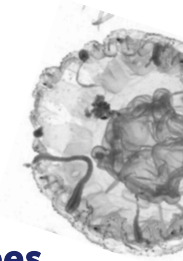
Morphological diversity increases with oligotrophy along a zooplankton time series

Miriam Beck, Caroline Cailleton, Lionel Guidi, Lars Stemmann, Sakina-Dorothée Ayata, Jean-Olivier Irisson

4th Marine Imaging Workshop
3.-6.10. Brest



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Context

- Taxonomic, phylogenetic, functional biodiversity
- Body size considered a “master trait”,
  but other morphological features often ignored
- Can be measured from image-data
  —> automated | objective | taxa independent | big data

LIMNOLOGY
and
OCEANOGRAPHY

ASLO

Limnol. Oceanogr. 66, 2021, 1155–1167

doi: 10.1002/lno.11672

Trait-based approach using in situ copepod images reveals contrasting ecological patterns across an Arctic ice melt zone

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[1]Sorbonne Université, CNRS, Laboratoire d'Océanographie de Villefranche (LOV), Villefranche-sur-Mer, France
[2]Takuvik Joint International Laboratory Université Laval-CNRS, Département de Biologie and Québec-Océan, Université Laval, Québec, Canada
[3]Institut de Systématique, Evolution, Biodiversité (ISYEB), Muséum national d'Histoire naturelle, CNRS, Sorbonne Université, EPHE, Paris, France

Article | Open Access | Published: 14 May 2021

Marine snow morphology illuminates the evolution of phytoplankton blooms and determines their subsequent vertical export

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What about morphological diversity

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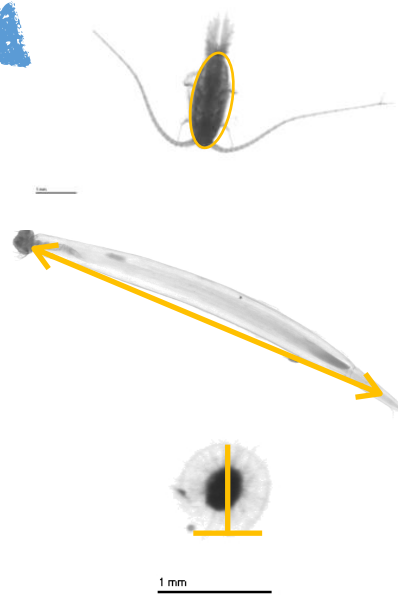

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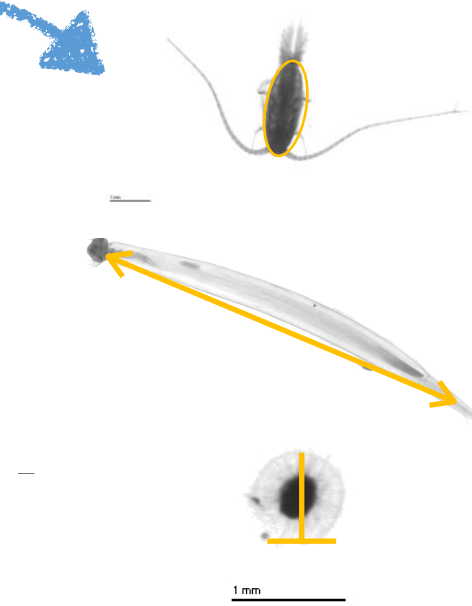

45 morphological traits
—> size | shape | grey level | symmetry

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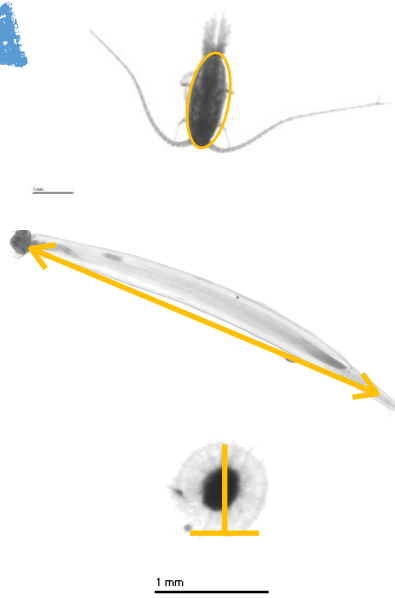
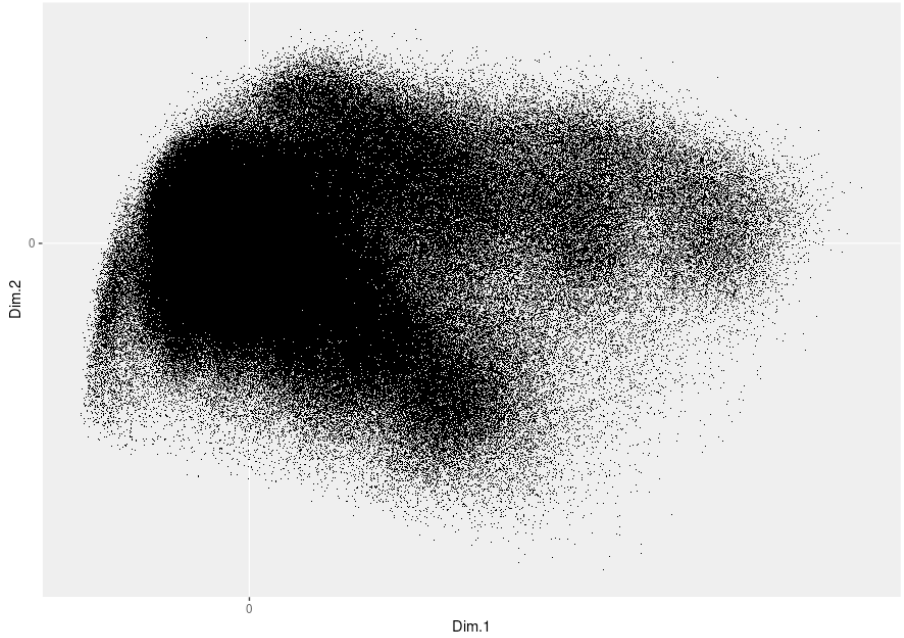


45 morphological traits
—> size | shape | grey level | symmetry

Time series at Point B in Villefranche, France (NW Mediterranean)
12 years | weekly samplings of zooplankton
—> 845812 images

2) Morphological space

PCA including all 45 morphological features (1 dot = 1 individual image)



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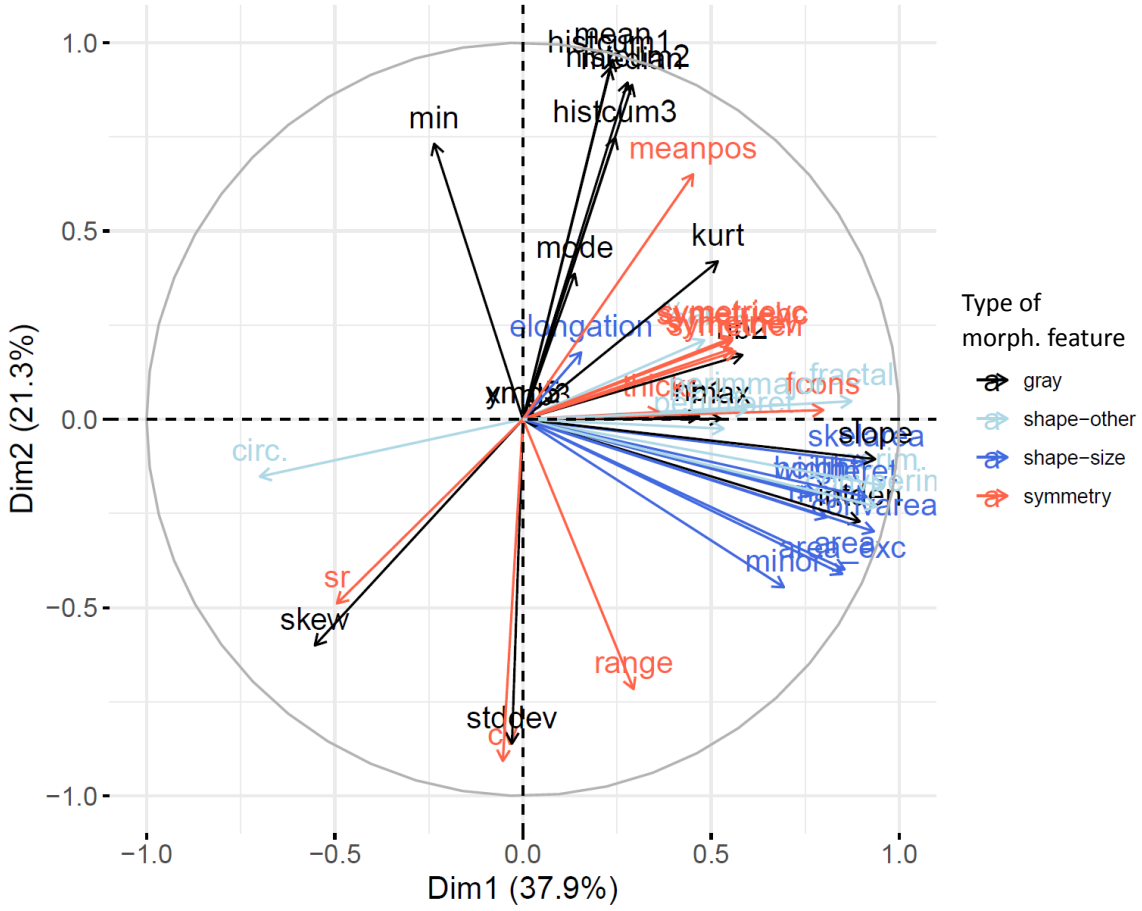

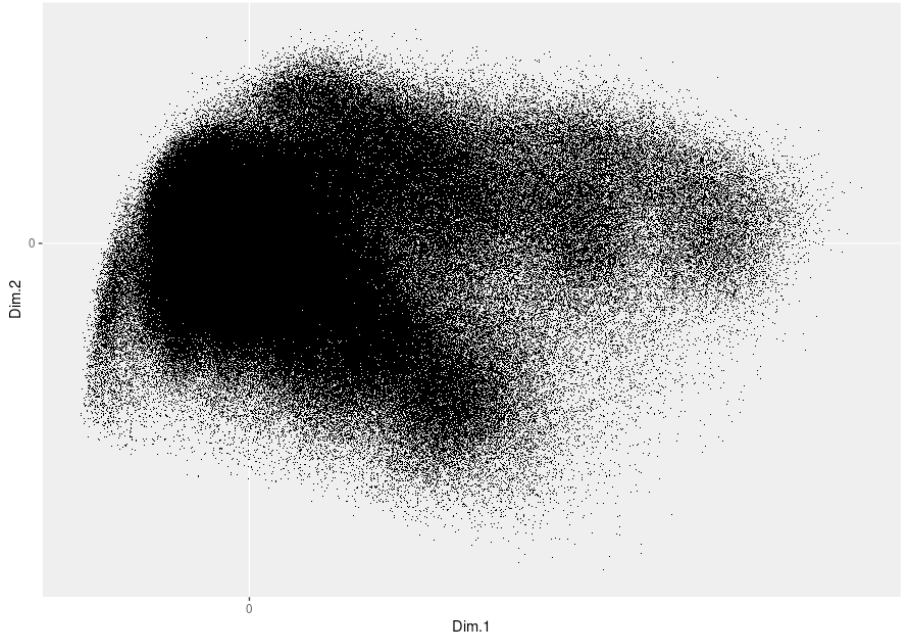

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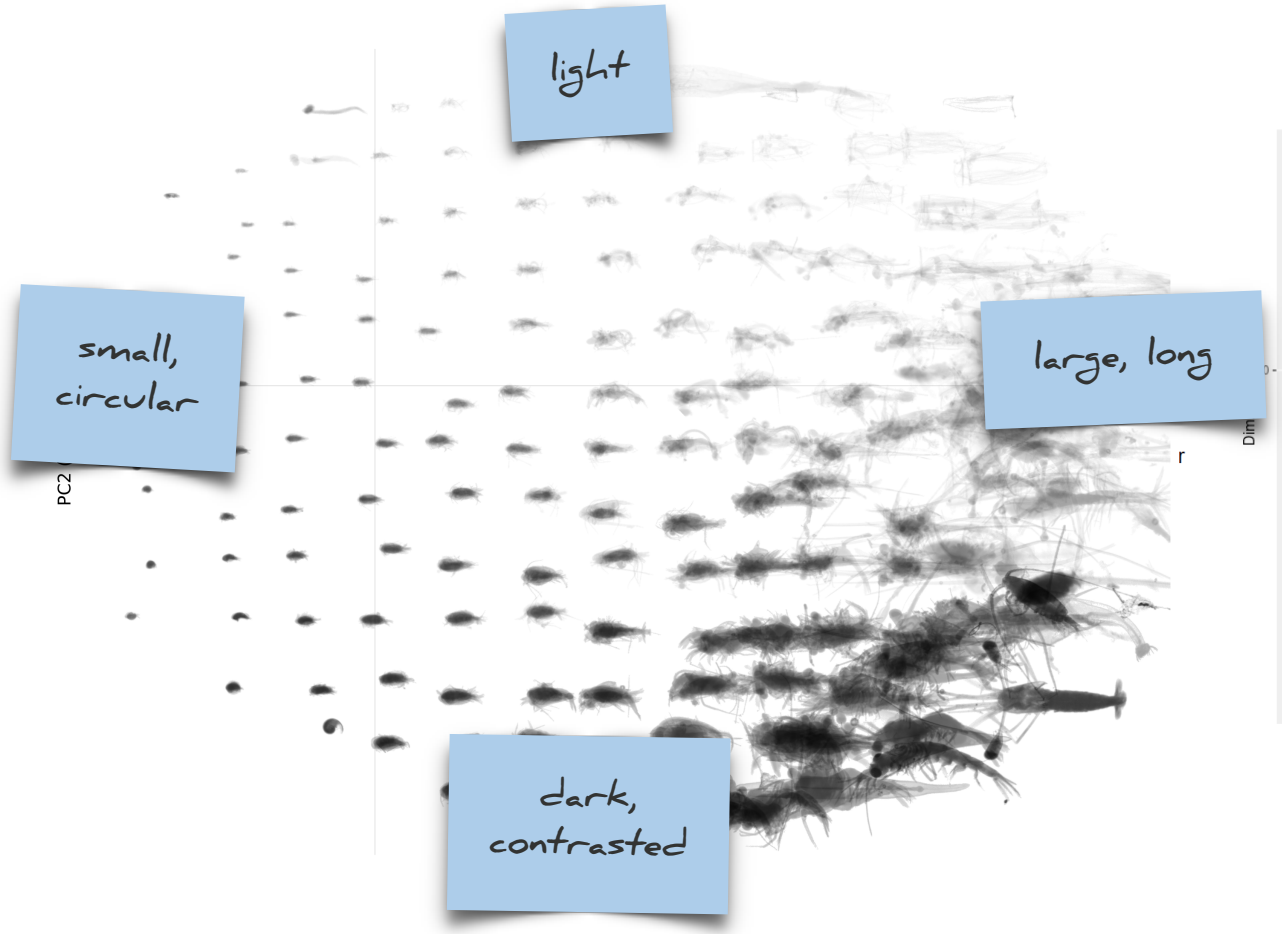
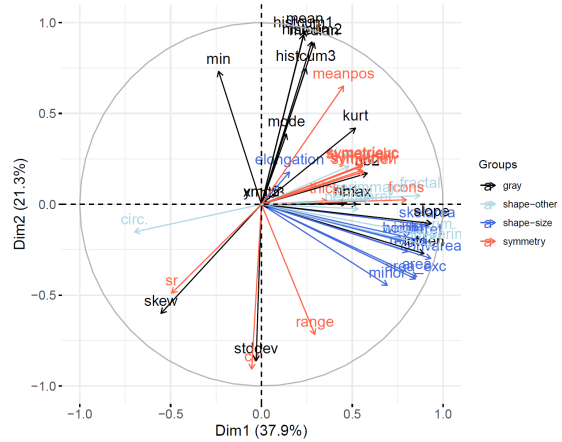
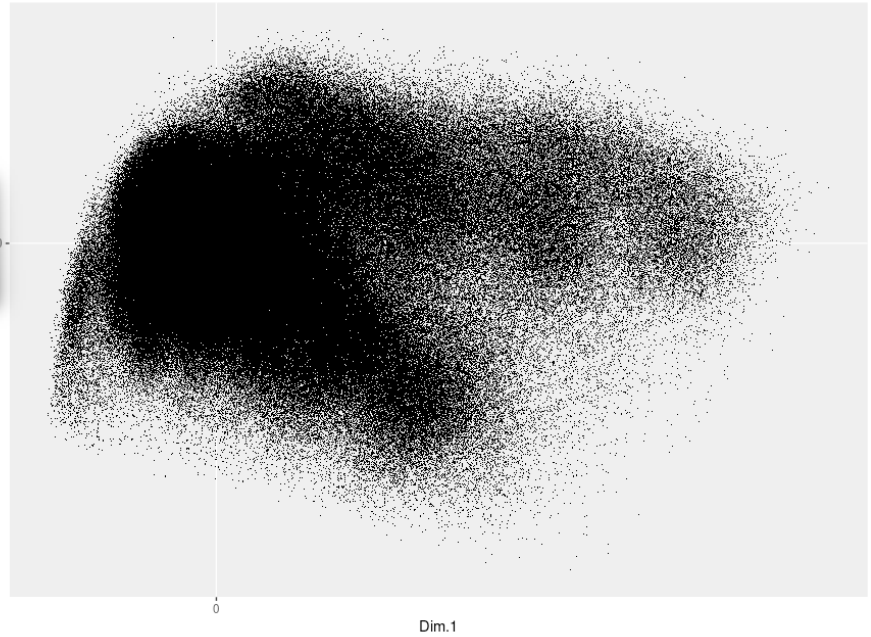
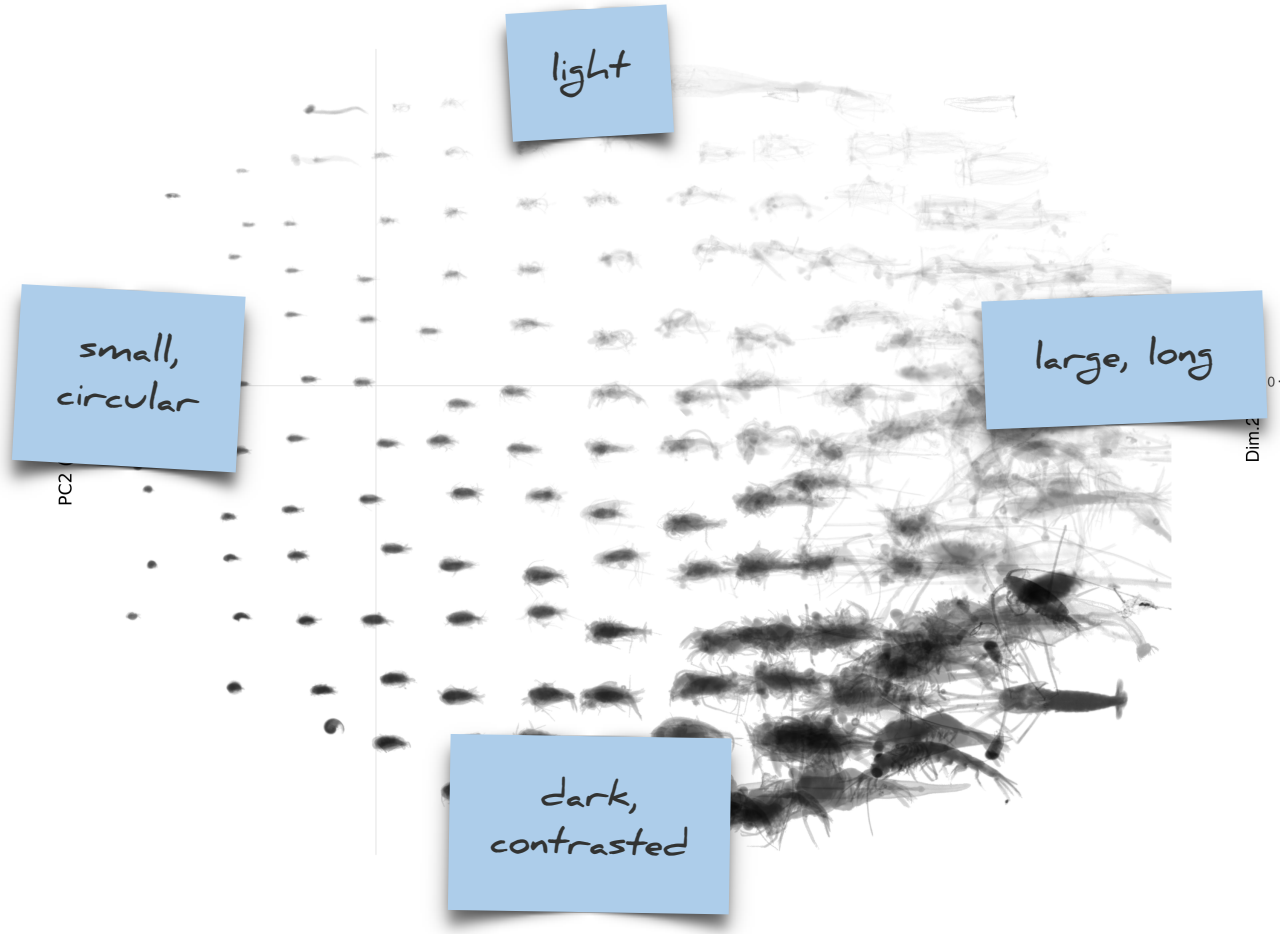


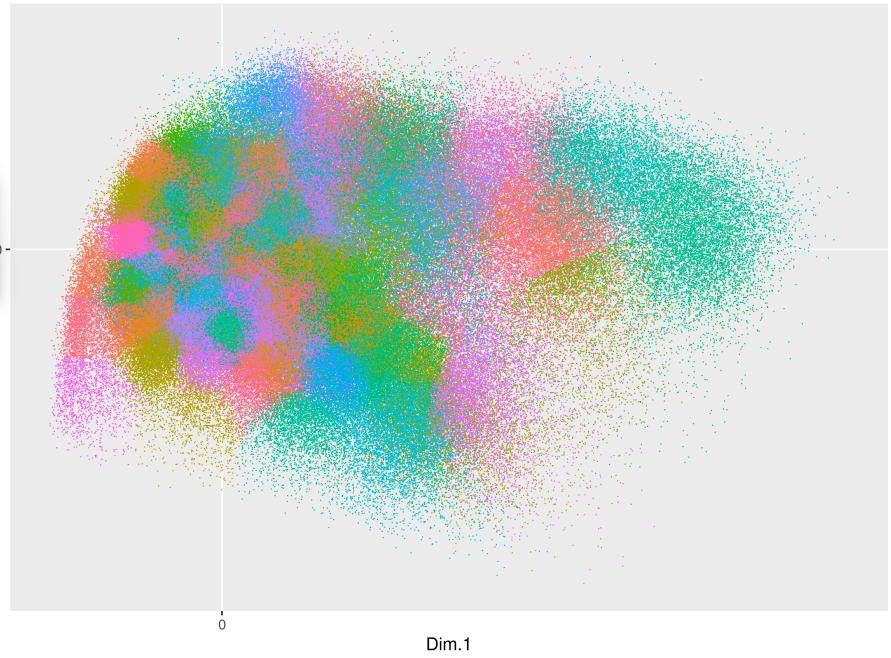




3) Definition of “morphs”

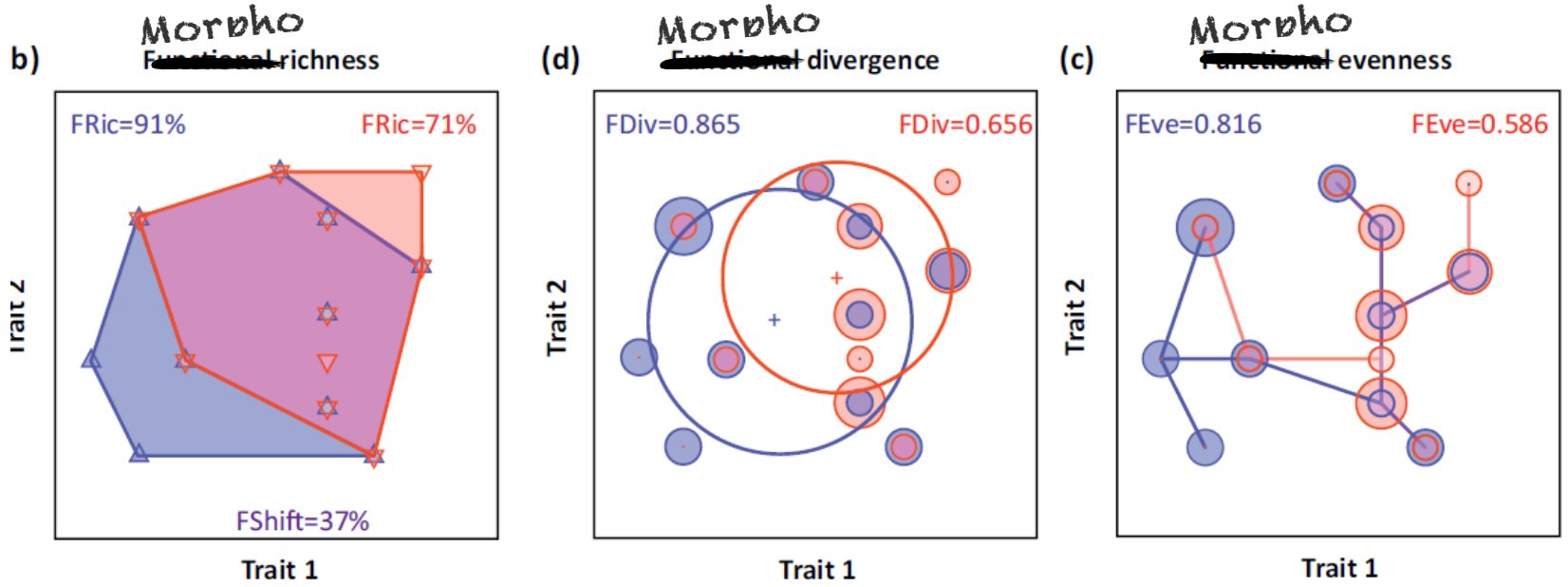
observation-weighted k-means clustering





4) Morphological diversity indices

as developed for functional diversity (Villager *et al.* 2008; Mouillot *et al.* 2013)



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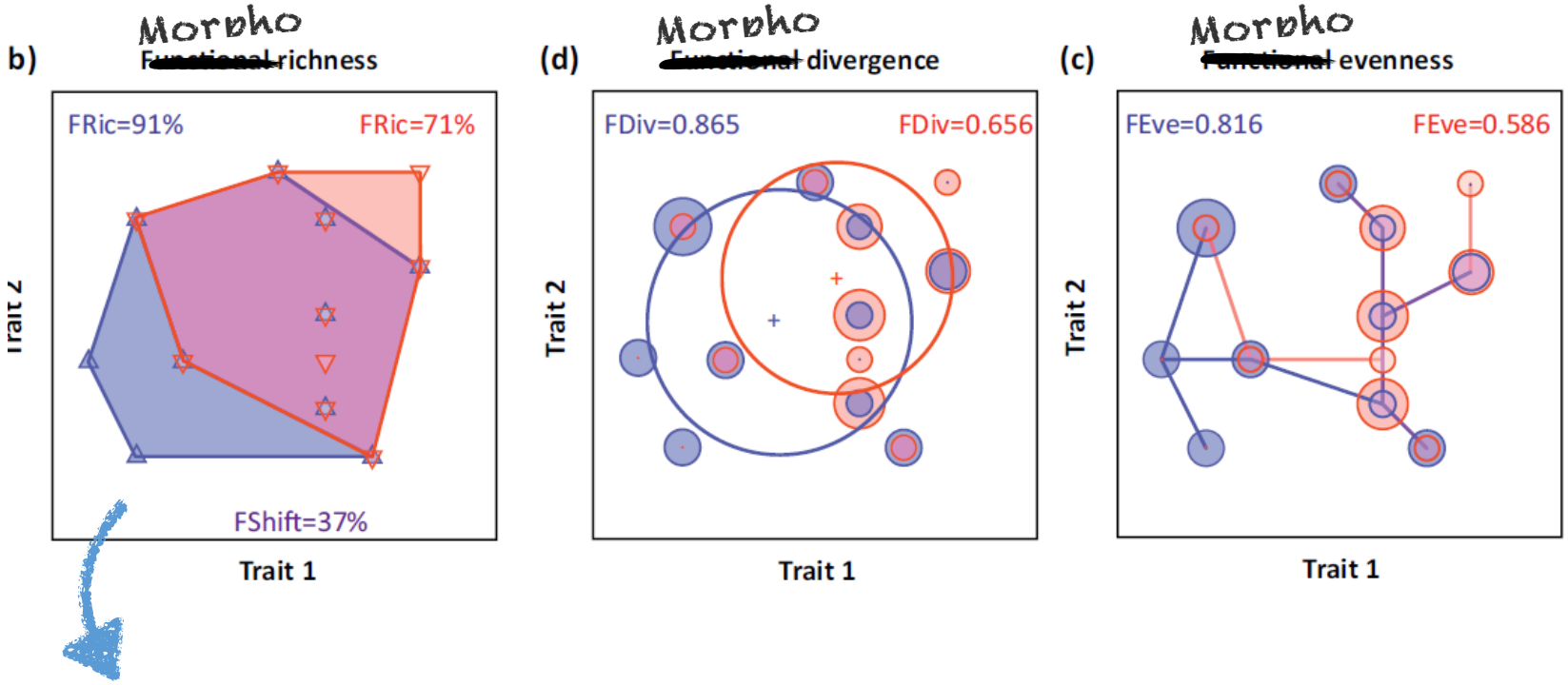

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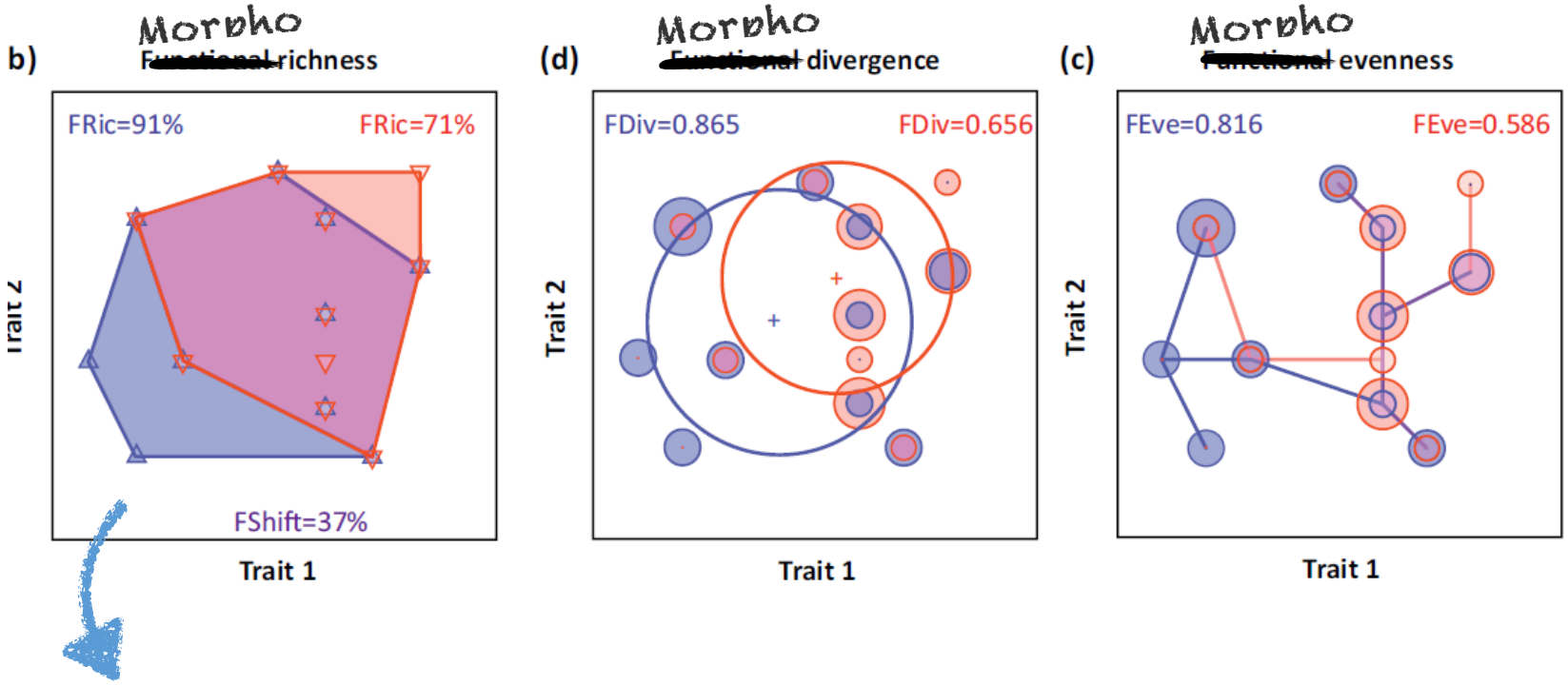

Proportion of occupied morhological space

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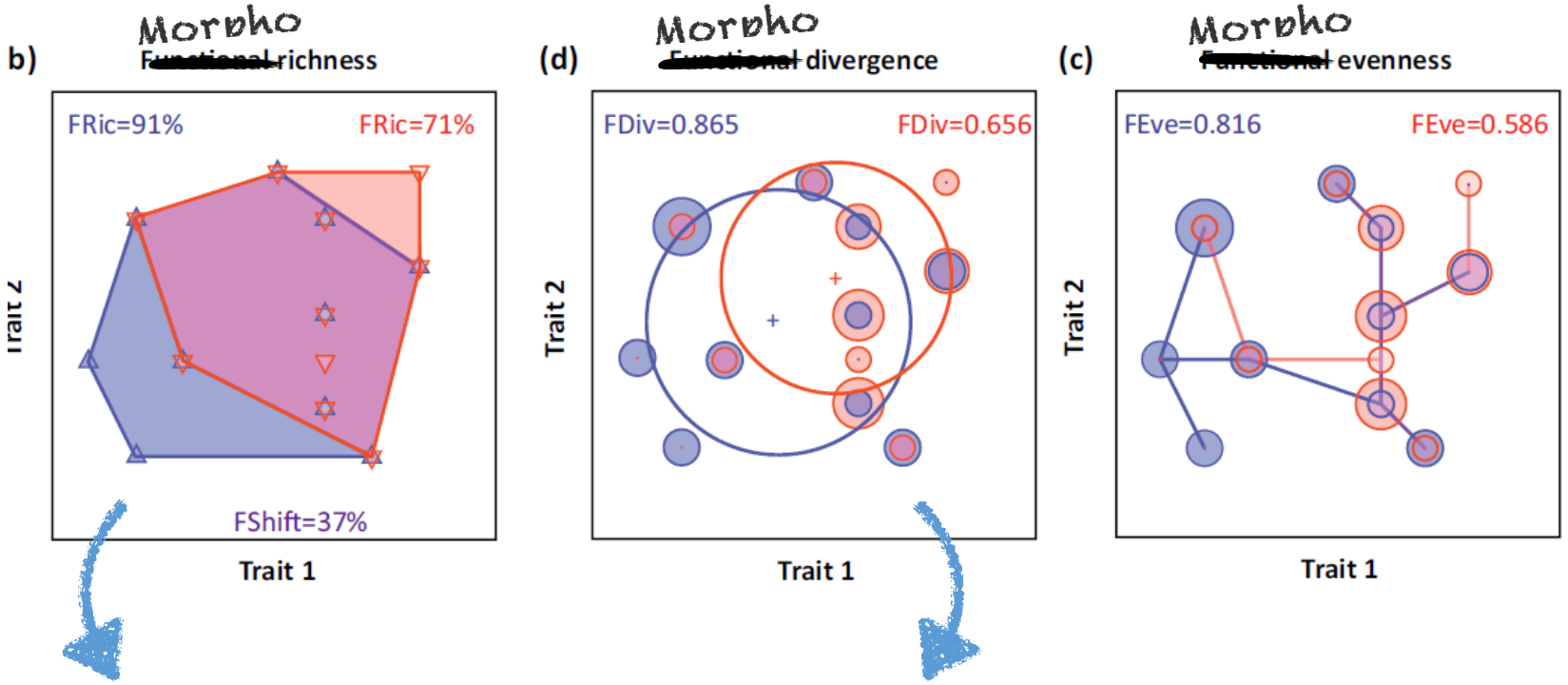

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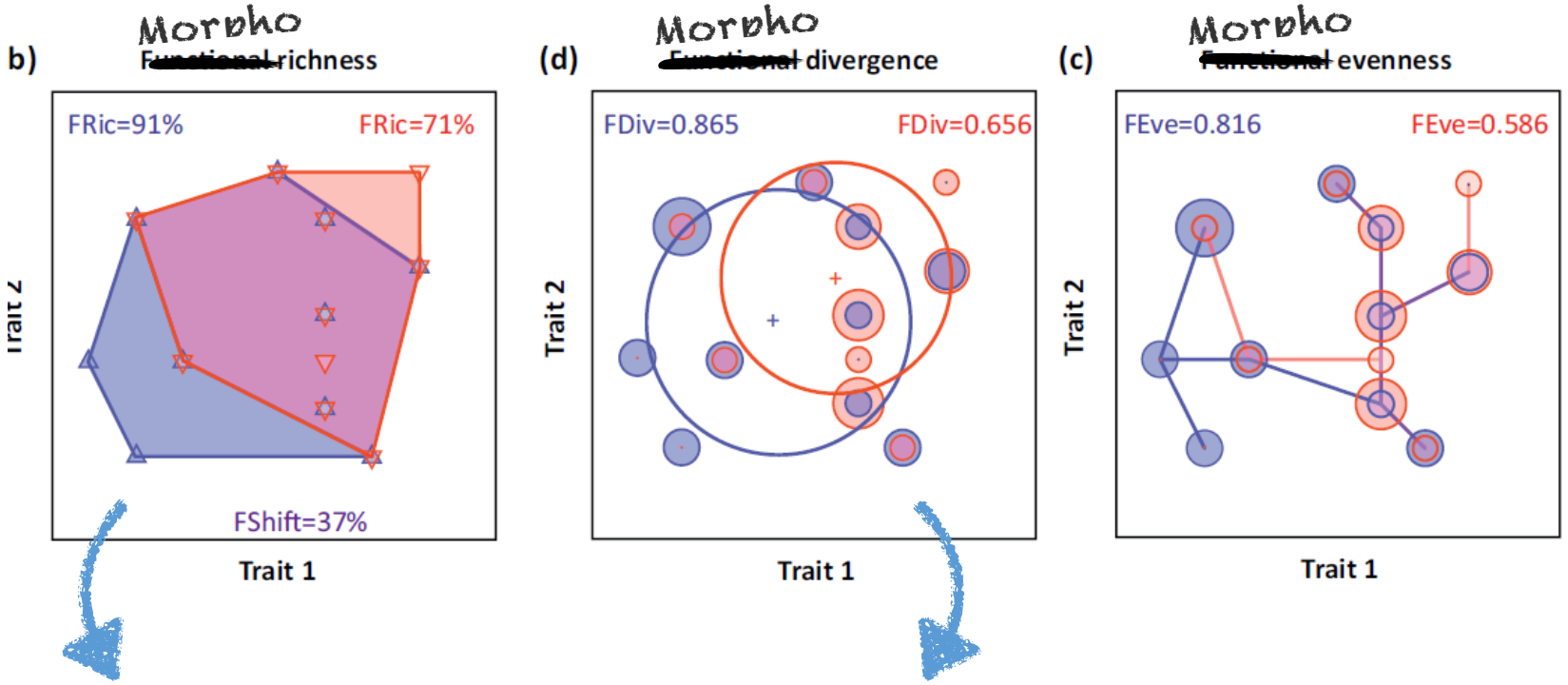

Proportion of occupied morhological space

Diversity within the total diversity fraction

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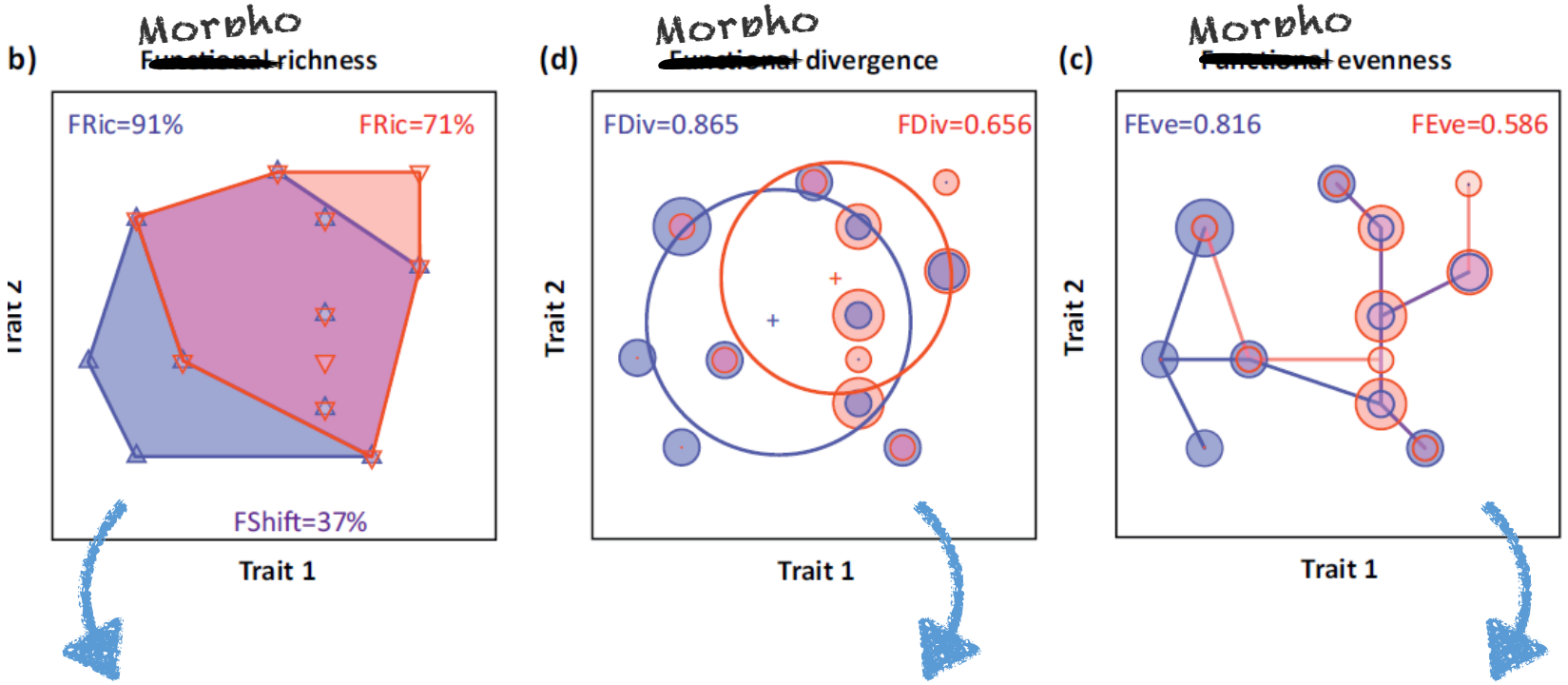

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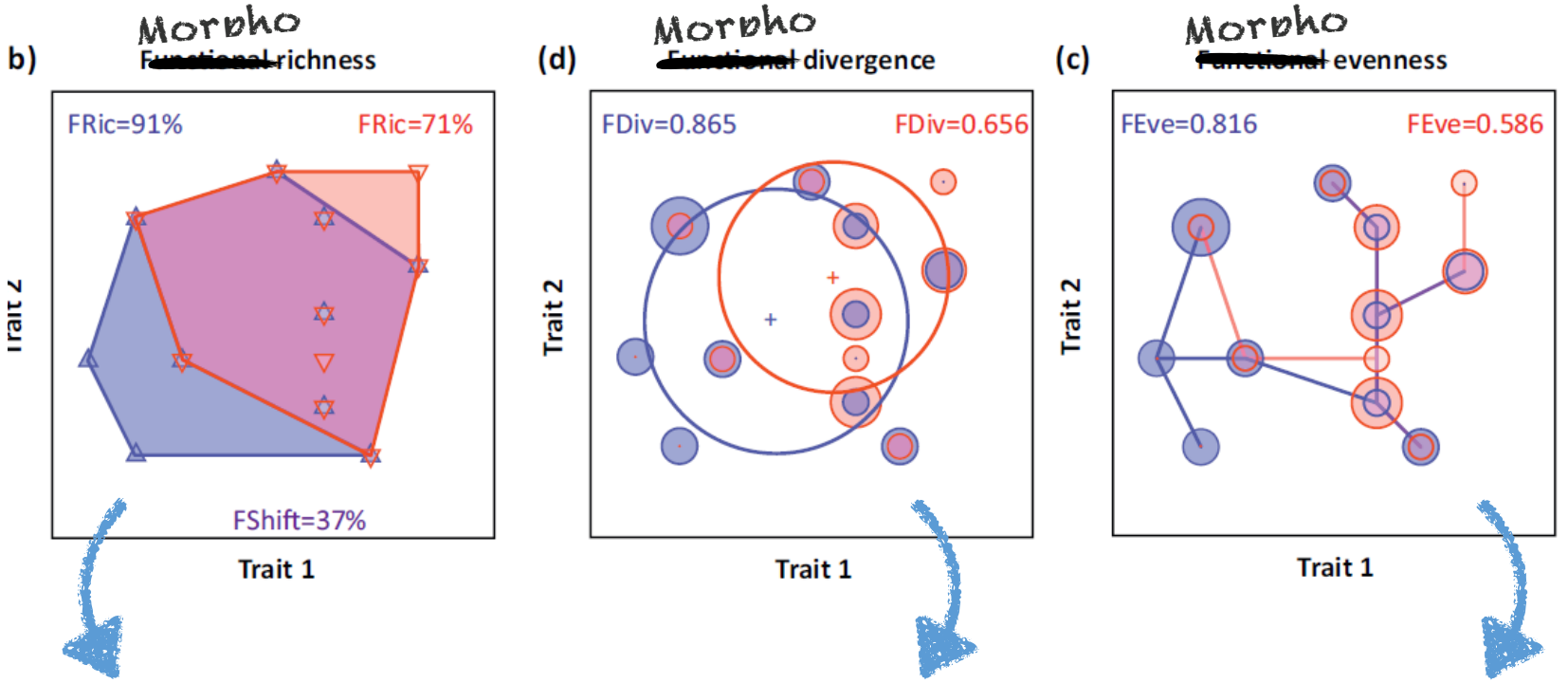


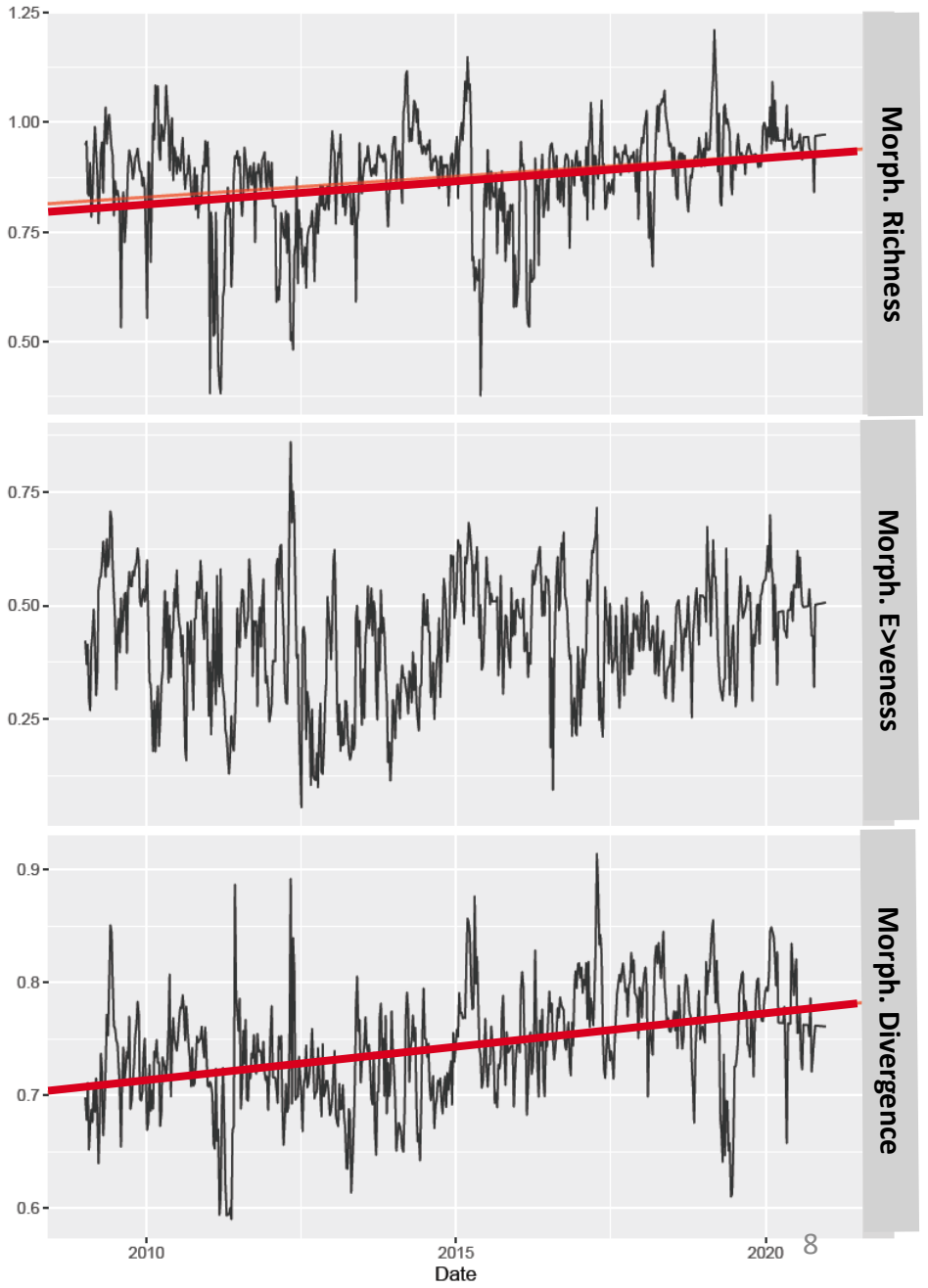
Proportion of occupied morhological space

Diversity within the total diversity fraction

Homogeneity of differences in appearances

5a) Trends

GLS on de-seasonalized time series (STL)



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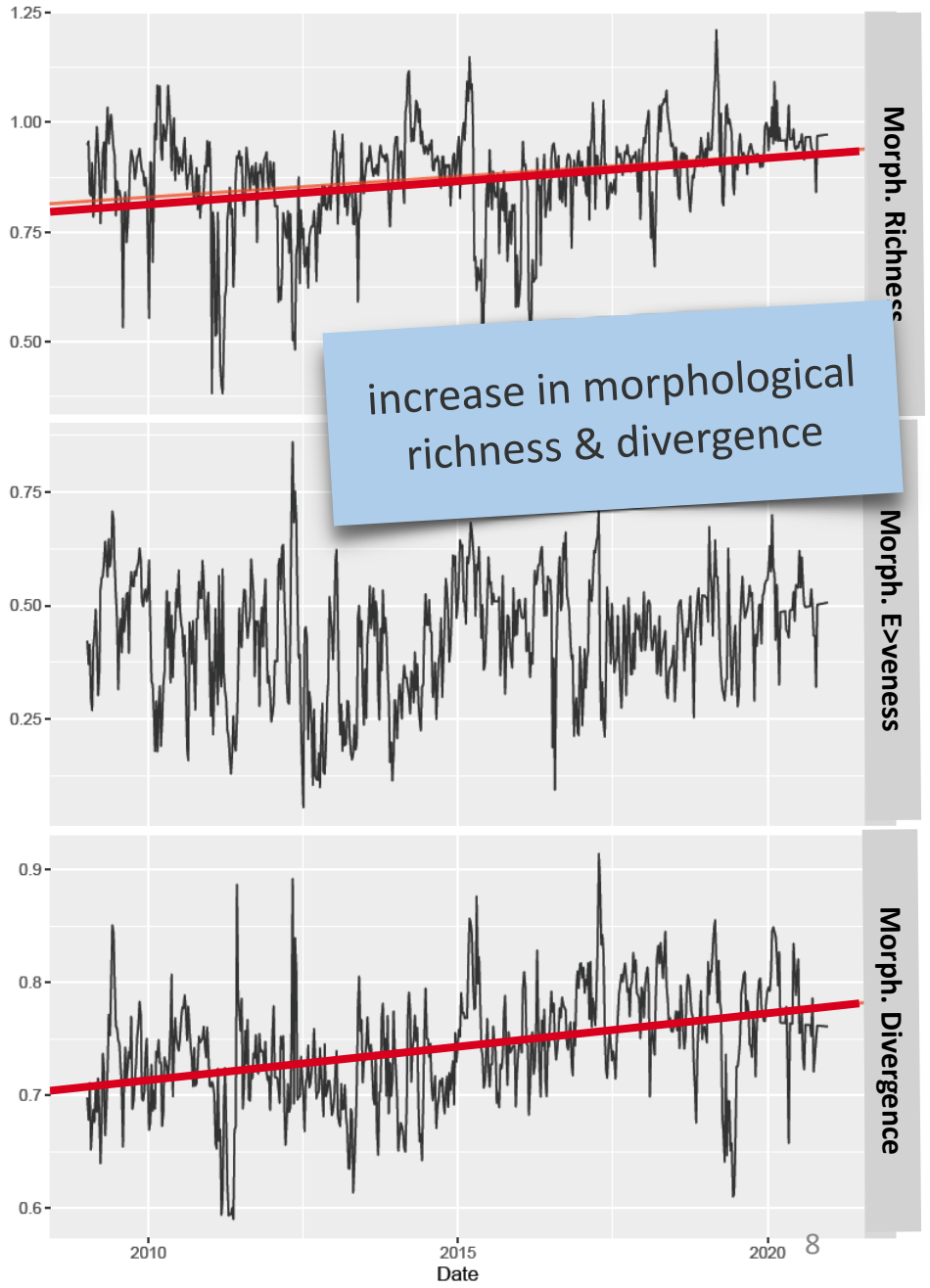

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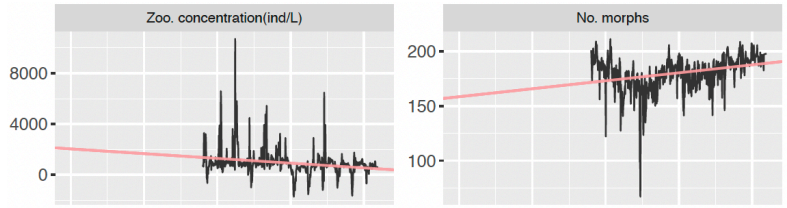

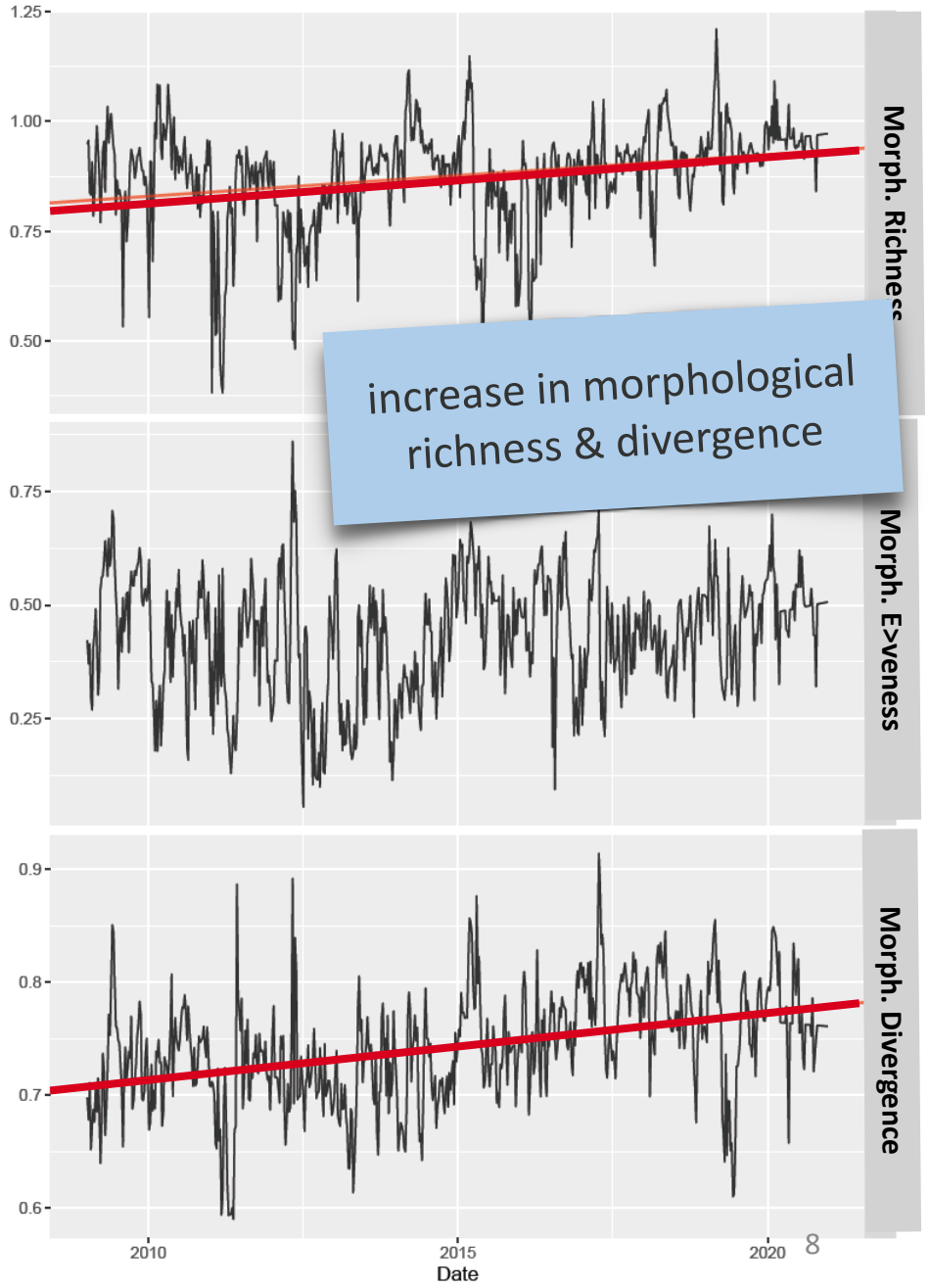

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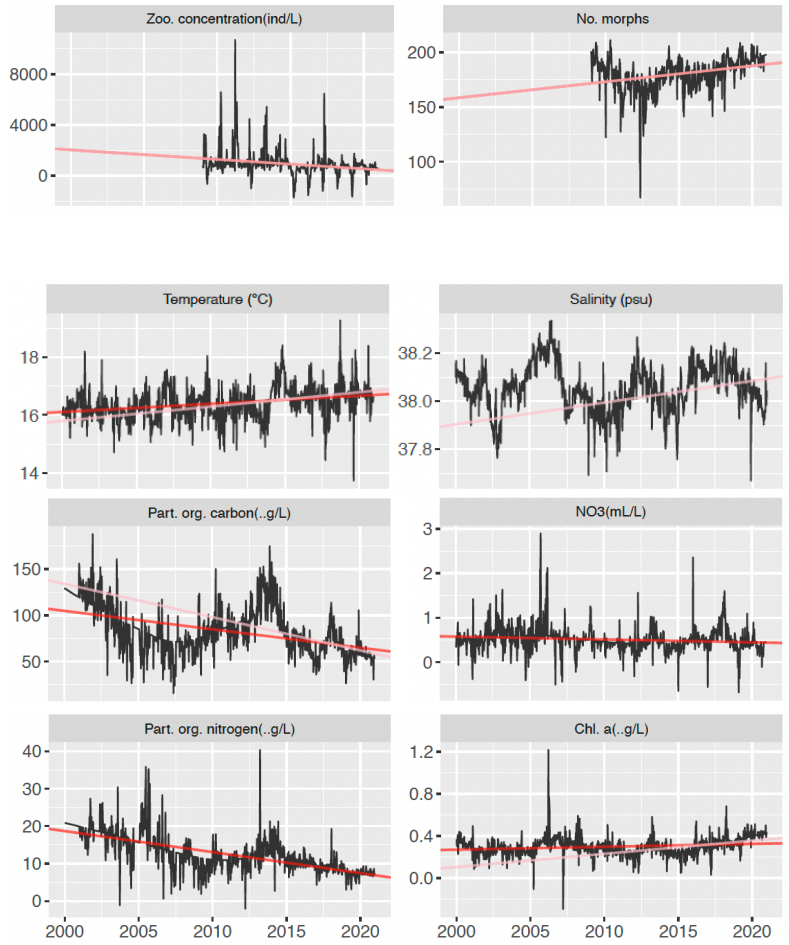

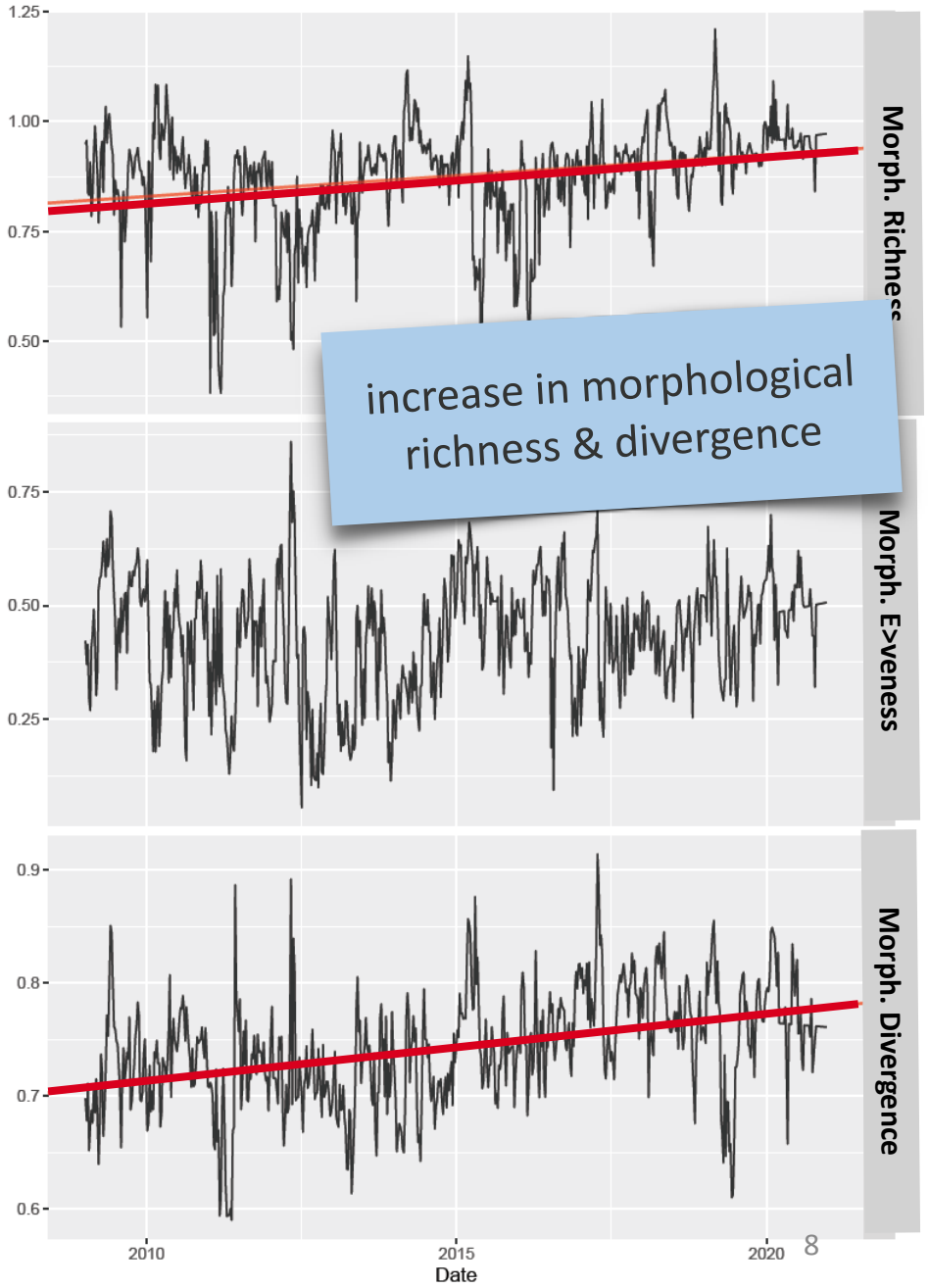

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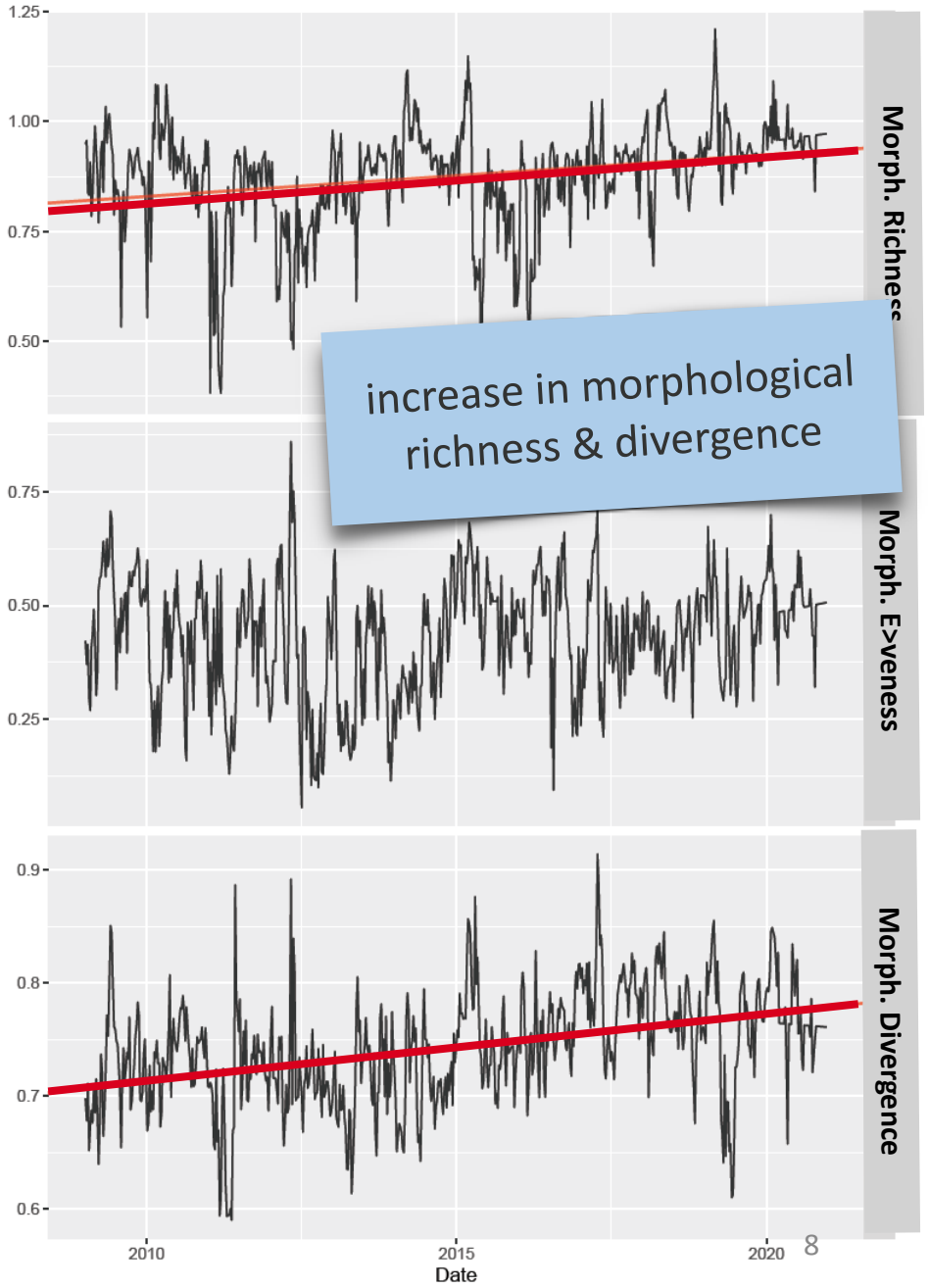
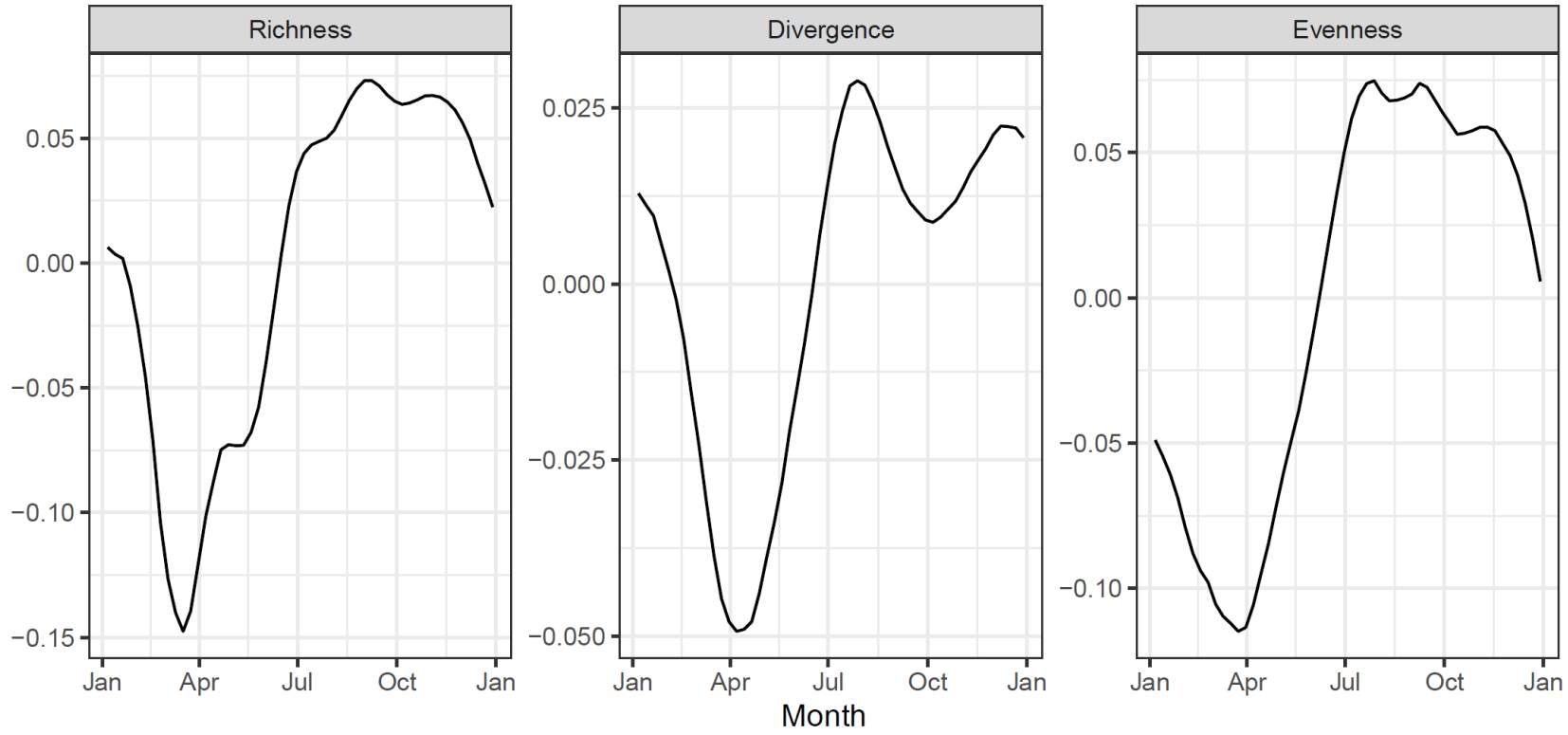


5b) Seasonal signal



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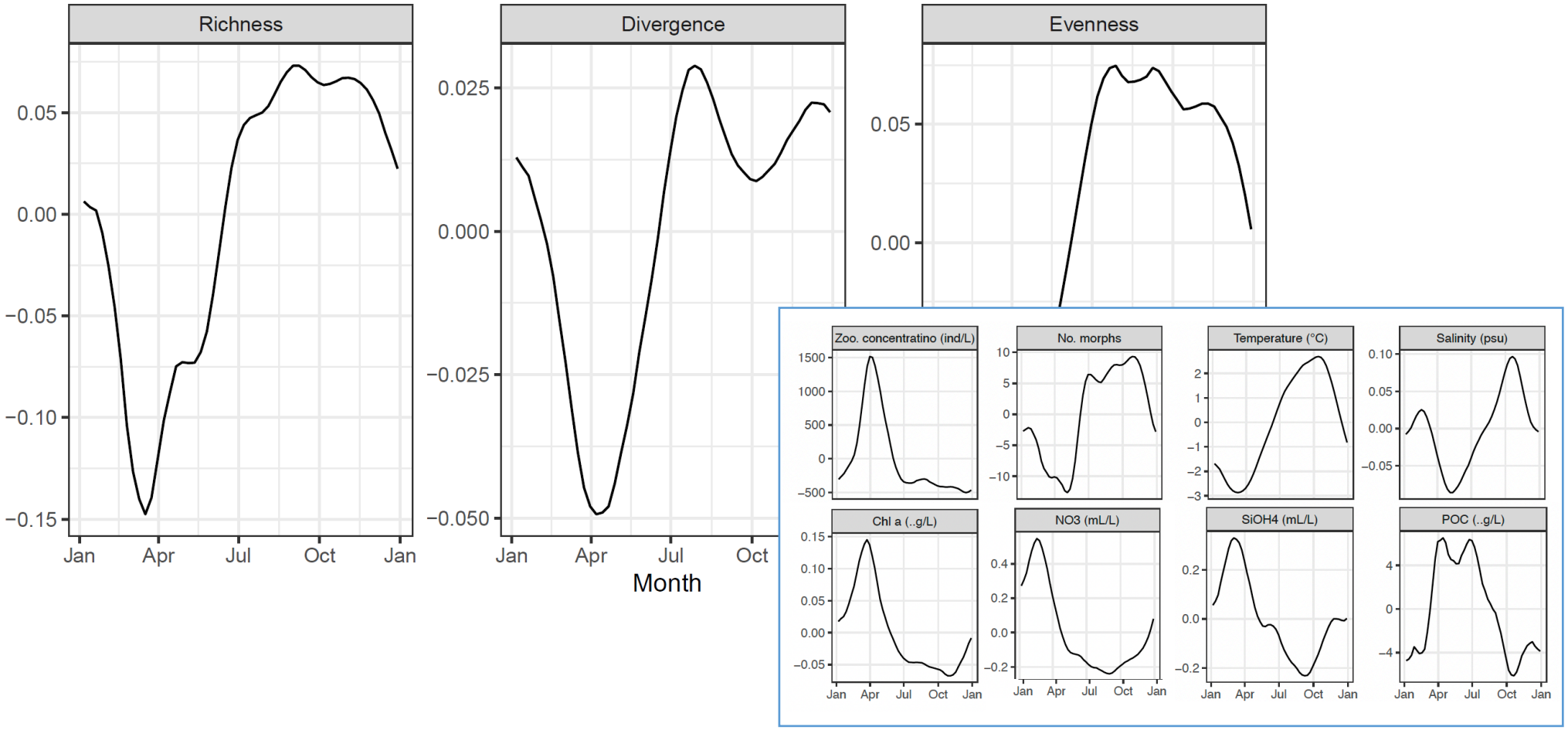

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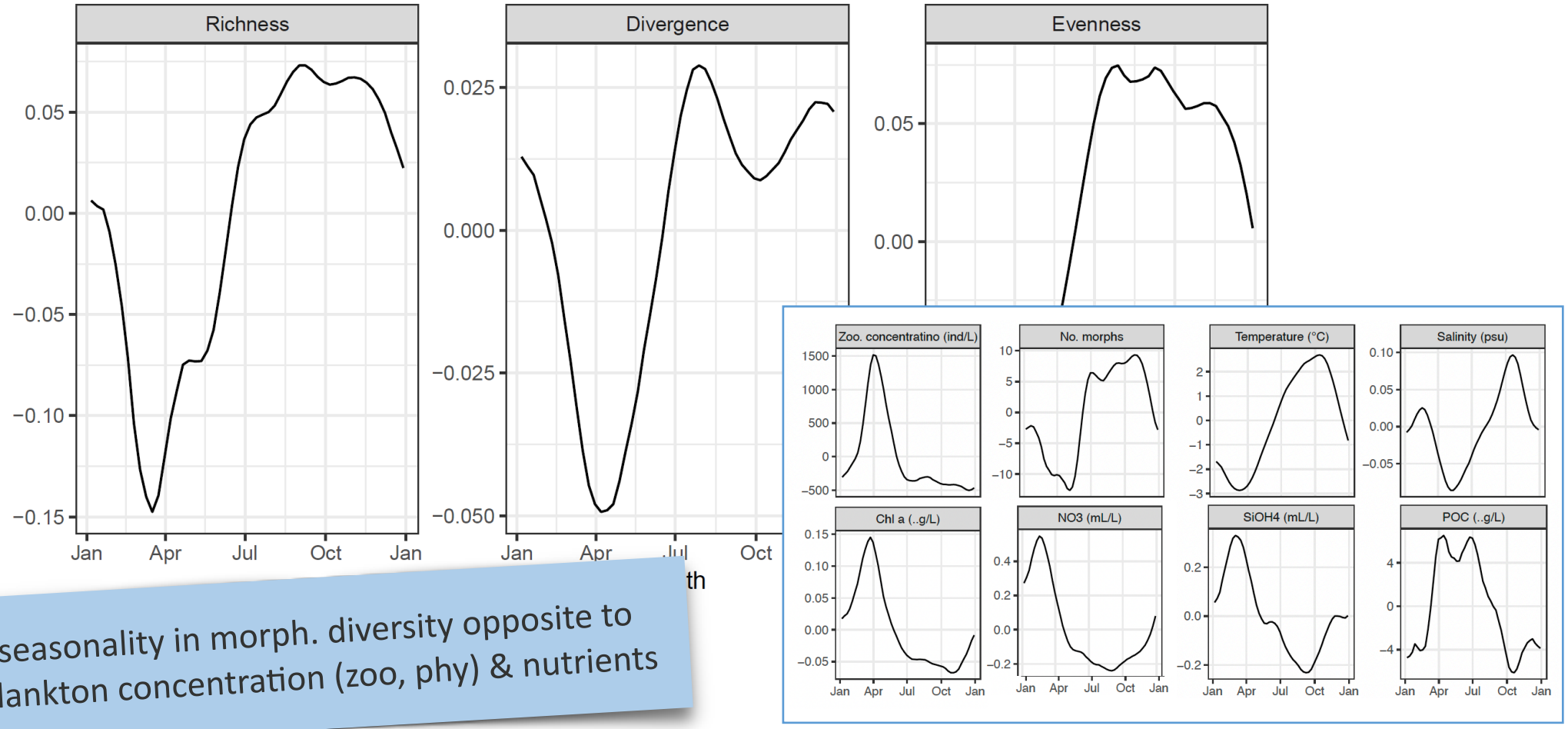

seasonality in morph. diversity opposite to plankton concentration (zoo, phy) & nutrients

Conclusion

- It is possible to define groups of morphological similar individuals based on image-derived features (morphs =/= taxa!)
- Long-term trend & seasonal signal in morphological diversity
- Increasing diversity likely represents niche differentiation under impoverishment

Thank you for your attention!

Caroline Cailleton
Lionel Guidi
Lars Stemmann
Sakina-Dorothée Ayata
Jean-Olivier Irisson

…& all those involved
in the sampling process!

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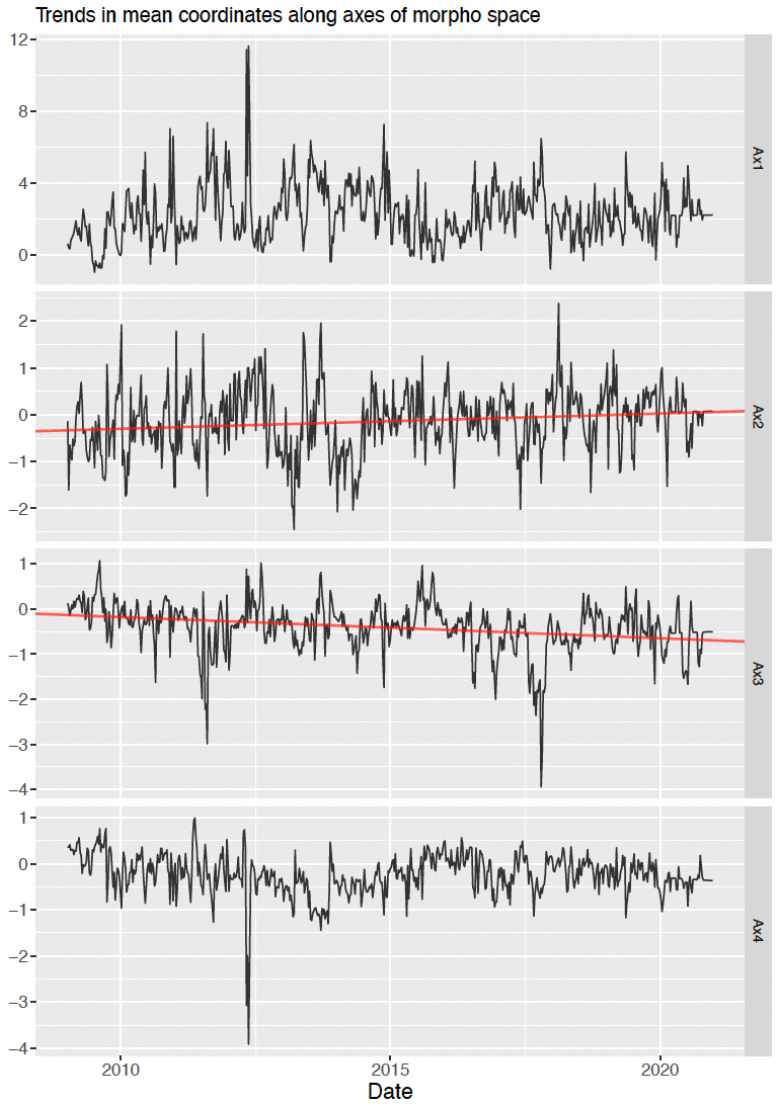
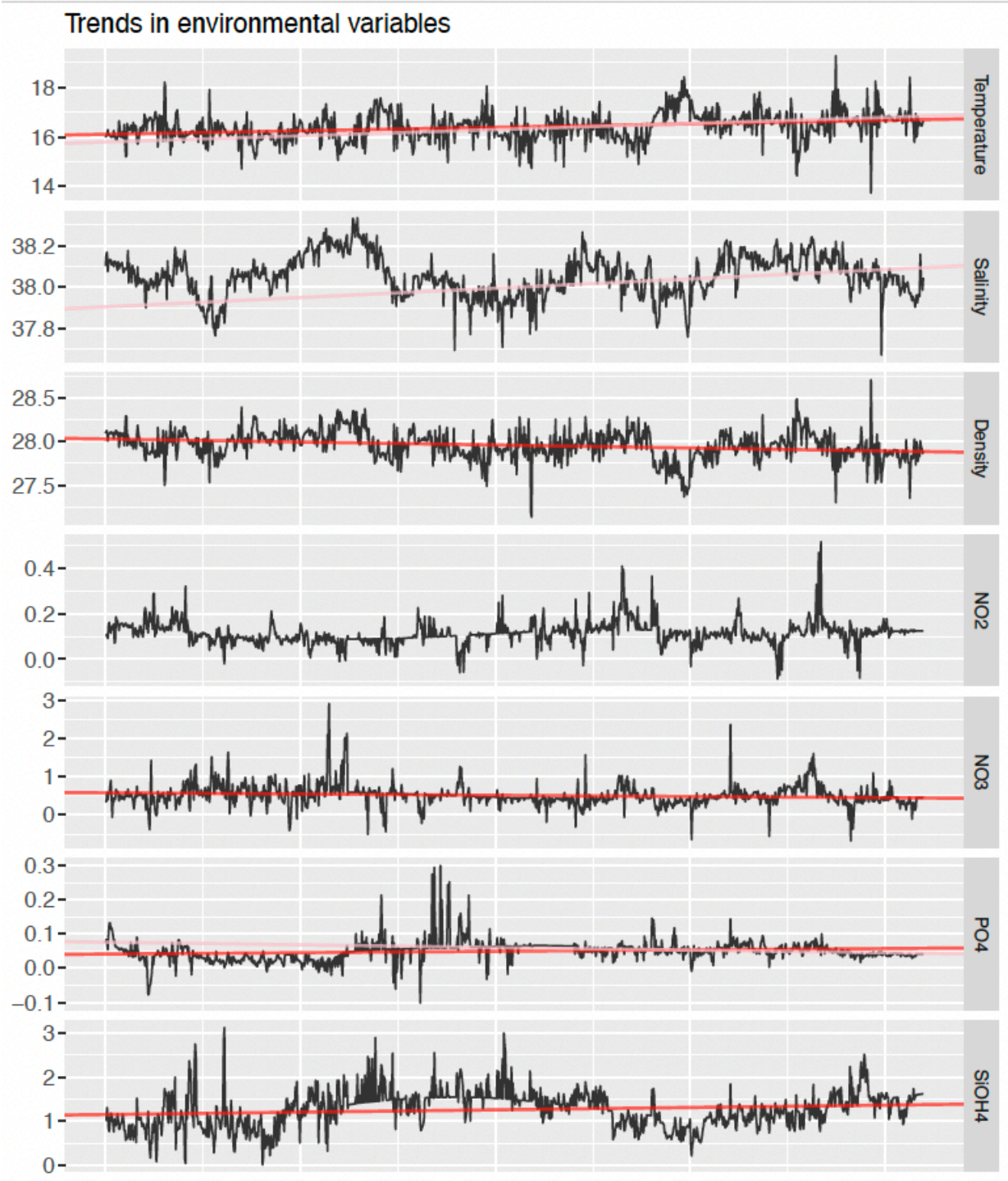
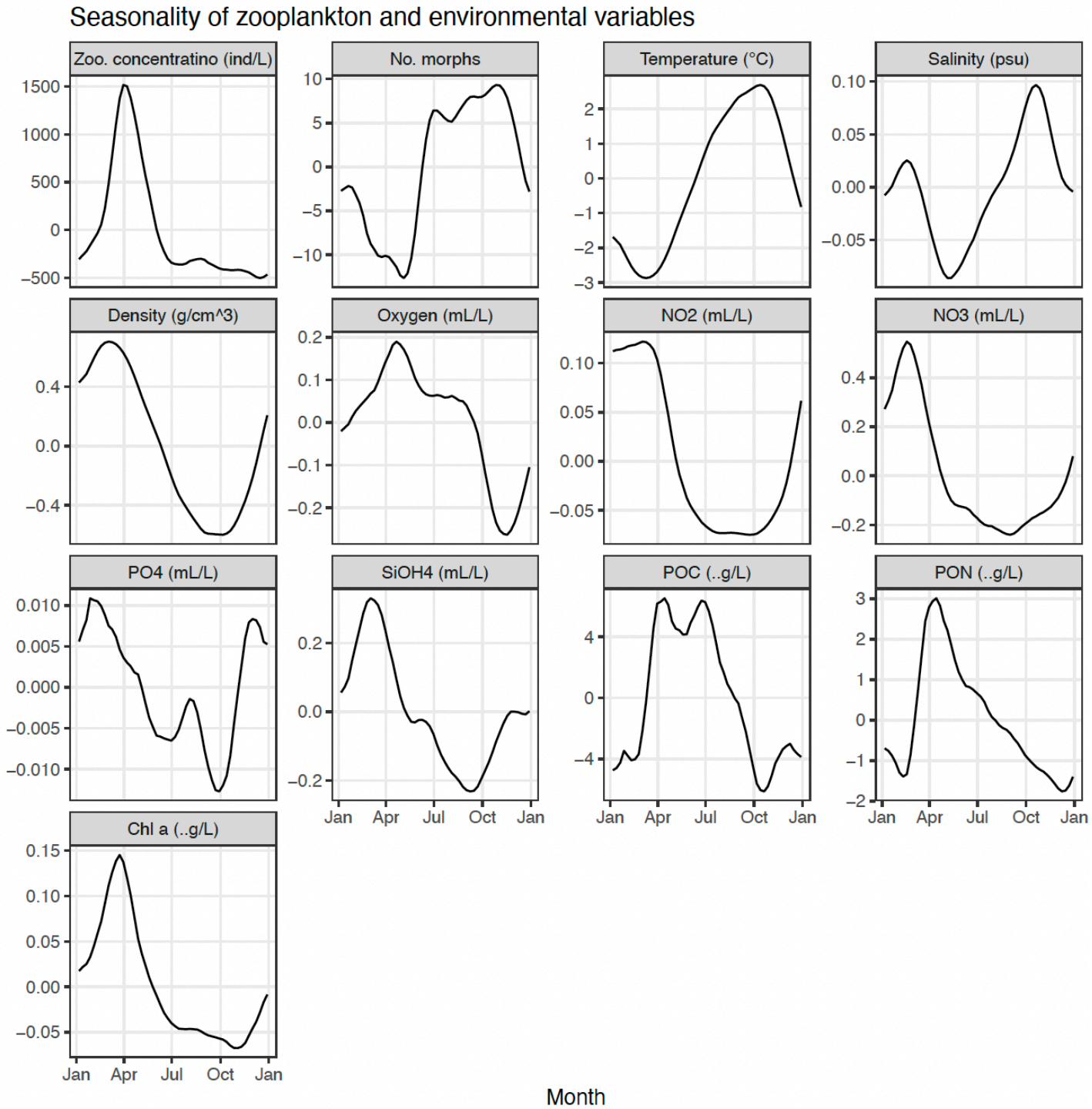
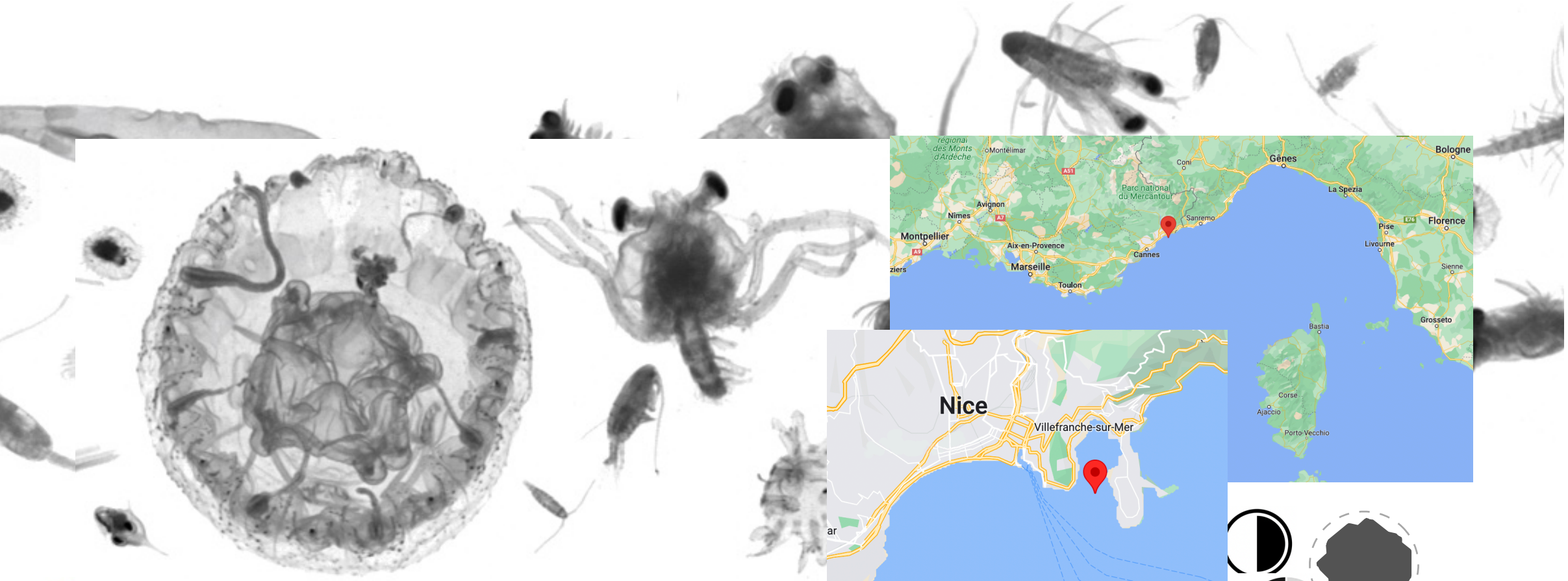
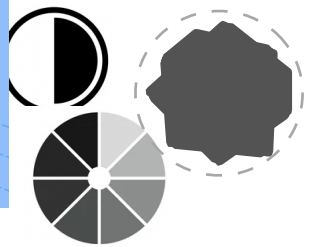

Trends in mean coordinates along axes of morpho space
Ax1
Ax2
Ax3
Ax4
2010
2015
2020
Date


Trends in environmental variables
Temperature
Salinity
Density
NO2
NO3
PO4
SiOH4


Seasonality of zooplankton and environmental variables
Zoo. concentratino (ind/L)
No. morphs
Temperature (°C)
Salinity (psu)
Density (g/cm^3)
Oxygen (mL/L)
NO2 (mL/L)
NO3 (mL/L)
PO4 (mL/L)
SiOH4 (mL/L)
POC (..g/L)
PON (..g/L)
Chl a (..g/L)
Jan
Apr
Jul
Oct
Jan
Month





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