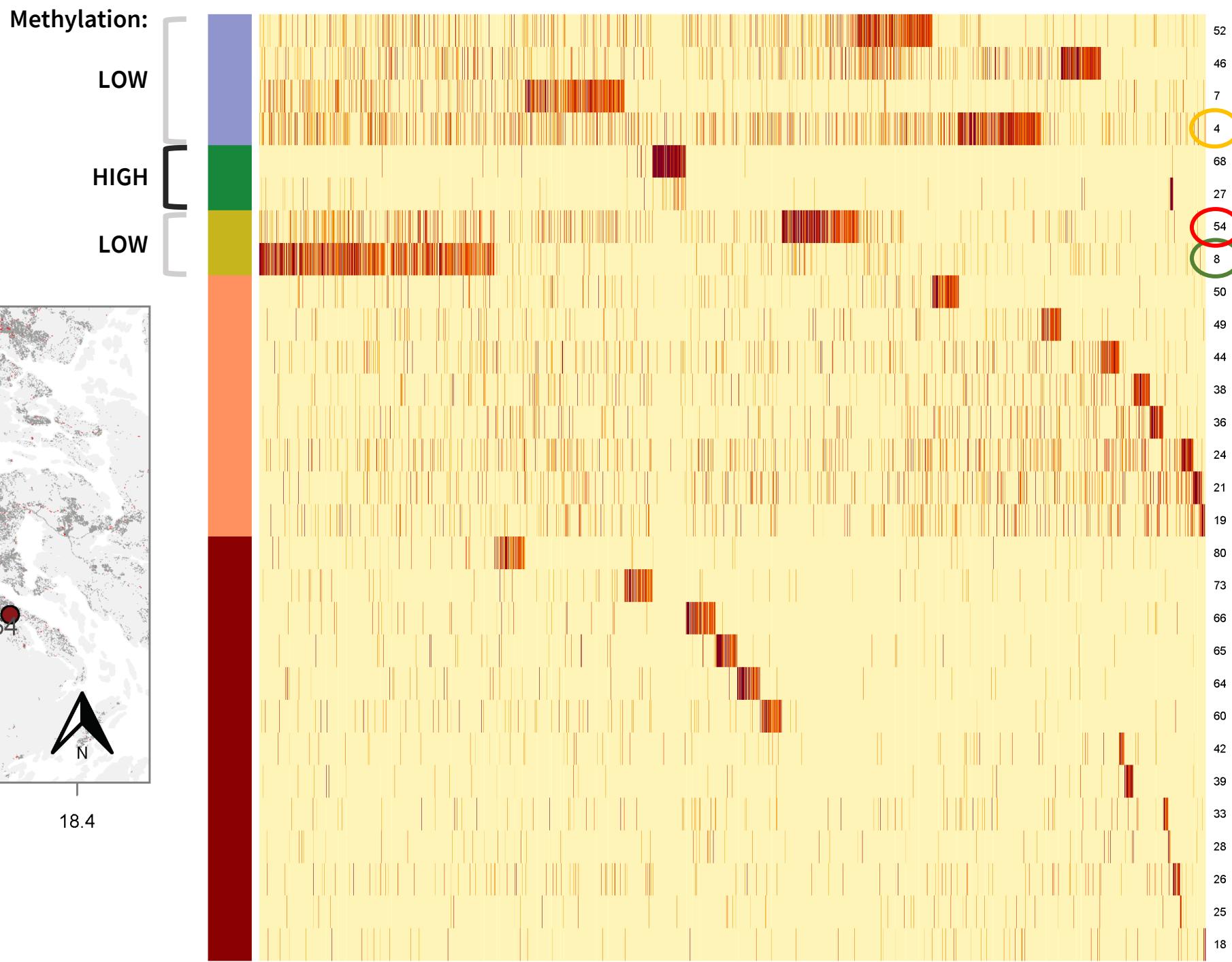
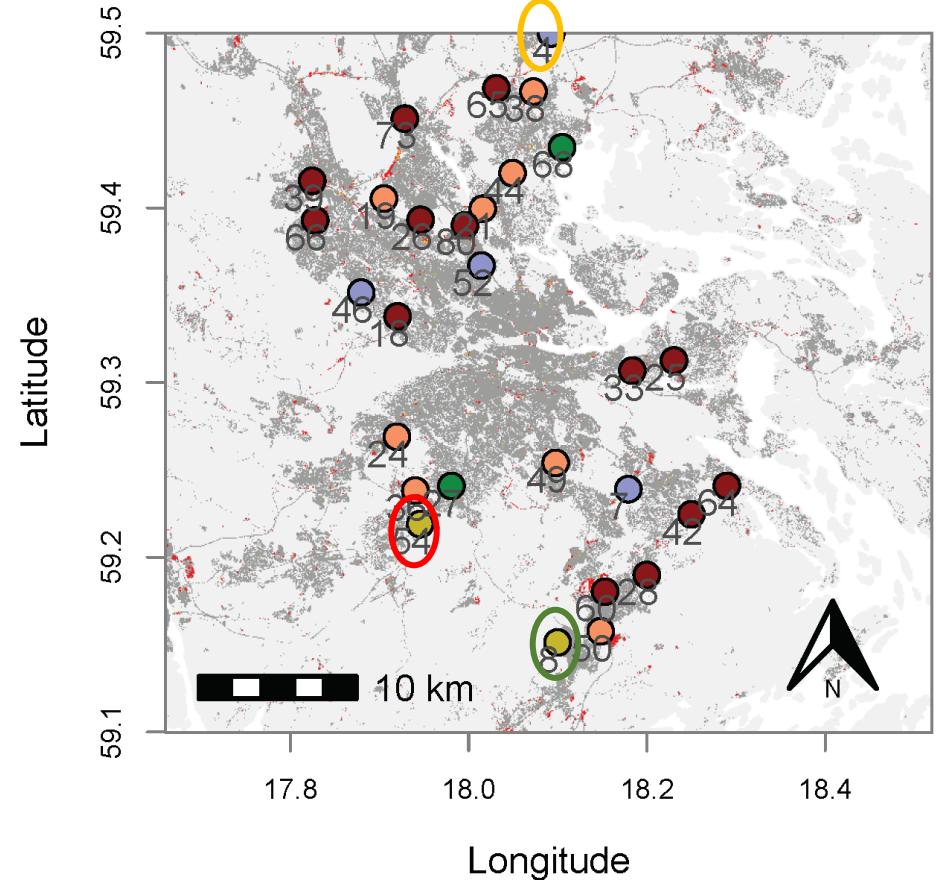
29 ponds
10-12 individuals per pond



(Epi-)genetic Clusters

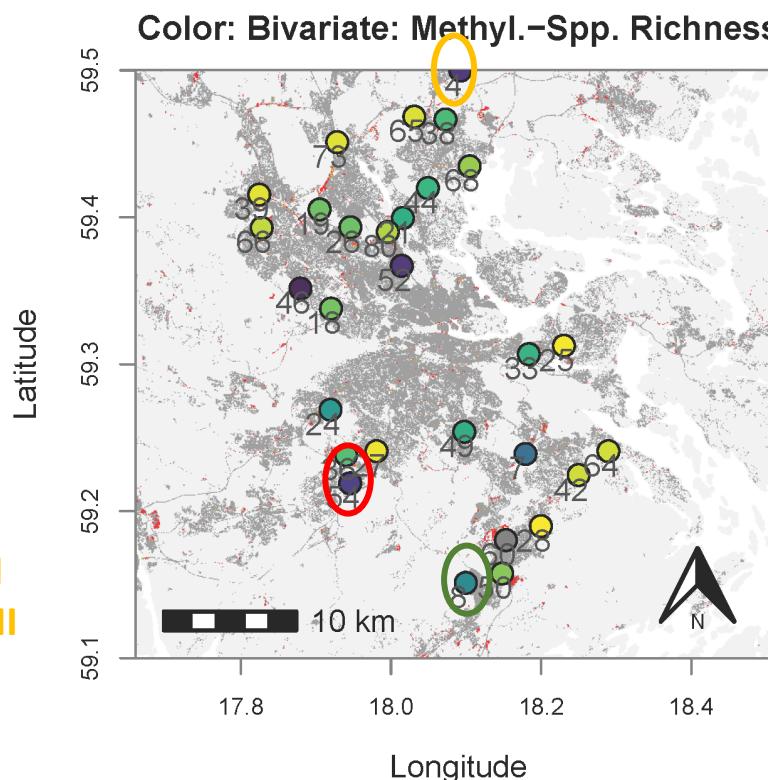
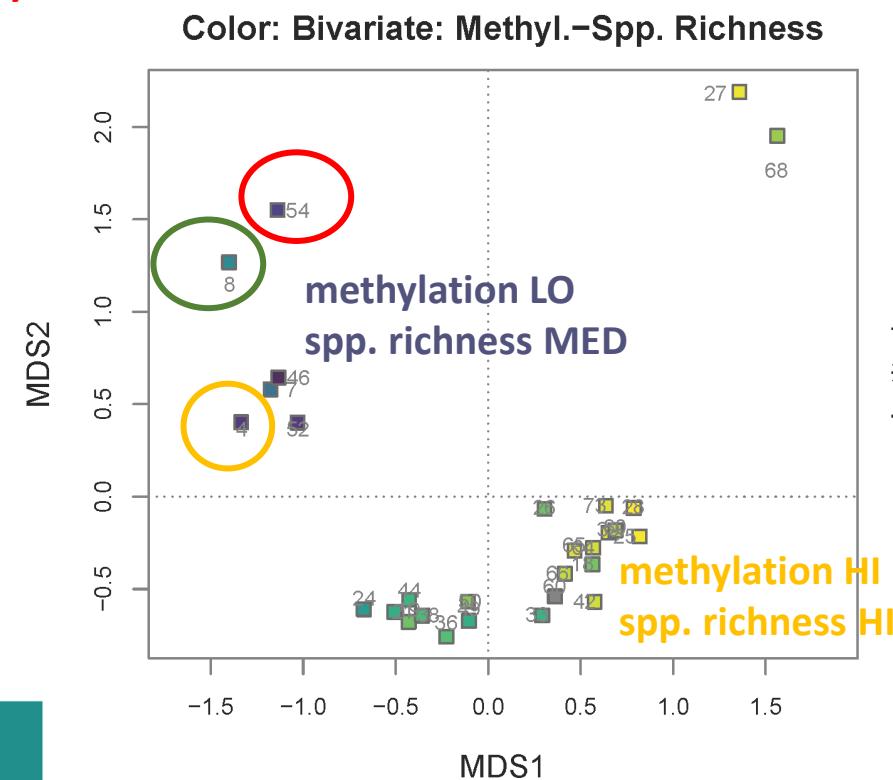
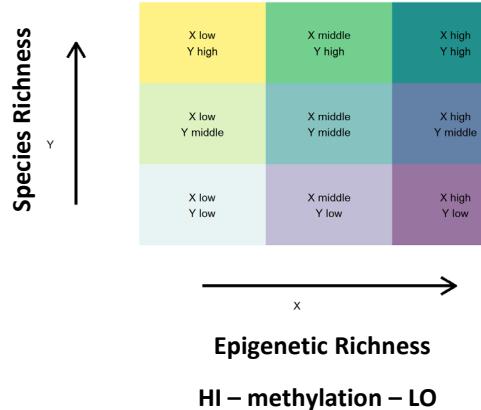


Methylation Patterns



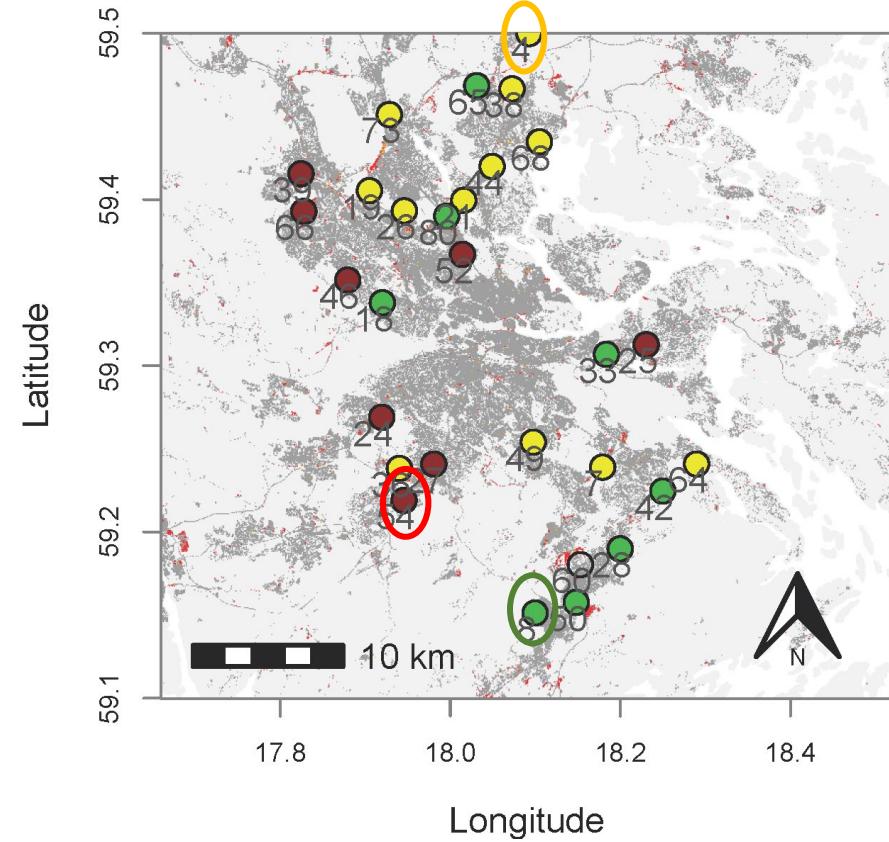
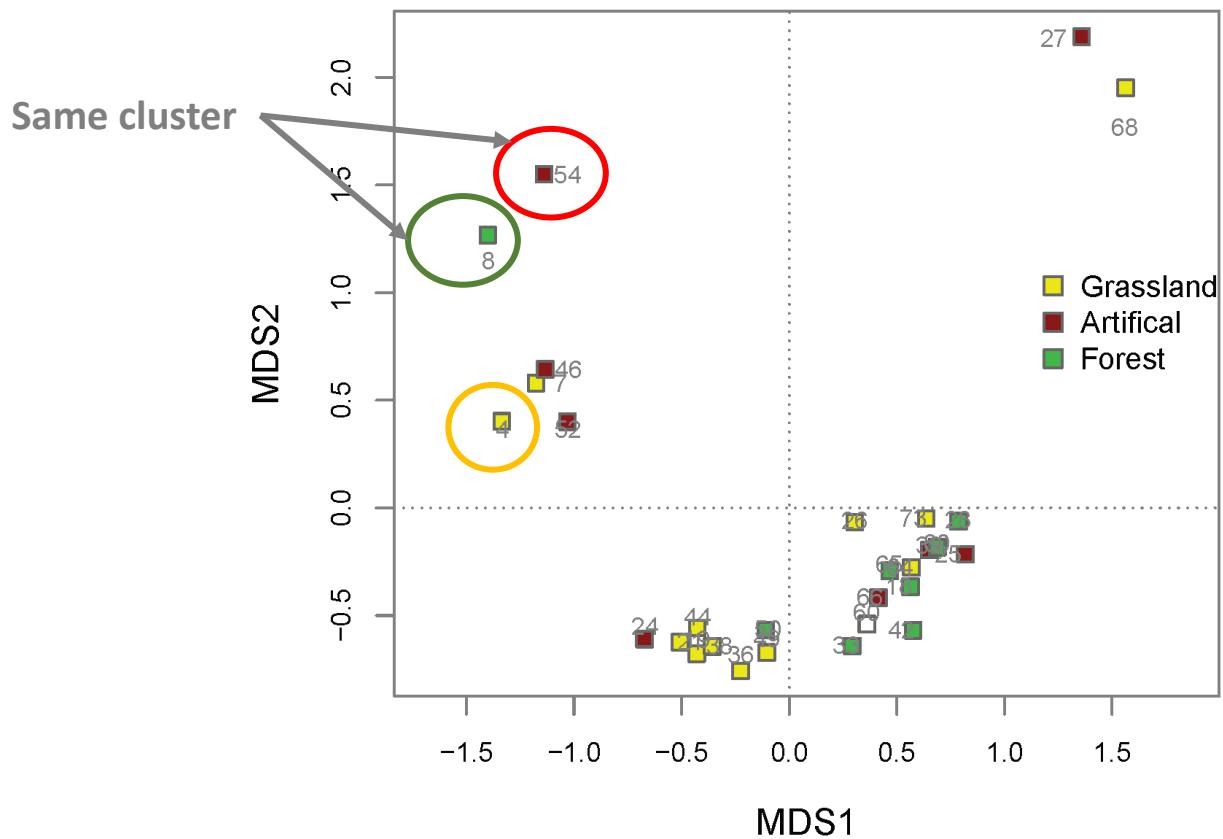
Methylation Patterns (Spp.)

Species-epigenetic diversity:
Corr. = -0.37



Methylation Patterns (Env.)

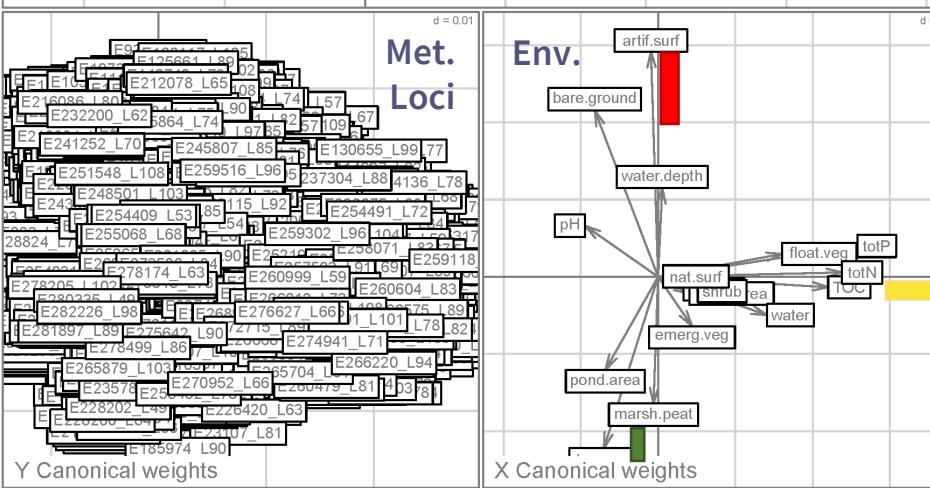
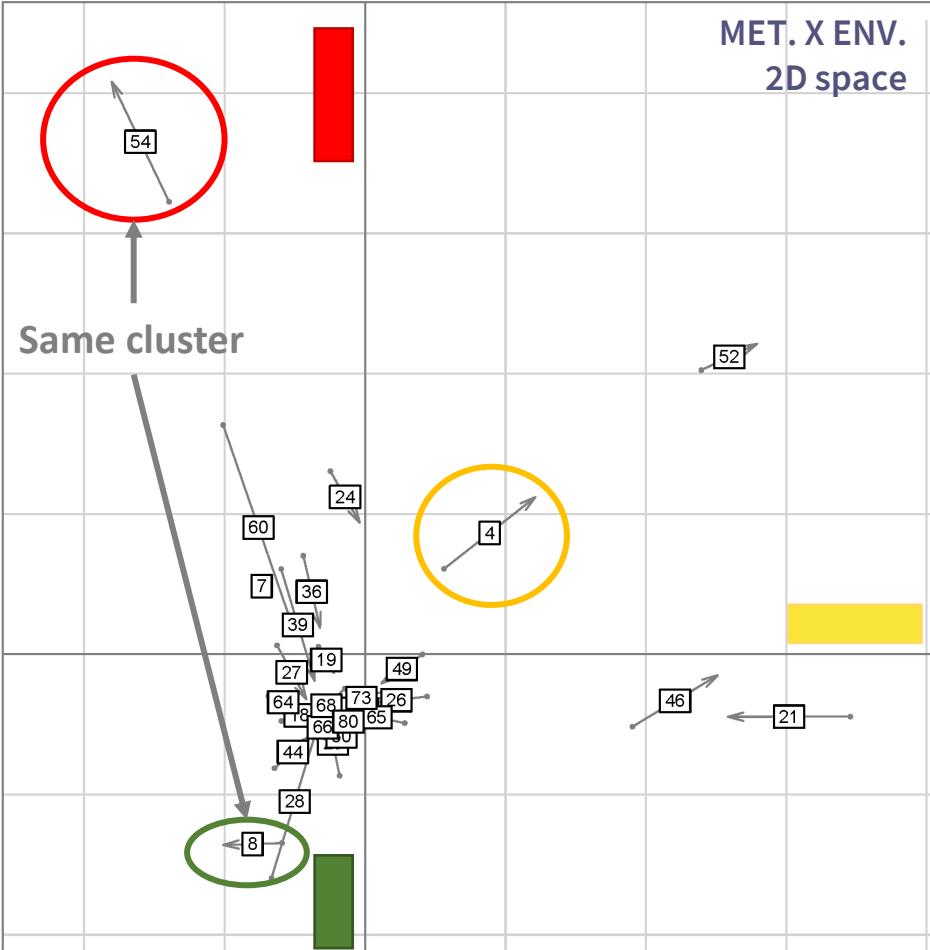
MDS – Differential Methylation Frequencies:
w/ Pond Class



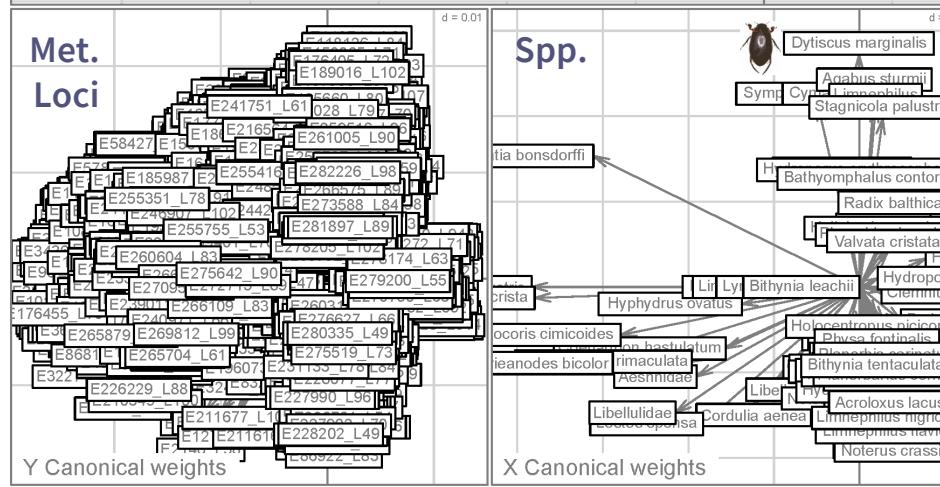
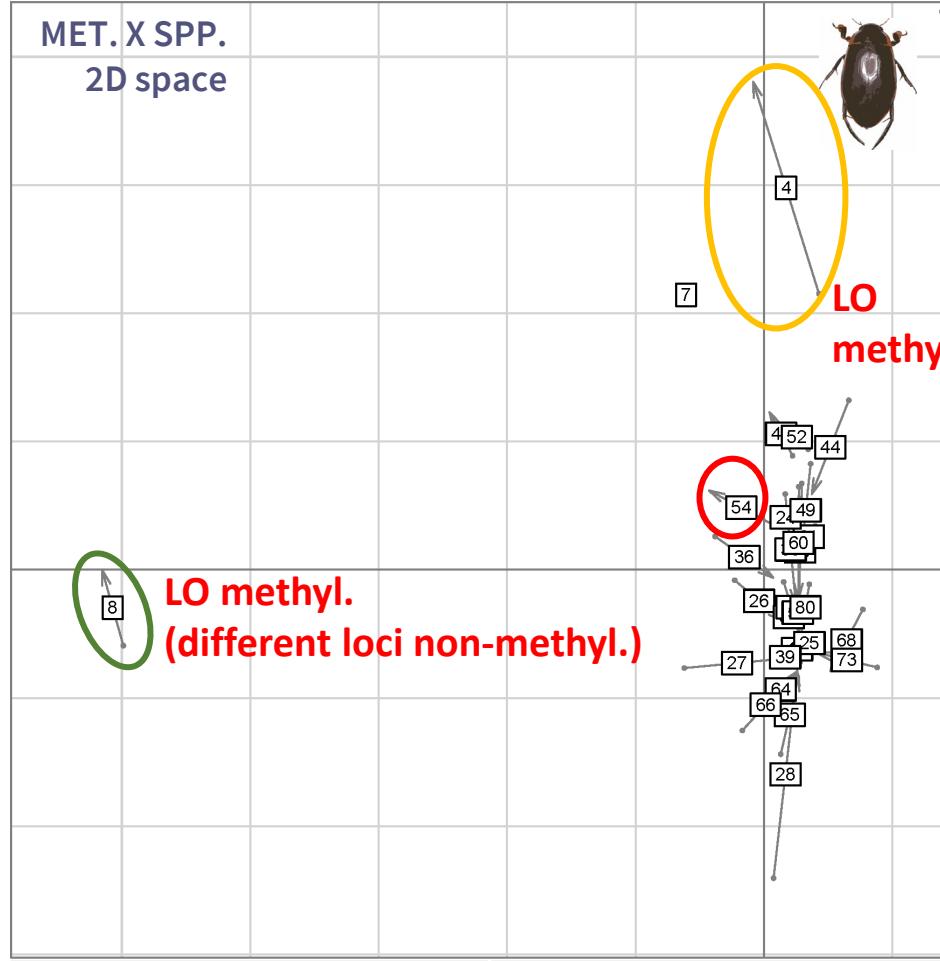
Co-Inertia: Met. X Env.

Ponds #8 and #54:

Same cluster
BUT,
Different MET. profiles
matching
Different ENV.



Co-Inertia: Met. X Spp.



Predation?

What may be happening in Pond #4:

Reduced species diversity
(of prey)

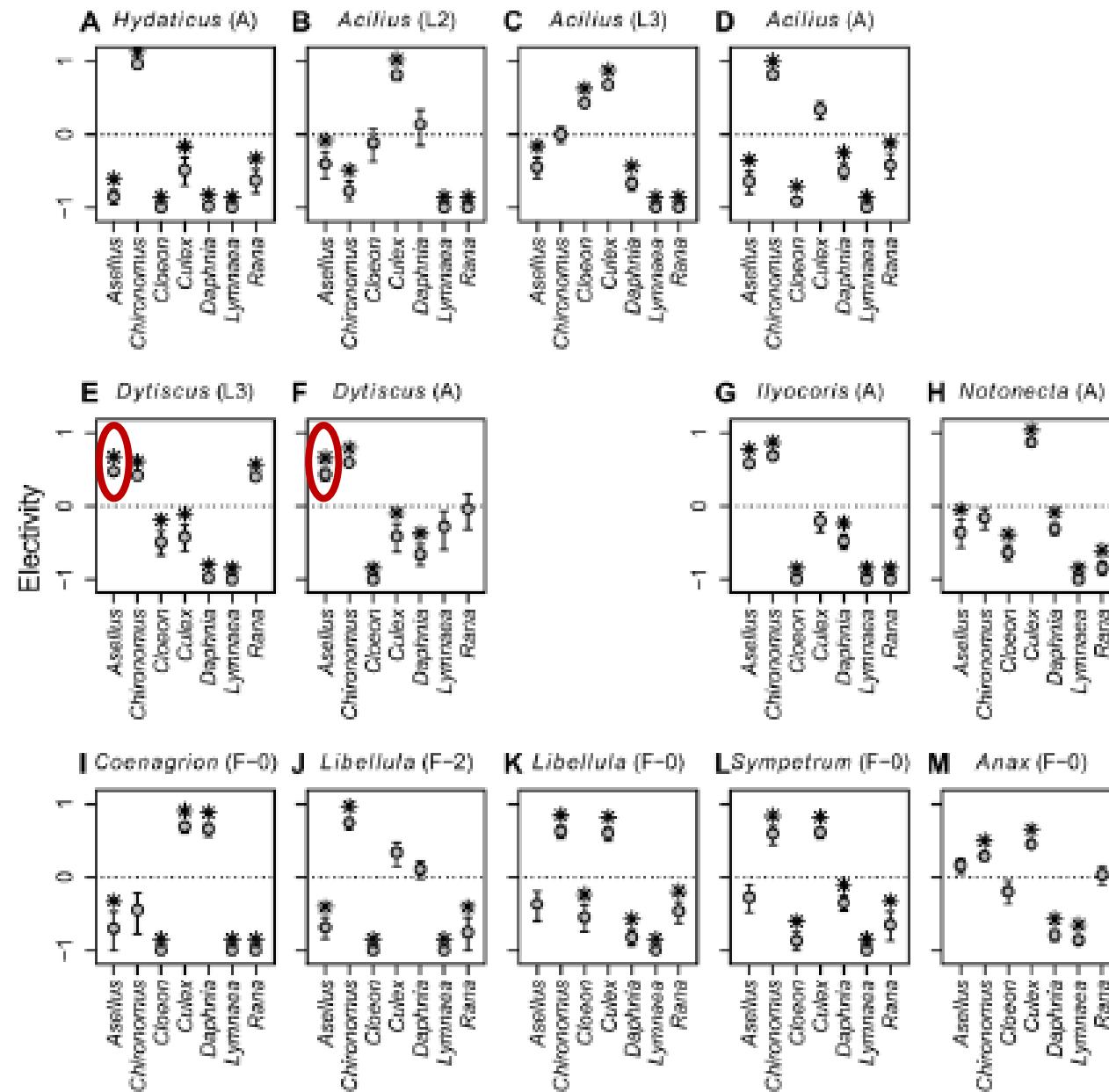
→ Predation pressure on *Asellus*

HIGH

→ Methylation

LOW

(# non-methylated loci HIGH)



Species-(epi)genetic diversity correlation: Negative

**High species diversity associated with
low epigenetic diversity → MORE methylated loci**

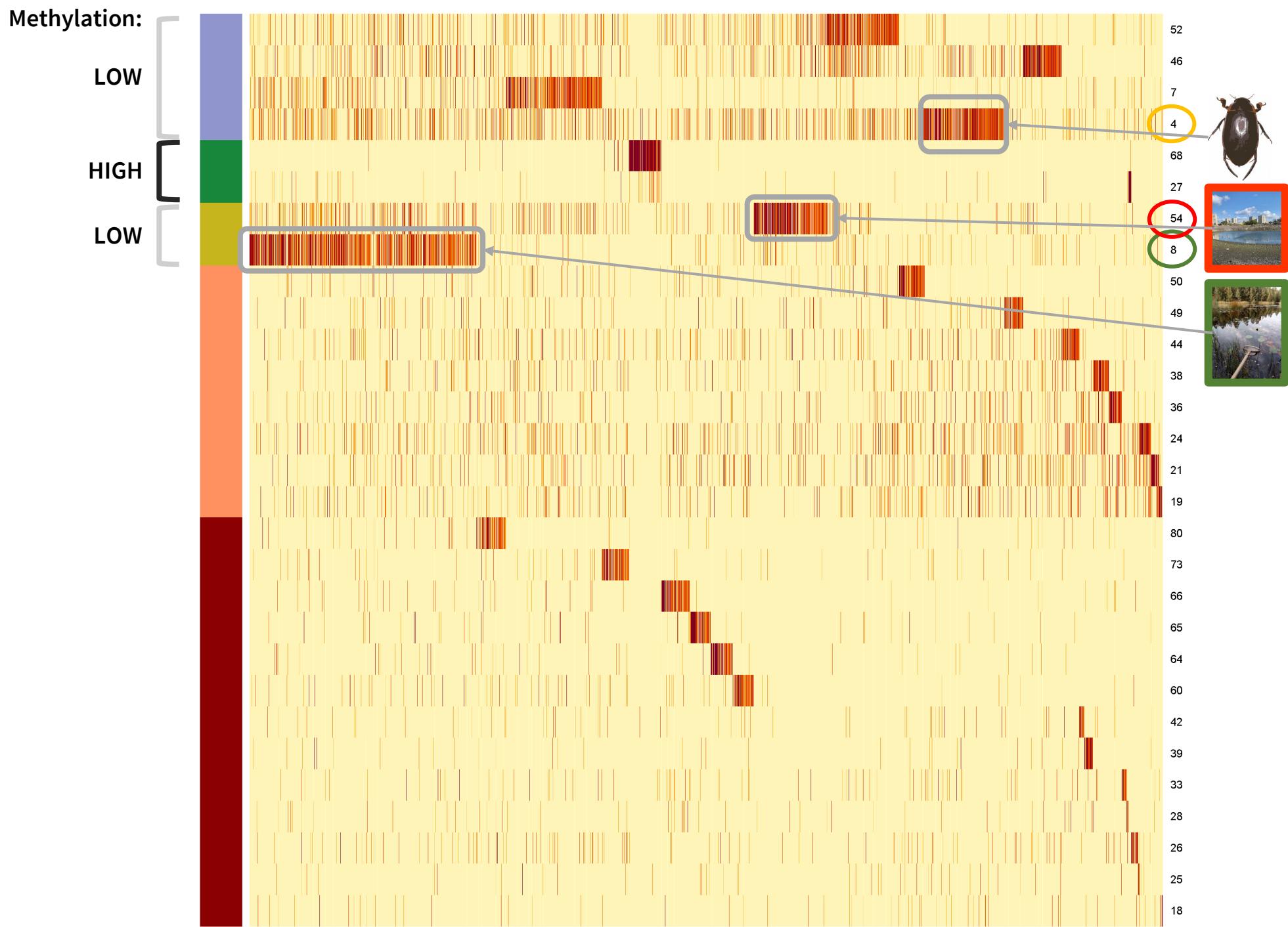
Species-(epi)genetic diversity correlation: Negative

High species diversity associated with
low epigenetic diversity → MORE methylated loci

Covariance of methylation w/ both biotic and abiotic factors

Abiotic: artificial surfaces/vegetation & water chemistry

Biotic: predation a potential factor



Thank you!

Looking forward to your questions

Chaz Hyseni



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UNIVERSITET