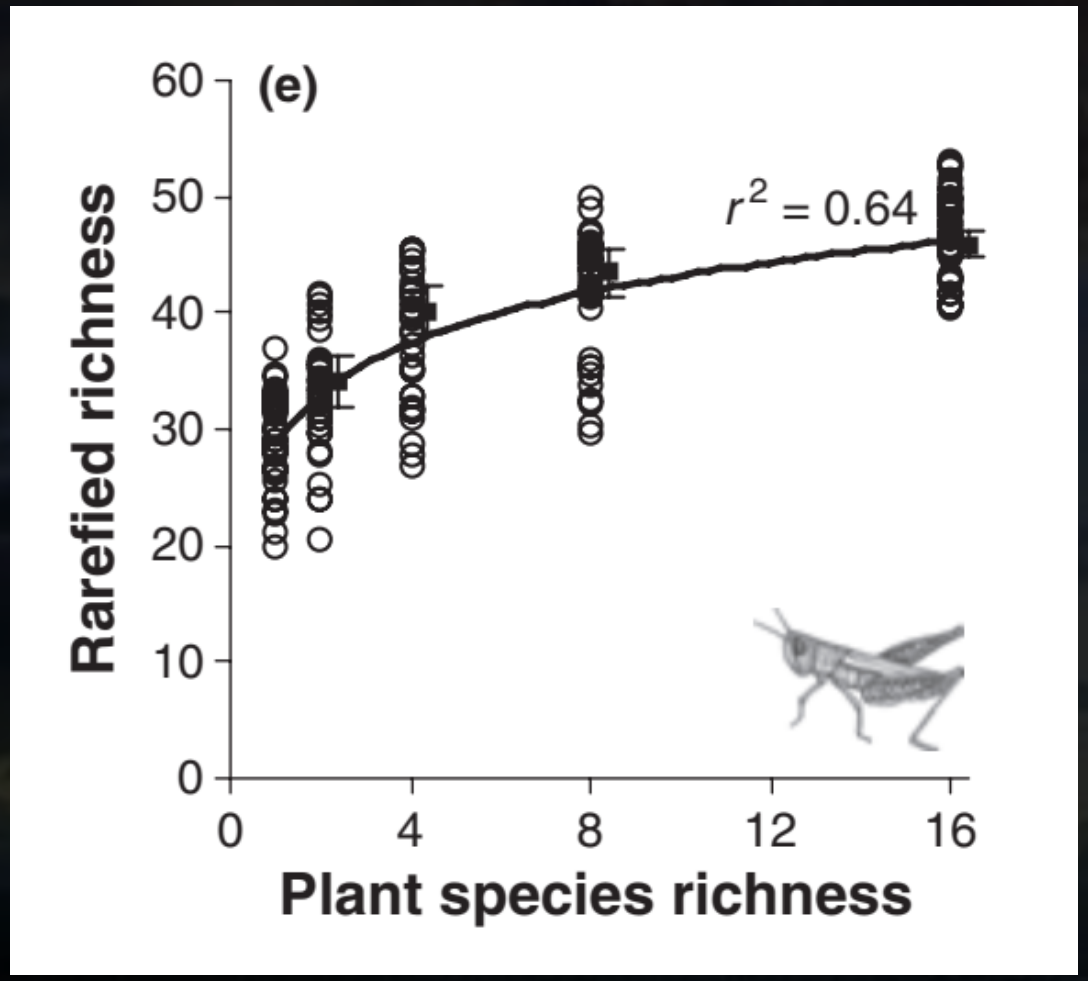
Mechanisms underlying the predator-prey diversity relationships in marine bacterioplankton

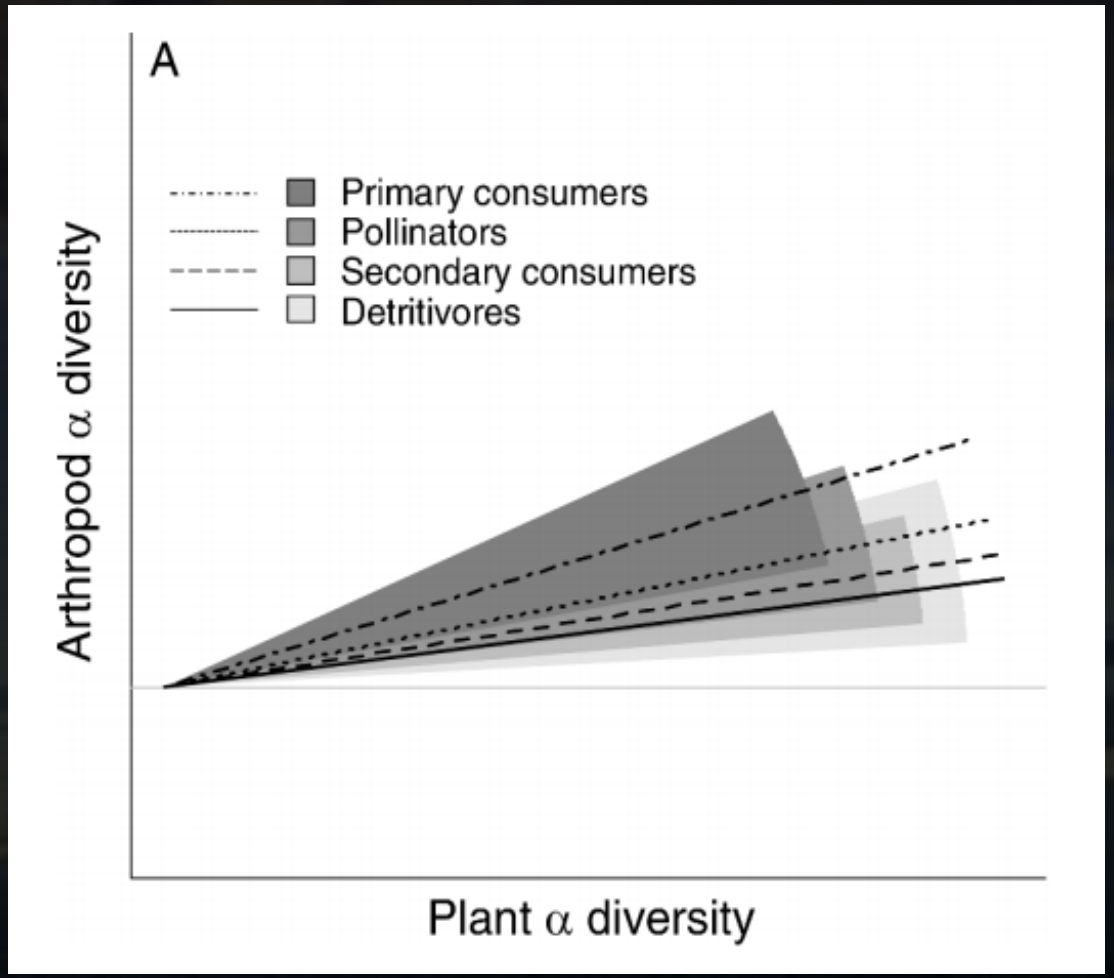
– implications from the community assembly processes

Feng-Hsun Oscar Chang

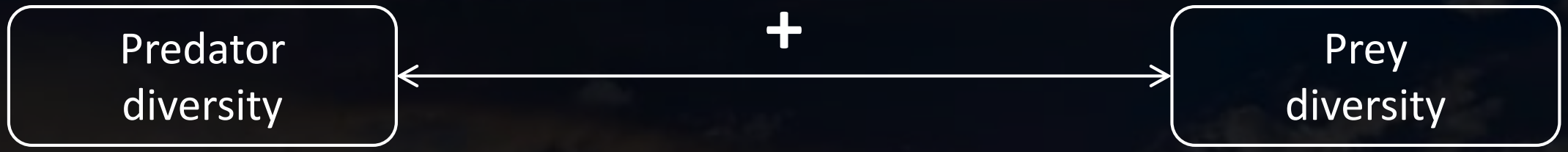
@ IONTU 422 lab meeting



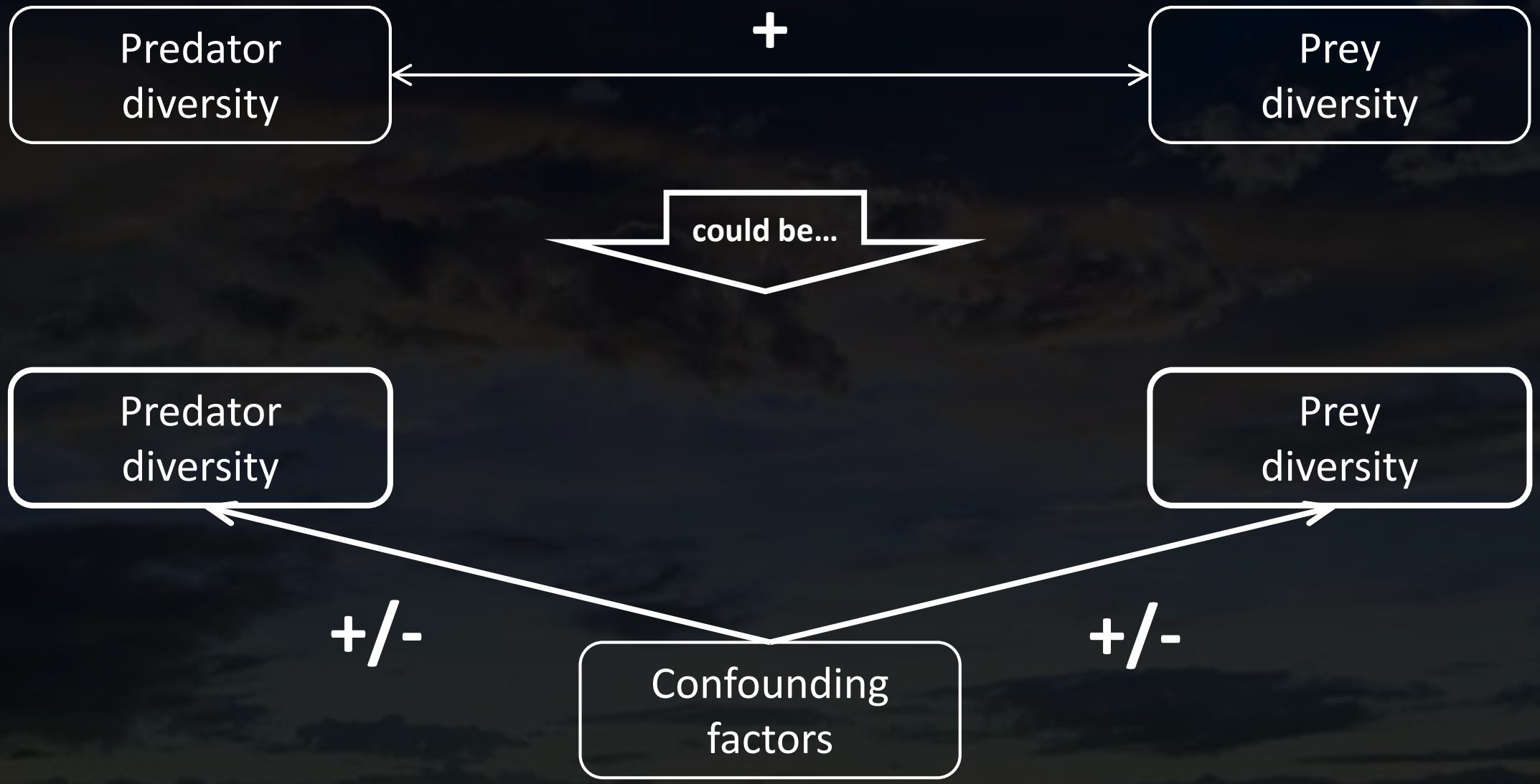
Haddad et al. 2009 @ Eco. Lett.

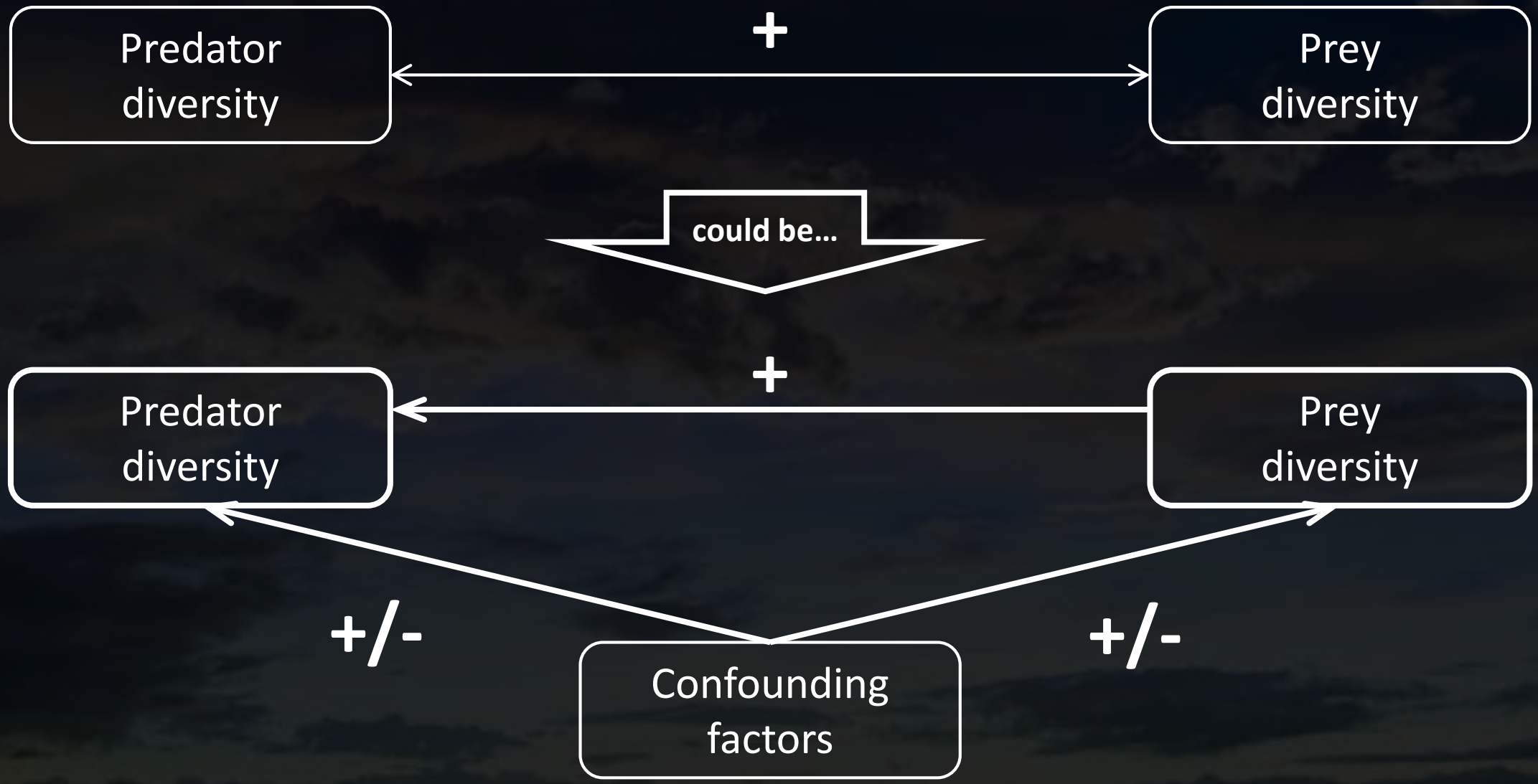


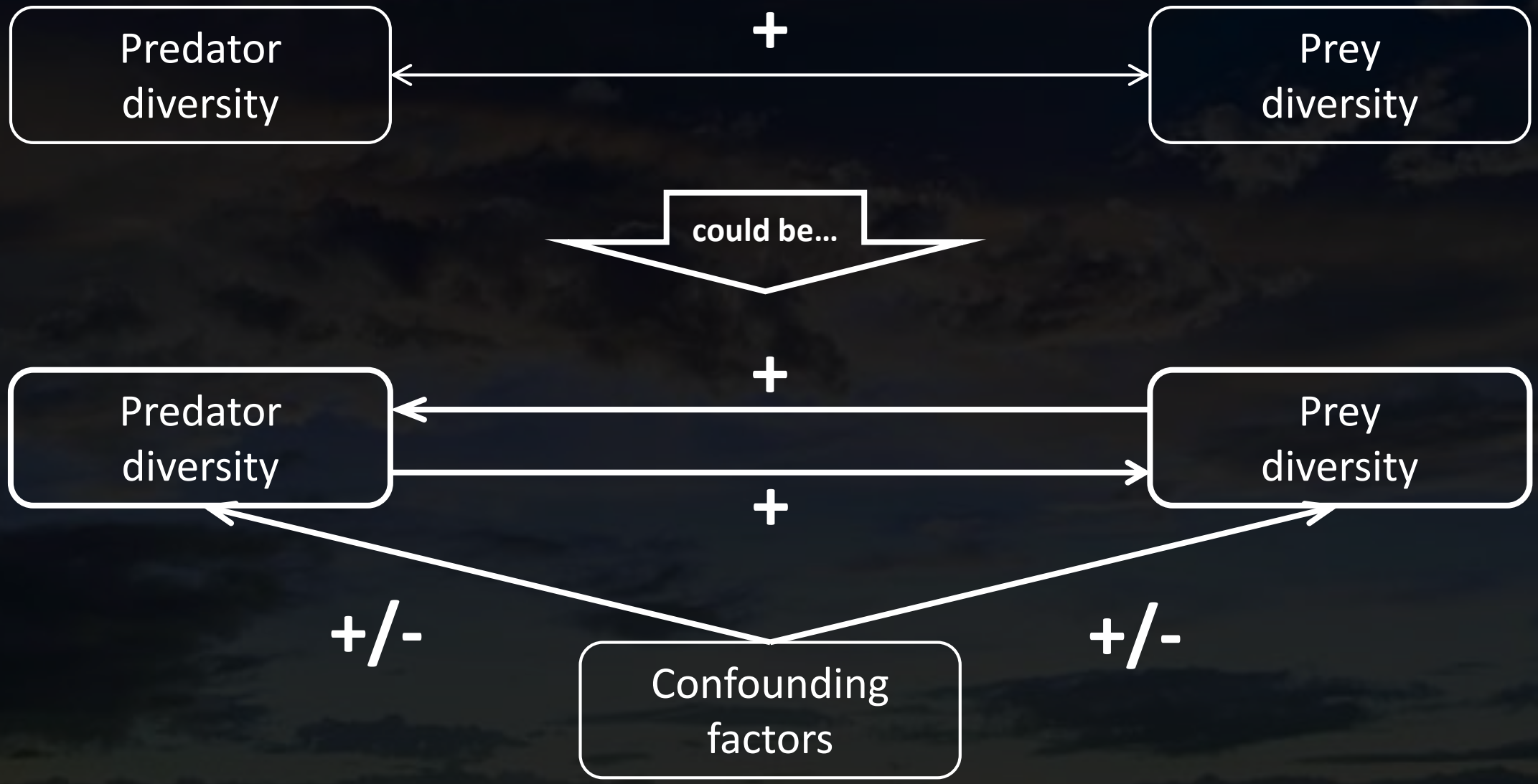
Castagneyrol et al. 2012 @ Ecology



Why the diversity of predator and prey are positively associated?


Predator diversity
+
Prey diversity
could be…
Predator diversity
Prey diversity
+/-
+/-
Confounding factors


Predator diversity
+
Prey diversity
could be…
Predator diversity
+
Prey diversity
+/-
+/-
Confounding factors


Predator diversity
+
Prey diversity
could be…
Predator diversity
+
+
Prey diversity
+/-
+/-
Confounding factors

Can community assembly processes help?

Community assembly processes

Ecological community

Patterns

- Species-area relationships
- Diversity gradients
- Relative abundance distributions
- etc…

Vellend 2010 @ Q. Rev. Biol.

Can community assembly processes help?

Drift
Selection
Speciation
Dispersal

Ecological community

Patterns

- Species-area relationships
- Diversity gradients
- Relative abundance distributions
- etc…

Vellend 2010 @ Q. Rev. Biol.

Can community assembly processes help?

Random / Stochasticity

Drift
Selection
Speciation
Dispersal

Ecological community

Patterns

- Species-area relationships
- Diversity gradients
- Relative abundance distributions
- etc…

Vellend 2010 @ Q. Rev. Biol.

Can community assembly processes help?

Random / Stochasticity
- Drift

Non-random / Deterministic
- Selection
- Speciation
- Dispersal

Ecological community

Patterns

- Species-area relationships
- Diversity gradients
- Relative abundance distributions
- etc…

Vellend 2010 @ Q. Rev. Biol.

Can community assembly processes help?

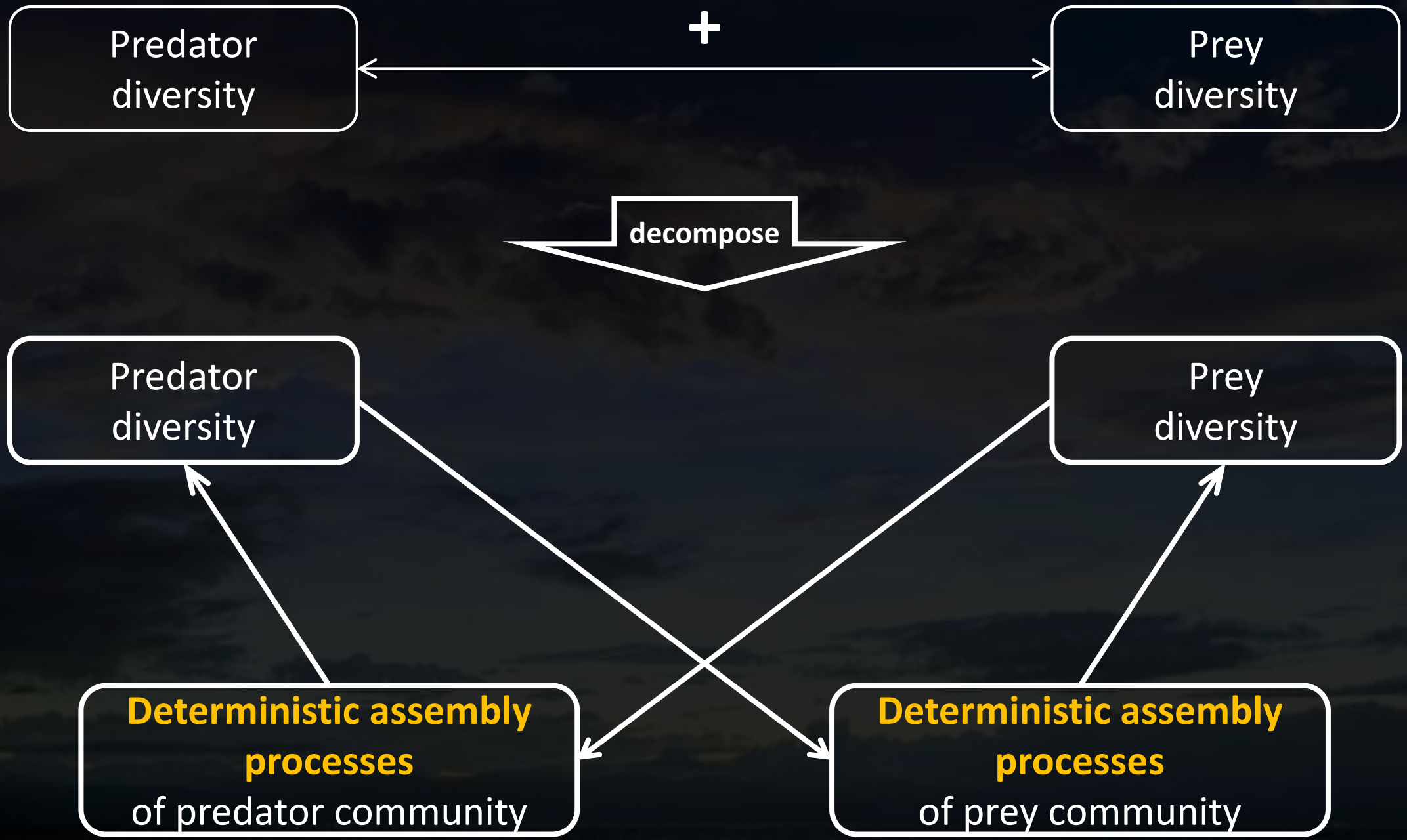
Random / Stochasticity	Drift
Non-random / Deterministic	Selection Speciation
Both ???	Dispersal

Ecological community

Patterns

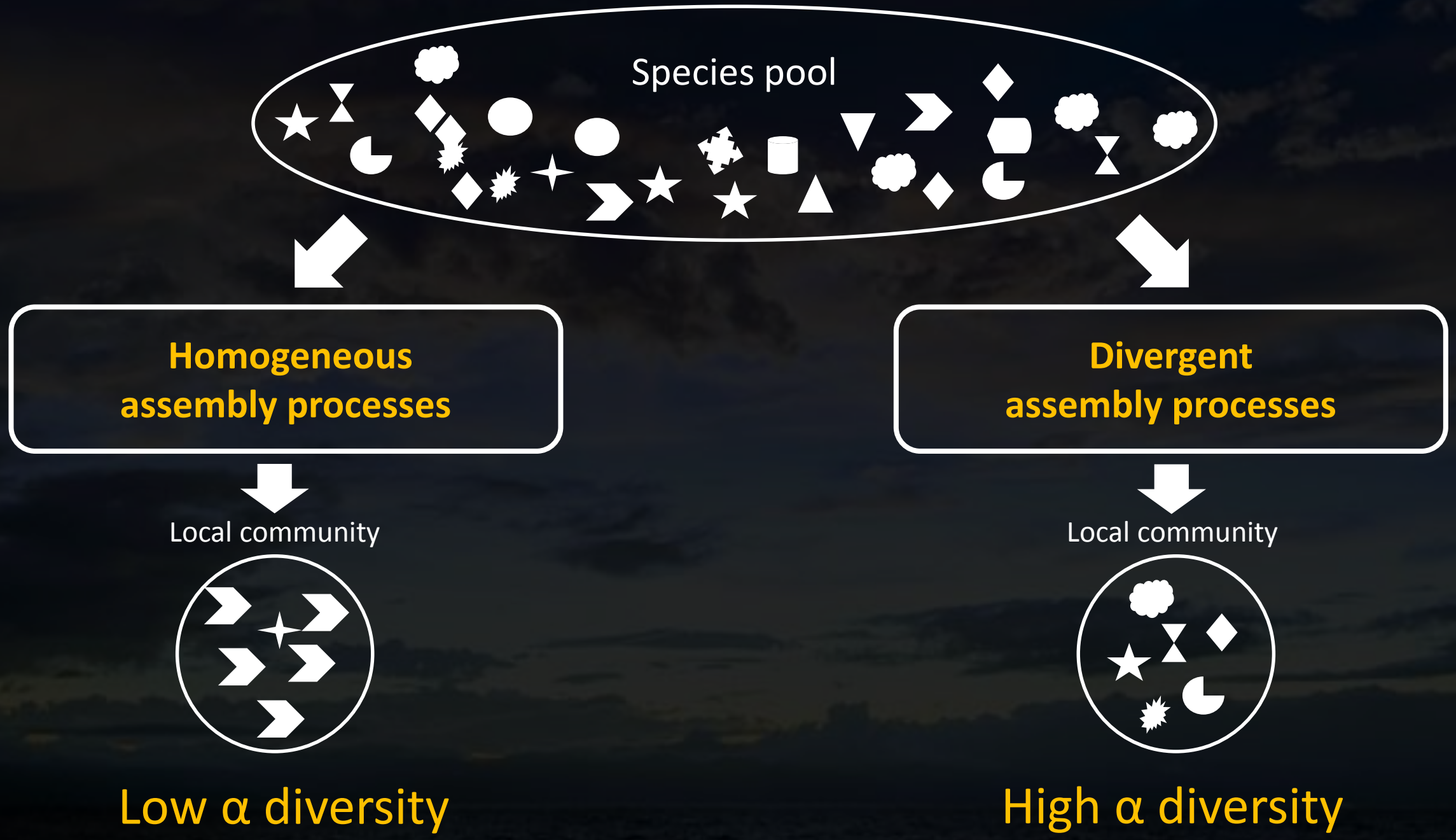
- Species-area relationships
- Diversity gradients
- Relative abundance distributions
- etc…

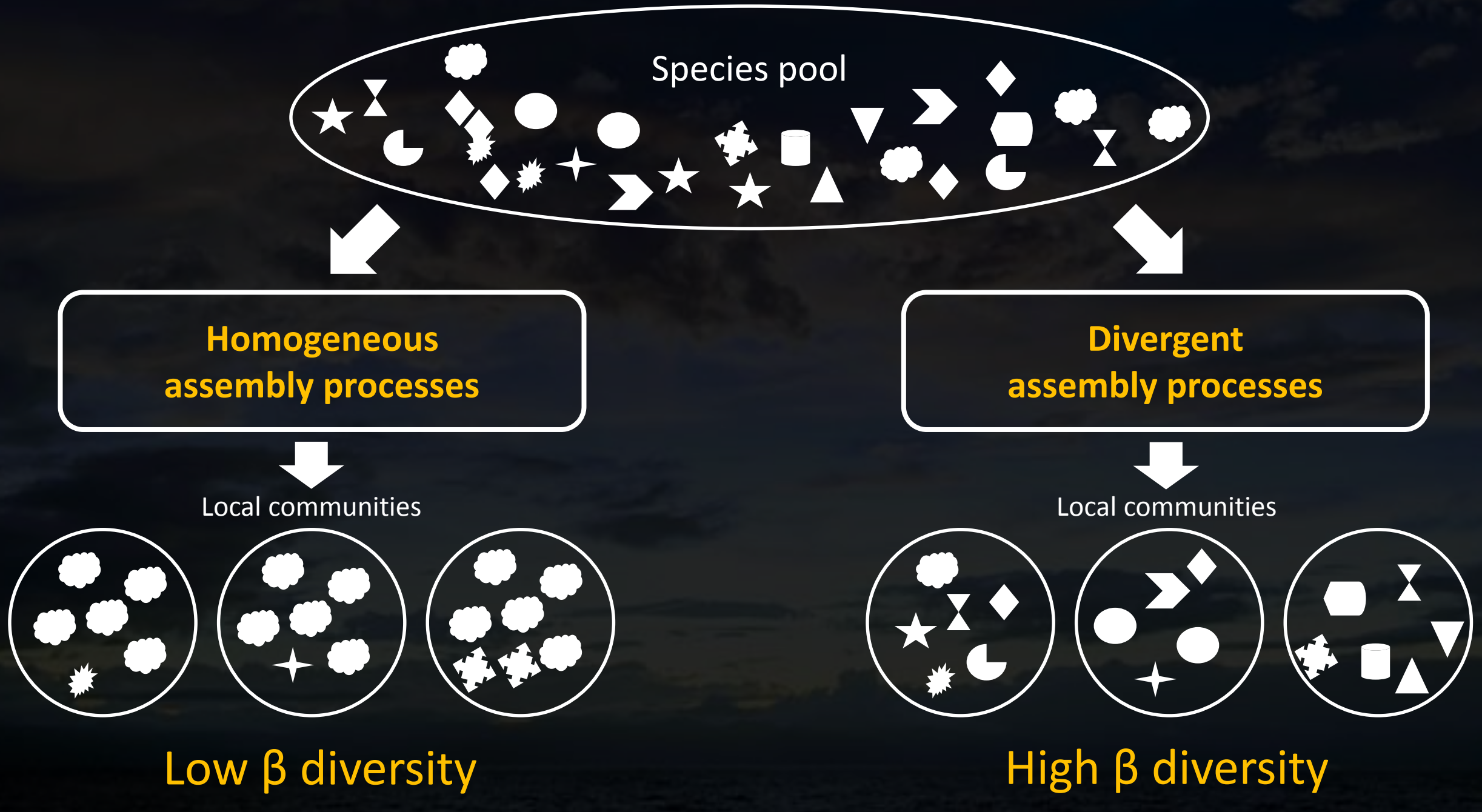
Vellend 2010 @ Q. Rev. Biol.


Predator diversity
+
Prey diversity
decompose
Predator diversity
Prey diversity
Deterministic assembly processes of predator community
Deterministic assembly processes of prey community

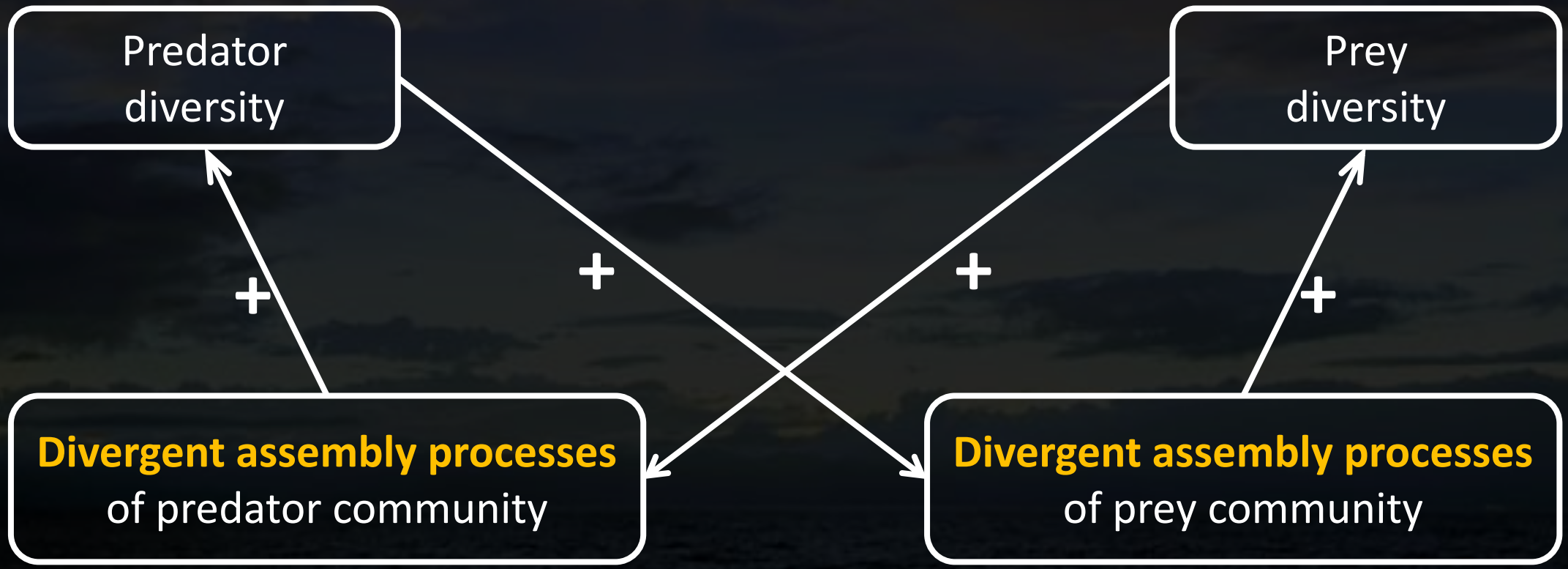
Divergent
assembly processes

Homogeneous
assembly processes


Species pool
Homogeneous assembly processes
Divergent assembly processes
Local community
Local community
Low α diversity
High α diversity


Species pool
Homogeneous assembly processes
Divergent assembly processes
Local communities
Local communities
Low β diversity
High β diversity

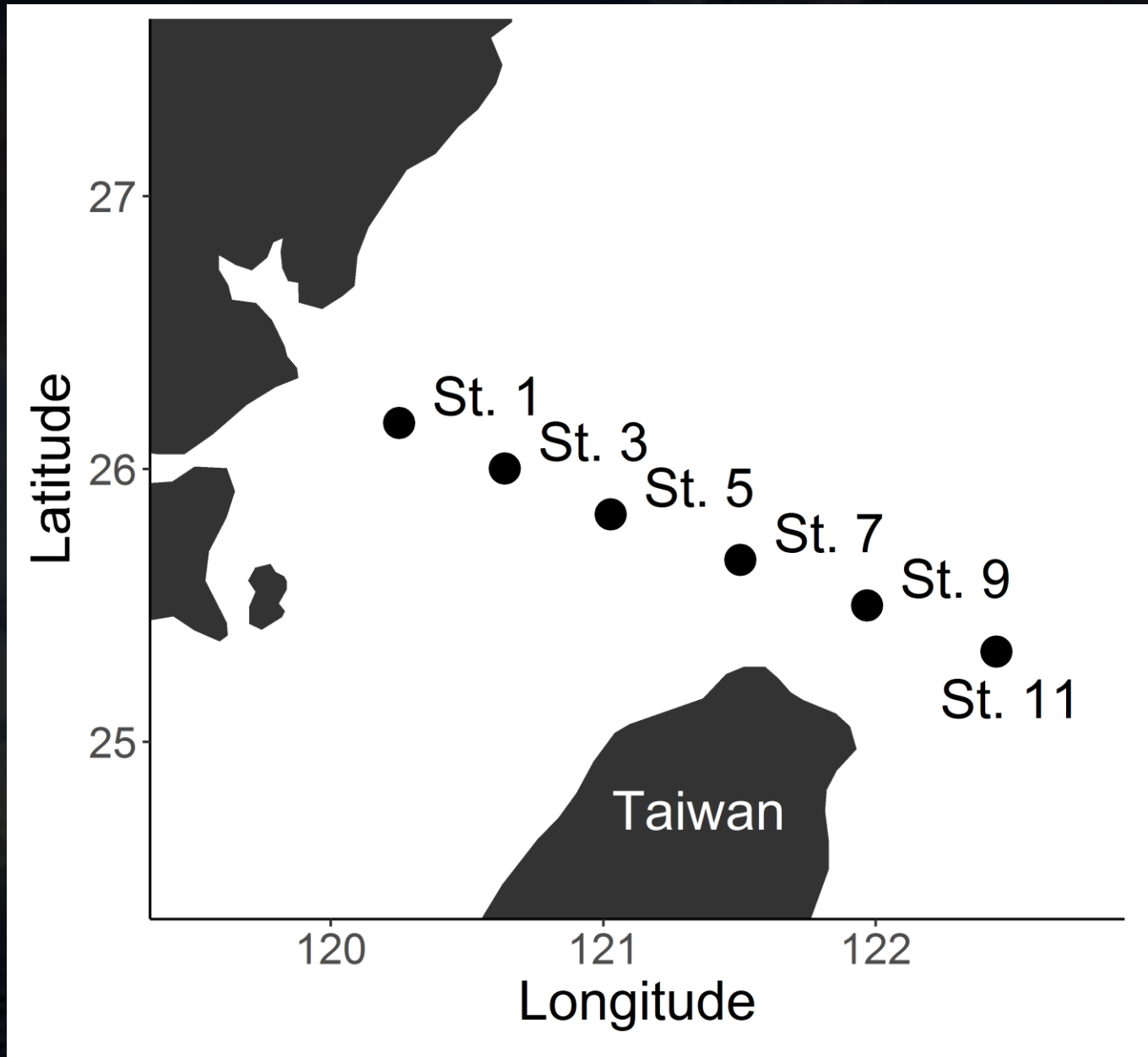
Predator (prey) diversity increases the
divergent assembly processes of prey (predator) community,
which in turn increase prey (predator) diversity,
in both α and β levels



- 14 cruises

- Predator:
  Heterotrophic nano-flagellates
  (HNF; 18S rDNA)

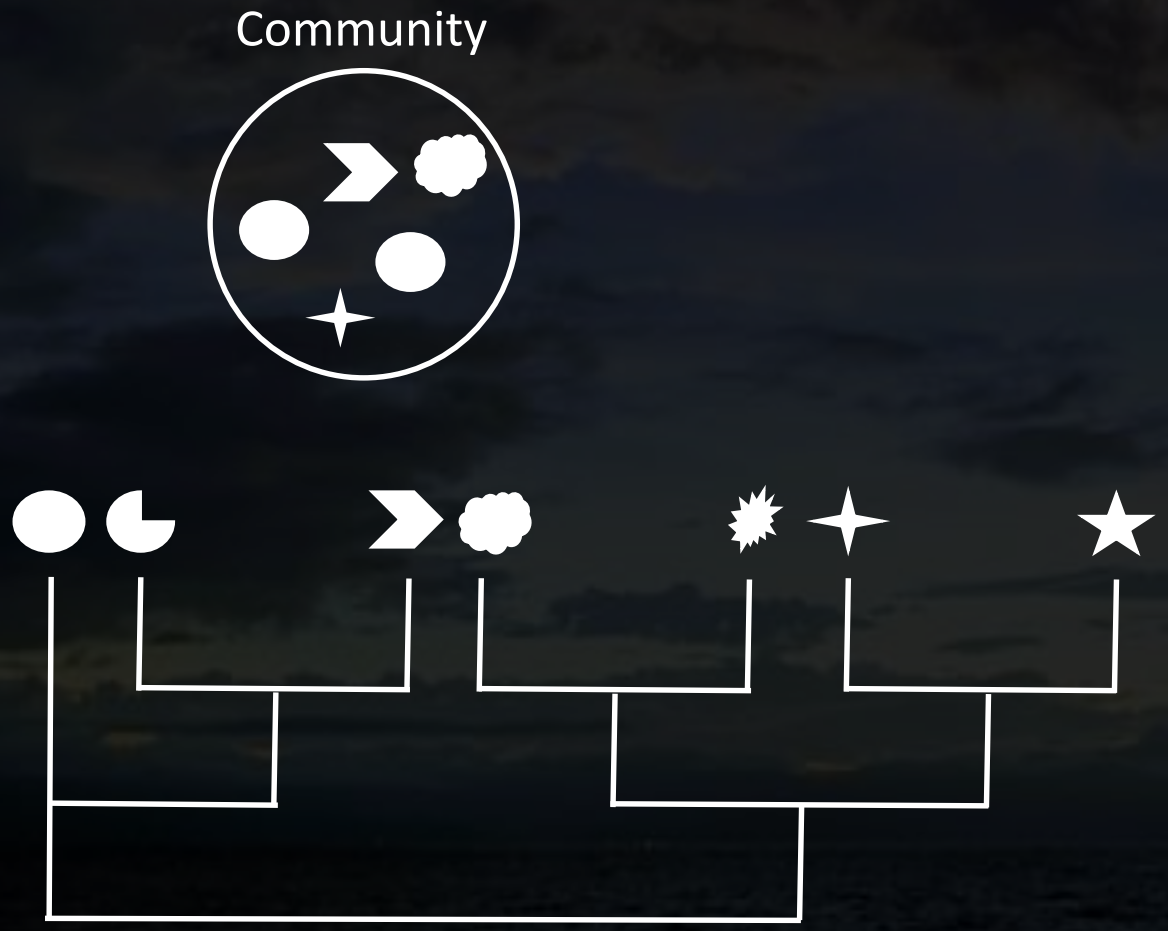
- Prey: Bacteria (16S rDNA)

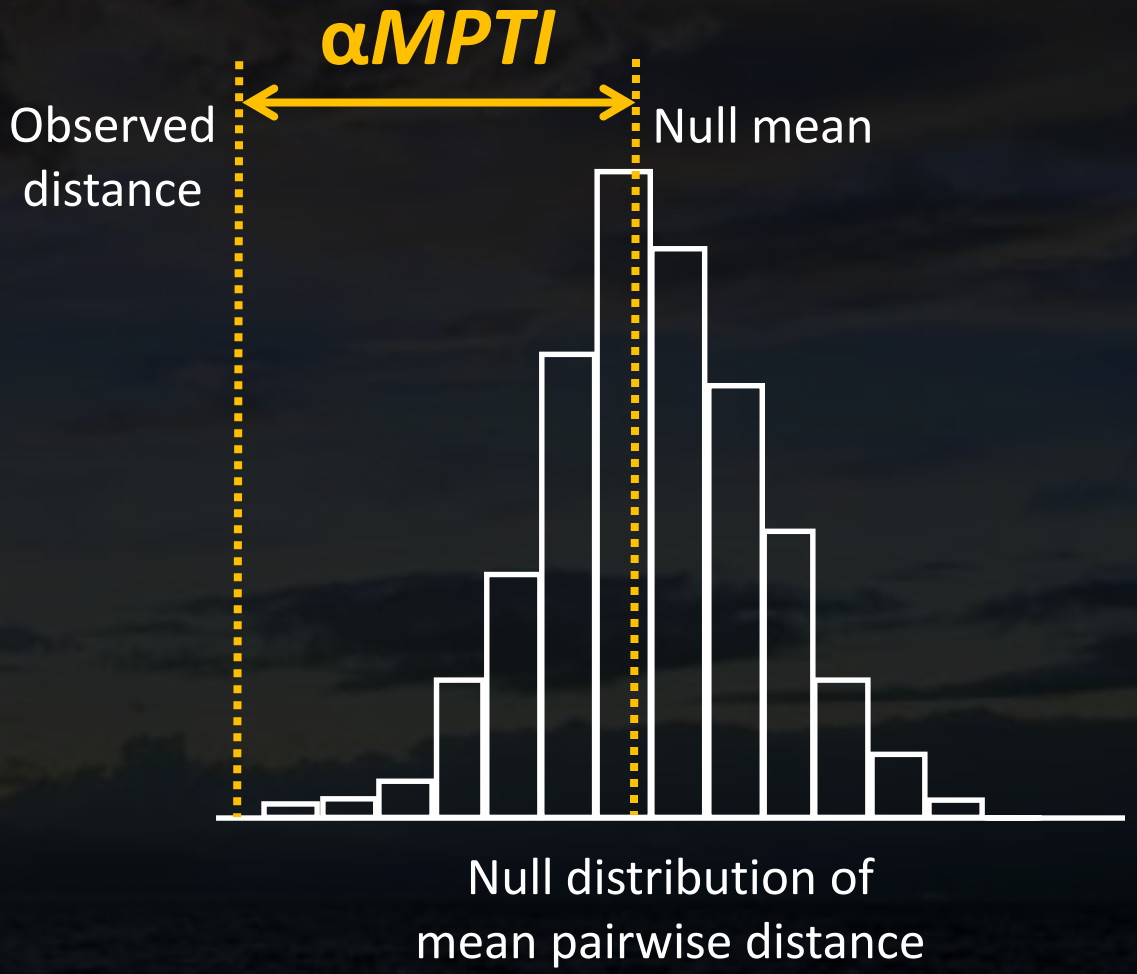


Deterministic assembly processes:

Mean Pairwise Taxa Index (*MPTI*),

calculated from mean pairwise phylogenetic distance

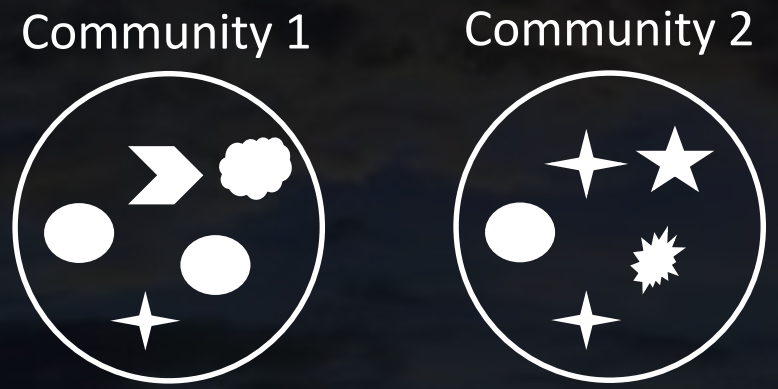


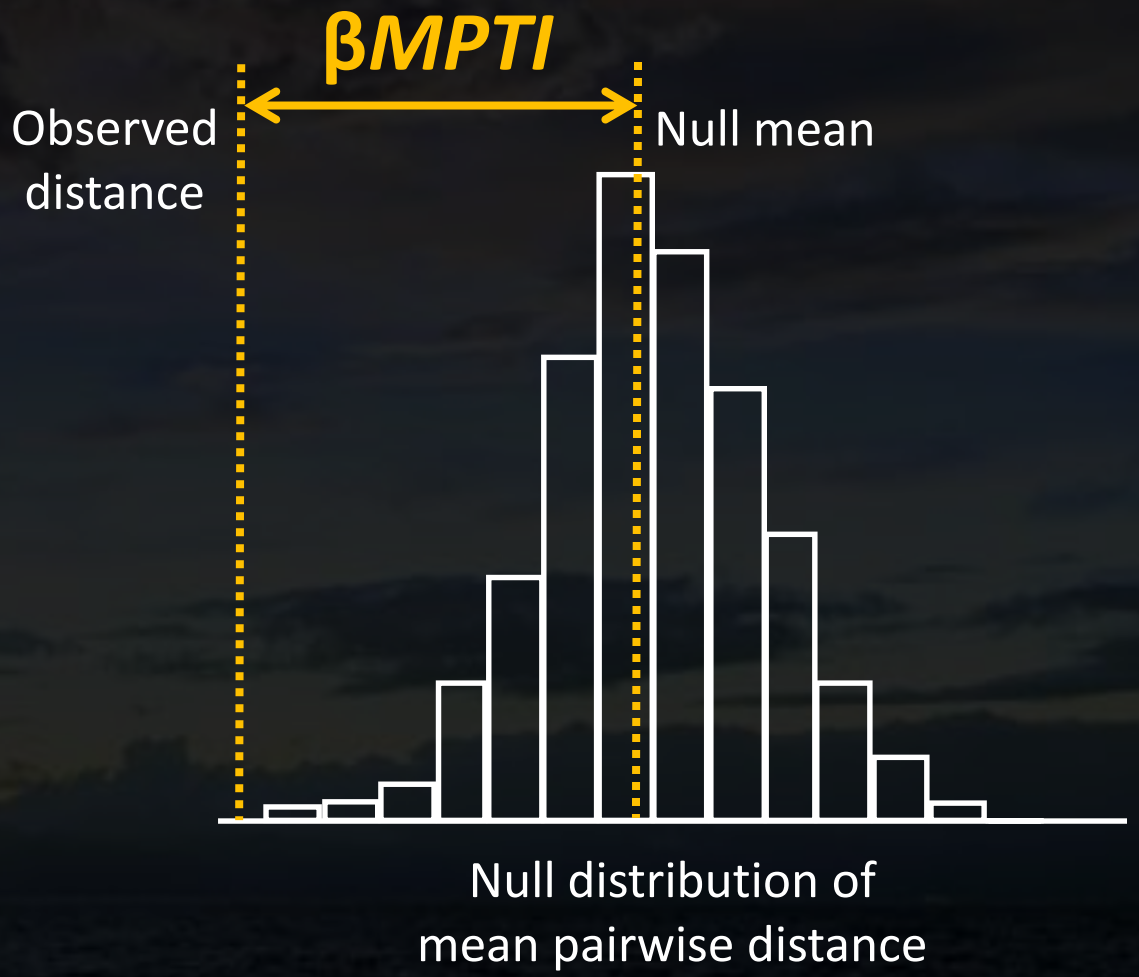


Deterministic assembly processes:

Mean Pairwise Taxa Index (*MPTI*),

calculated from mean pairwise phylogenetic distance





Deterministic assembly processes:

Mean Pairwise Taxa Index (*MPTI*)

More
negative *MPTI*

Stronger
homogeneous
assembly processes

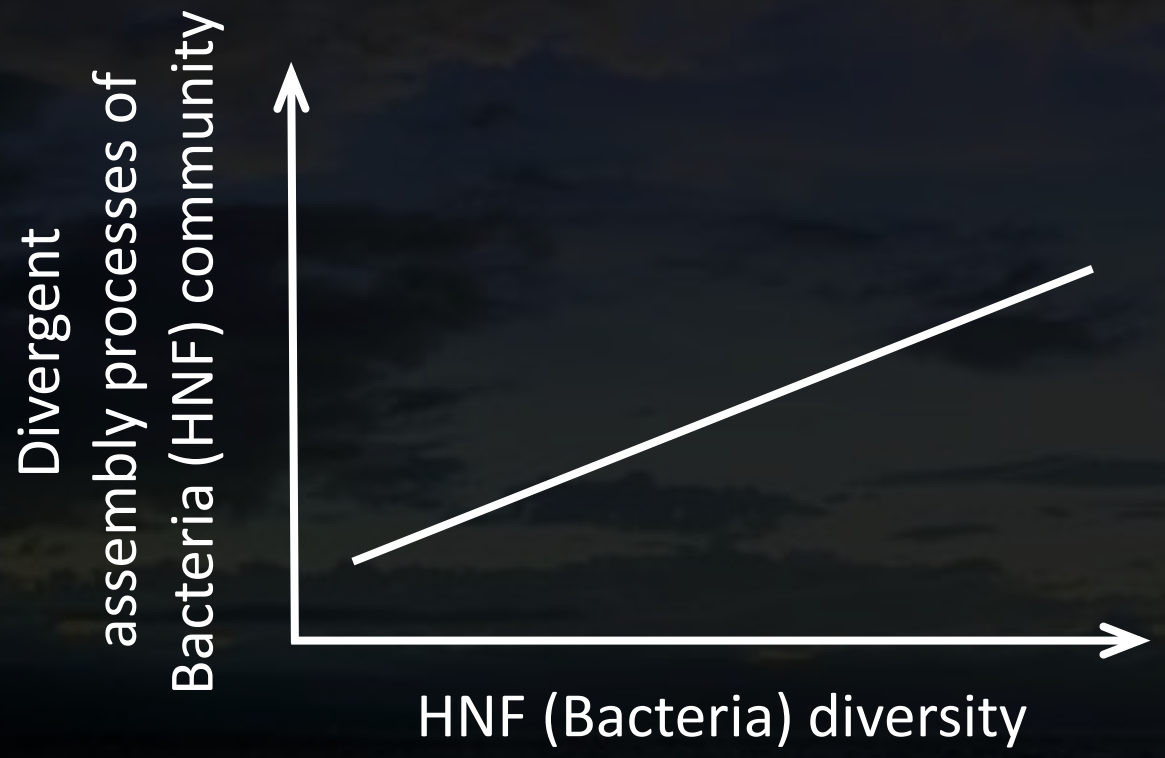
Null mean

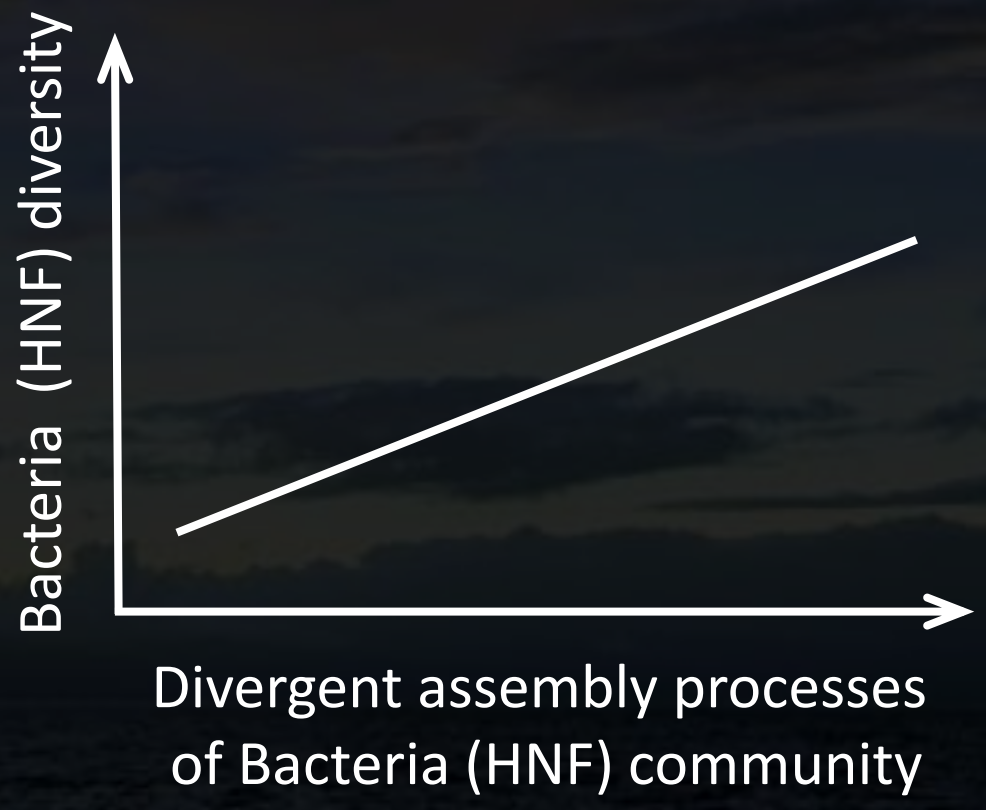
More
positive *MPTI*

Stronger
divergent
assembly processes

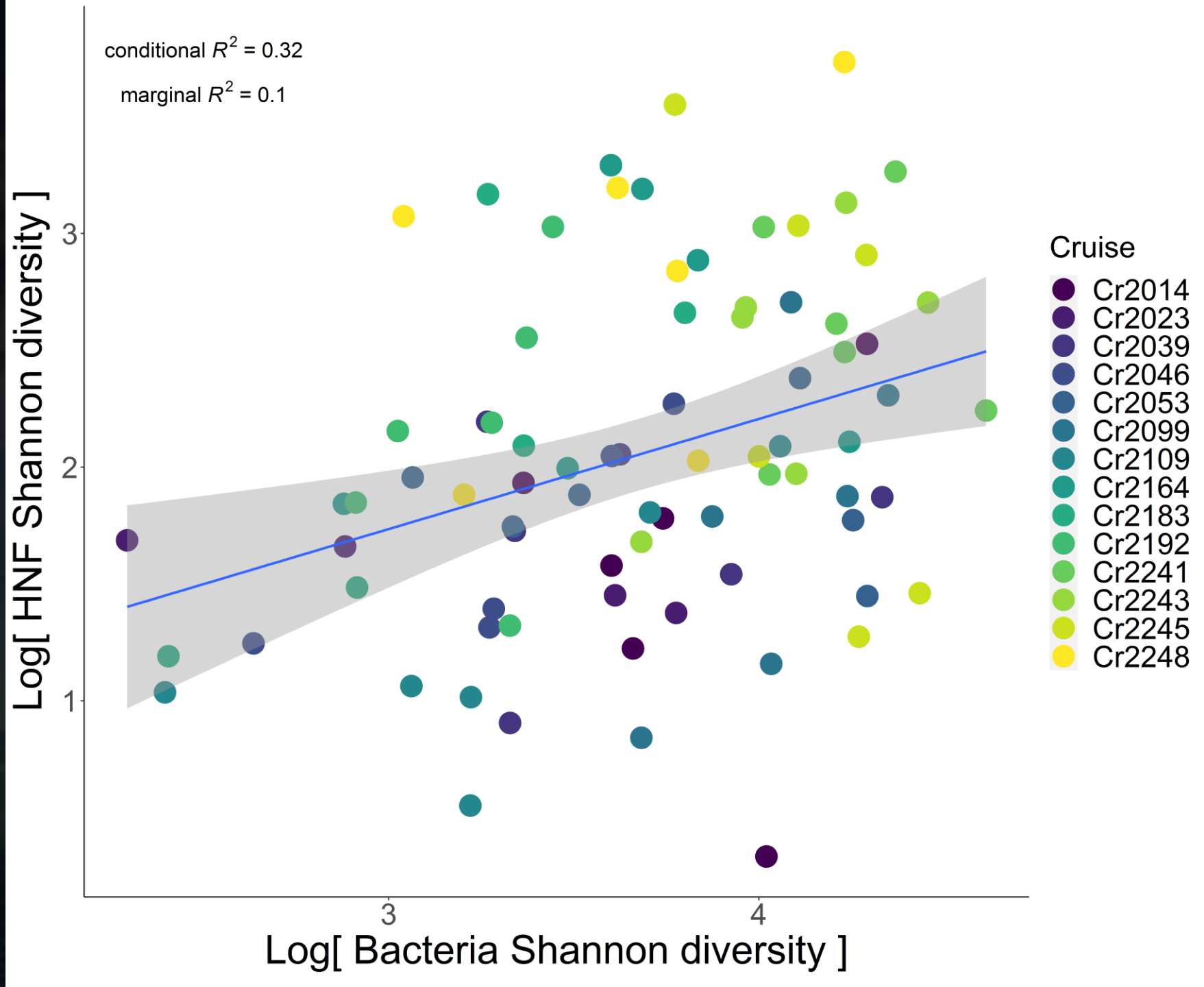
Null distribution of
mean pairwise distance


HNF diversity
Bacteria diversity
+
+
+
+
MPTI of HNF community
MPTI of bacteria community

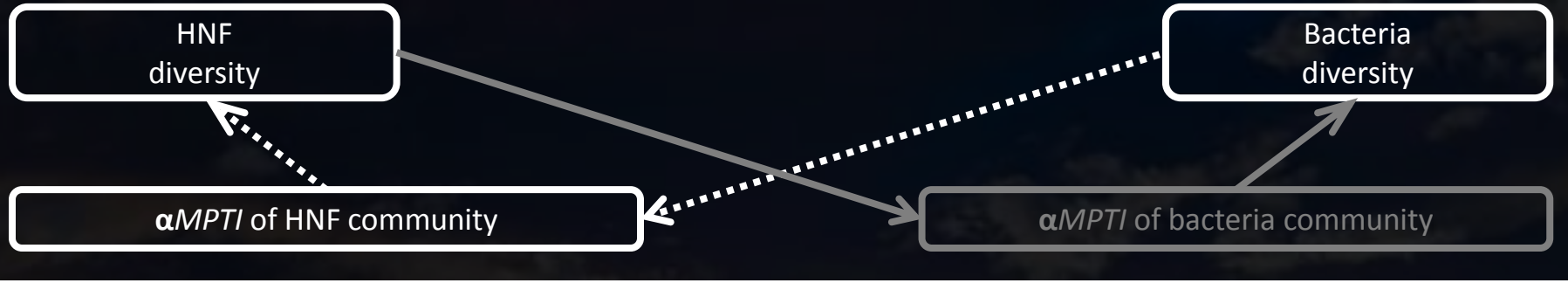

Divergent assembly processes of Bacteria (HNF) community
HNF (Bacteria) diversity

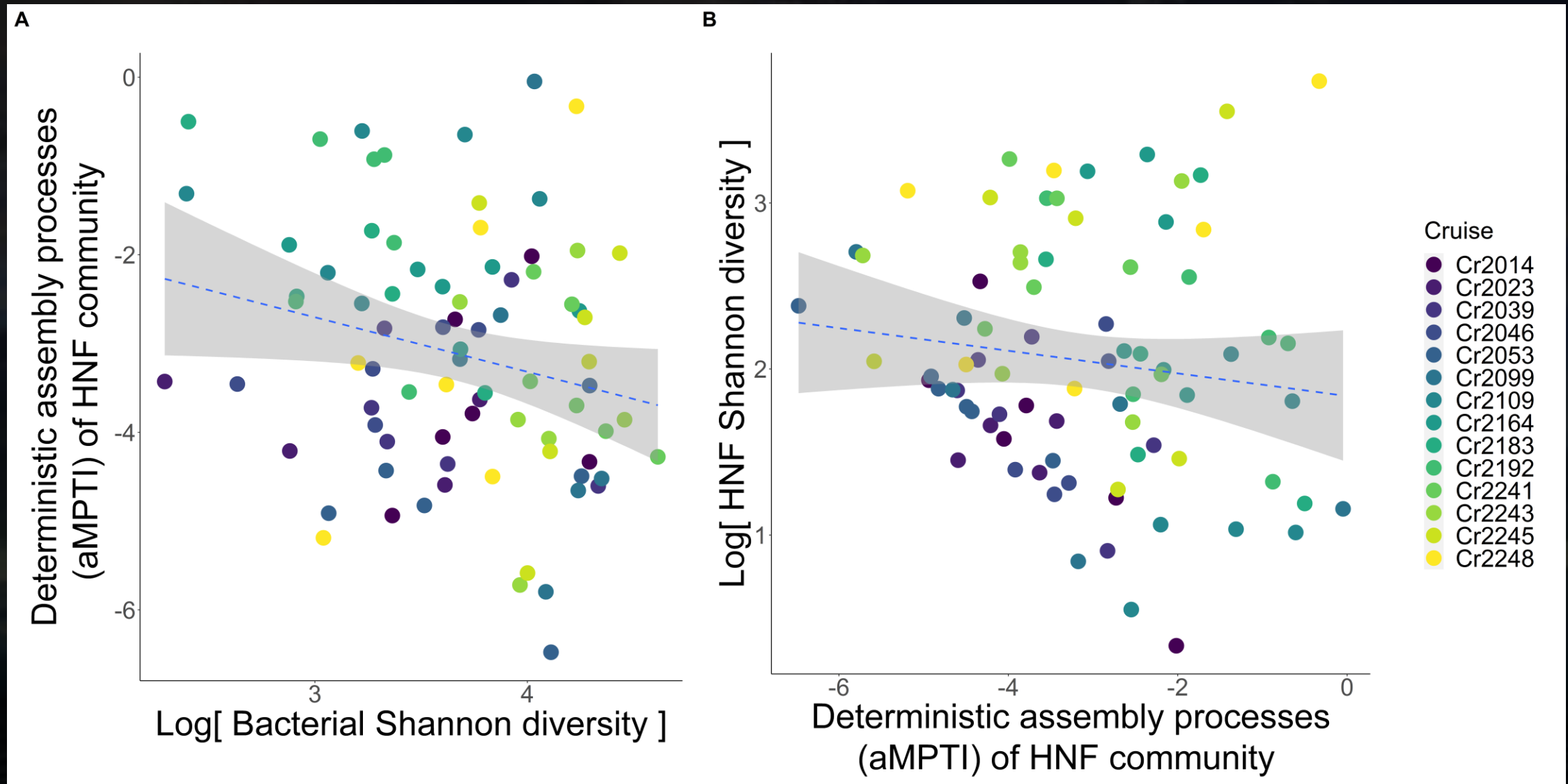

Bacteria (HNF) diversity
Divergent assembly processes of Bacteria (HNF) community

In α level…


conditional R^2 = 0.32
marginal R^2 = 0.1
Log[HNF Shannon diversity]
Log[Bacteria Shannon diversity]
1
2
3
3
4
Cruise
Cr2014
Cr2023
Cr2039
Cr2046
Cr2053
Cr2099
Cr2109
Cr2164
Cr2183
Cr2192
Cr2241
Cr2243
Cr2245
Cr2248

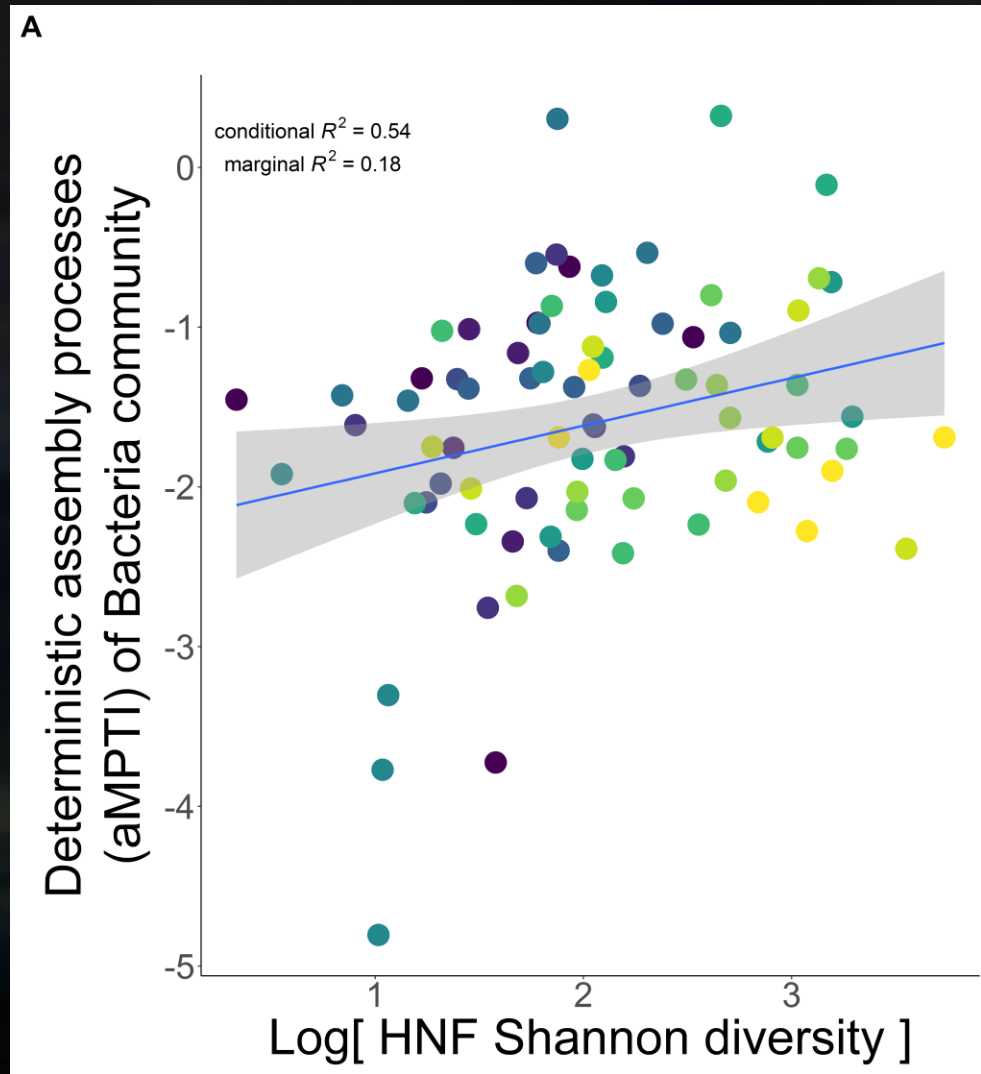
In α level...

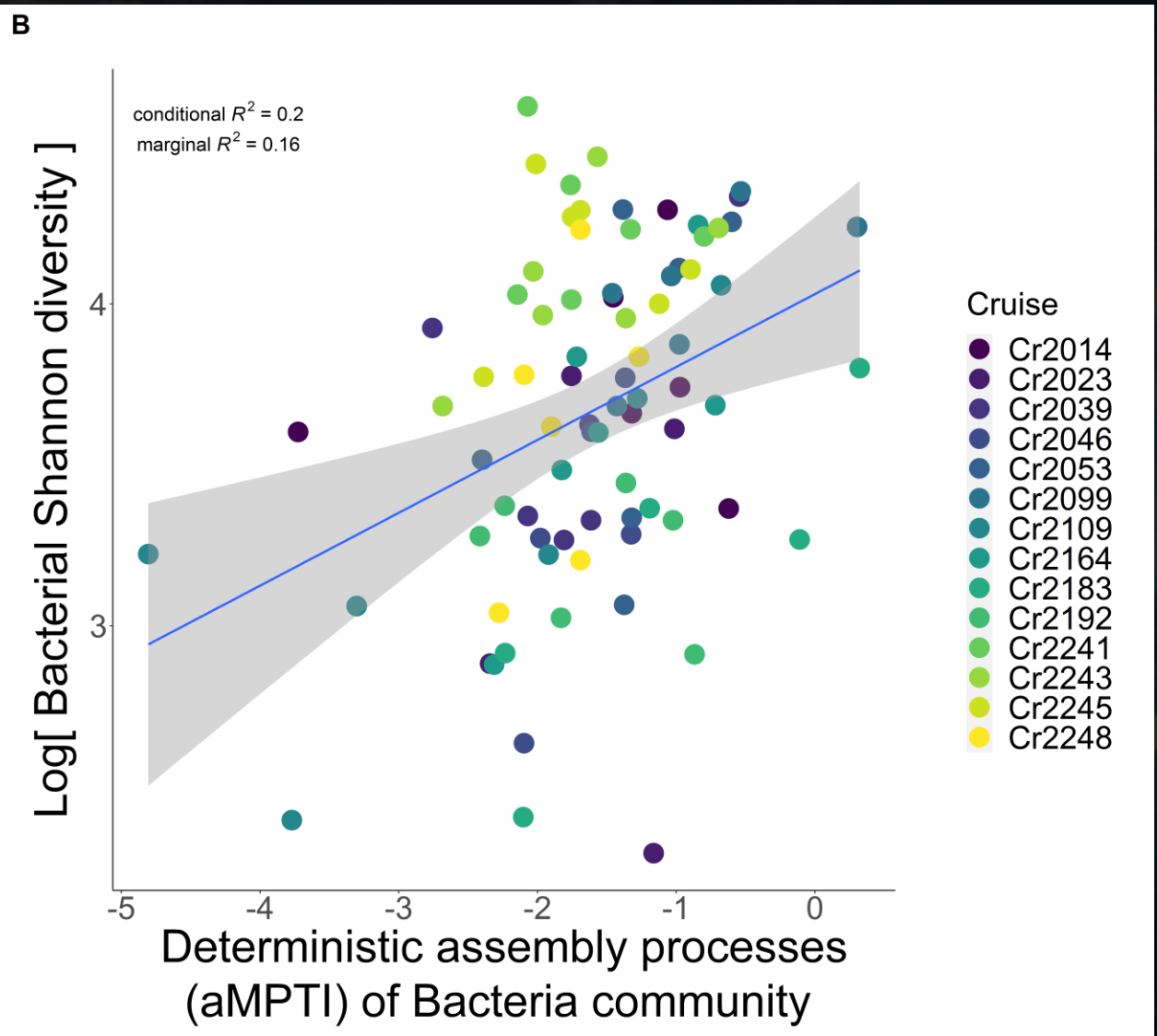

HNF diversity
Bacteria diversity
αMPTI of HNF community
αMPTI of bacteria community

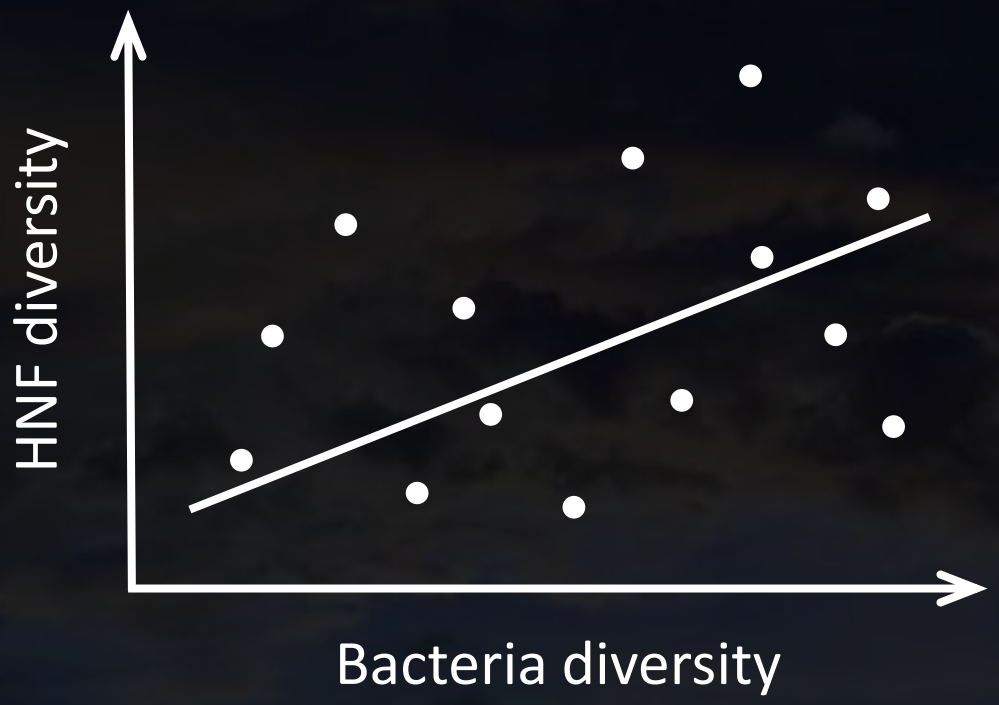

A
Deterministic assembly processes (aMPTI) of HNF community
0
-2
-4
-6
3
4
Log[Bacterial Shannon diversity]
B
Log[HNF Shannon diversity]
3
2
1
-6
-4
-2
0
Deterministic assembly processes (aMPTI) of HNF community
Cruise
Cr2014
Cr2023
Cr2039
Cr2046
Cr2053
Cr2099
Cr2109
Cr2164
Cr2183
Cr2192
Cr2241
Cr2243
Cr2245
Cr2248

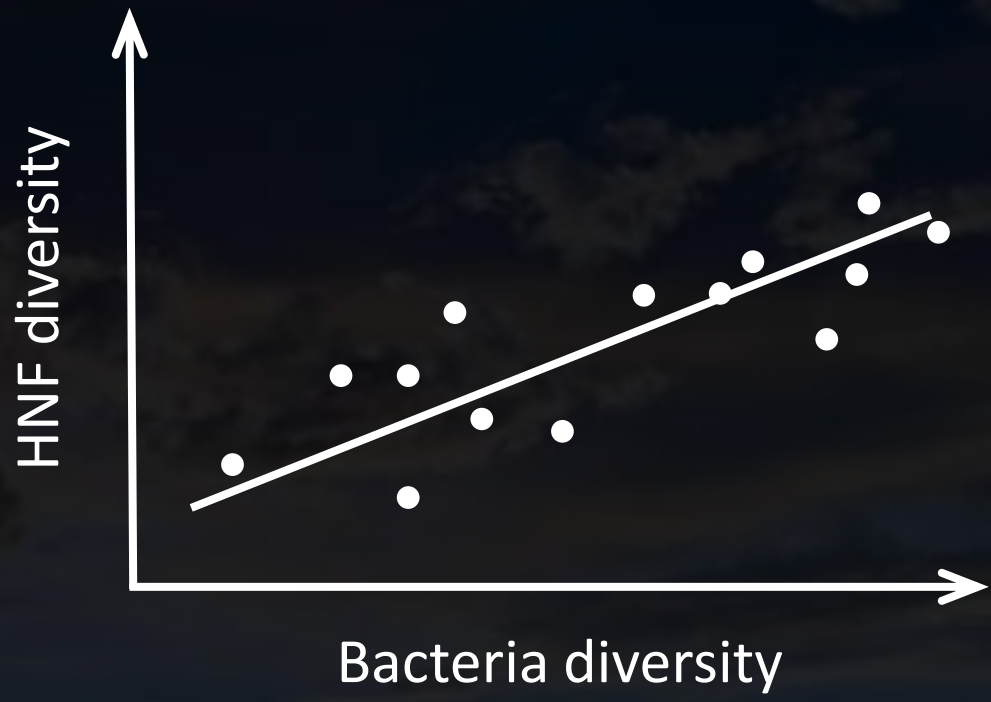
In α level...


HNF diversity
+
Bacteria diversity
+
αMPTI of HNF community
αMPTI of bacteria community


A
conditional R^2 = 0.54
marginal R^2 = 0.18
Deterministic assembly processes (aMPTI) of Bacteria community
0
-1
-2
-3
-4
-5
1
2
3
Log[HNF Shannon diversity]

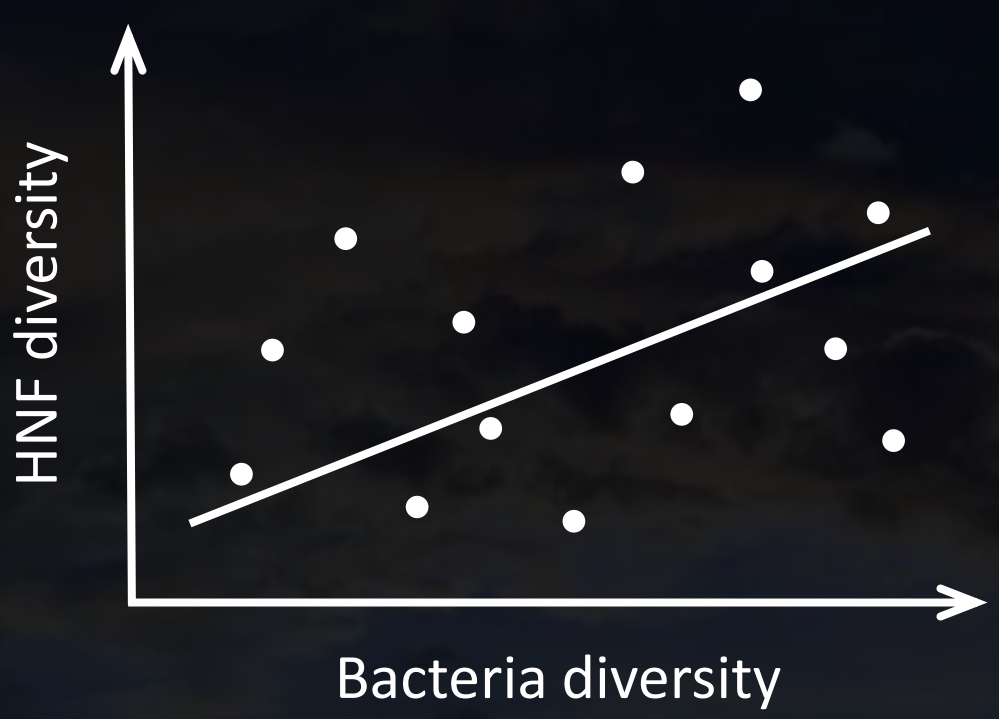

B
conditional R^2 = 0.2
marginal R^2 = 0.16
Log[Bacterial Shannon diversity]
4
3
-5
-4
-3
-2
-1
0
Deterministic assembly processes (aMPTI) of Bacteria community
Cruise
Cr2014
Cr2023
Cr2039
Cr2046
Cr2053
Cr2099
Cr2109
Cr2164
Cr2183
Cr2192
Cr2241
Cr2243
Cr2245
Cr2248

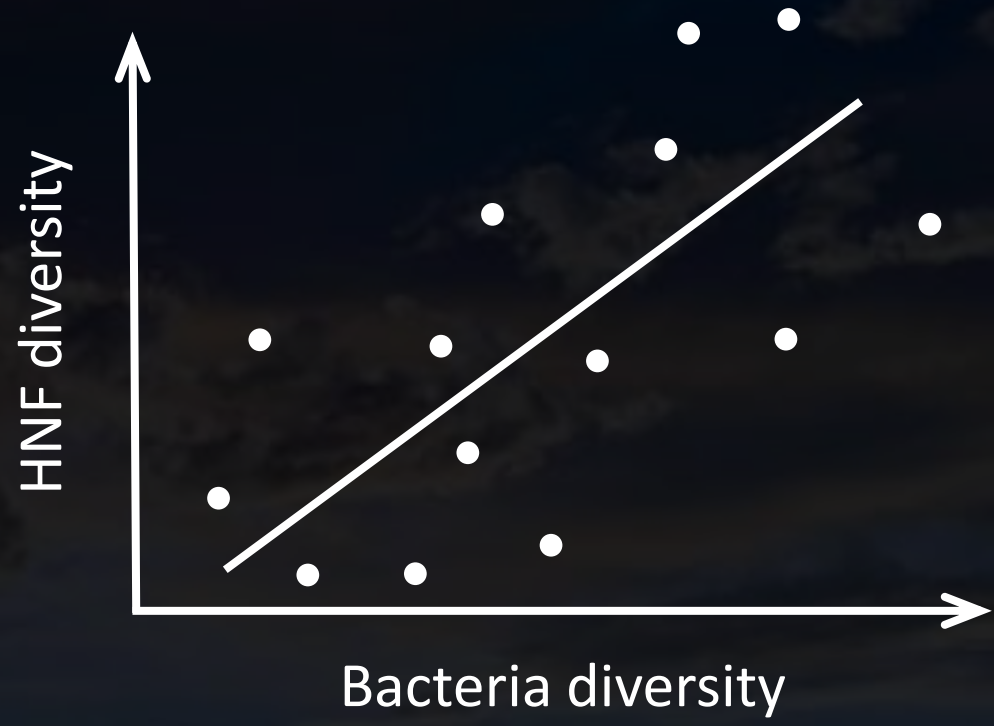




Stronger divergent processes

Tighter association (larger R^2) ?



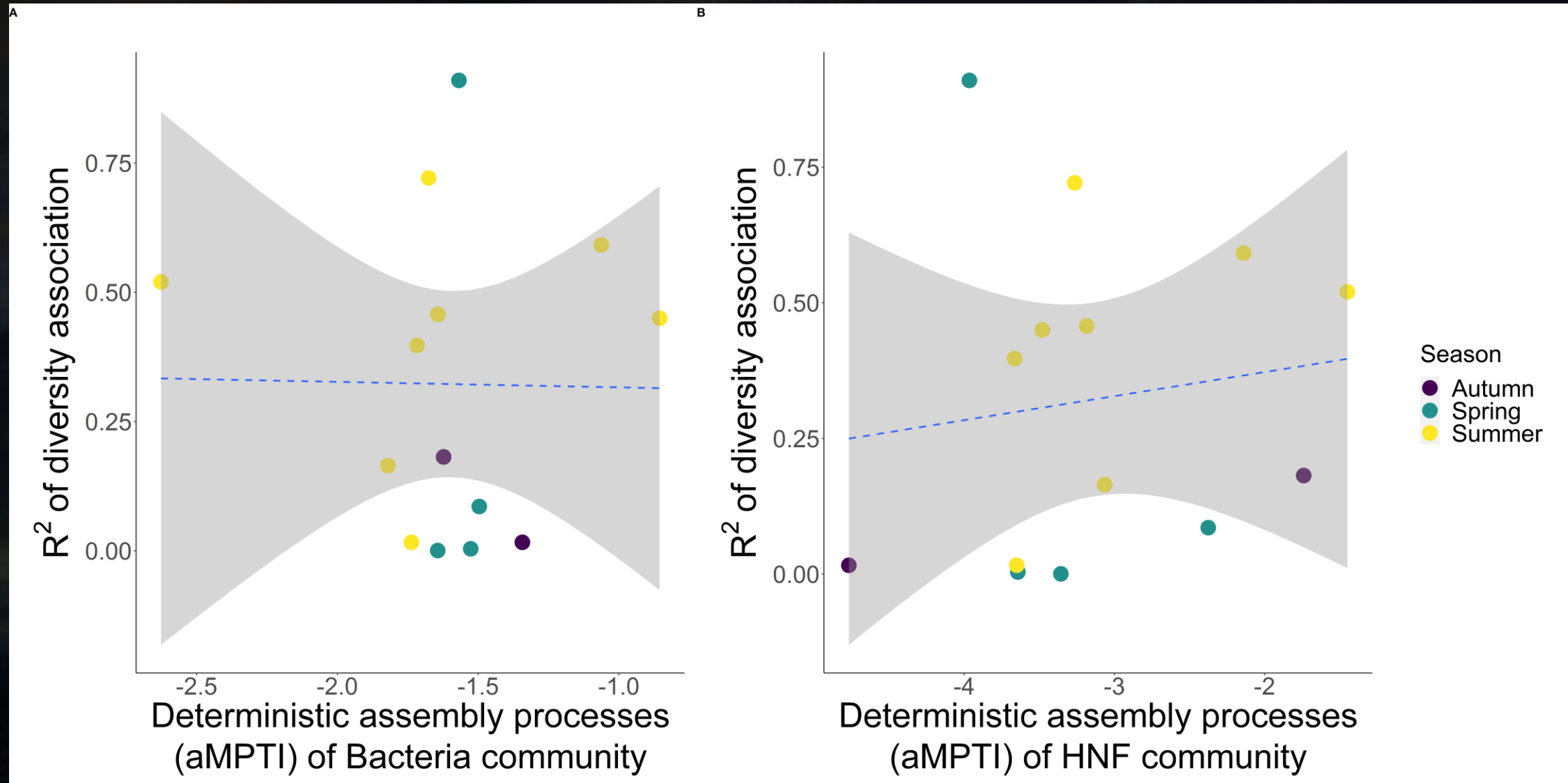


Stronger divergent processes

Larger diversity effects (larger regression coefficient) ?

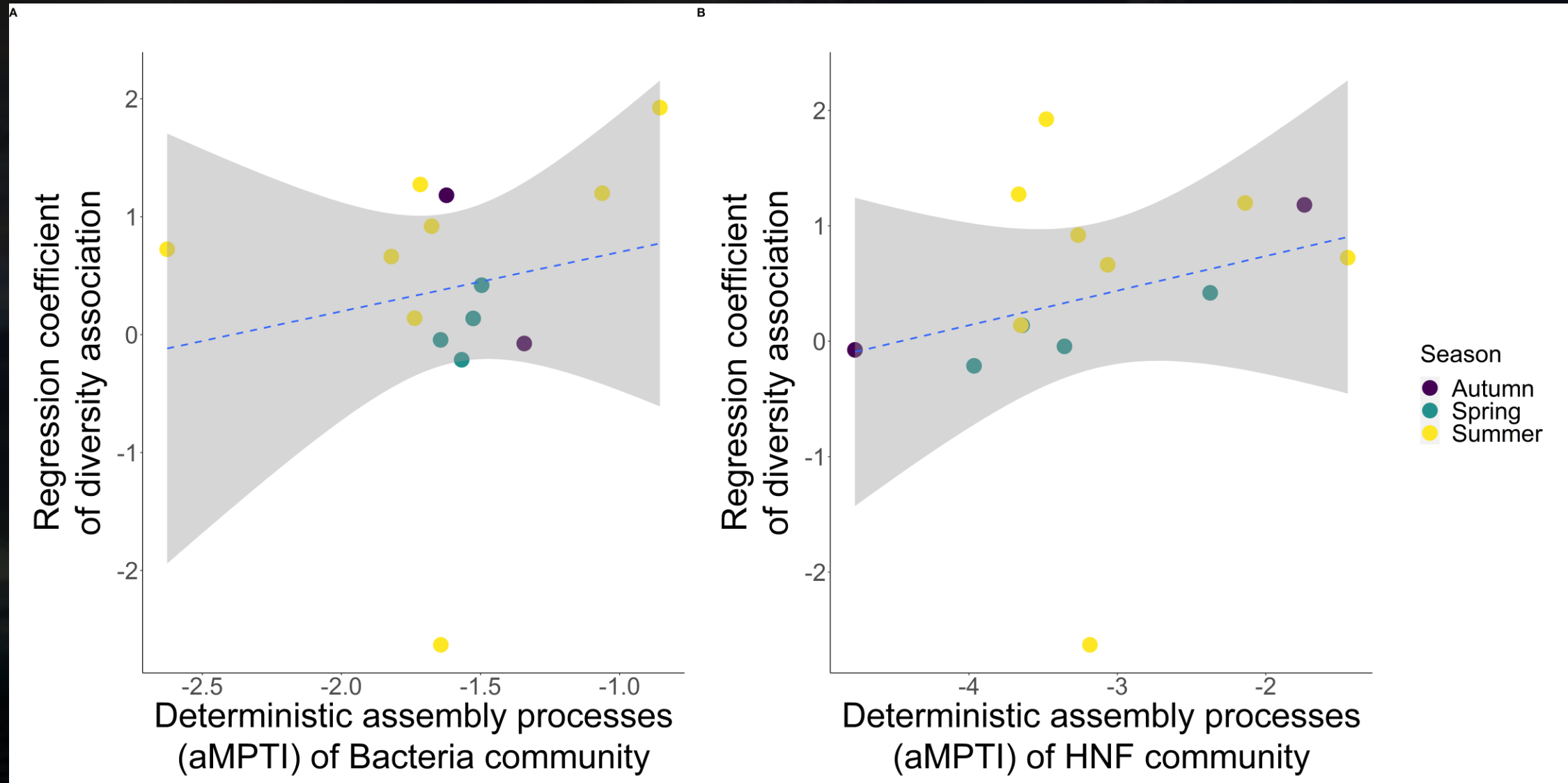
In α level…

Stronger divergent processes ≠> Tighter association (larger R^2)

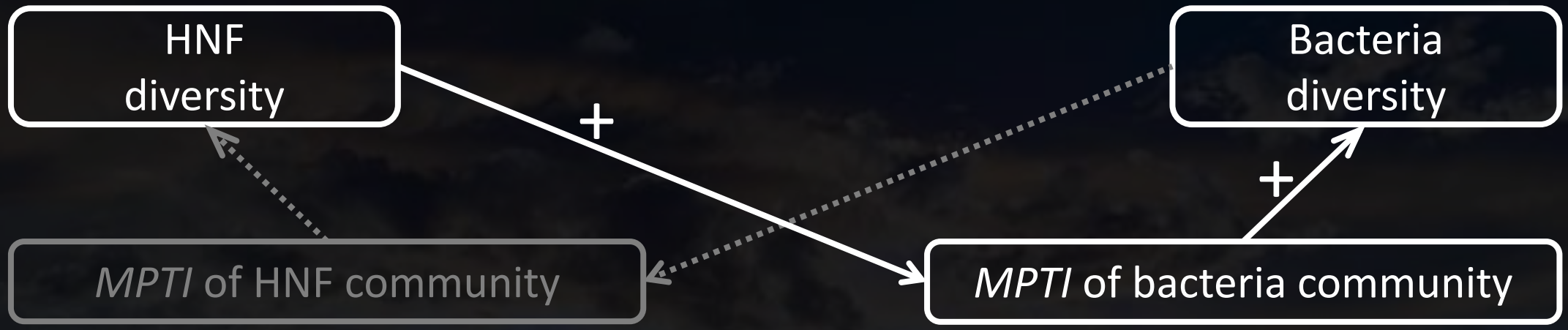


In α level…

Stronger divergent processes =? Larger diversity effects (larger regression coefficient)

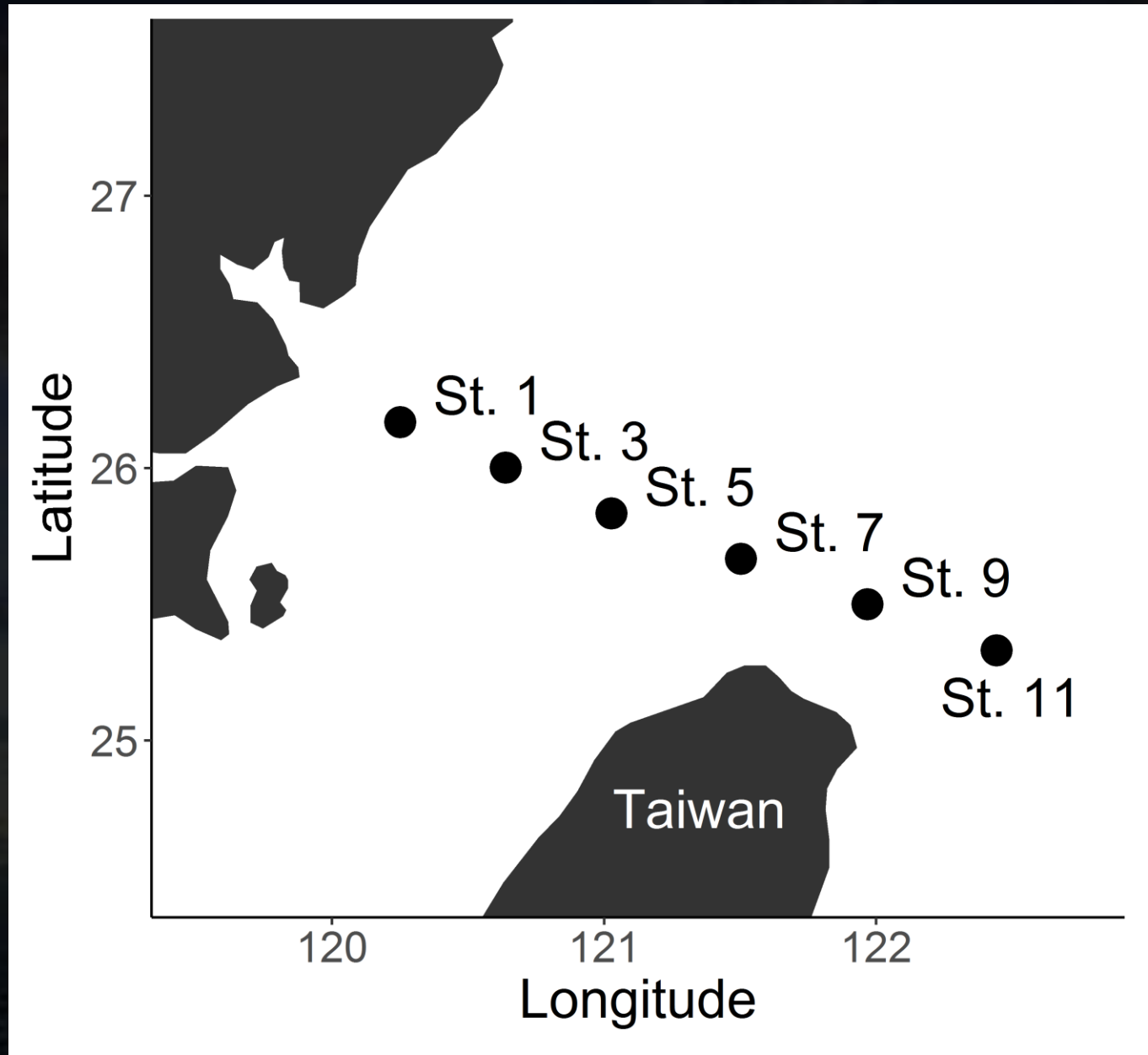


In α level…

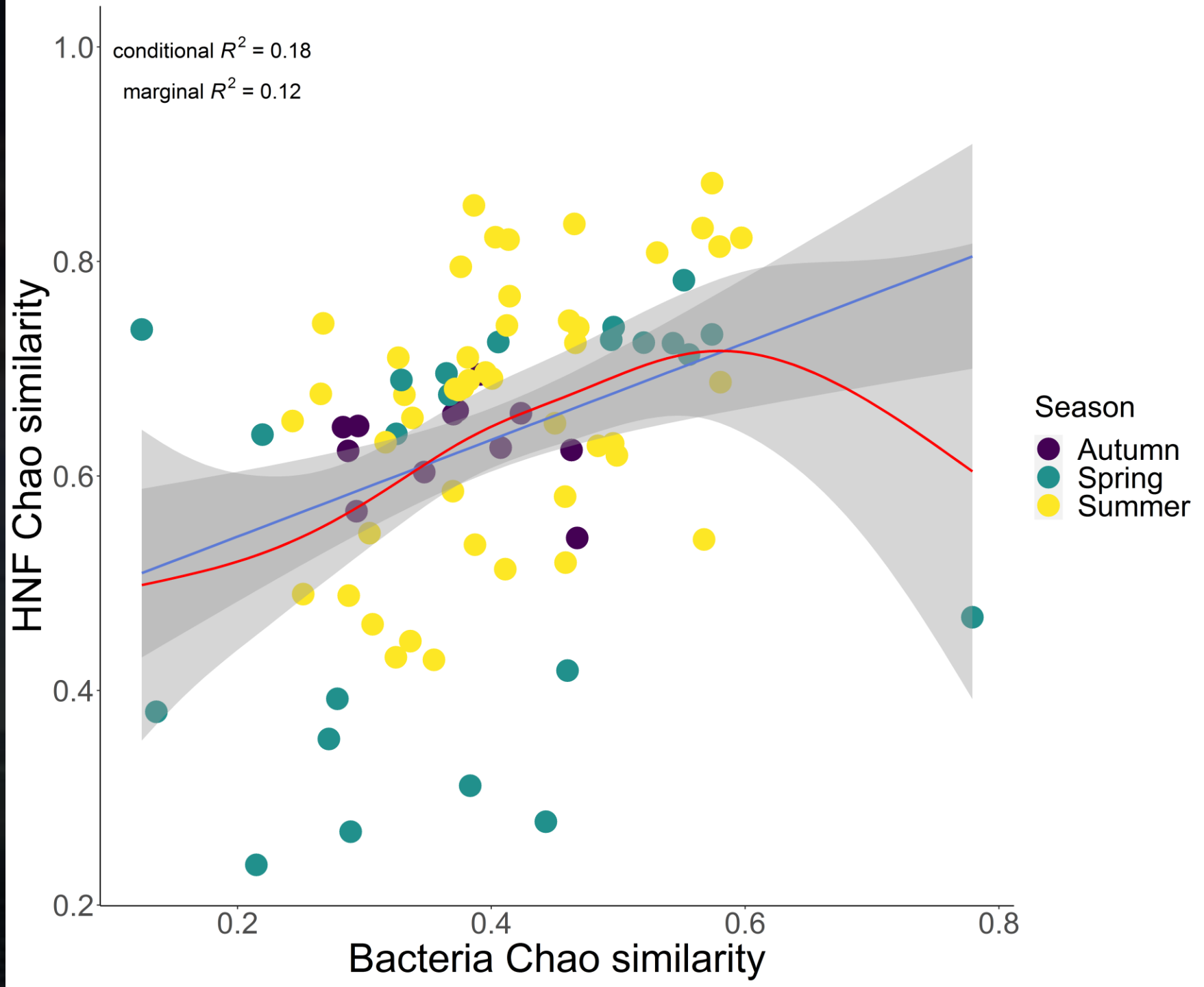

HNF diversity
+
Bacteria diversity
+
MPTI of HNF community
MPTI of bacteria community

In β level…

- Chao similarity
- mean pairwise similarity within a cruise

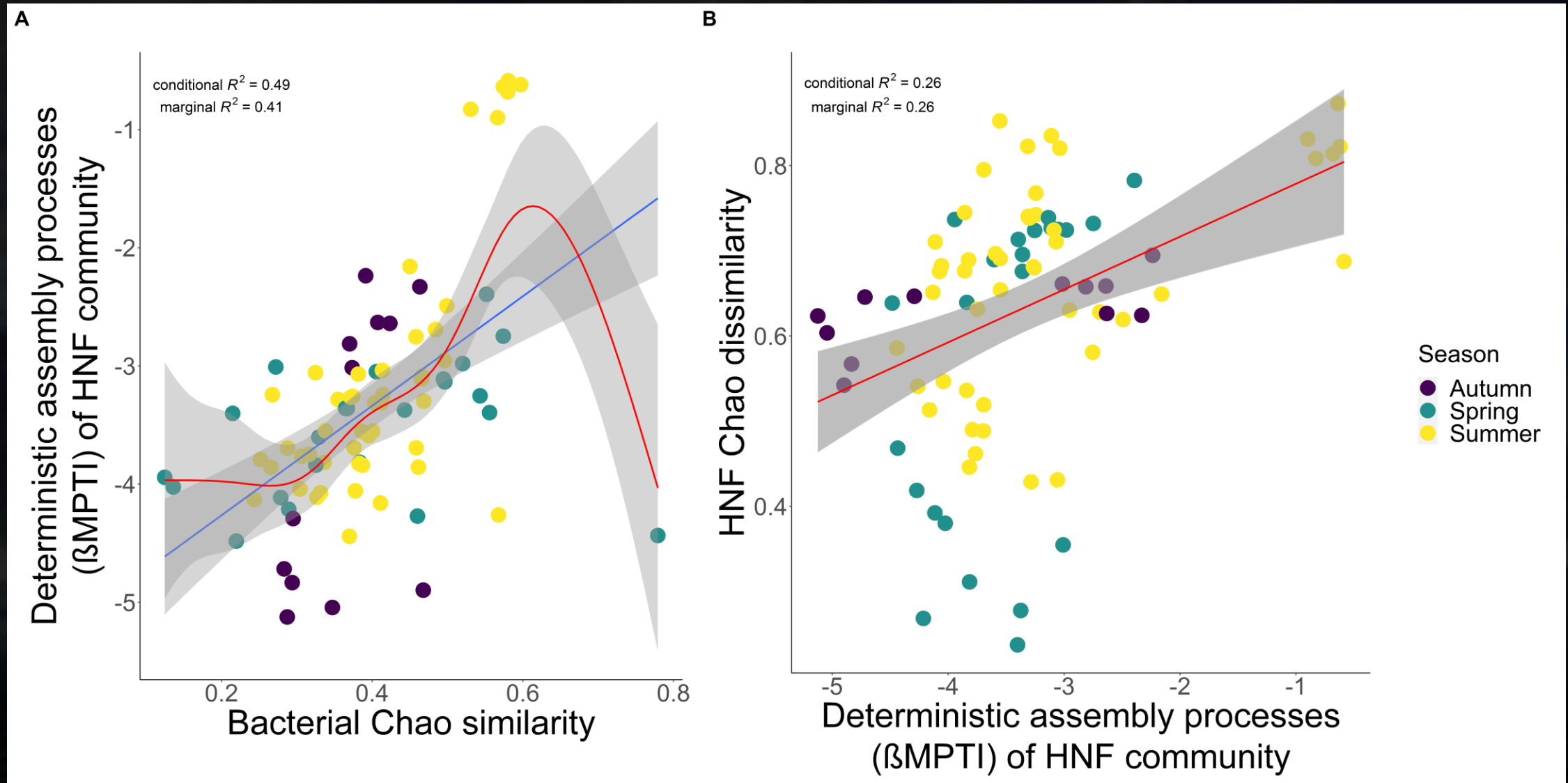


In β level...


conditional R^2 = 0.18
marginal R^2 = 0.12
HNF Chao similarity
Bacteria Chao similarity
1.0
0.8
0.6
0.4
0.2
0.2
0.4
0.6
0.8
Season
Autumn
Spring
Summer

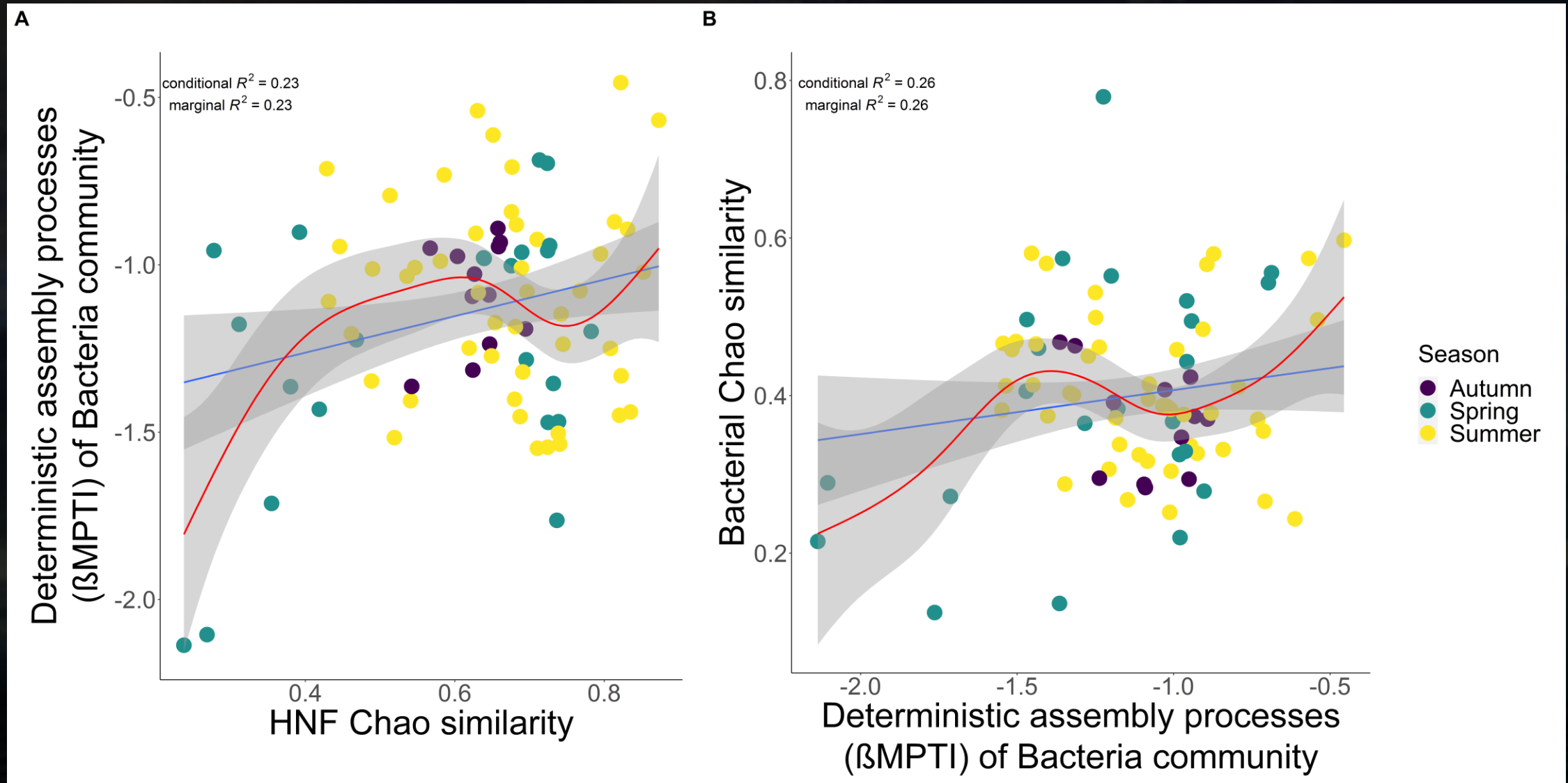
In β level...


HNF diversity
Bacteria diversity
+
+
MPTI of HNF community
MPTI of bacteria community


A
conditional R^2 = 0.49
marginal R^2 = 0.41
Deterministic assembly processes (ßMPTI) of HNF community
-1
-2
-3
-4
-5
0.2
0.4
0.6
0.8
Bacterial Chao similarity
B
conditional R^2 = 0.26
marginal R^2 = 0.26
HNF Chao dissimilarity
0.8
0.6
0.4
-5
-4
-3
-2
-1
Deterministic assembly processes (ßMPTI) of HNF community
Season
Autumn
Spring
Summer

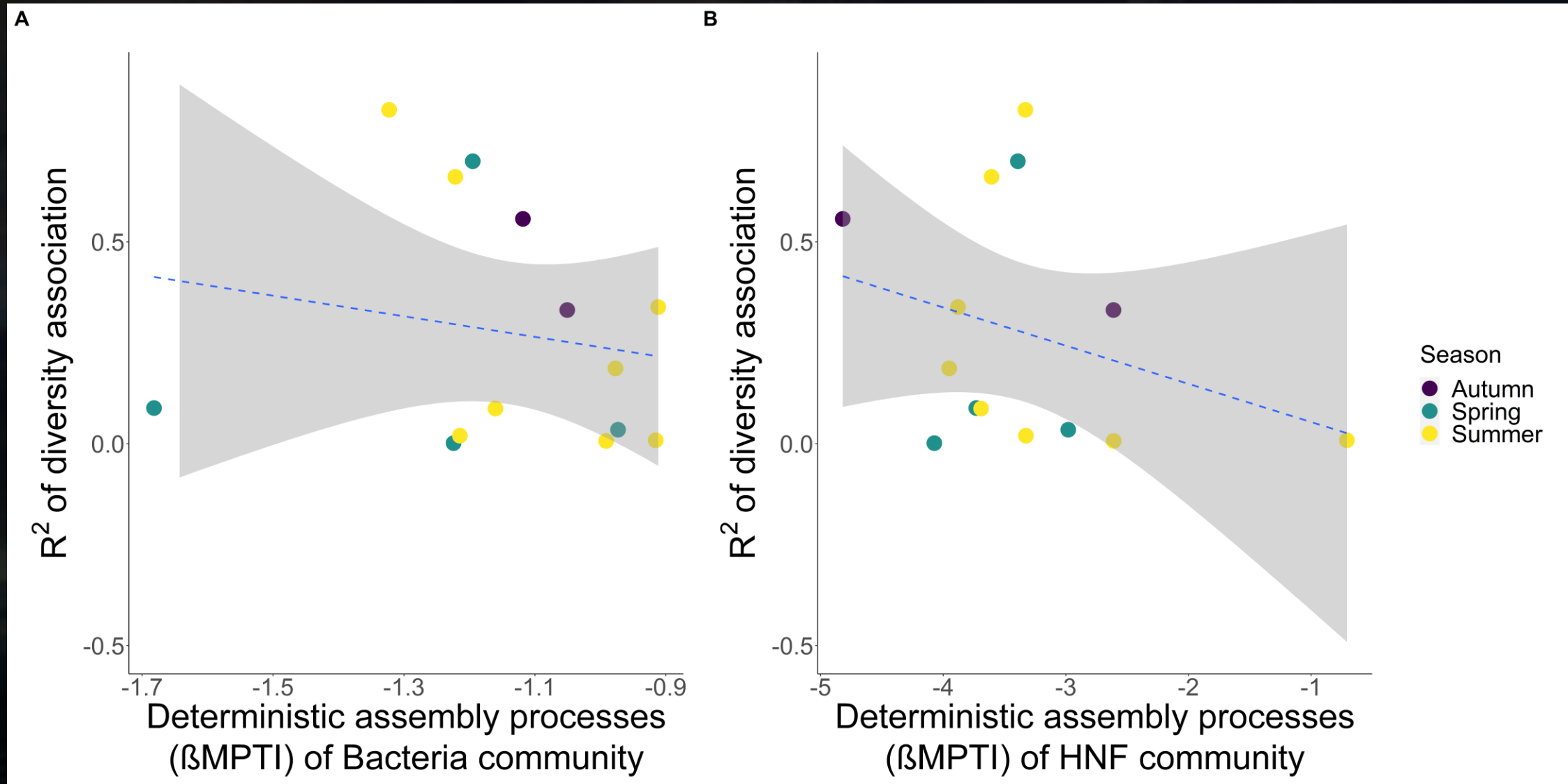
In β level...


HNF diversity
Bacteria diversity
+
+
+
+
MPTI of HNF community
MPTI of bacteria community


A
conditional R^2 = 0.23
marginal R^2 = 0.23
Deterministic assembly processes (ßMPTI) of Bacteria community
-0.5
-1.0
-1.5
-2.0
0.4
0.6
0.8
HNF Chao similarity
B
conditional R^2 = 0.26
marginal R^2 = 0.26
Bacterial Chao similarity
0.8
0.6
0.4
0.2
-2.0
-1.5
-1.0
-0.5
Deterministic assembly processes (ßMPTI) of Bacteria community
Season
Autumn
Spring
Summer

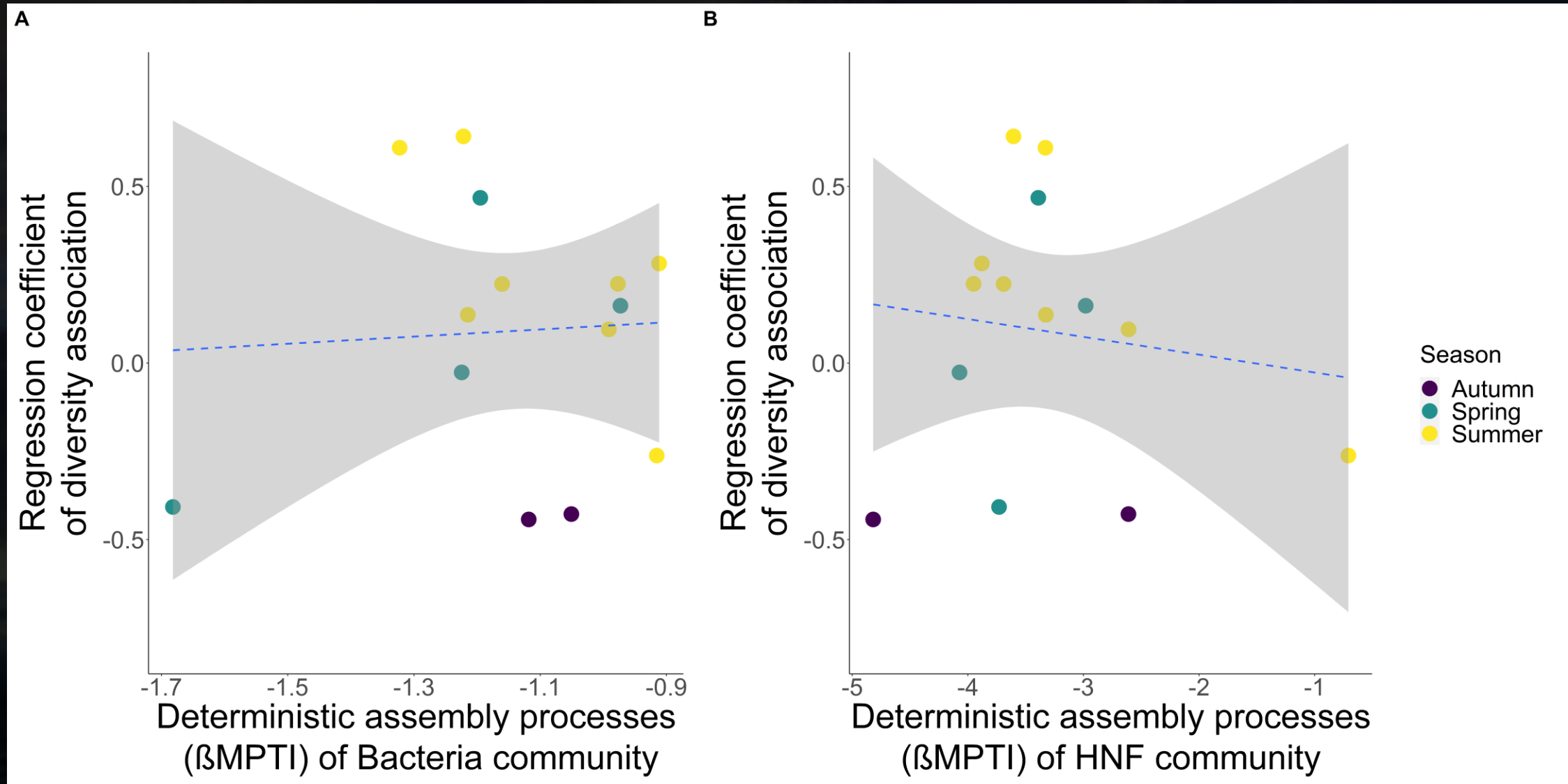
In β level…

Stronger divergent processes ≠> Tighter association (larger R^2)

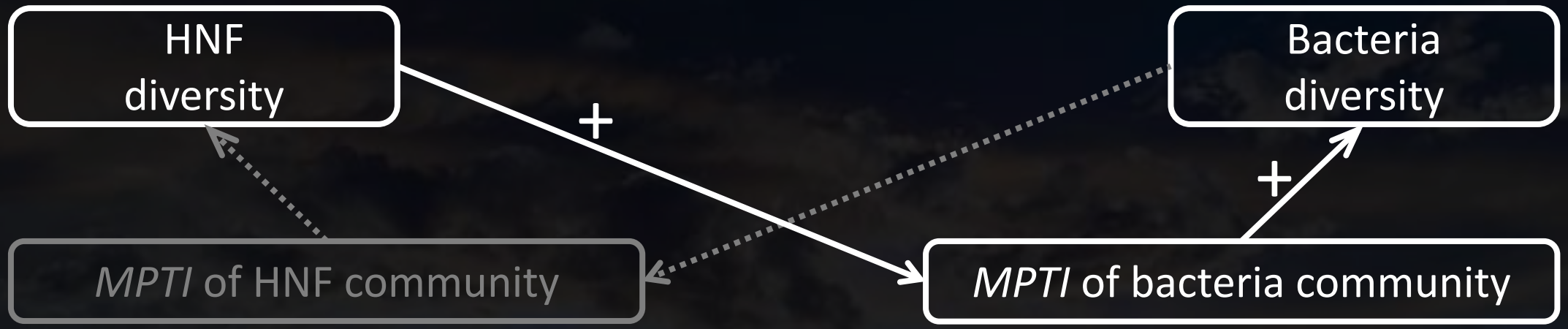


In β level…

Stronger divergent processes ≠> Larger diversity effects (larger regression coefficient)



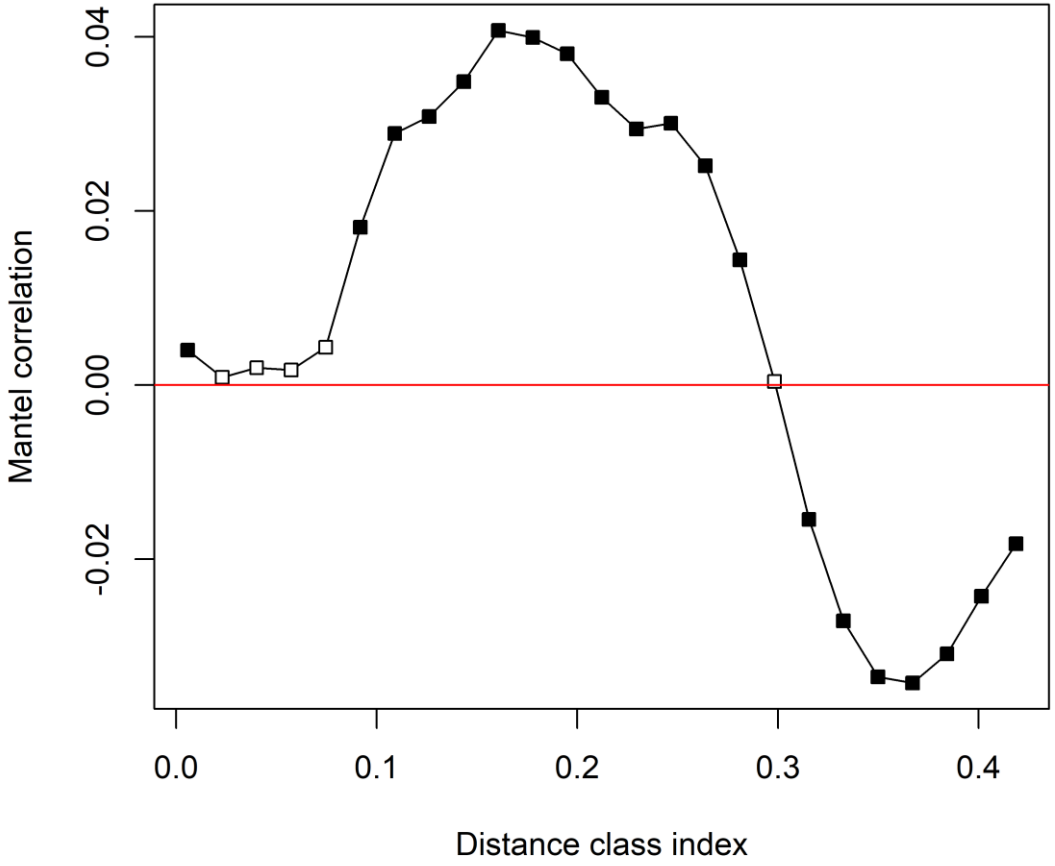
In α level...

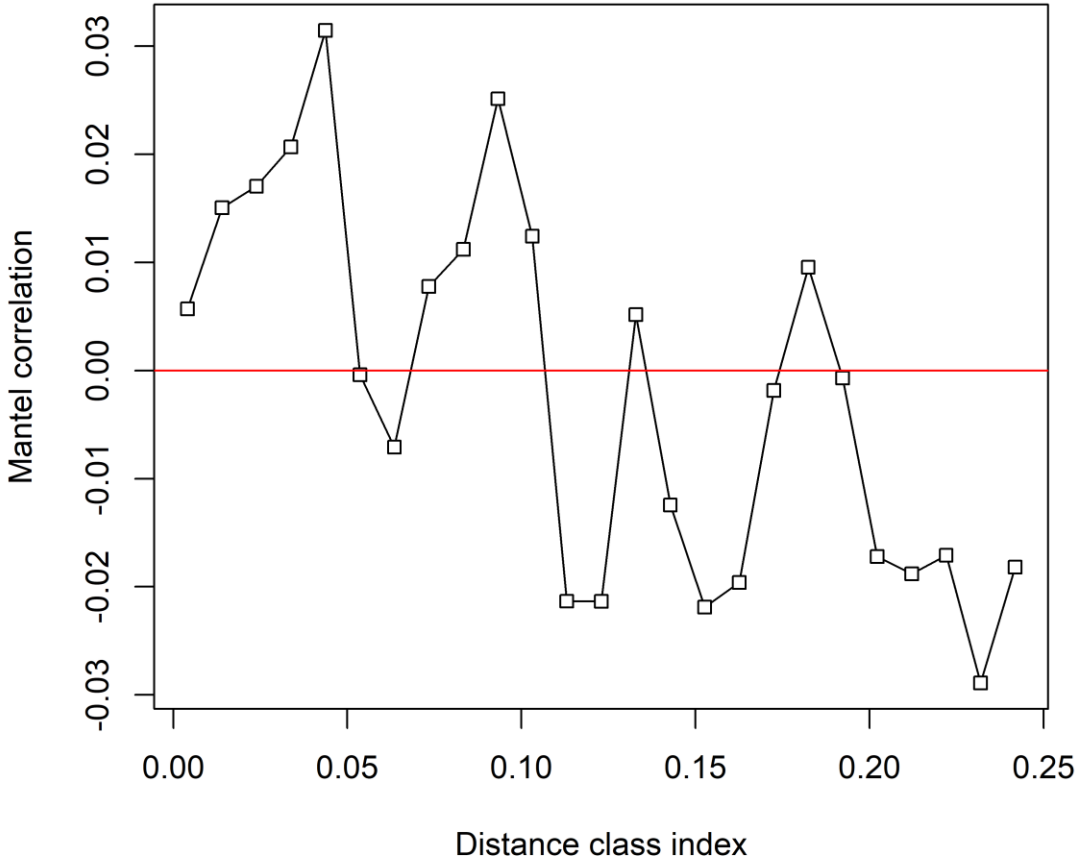


In β level...

Things remain unclear…

- Reliability of phylogenetic signal / niche conservatism?



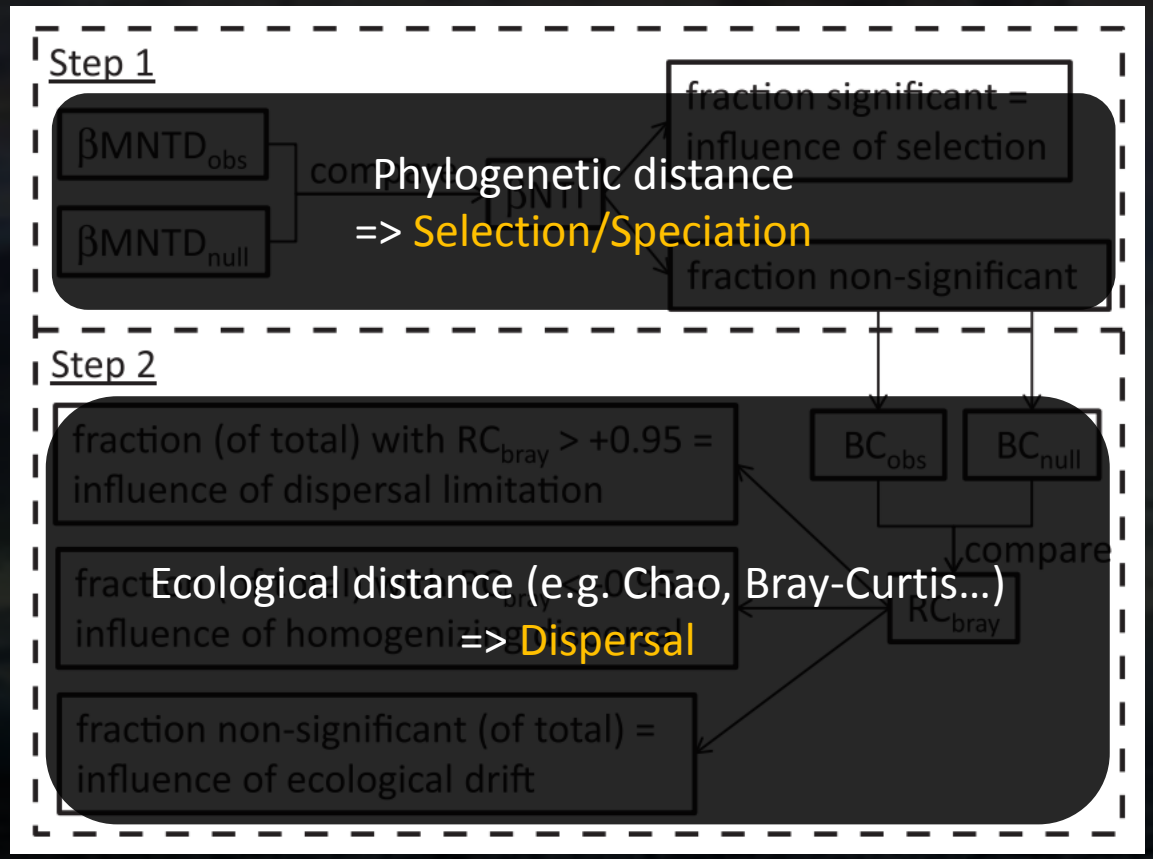


Things remain unclear…

- Reliability of phylogenetic signal / niche conservatism?
- Tighter association or stronger diversity effects?

Things remain unclear…

- Reliability of phylogenetic signal / niche conservatism?
- Tighter association or stronger diversity effects?
- How to quantify dispersal? Or, is it necessary to do so?



Stegen 2013 et al. @ ISME

Things remain unclear…

- Reliability of phylogenetic signal / niche conservatism?
- Tighter association or stronger diversity effects?
- How to quantify dispersal? Or, is it necessary to do so?

Stegen 2013 et al. @ ISME


Thank you.
All comments are welcome!