



# Bacterial Parasite Communities of the Fossorial Water Vole *Arvicola terrestris* during peak abundance: richness and similarity at multiple scales

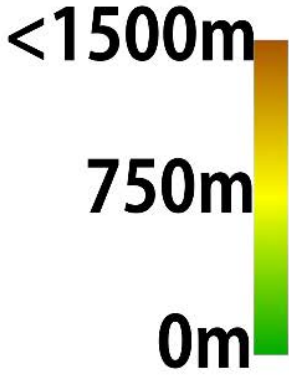
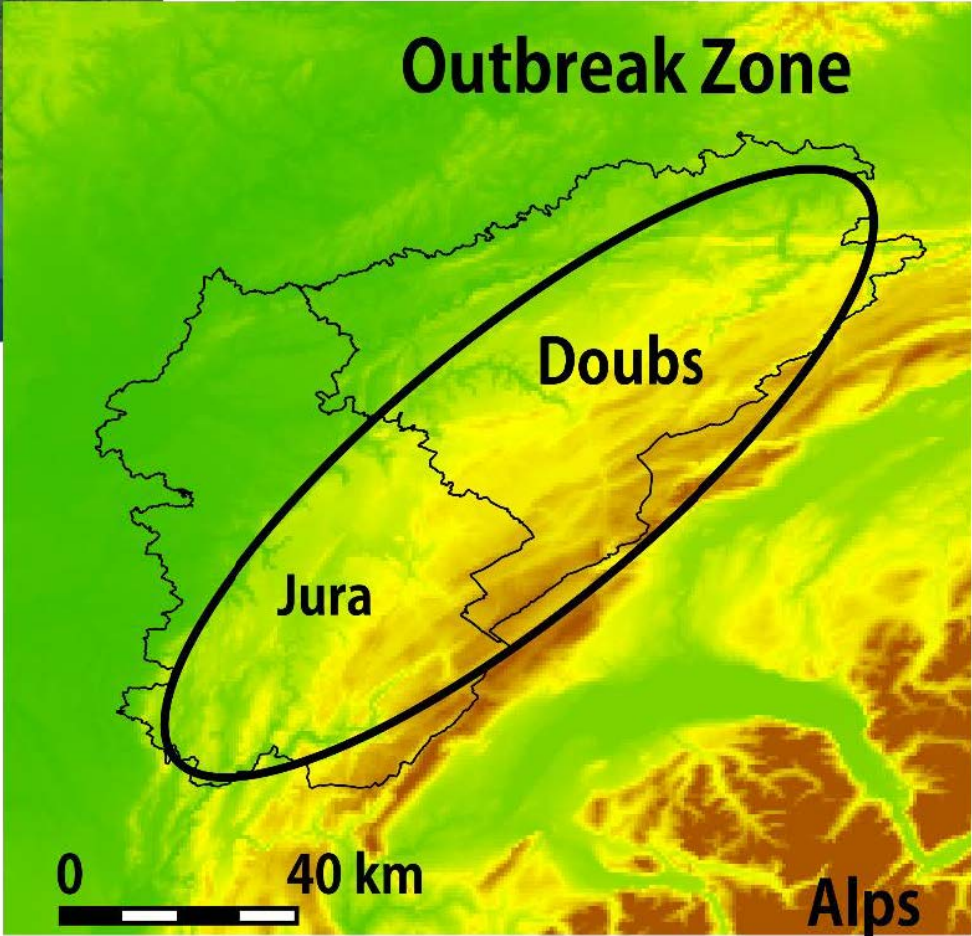


Petra Villette, Eve Afonso,  
Geoffroy Couval,  
Aurélien Levret, Jean-François  
Cosson, Patrick Giraudoux

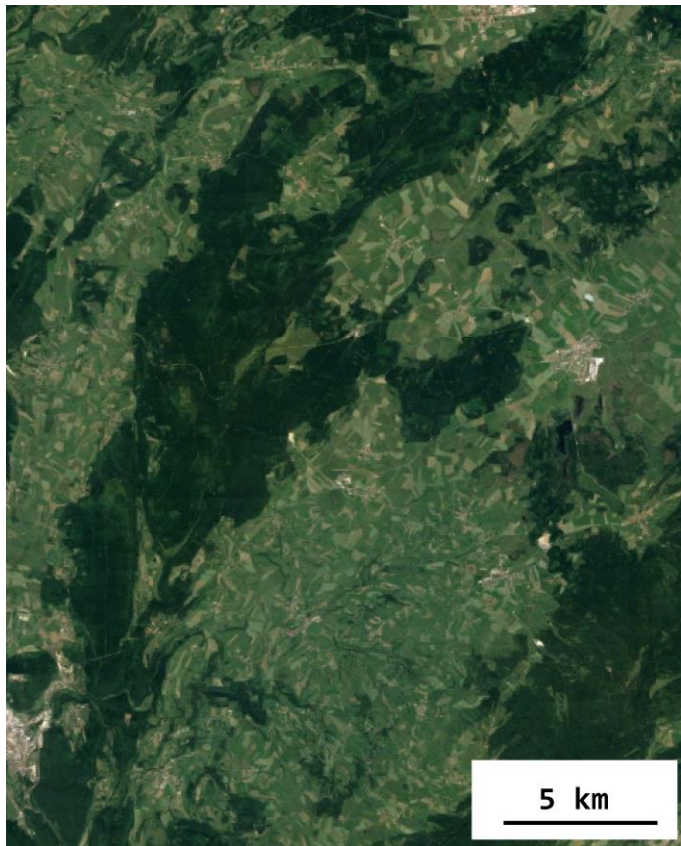




# *Arvicola terrestris* in Franche-Comtè

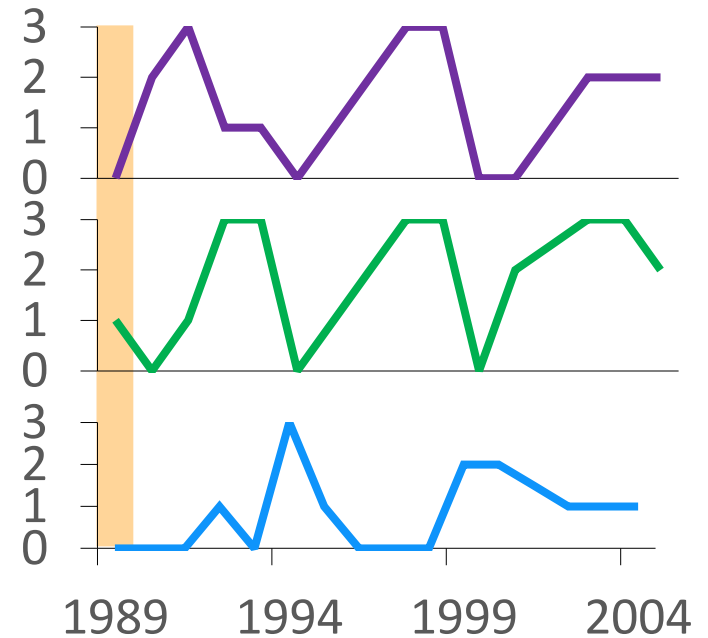
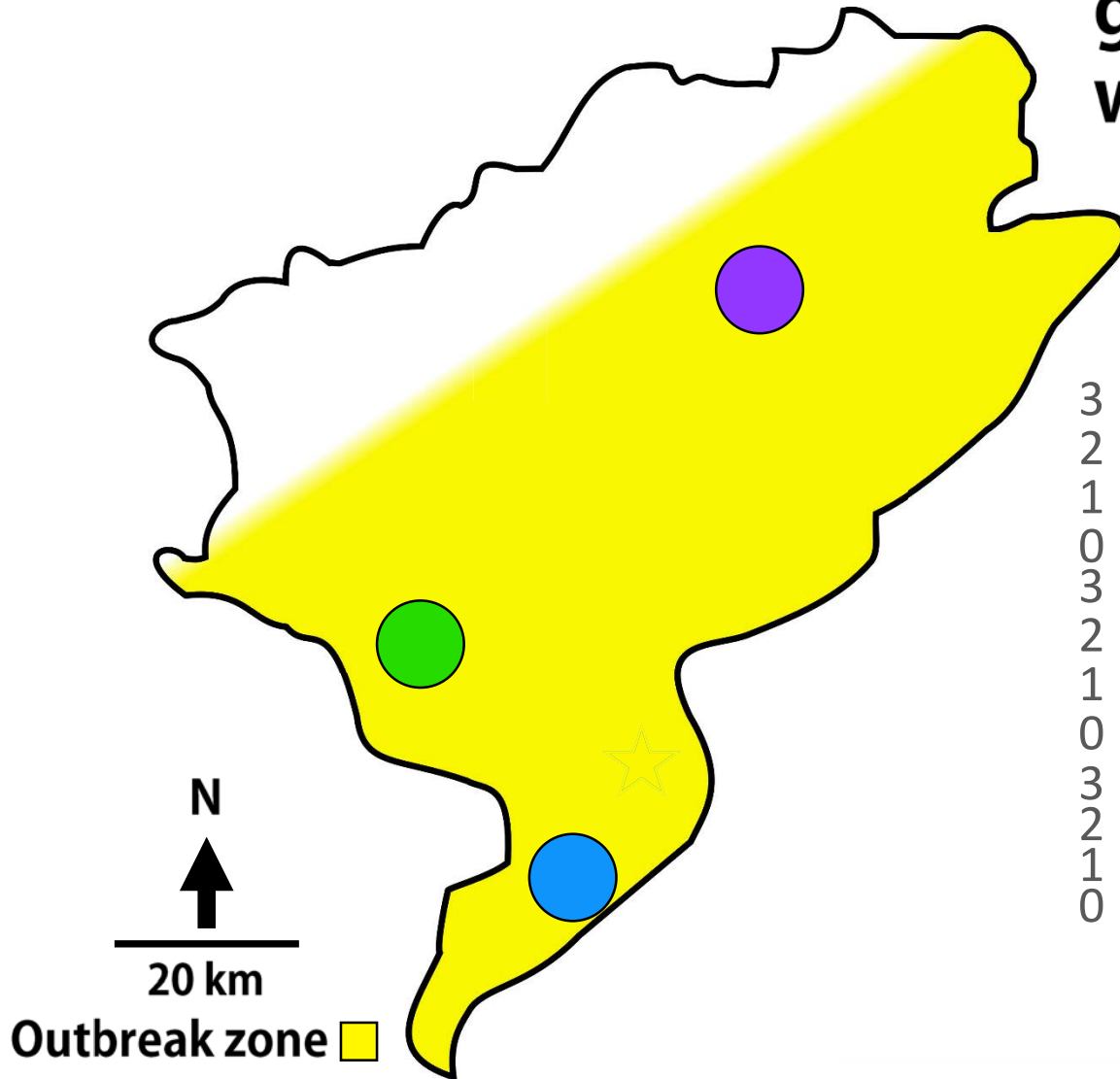






# Spatial and Temporal Dynamics

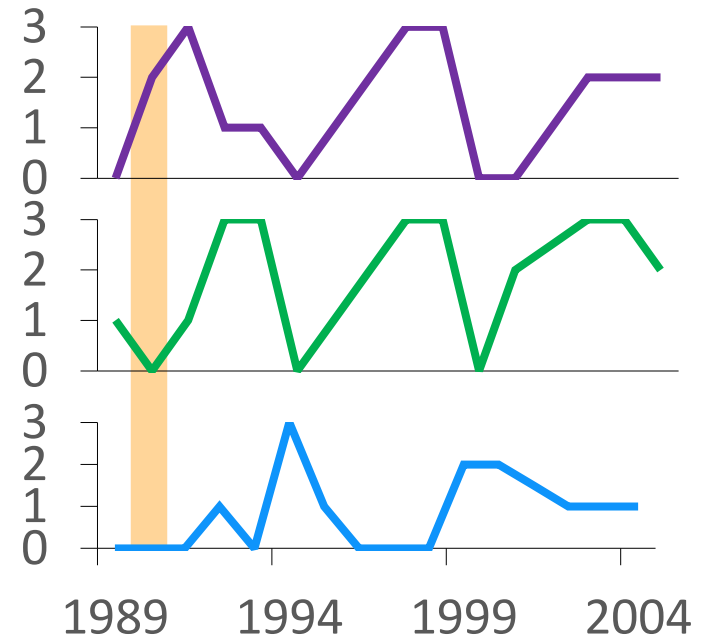
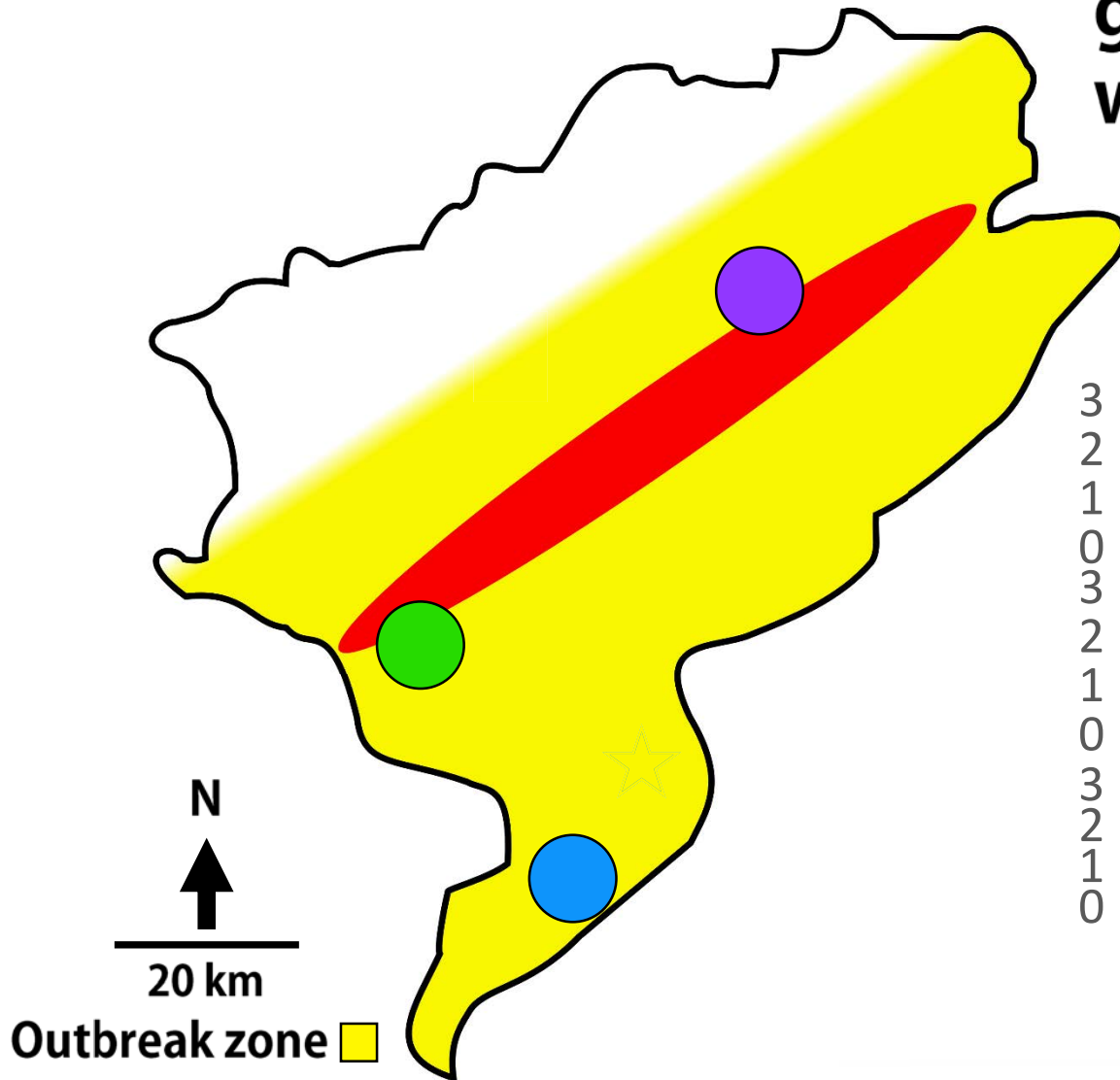
Lagged synchrony generates travelling wave



(Berthier et al 2014)

# Spatial and Temporal Dynamics

Lagged synchrony generates travelling wave

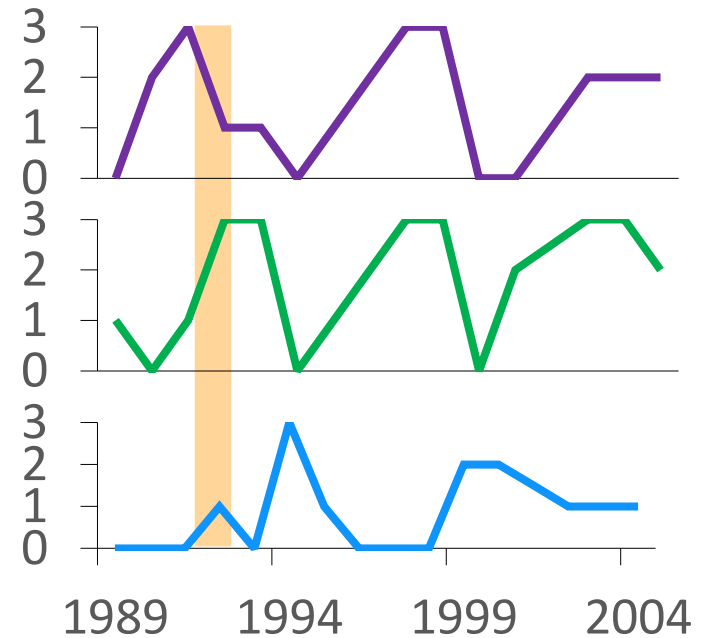
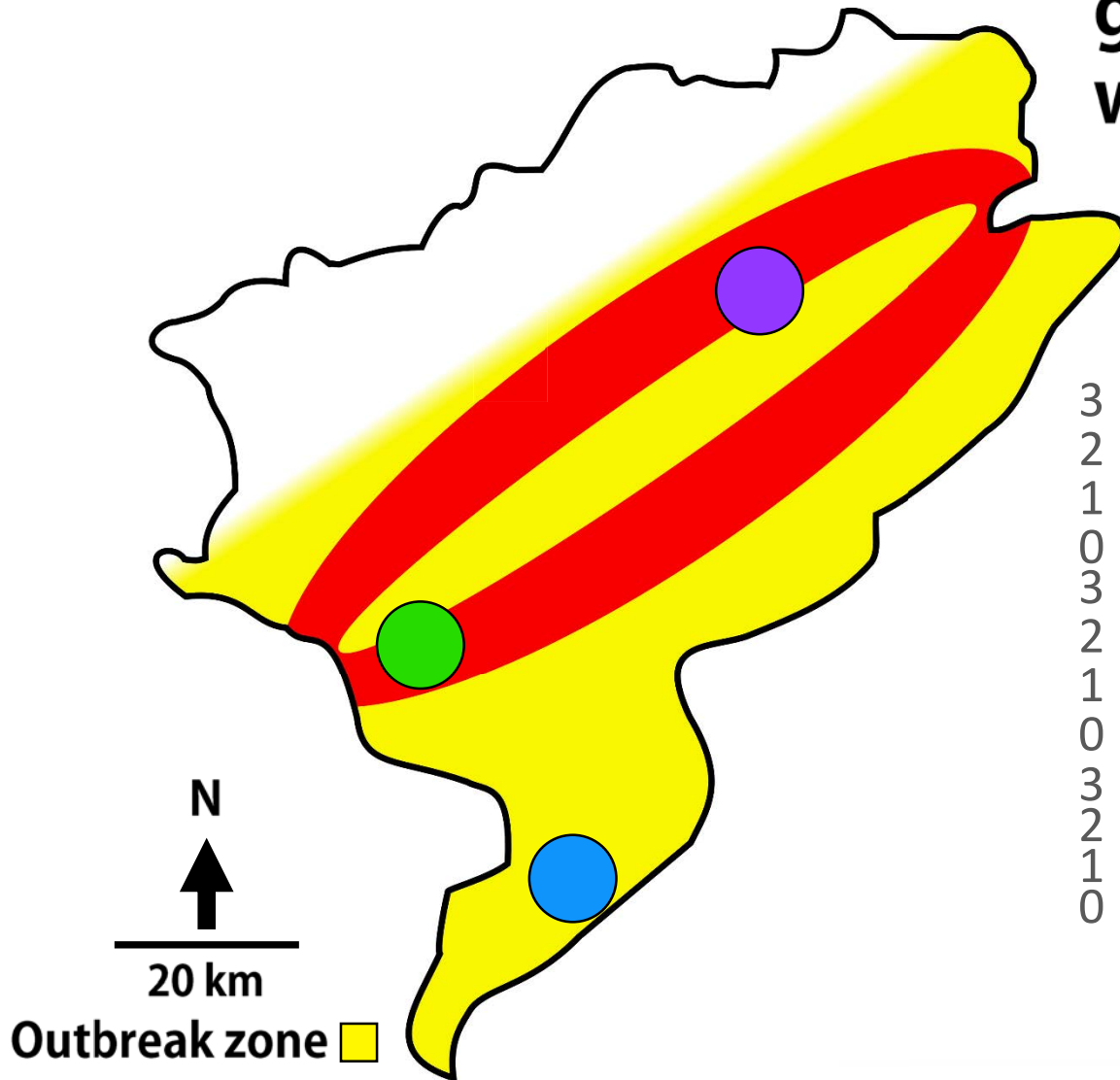


(Berthier et al 2014)



# Spatial and Temporal Dynamics

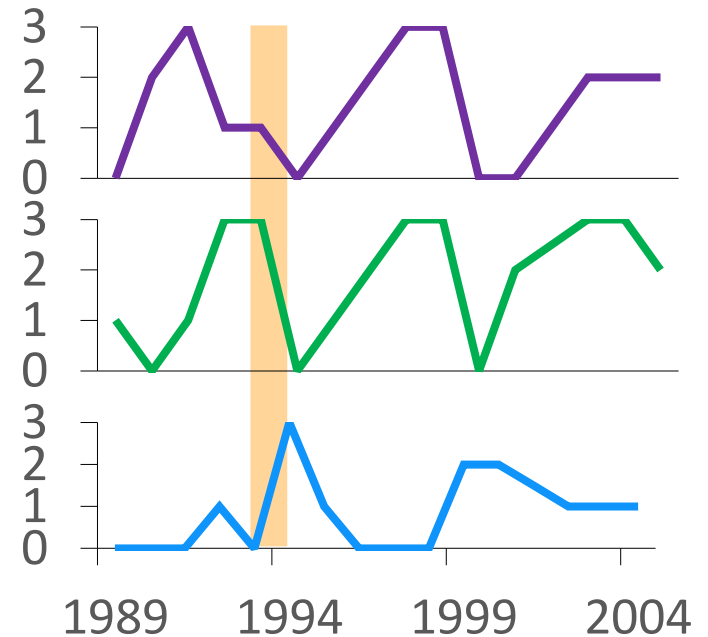
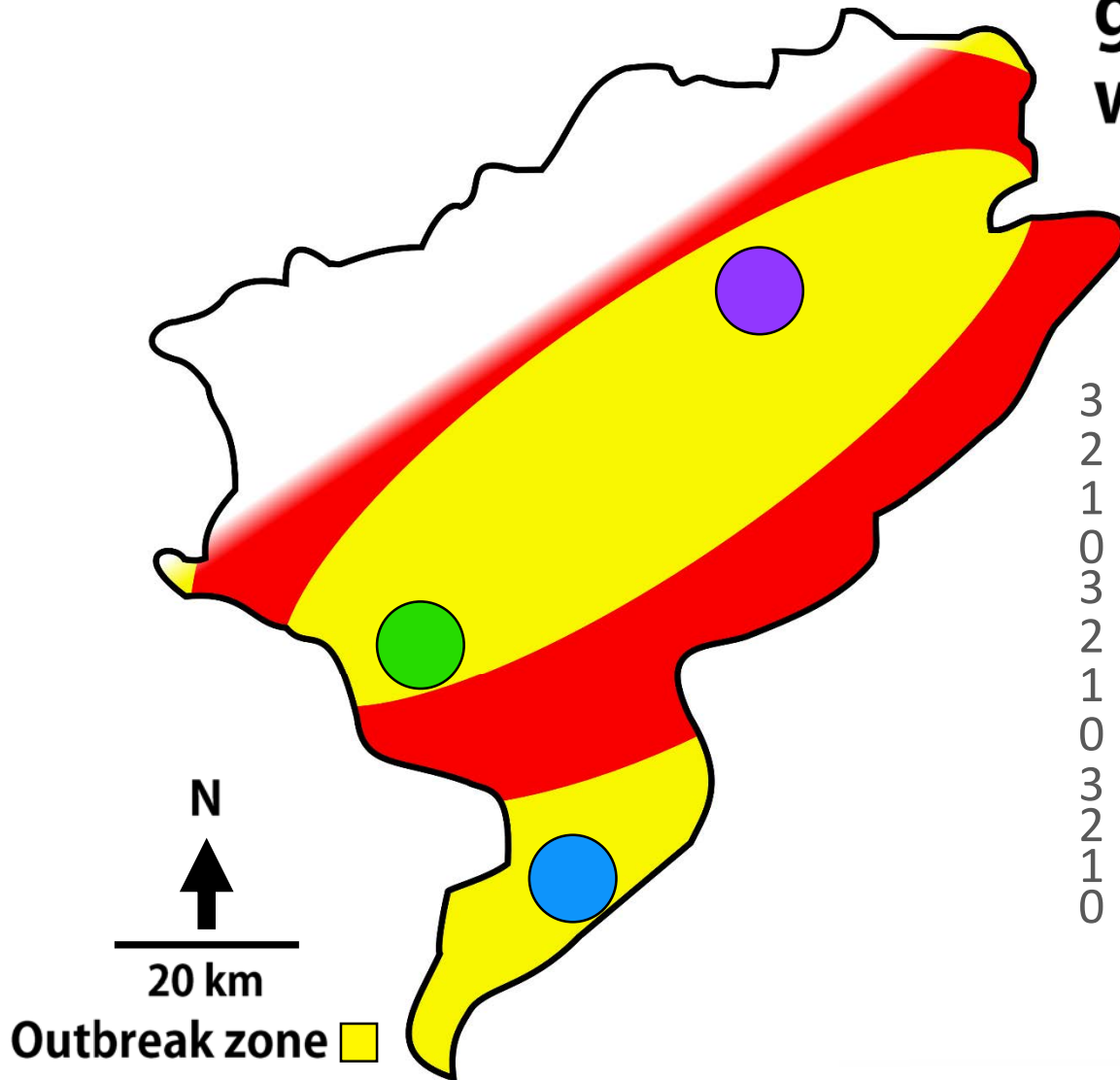
Lagged synchrony generates travelling wave



(Berthier et al 2014)

# Spatial and Temporal Dynamics

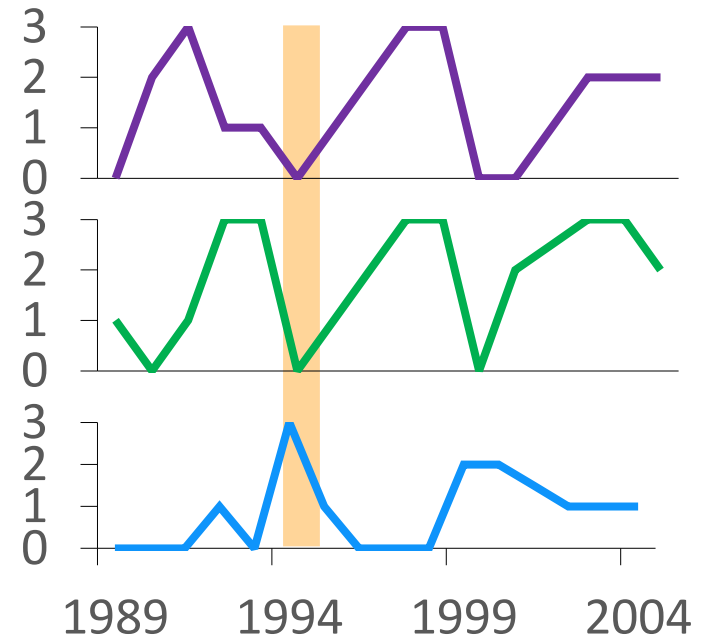
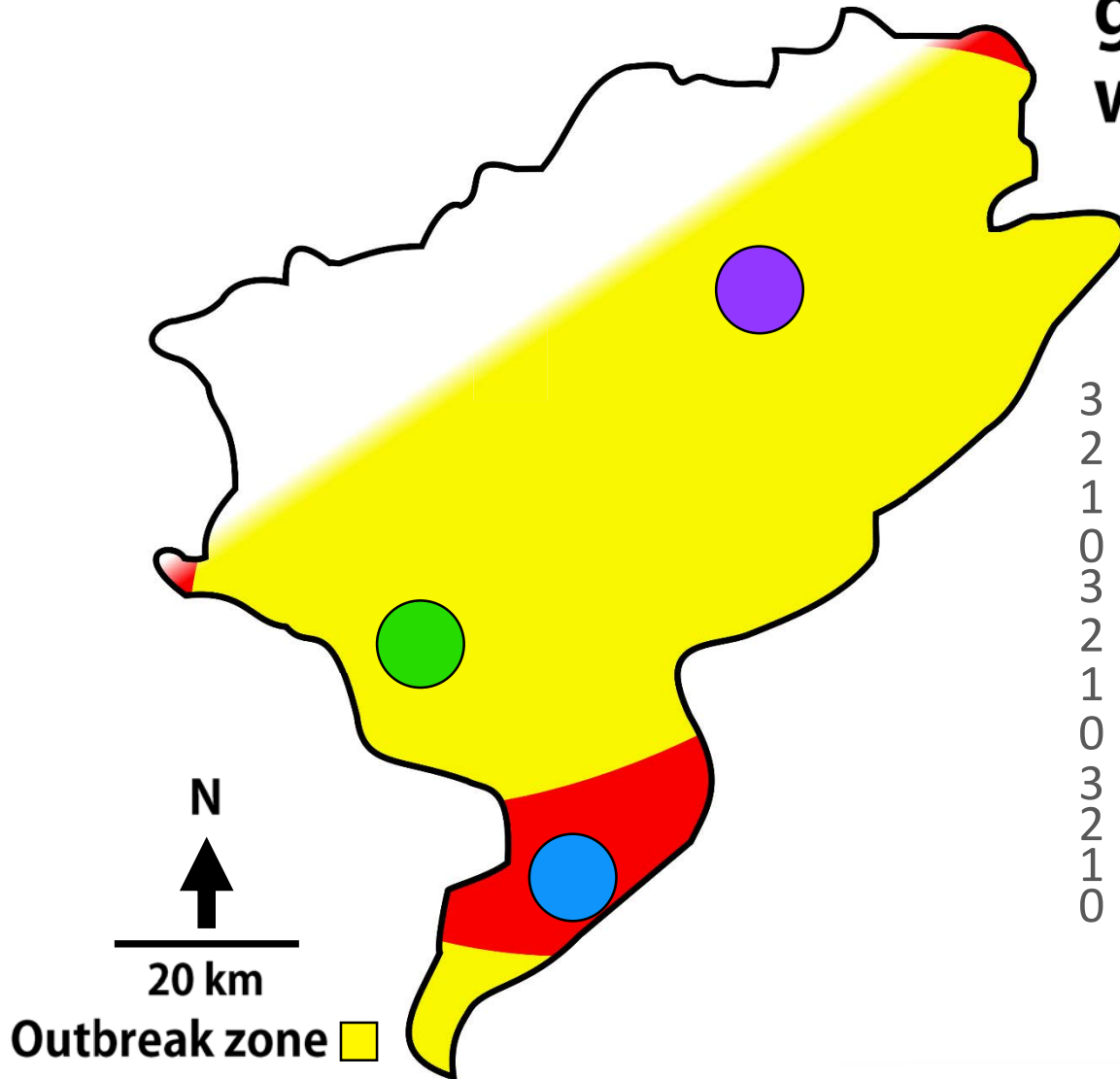
Lagged synchrony generates travelling wave



(Berthier et al 2014)

# Spatial and Temporal Dynamics

Lagged synchrony  
generates travelling  
wave

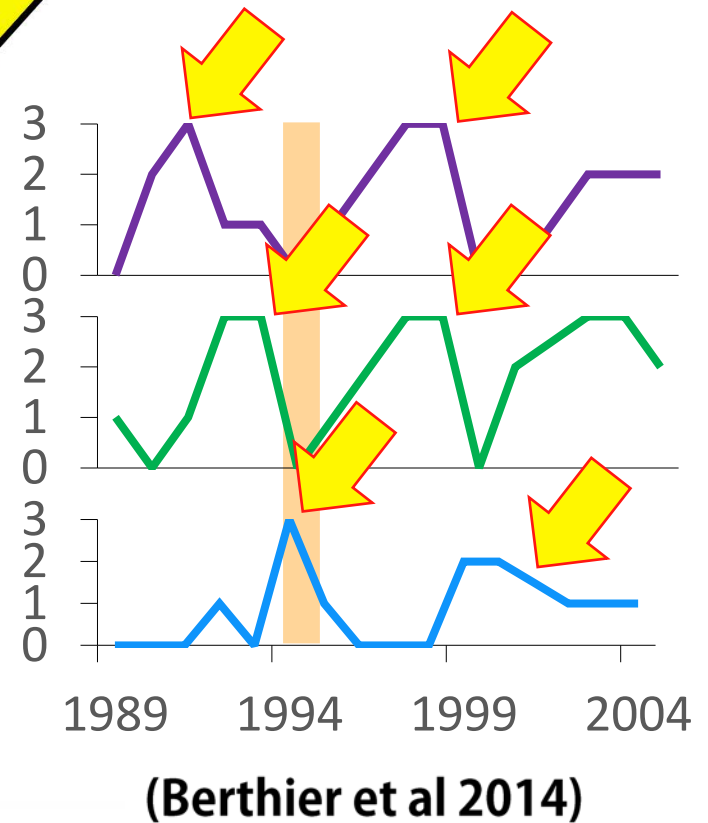
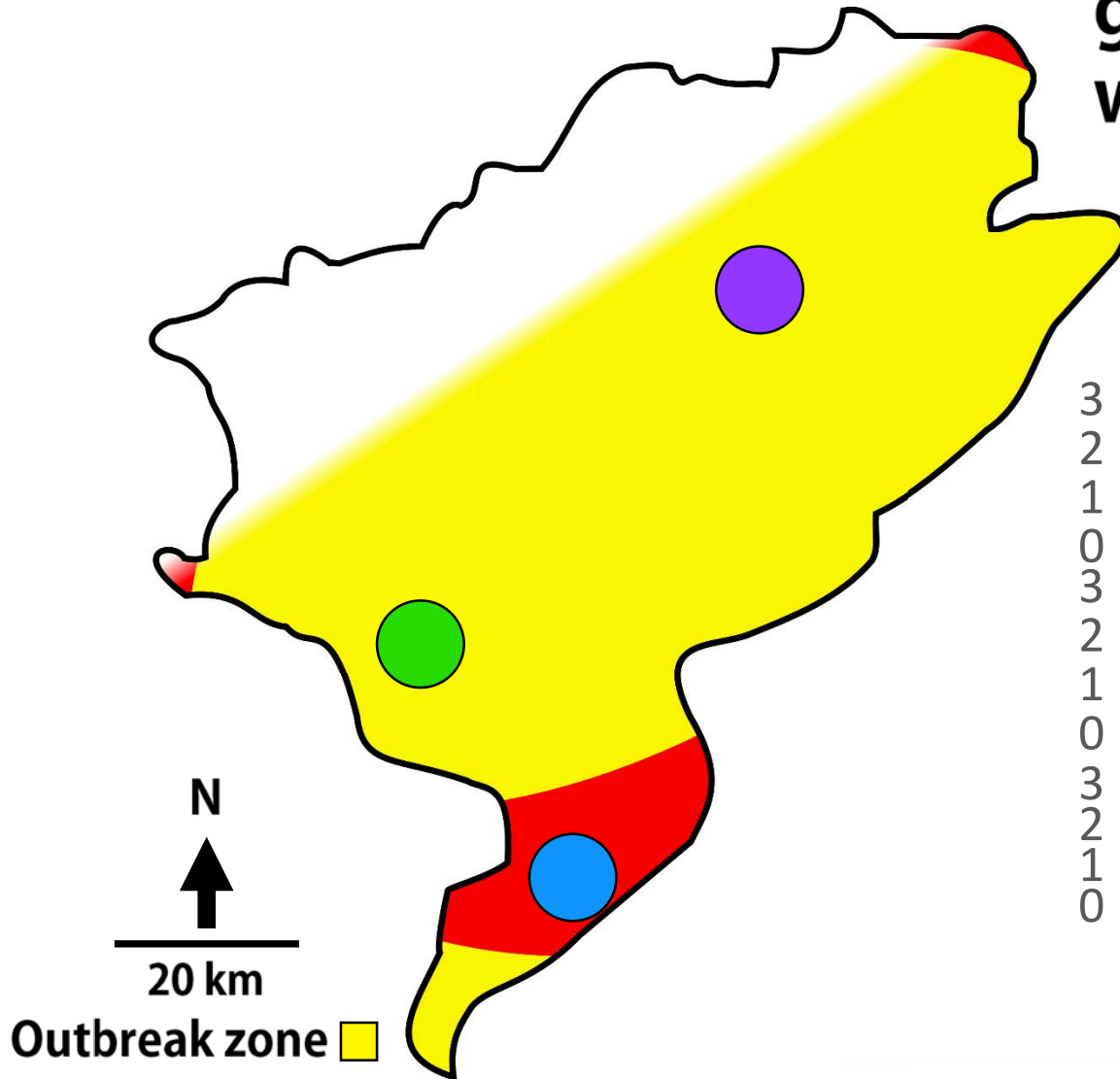


(Berthier et al 2014)



# Spatial and Temporal Dynamics

Lagged synchrony generates travelling wave



# Decline hypotheses

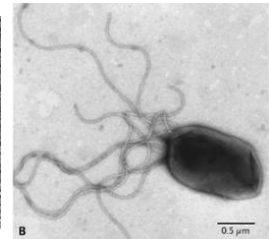
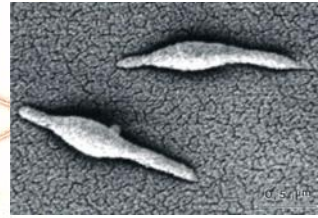
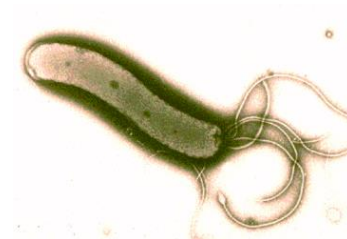
**Predation -**



**Food limitation -**



**Parasites and Diseases -**



# Decline hypotheses

Predation -

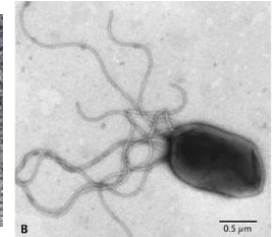
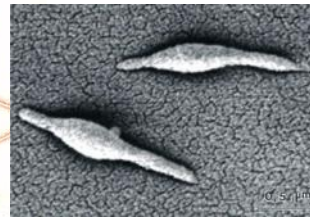
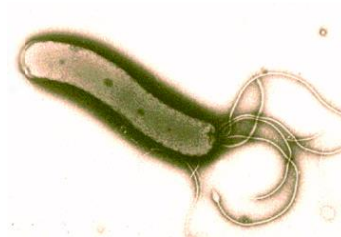


Food limitation -



Parasites and Diseases

- **Communities**
- **Bacteria**

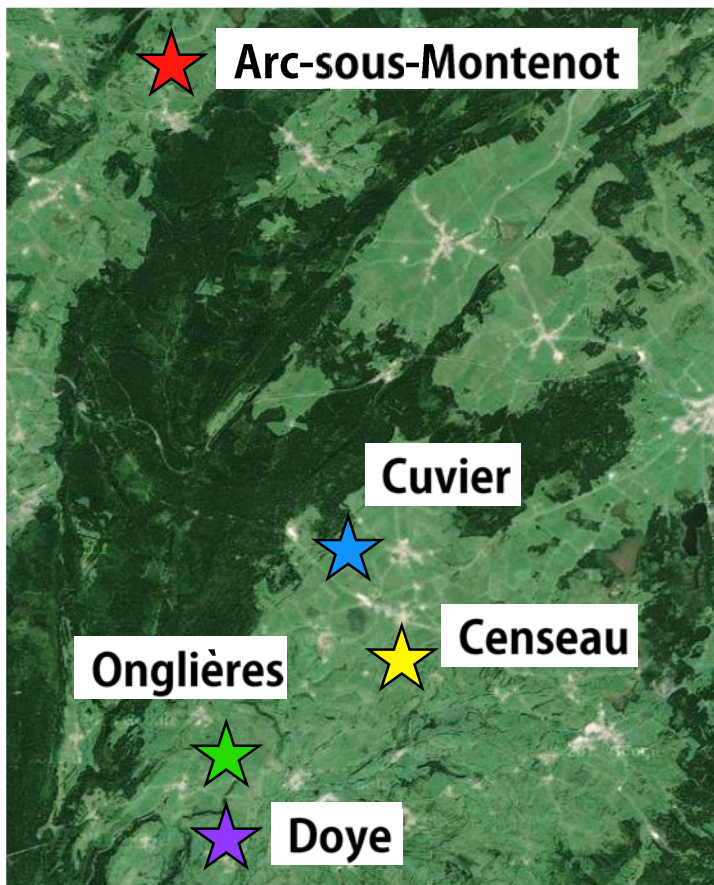




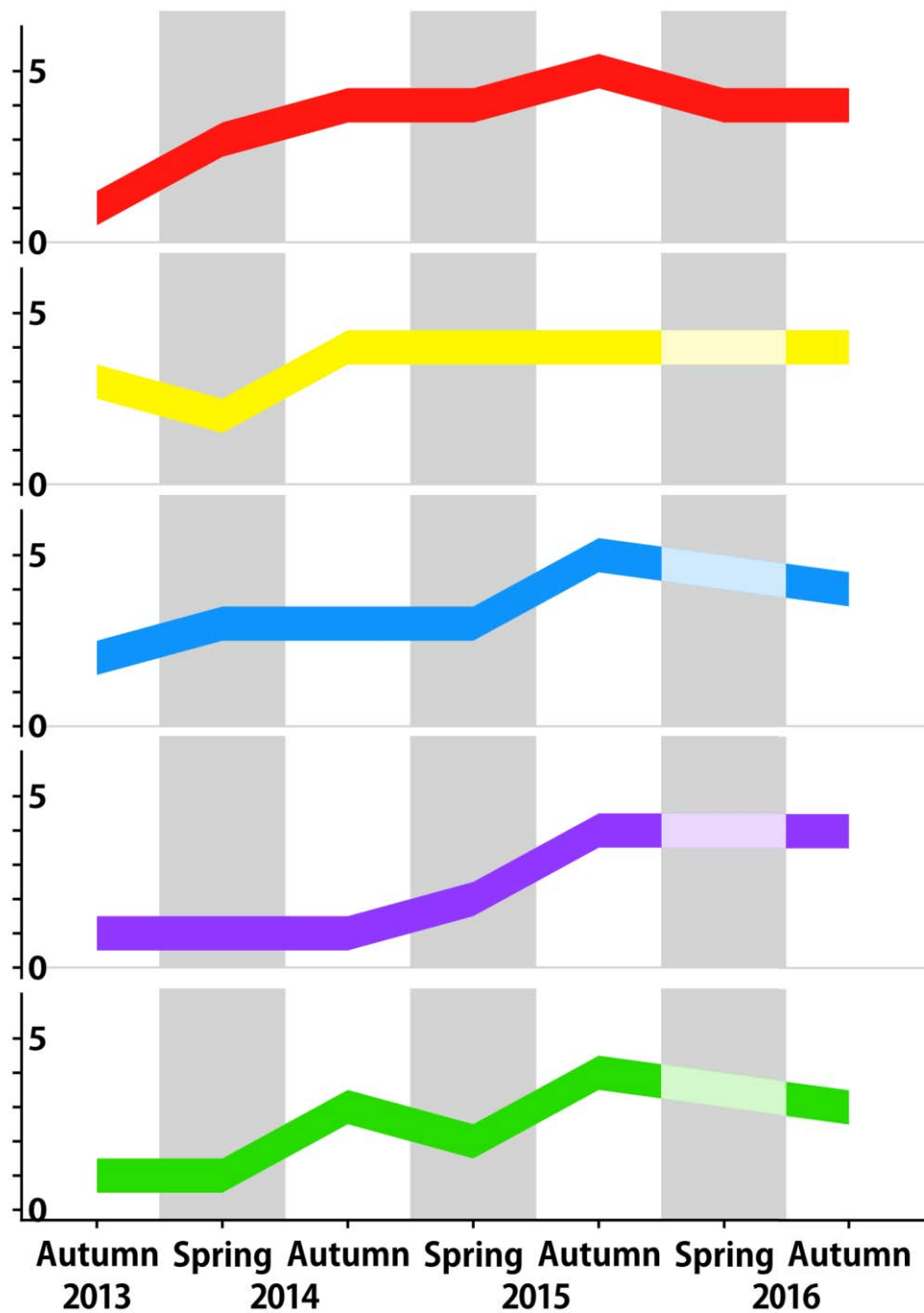
# Question

- **How do bacterial parasite communities vary spatially and temporally during the peak phase?**

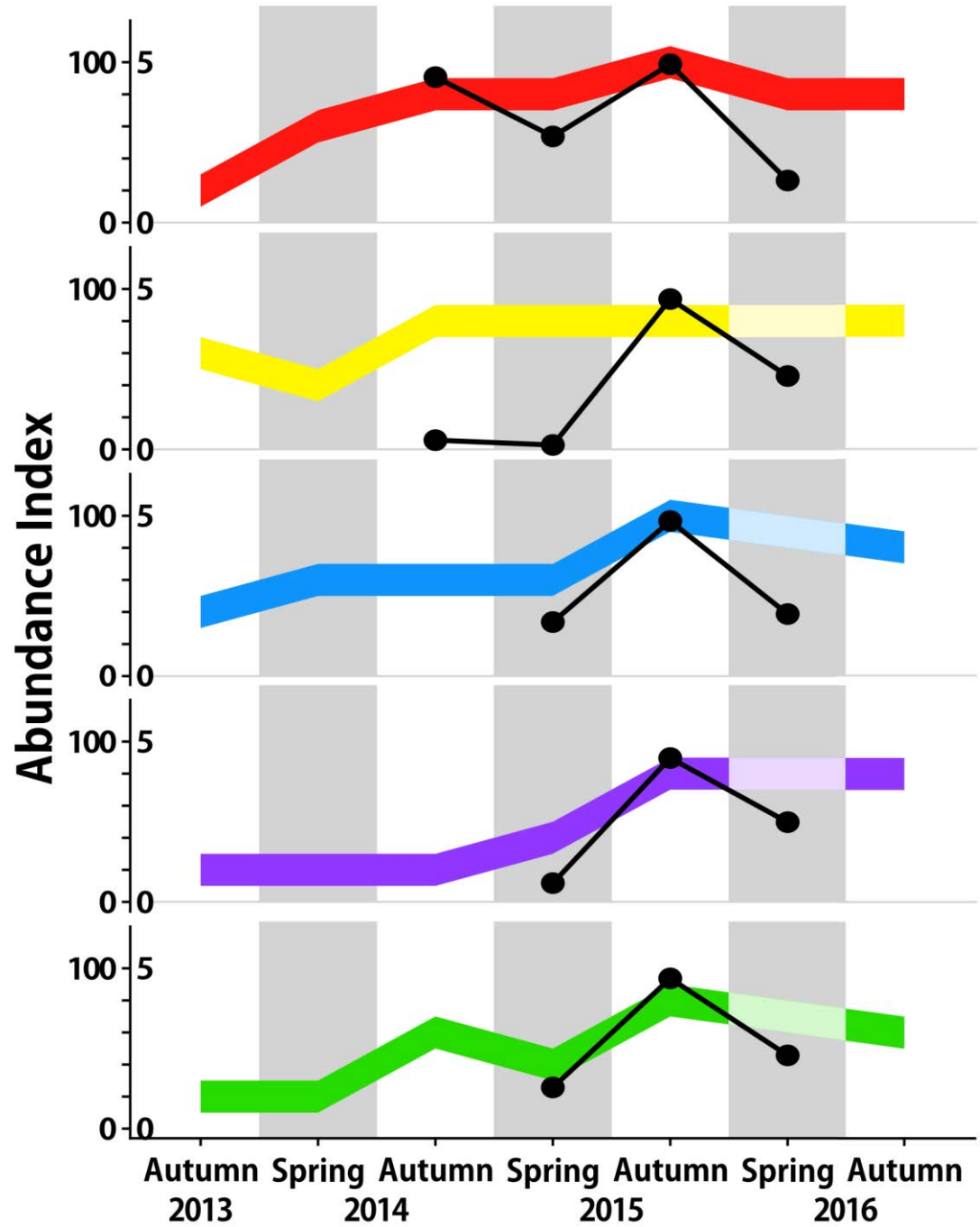
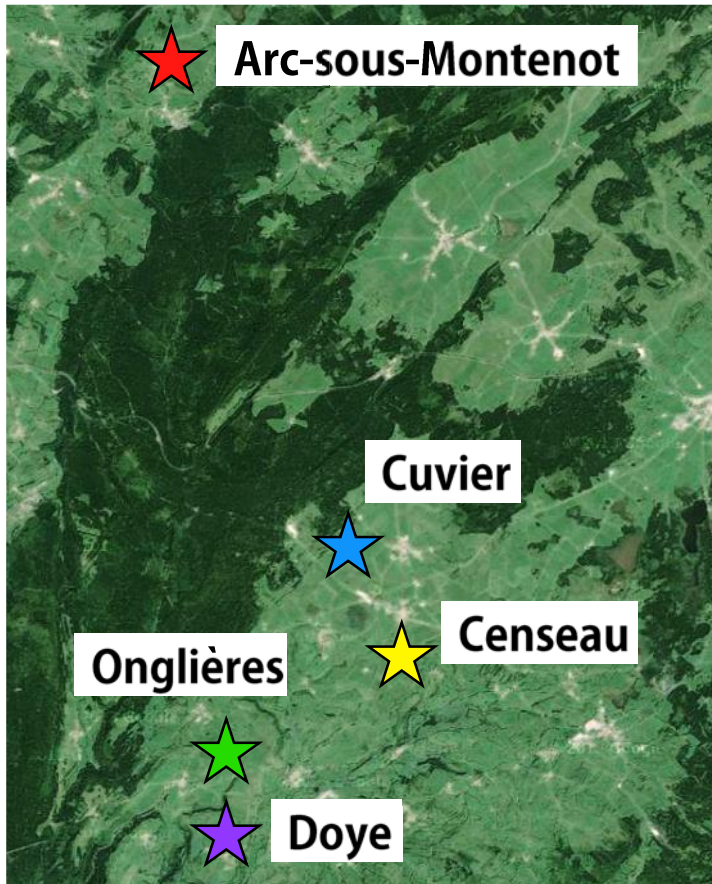
8 km



Abundance Index



8 km





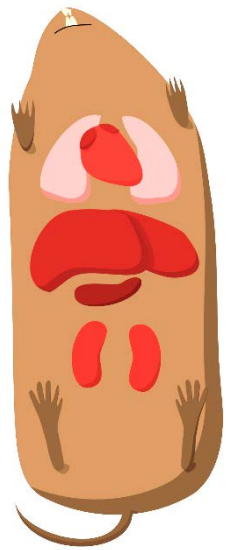




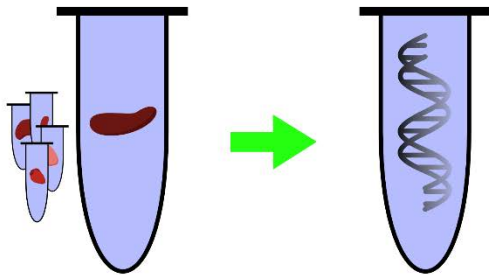




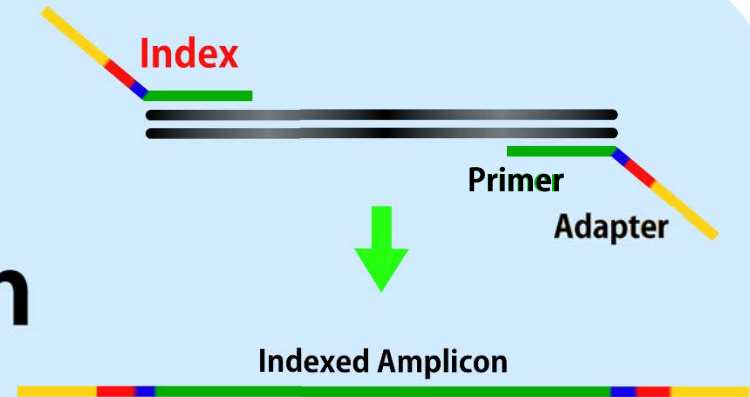




DNA extraction

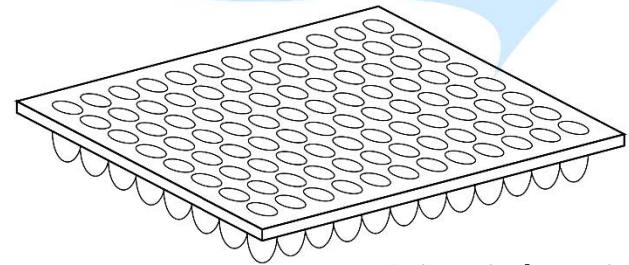
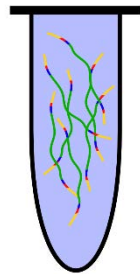


PCR amplification of V4 region of 16s rRNA gene

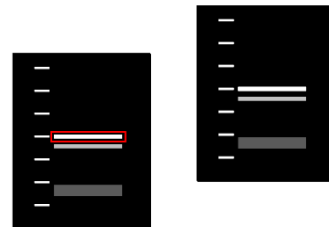


# Next Generation Sequencing

Pooled amplicons sent to sequencer

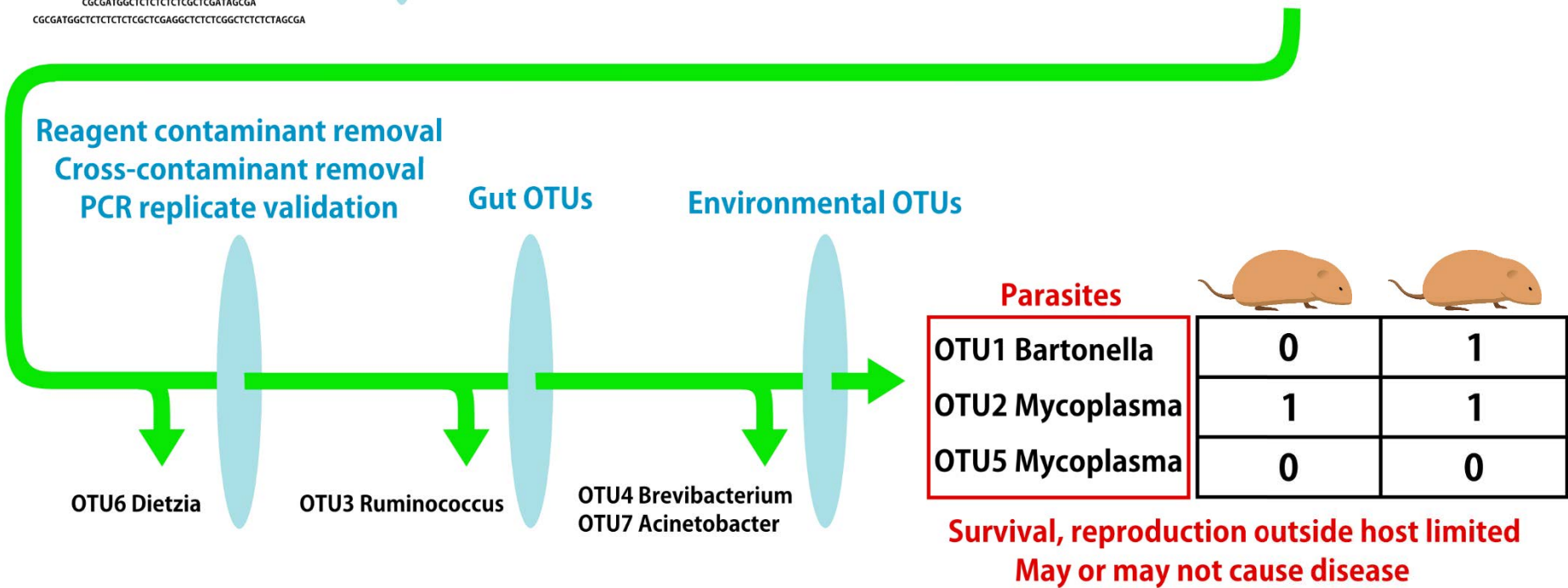
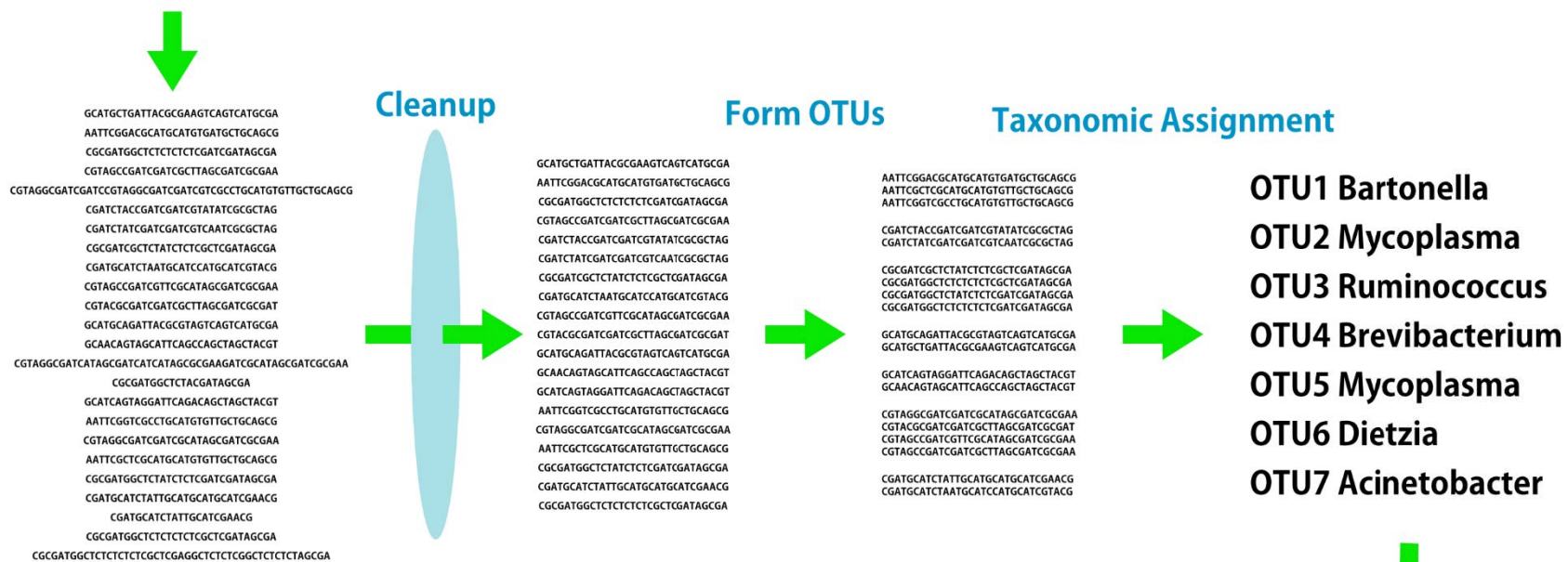


Unique index pairs in each well



Amplicons pooled, purified

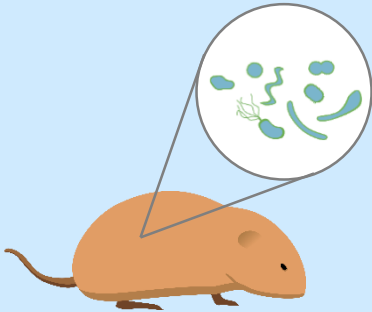




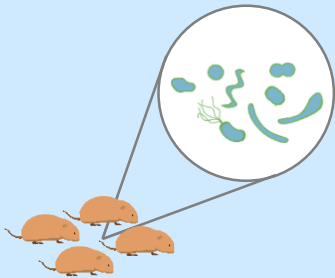
# Peak Phase: Bacterial Parasite Richness Bacterial Parasite Community Similarity

## Scales

### Infracommunity



### Component Community



## Intrinsic Factors

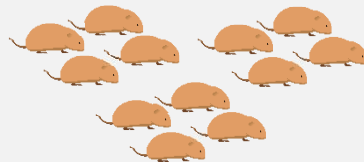
### Age Class



### Sex



### Abundance (Local, Commune)



## Extrinsic Factors

### Location



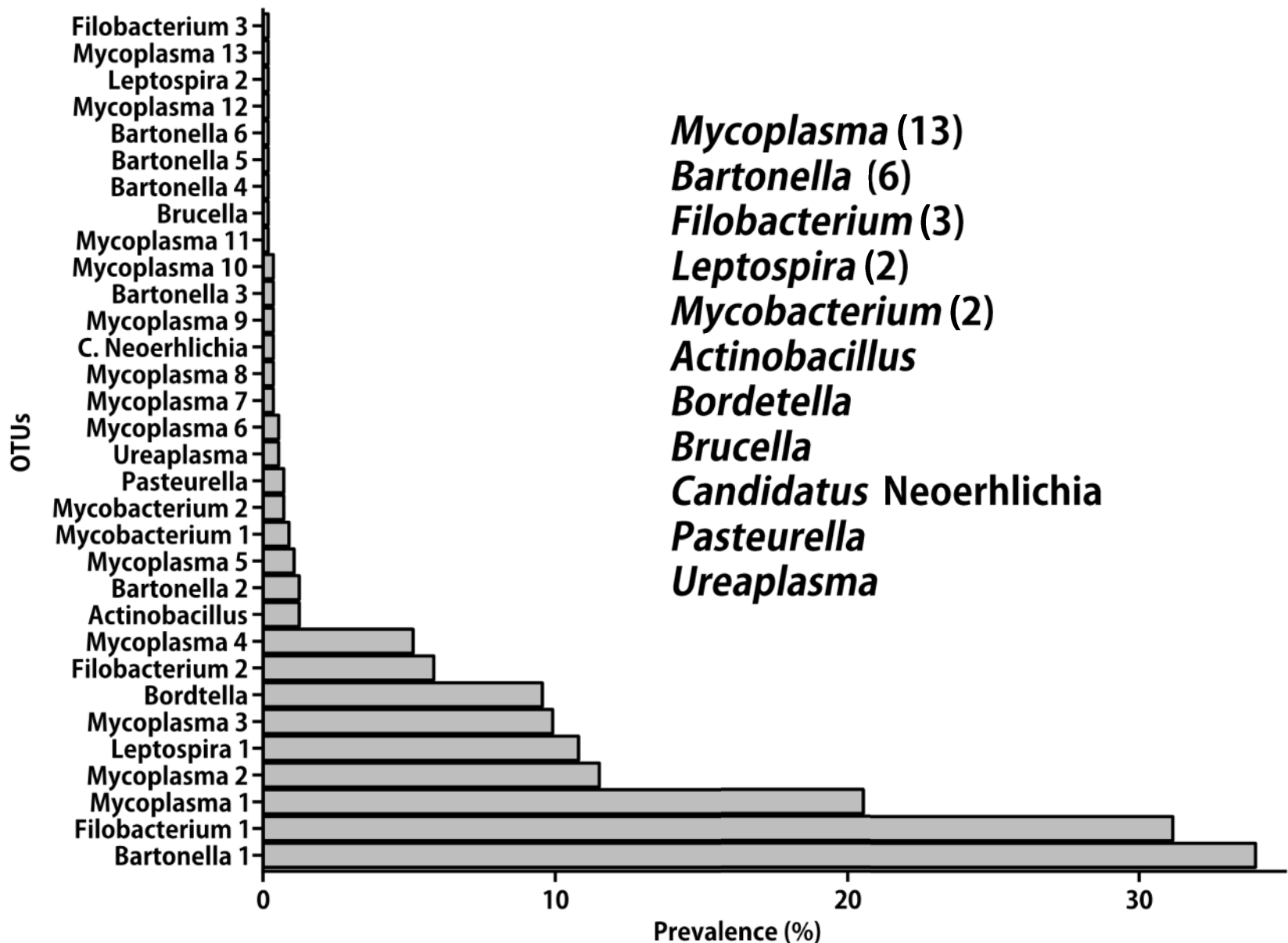
### Date (Season, Year)



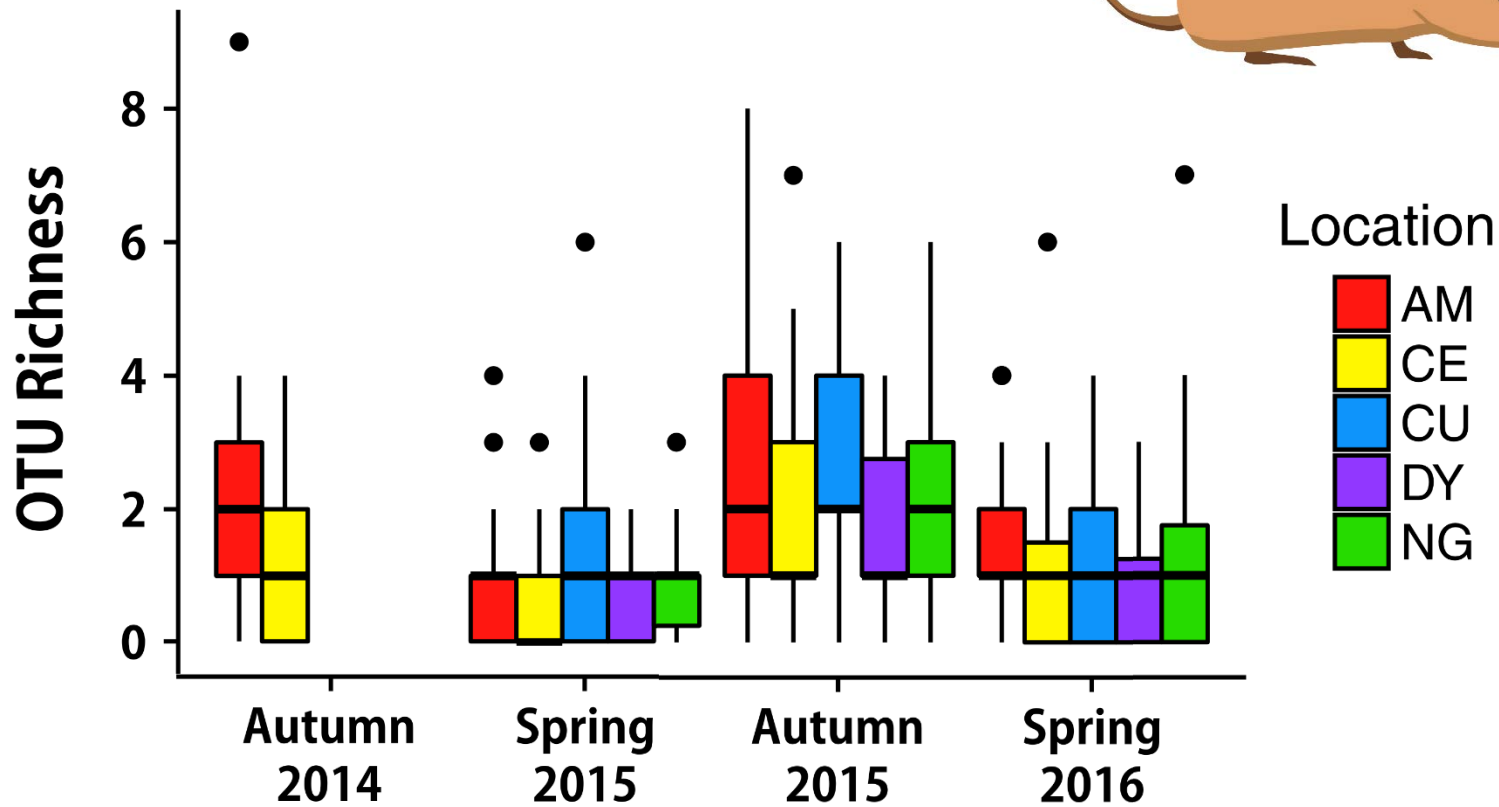
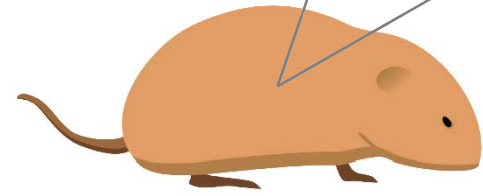
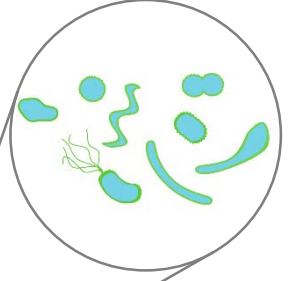
2014 2015 2016



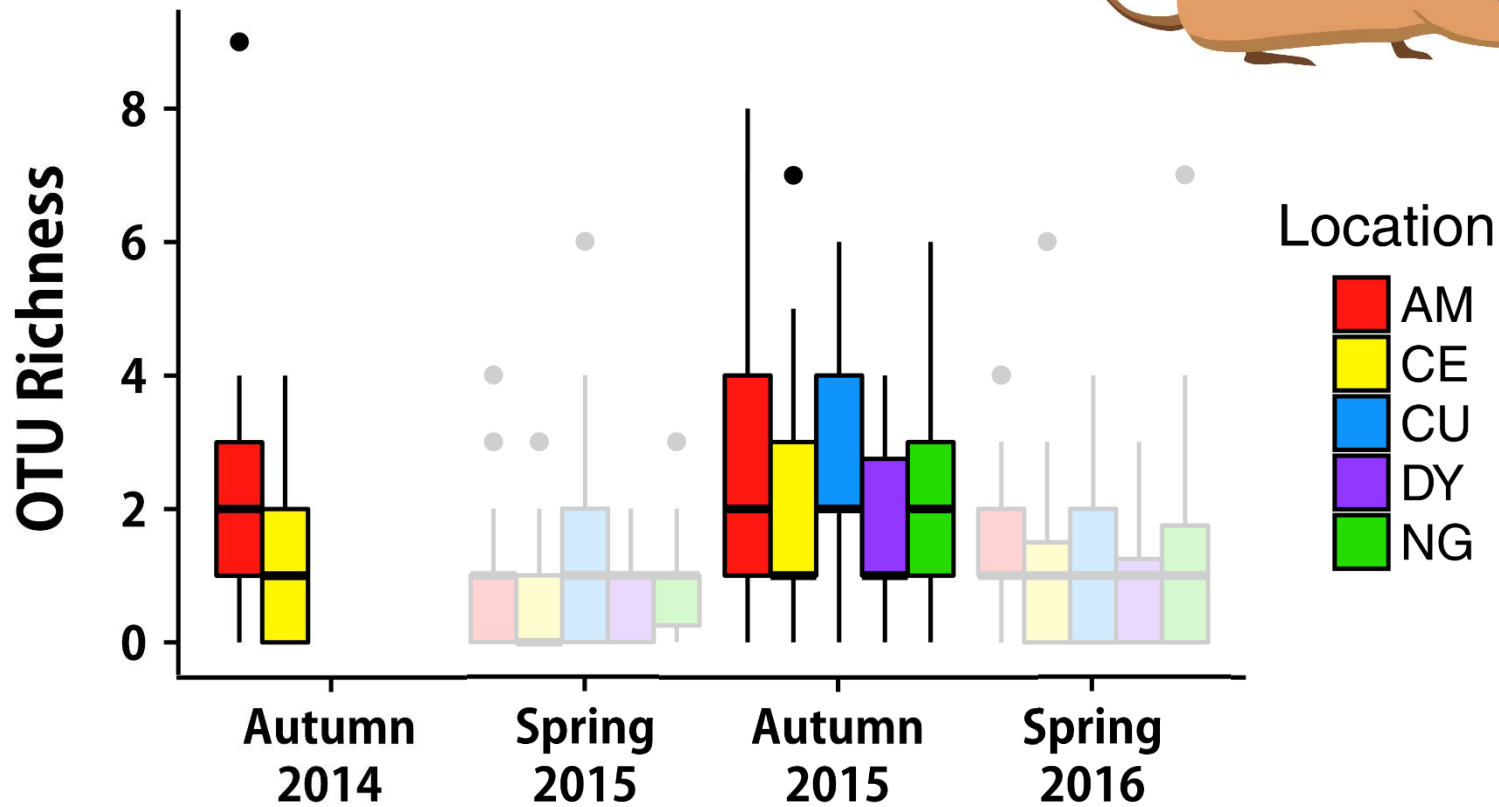
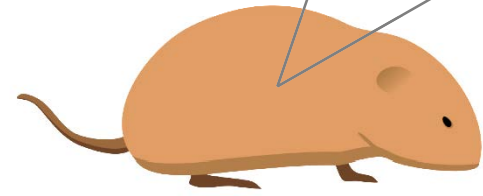
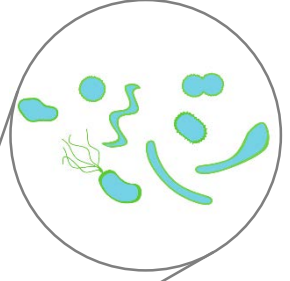
# Bacteria



# Infracommunity richness



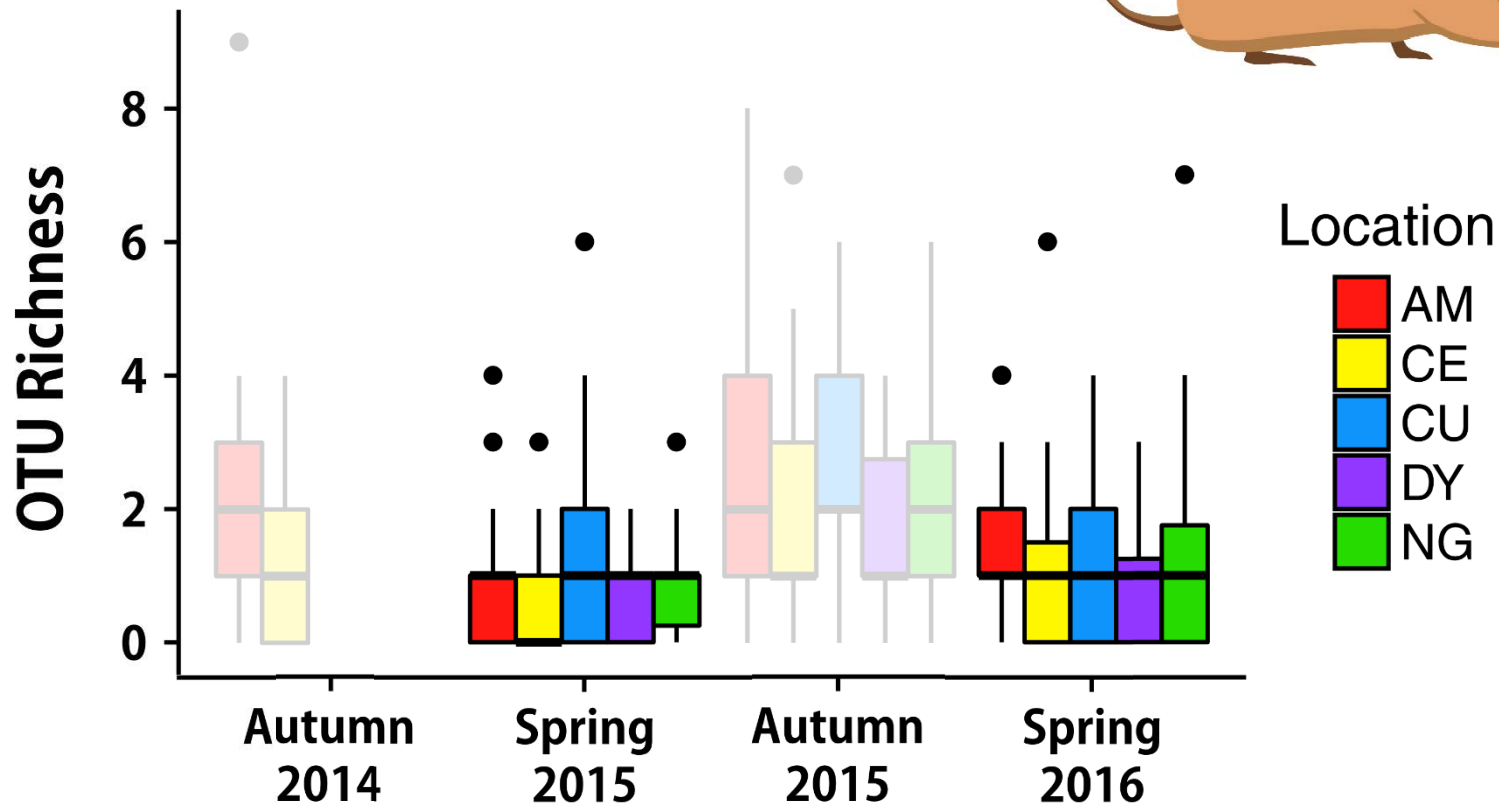
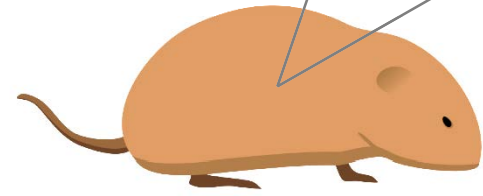
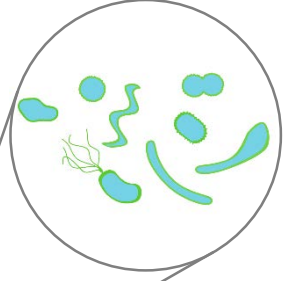
# Infracommunity richness



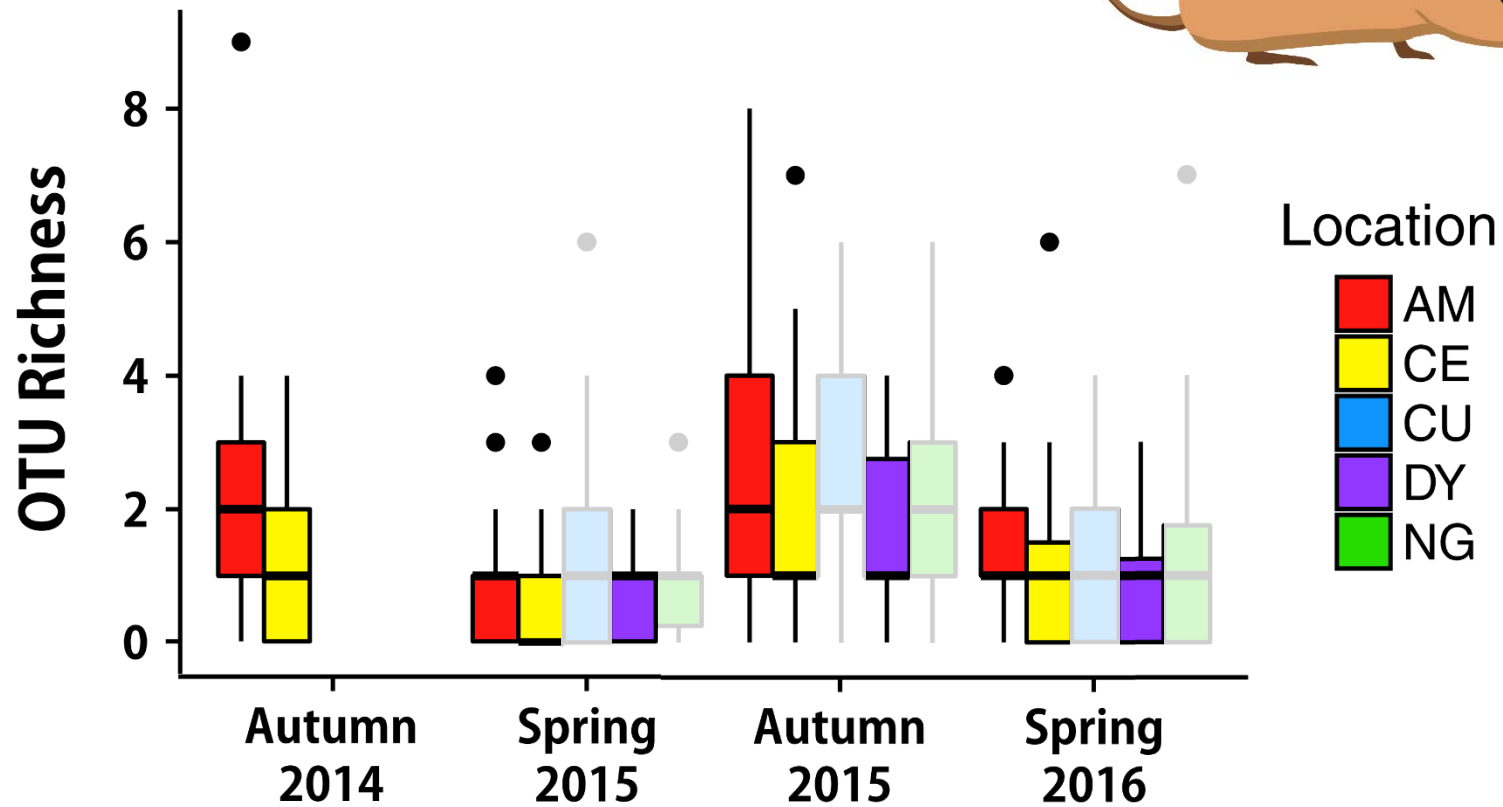
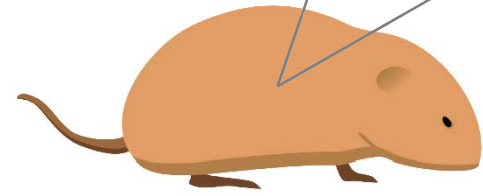
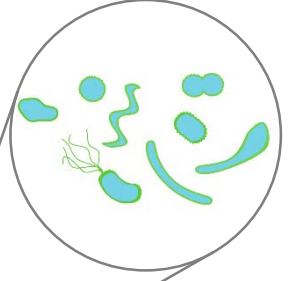
Zero-inflated Poisson Regression, AIC model selection



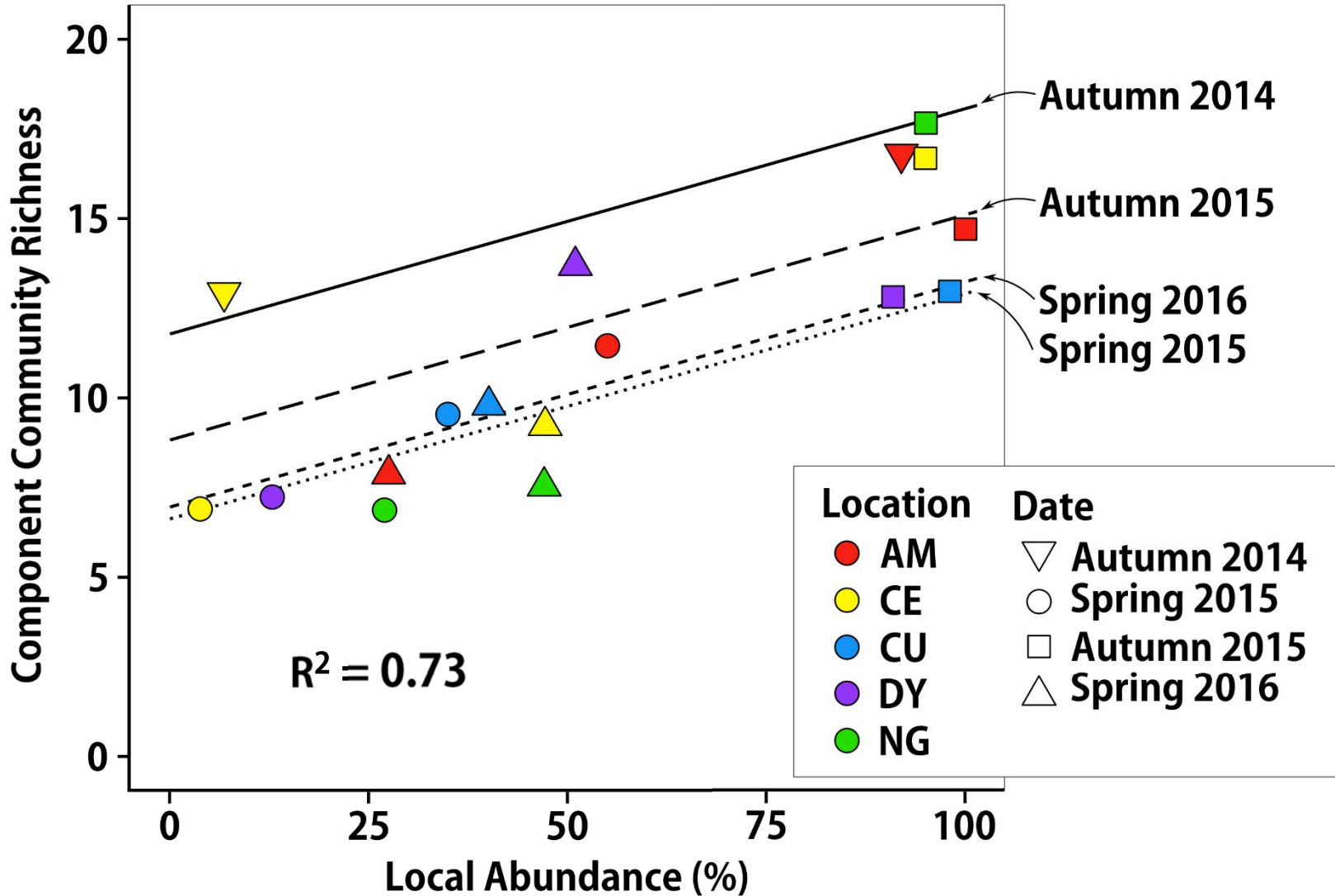
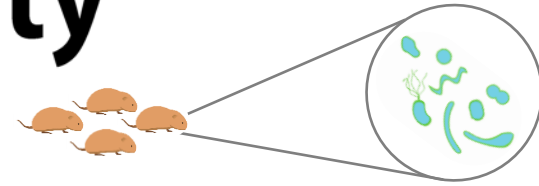
# Infracommunity richness



# Infracommunity richness



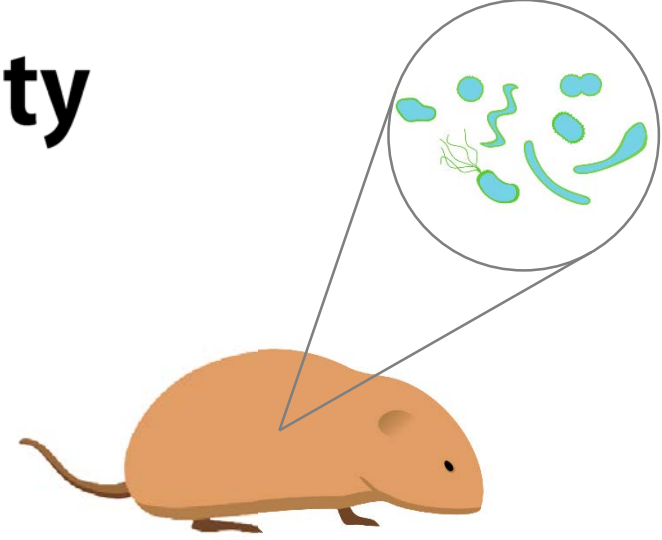
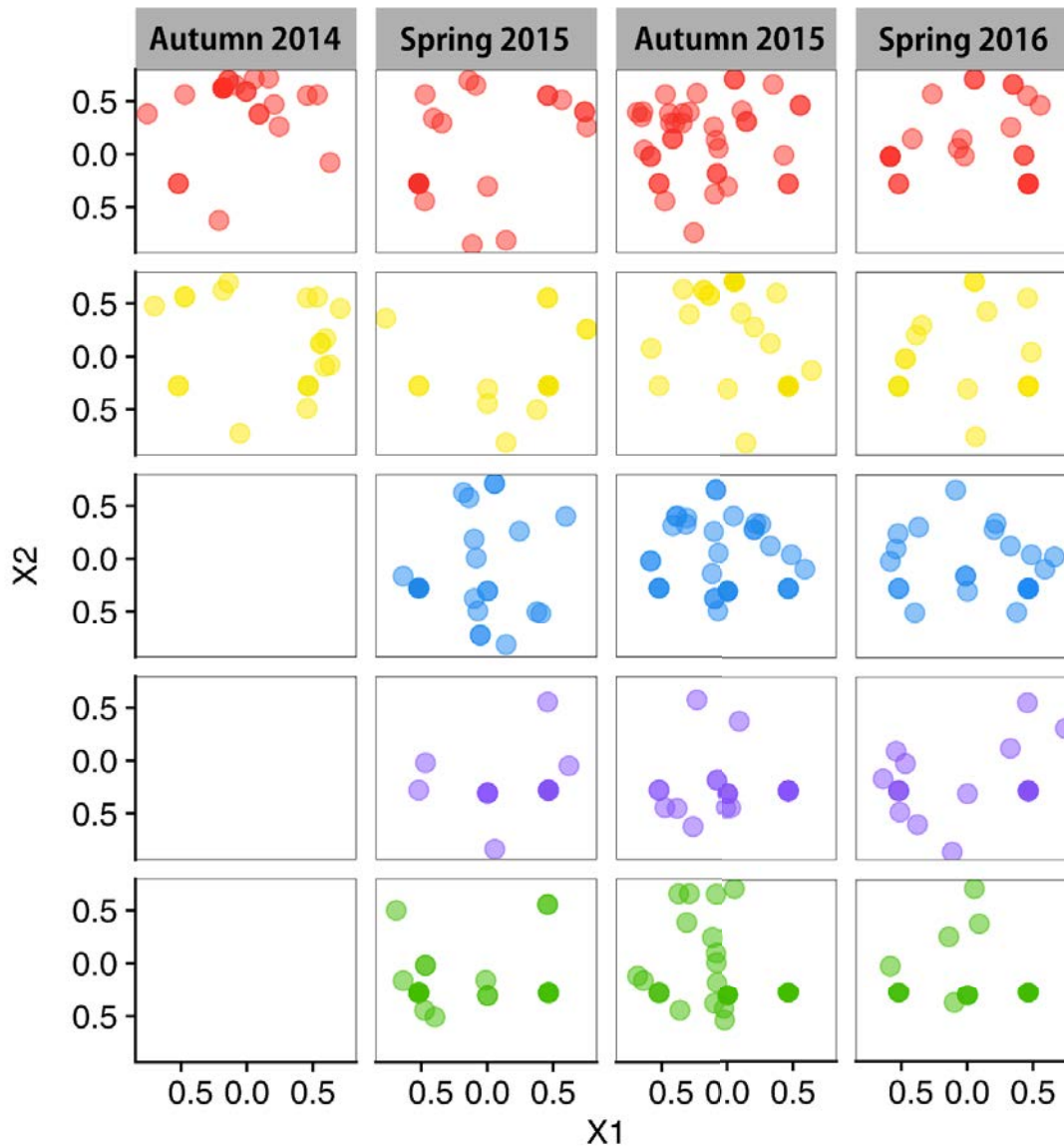
# Component Community richness



GLM, AIC model selection



# Infracommunity Similarity



**Location**

- AM
- CE
- CU
- DY
- NG

**PERMANOVA**

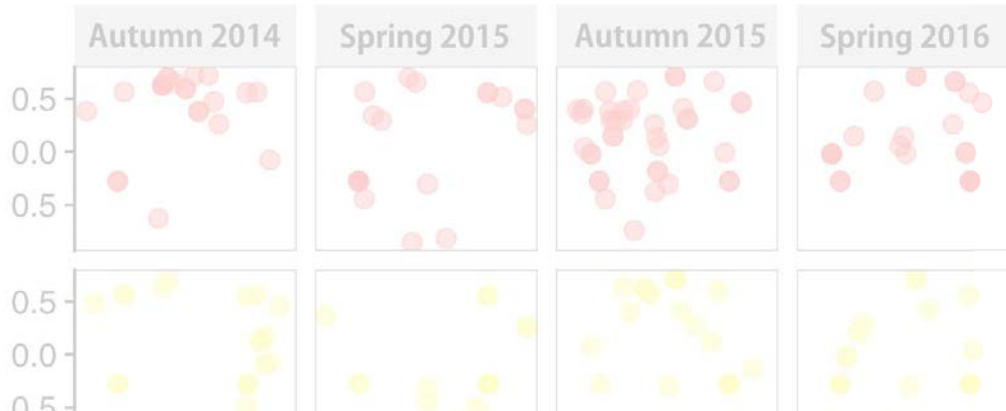
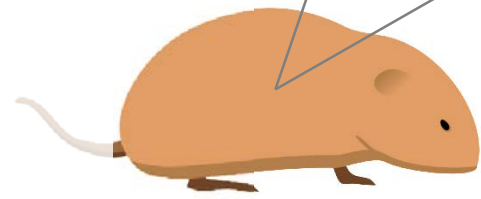
**Location - 3%**

**Date - 3%**

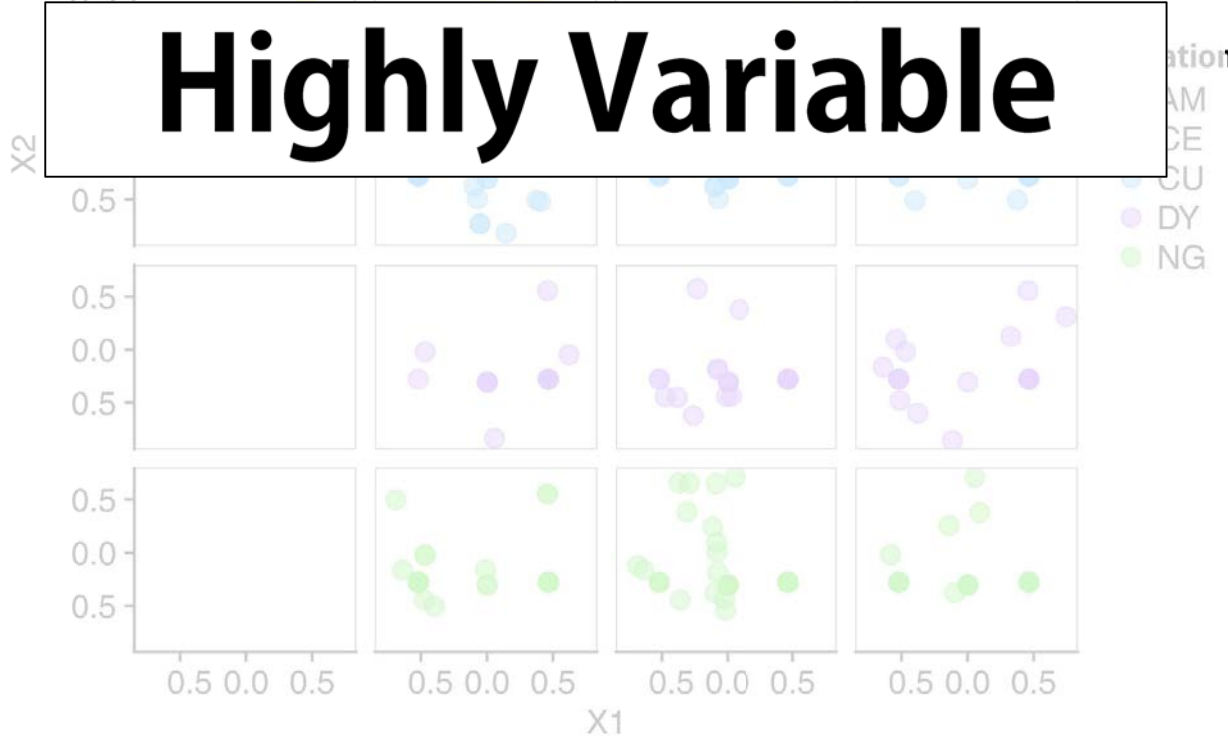
**Local abundance - 2%**

**Sex - 1%**

# Infracommunity Similarity



**Highly Variable**



**PERMANOVA**

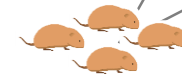
**Location - 3%**

**Date - 3%**

**Local abundance - 2%**

**Sex - 1%**

# Component Community Similarity



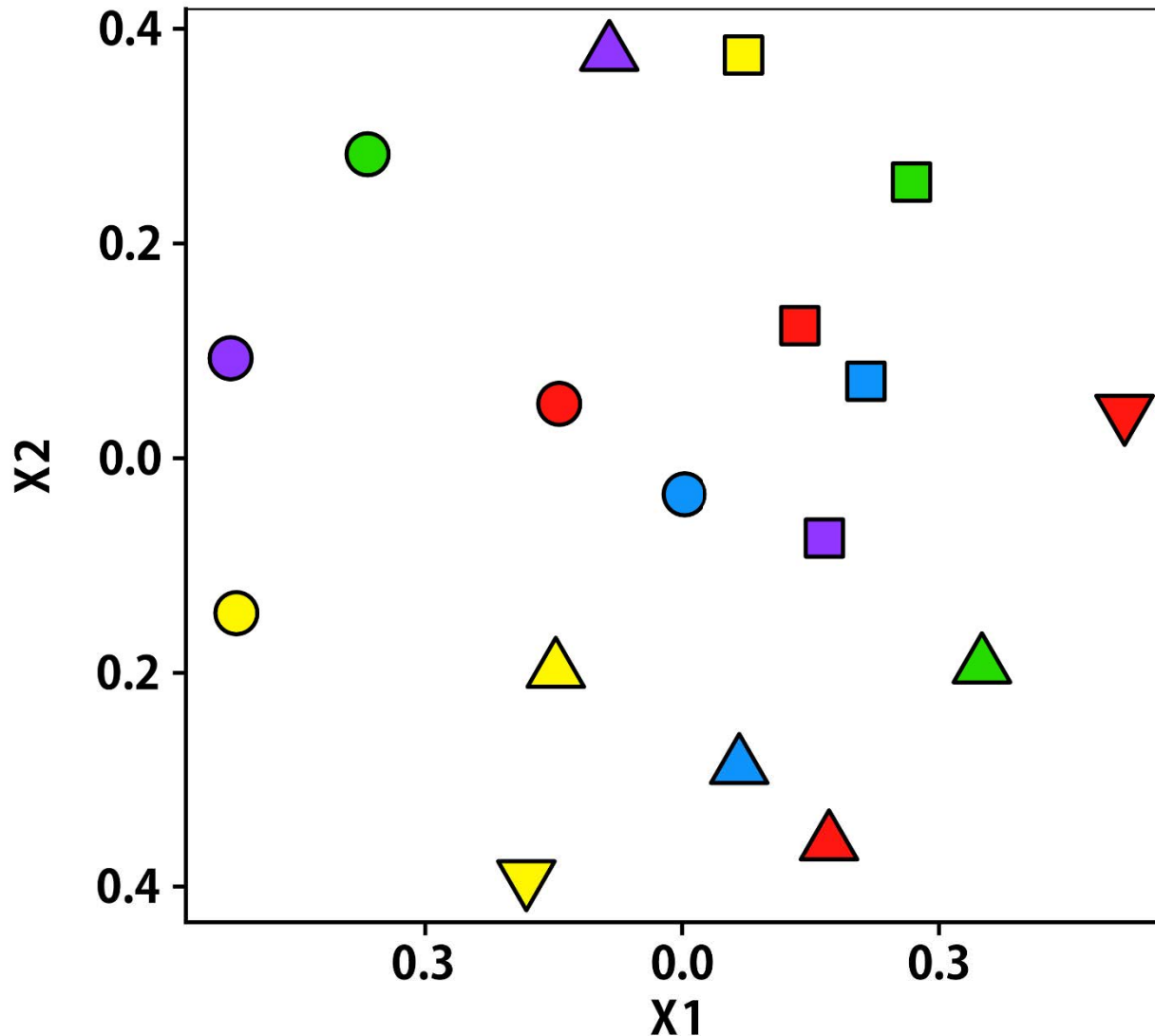
## Date

- ▽ Autumn 2014
- Spring 2015
- Autumn 2015
- △ Spring 2016

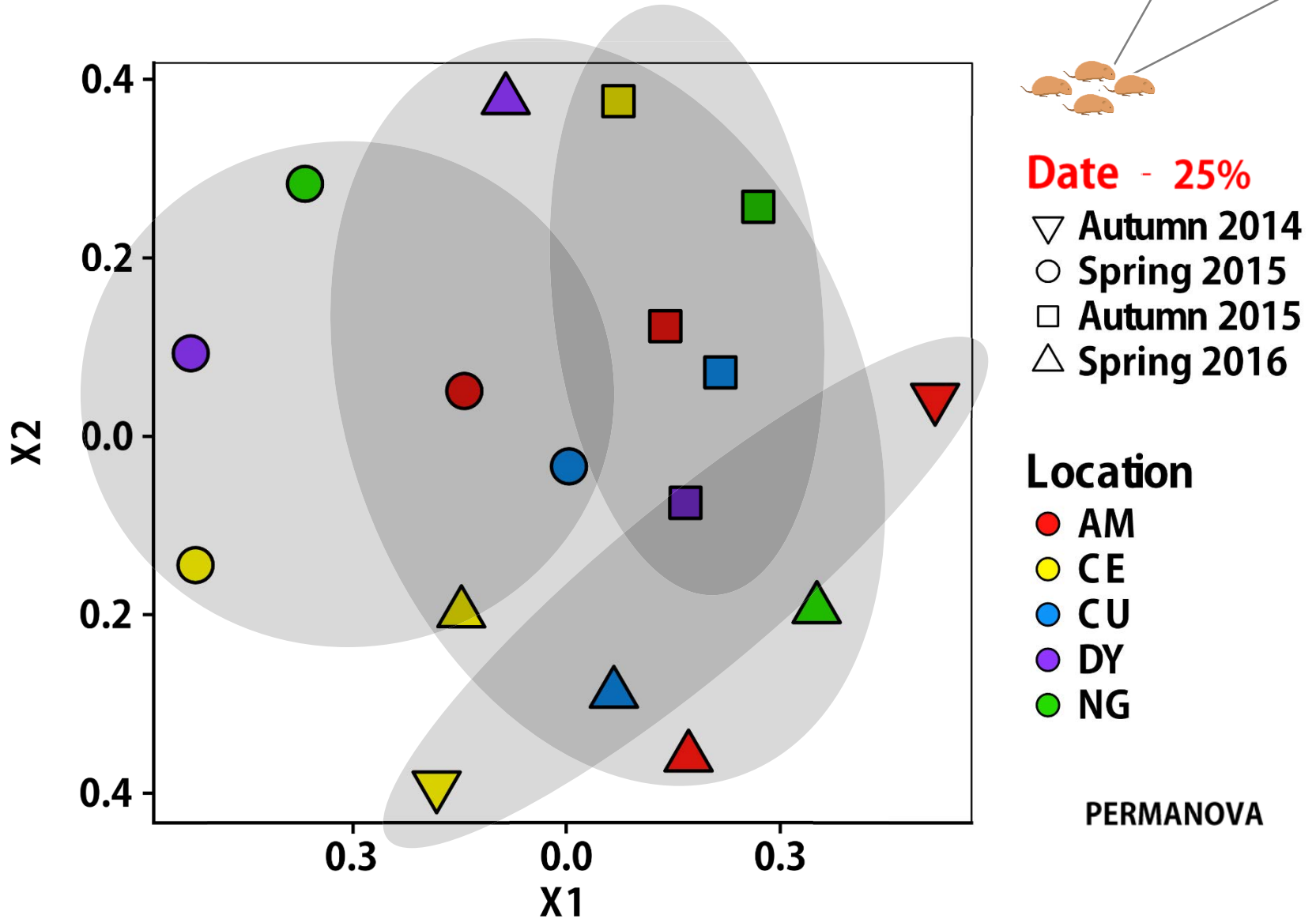
## Location

- AM
- CE
- CU
- DY
- NG

PERMANOVA



# Component Community Similarity





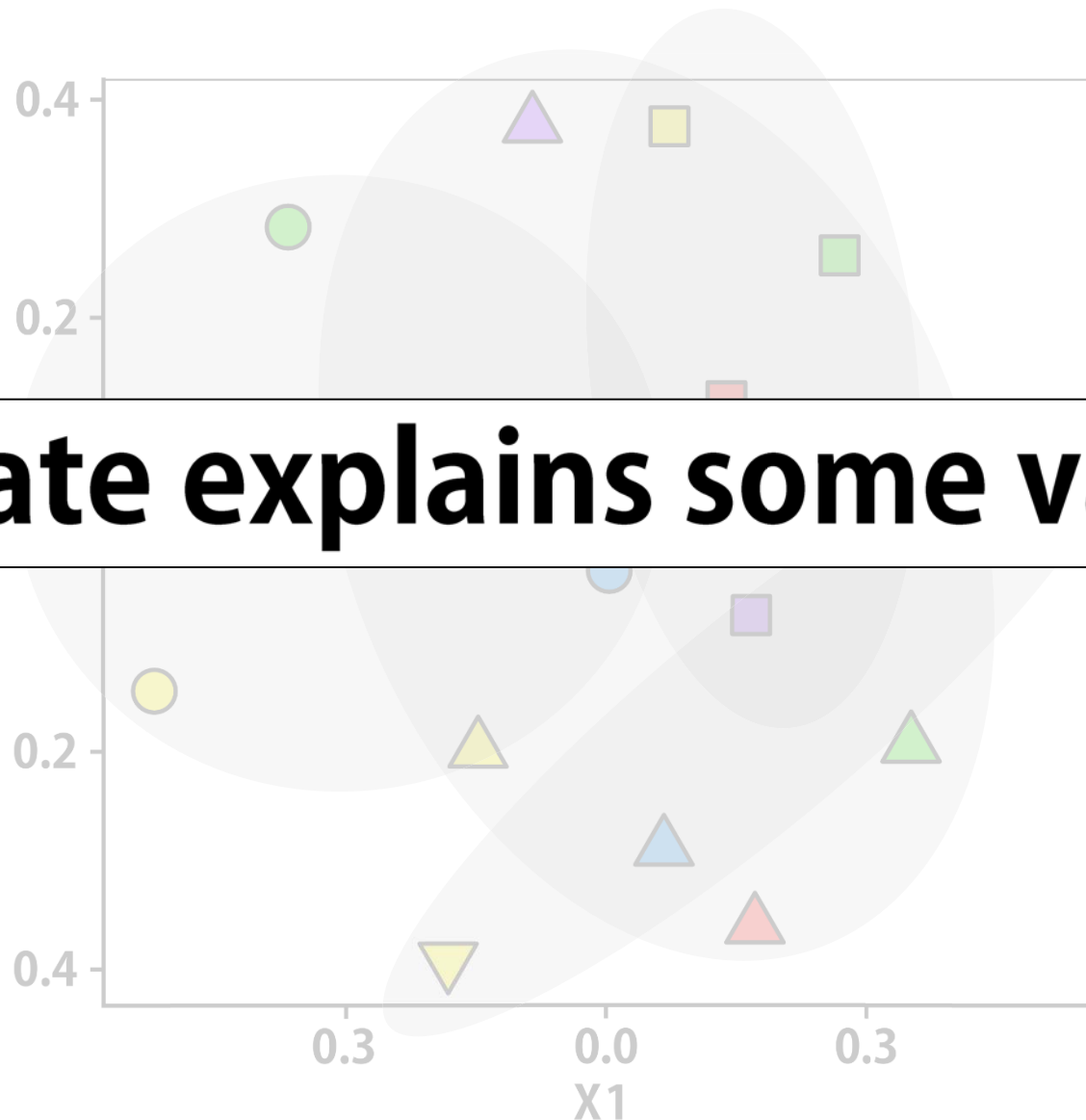
# Component Community Similarity



**Date - 25%**

- ▽ Autumn 2014
- Spring 2015
- Autumn 2015

**Date explains some variation**

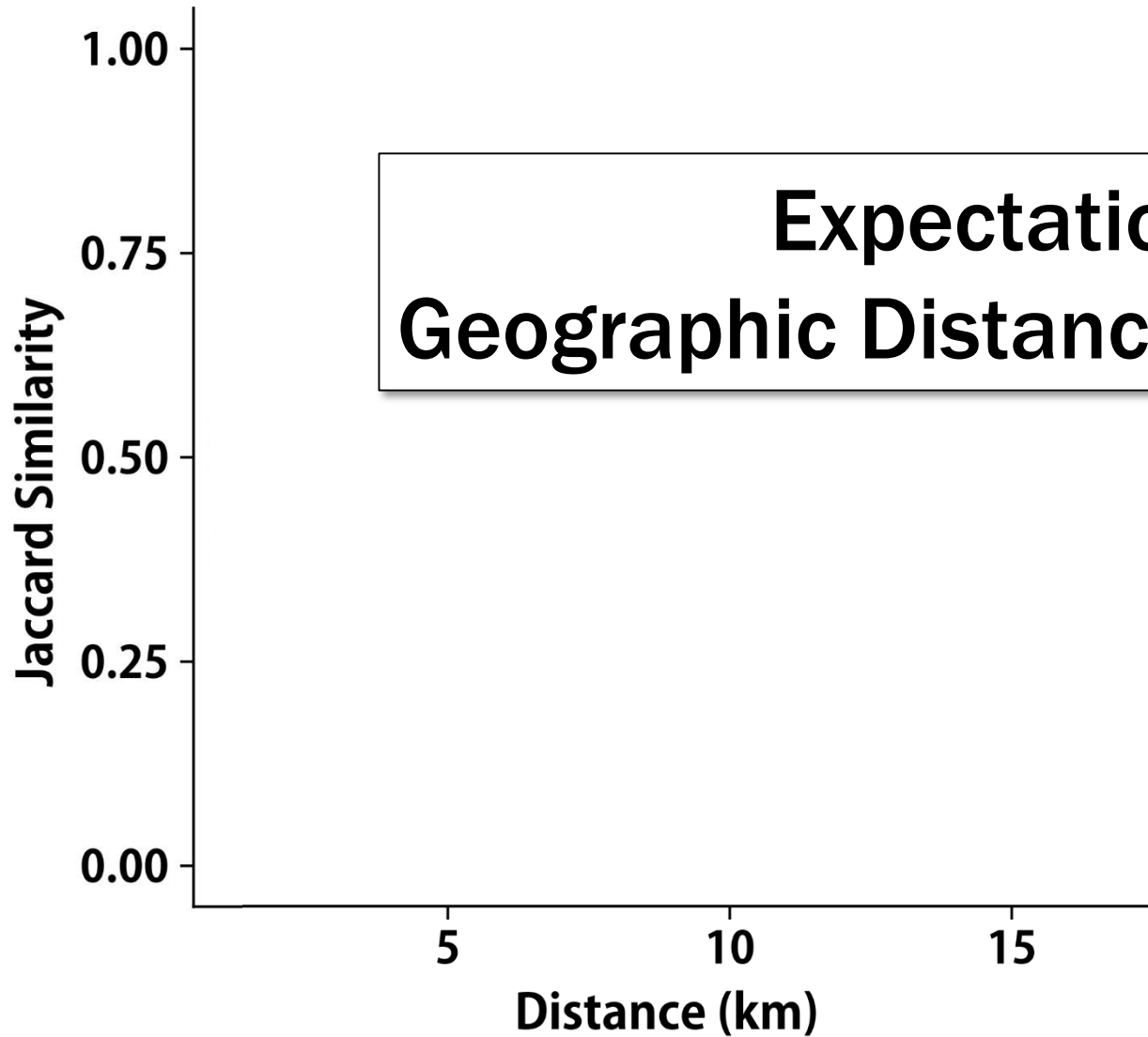
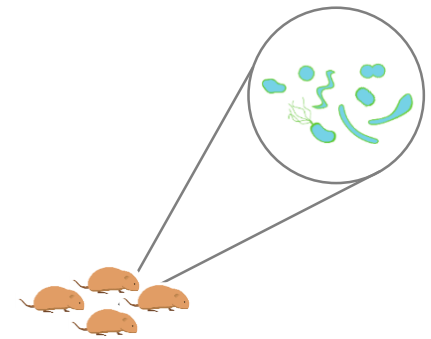


**Location**

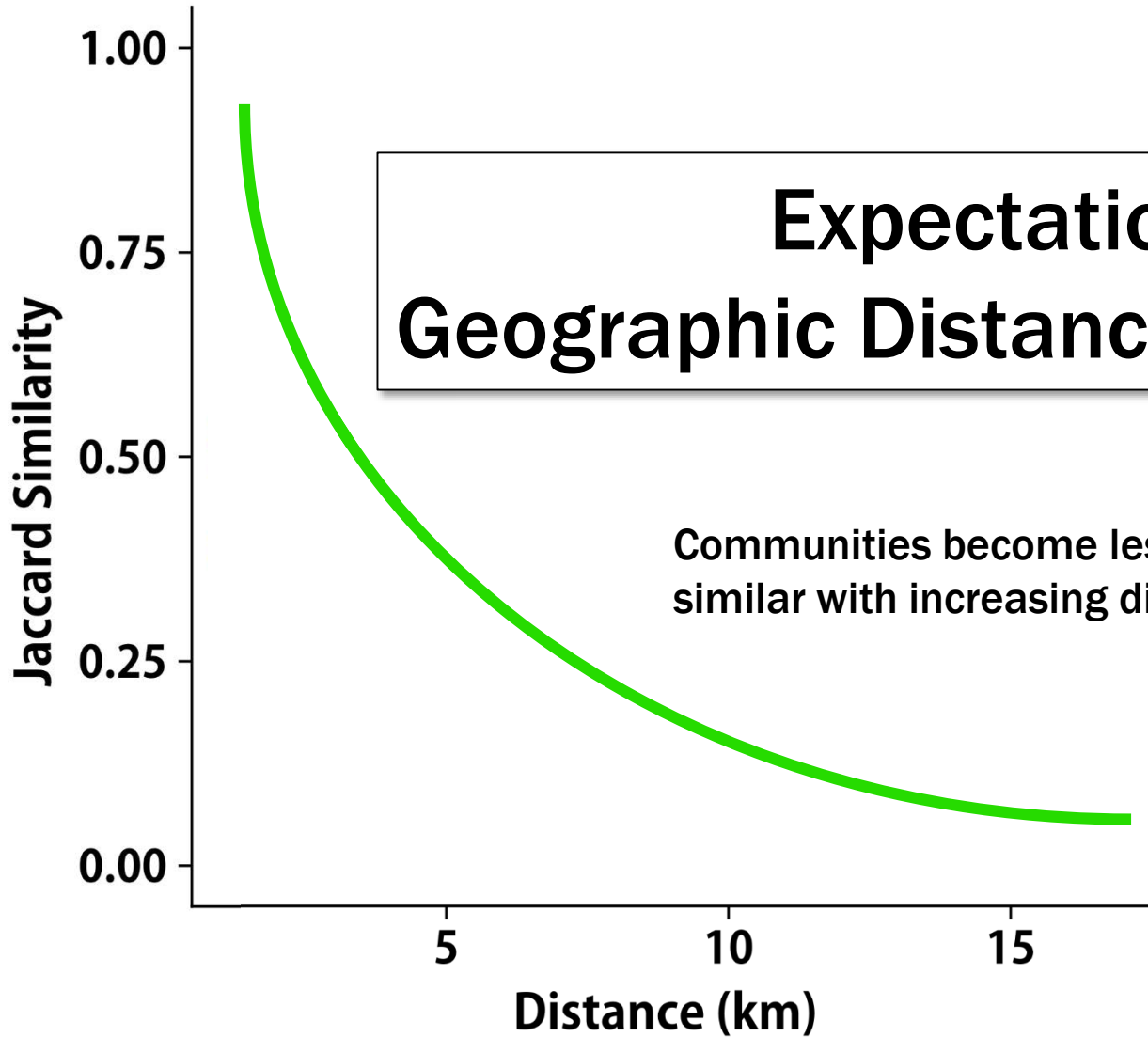
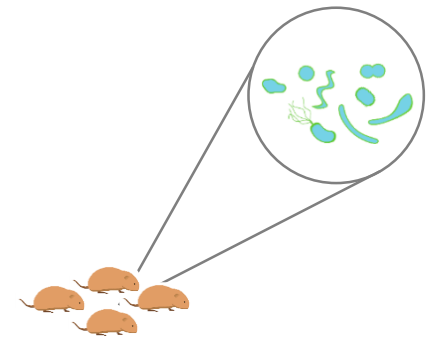
- AM
- CE
- CU
- DY
- NG

PERMANOVA

# Geographic Distance



# Geographic Distance

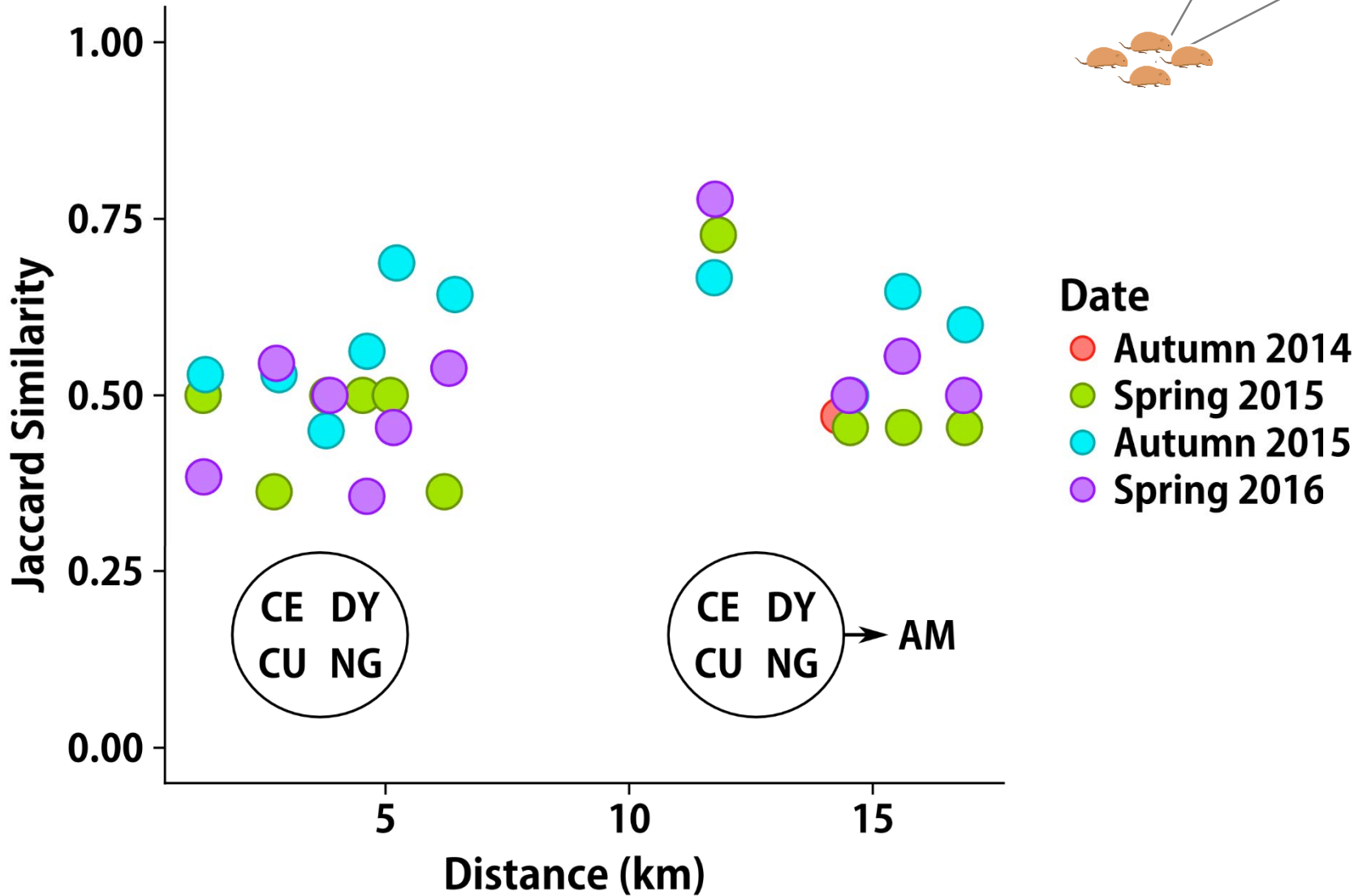
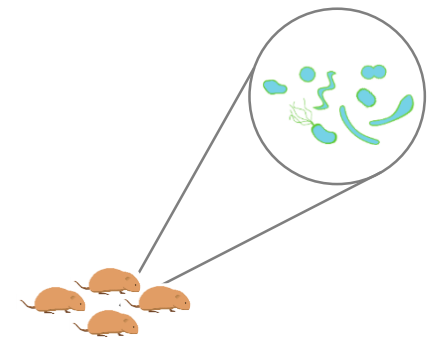


**Expectation:**  
**Geographic Distance = Isolation**

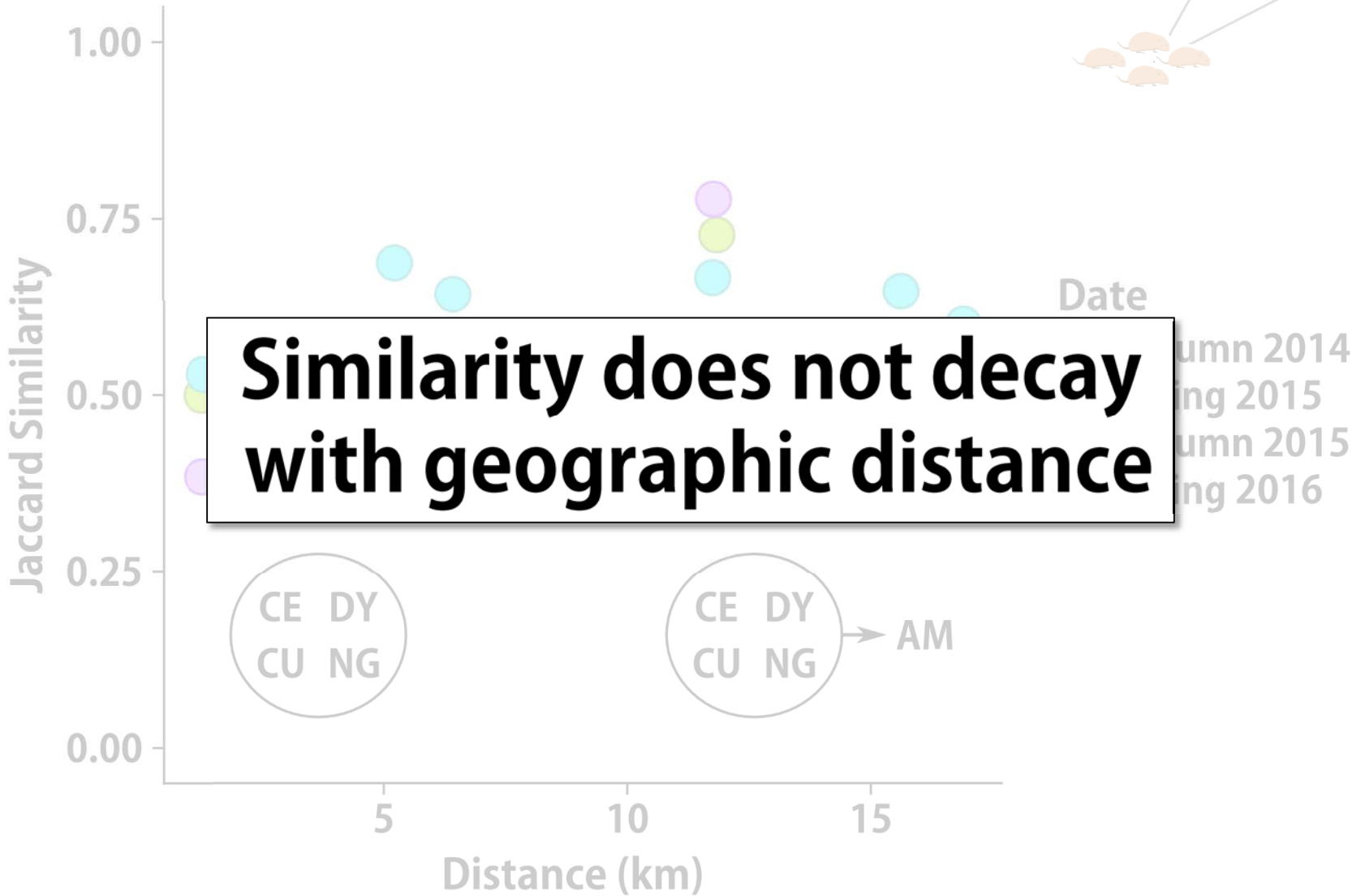
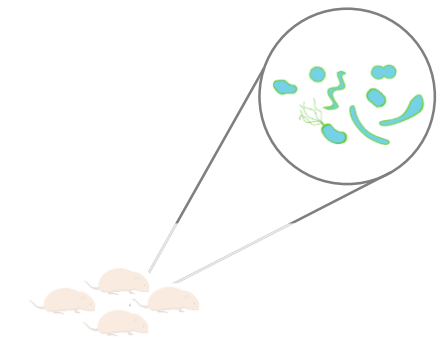
Communities become less similar with increasing distance



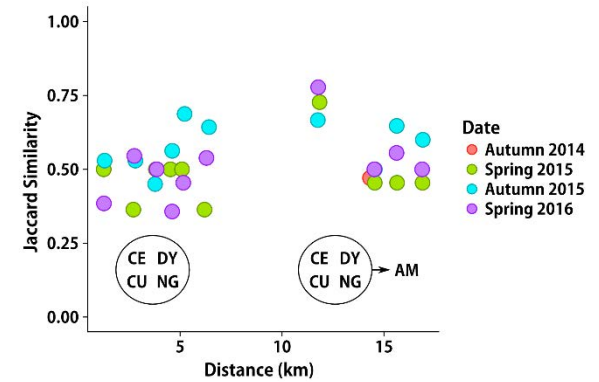
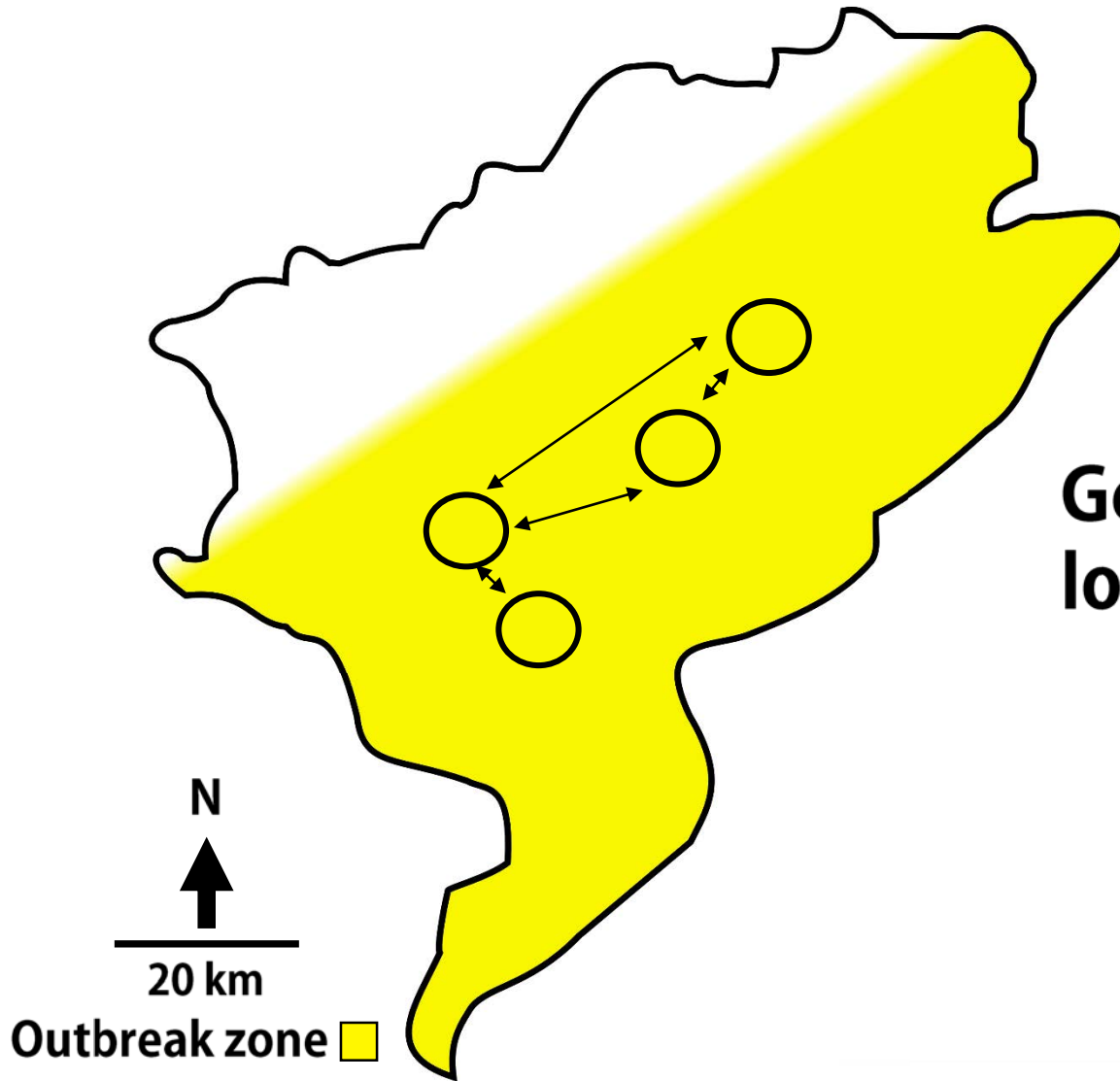
# Geographic Distance



# Geographic Distance



# Geographic Distance

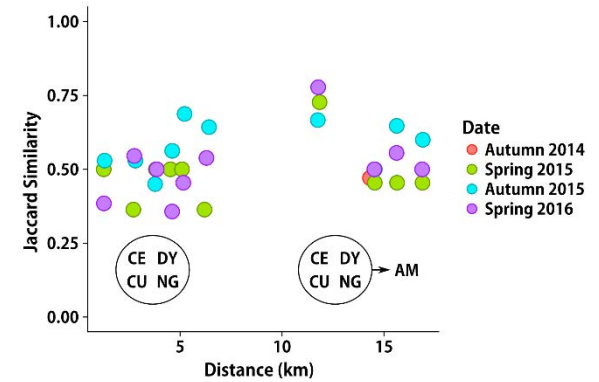
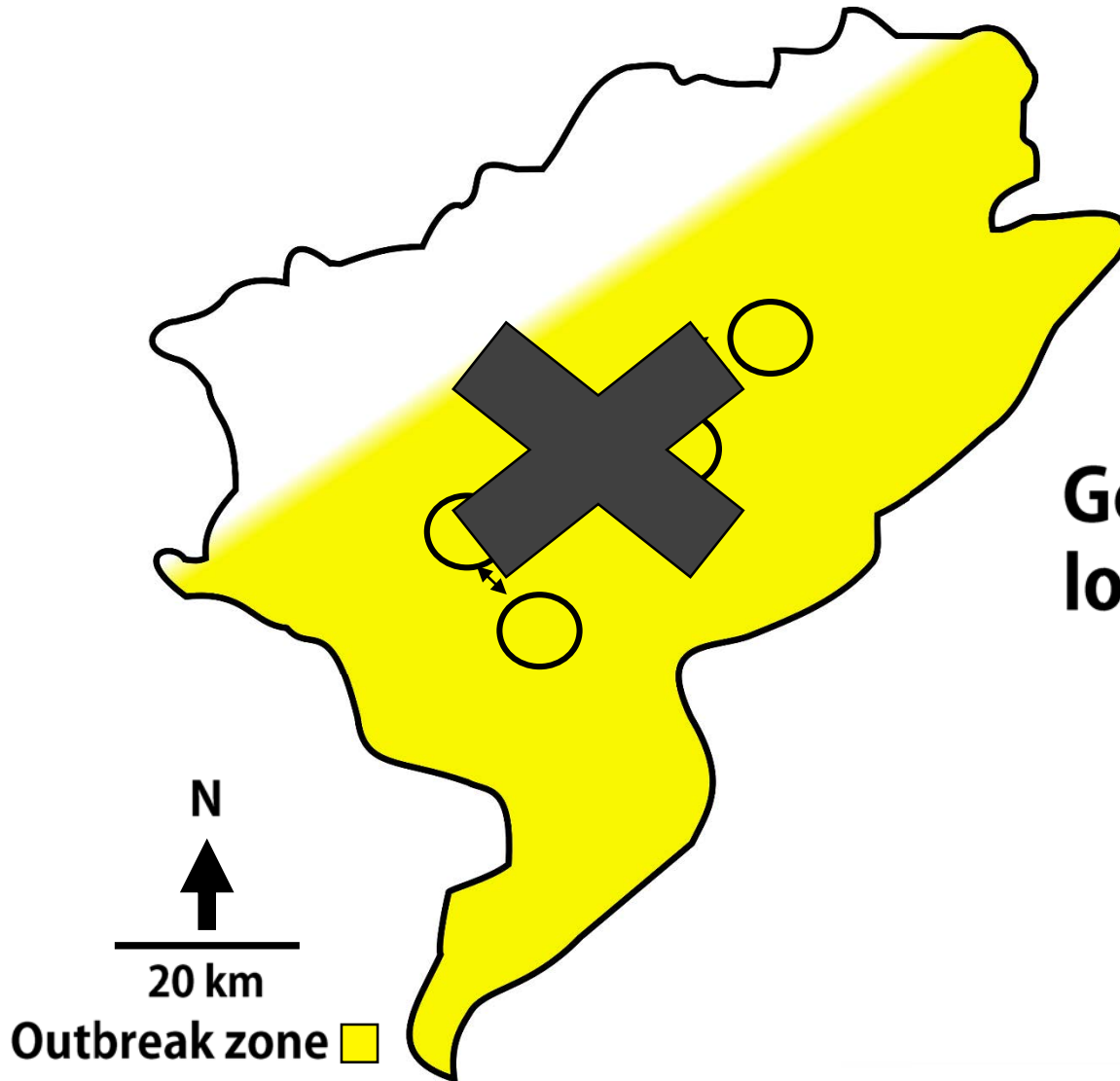


**Gene flow low at low density**

(Berthier et al 2005, 2006)



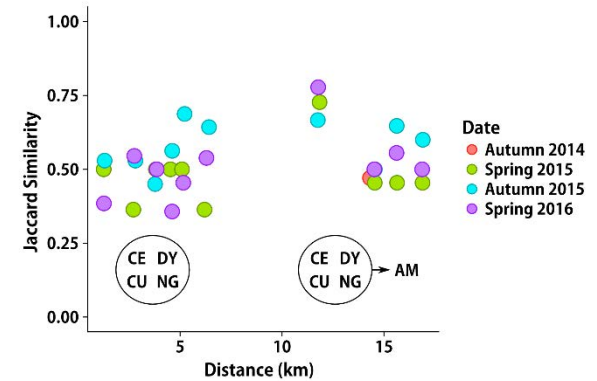
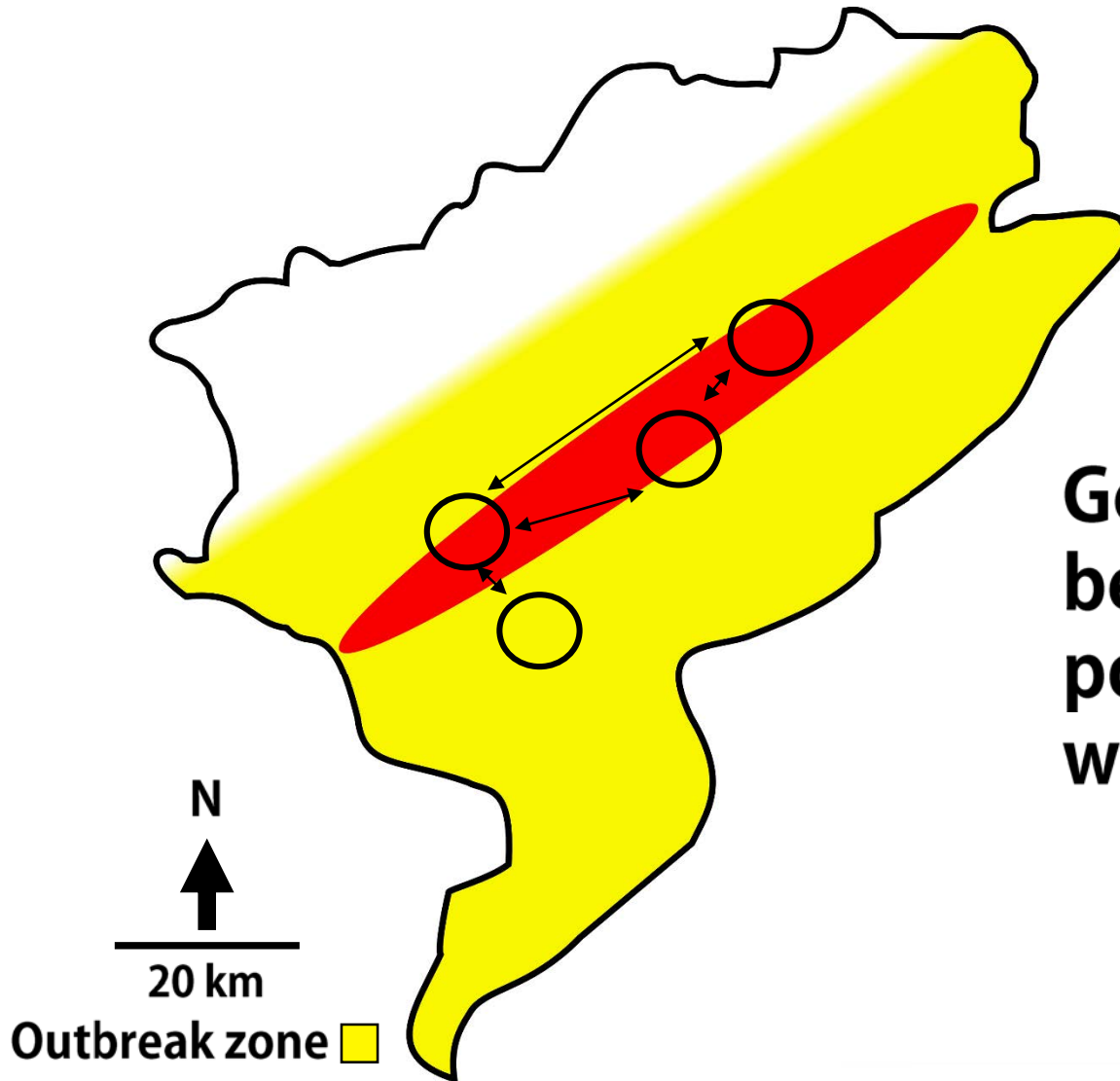
# Geographic Distance



**Gene flow low at low density**

(Berthier et al 2005, 2006)

# Geographic Distance



**Gene flow high between peak populations, decays with distance**

(Berthier et al 2005, 2006)

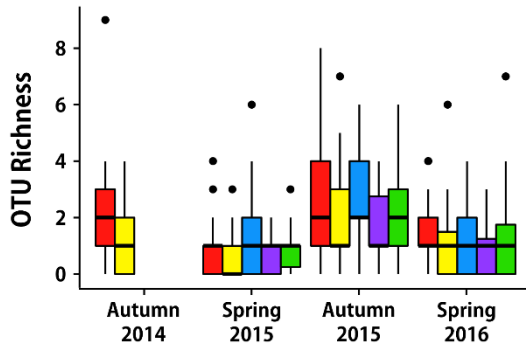
# Summary

## Richness

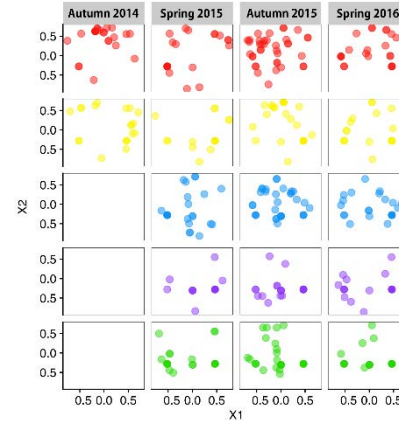
## Community Similarity



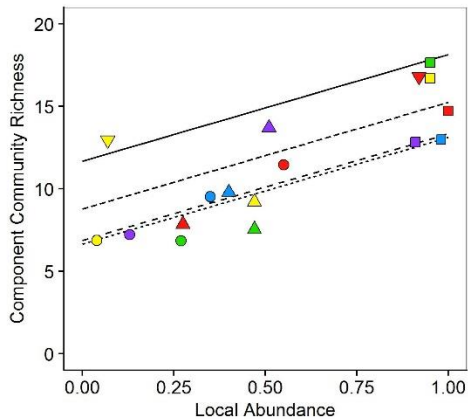
Location, Date



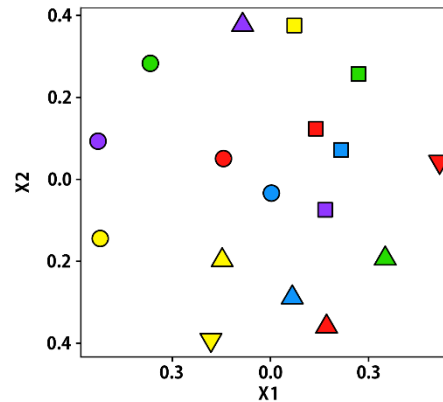
Highly Variable



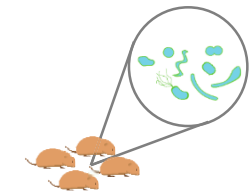
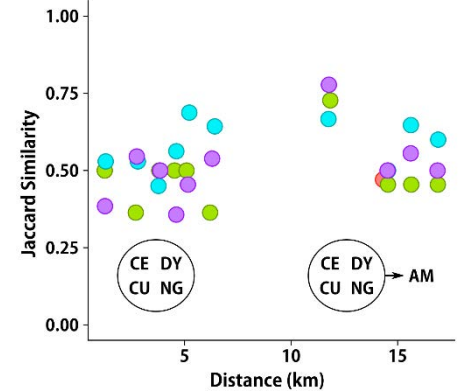
Local Abundance, Date



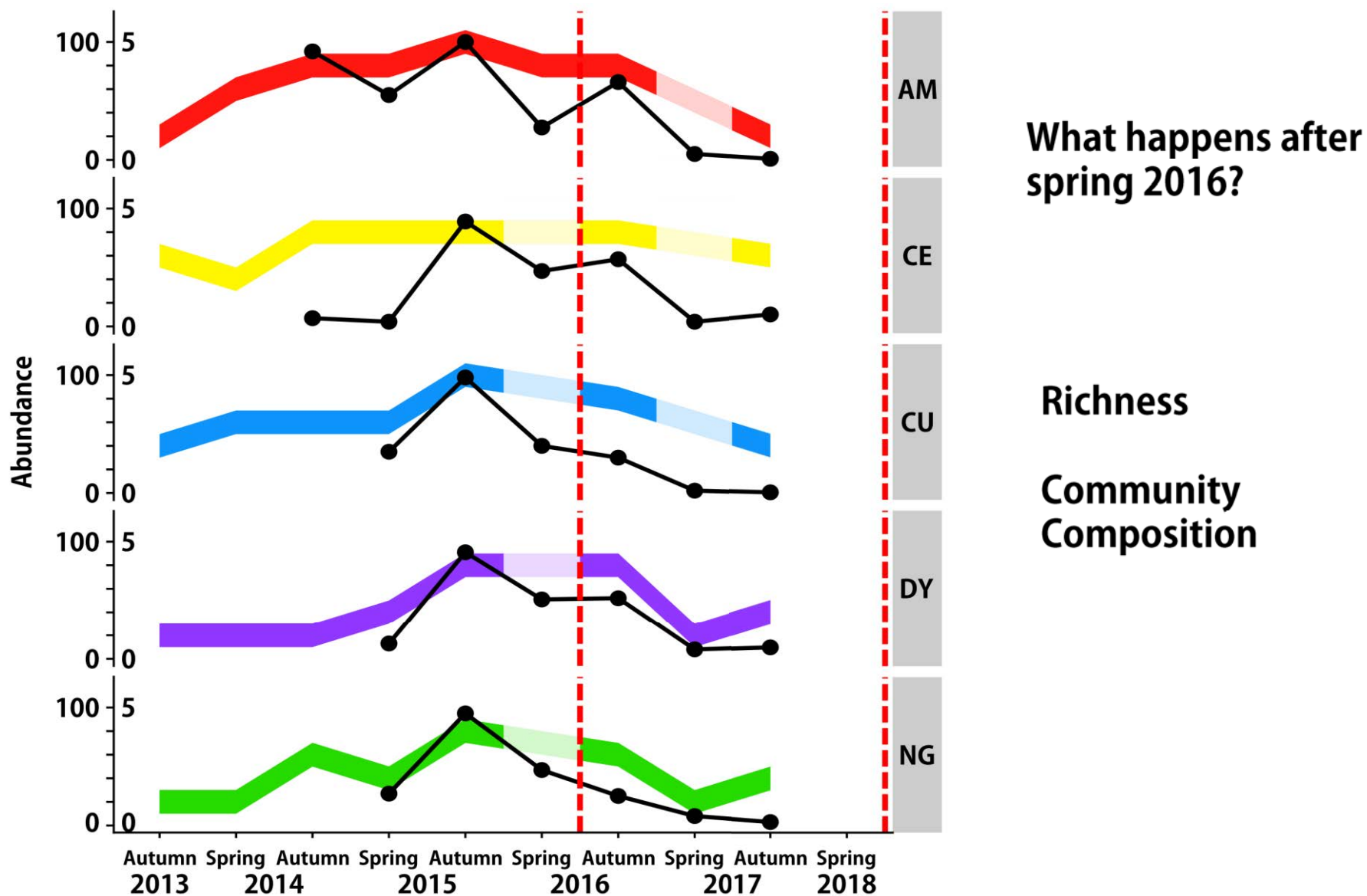
Date



~~Geographic Distance~~



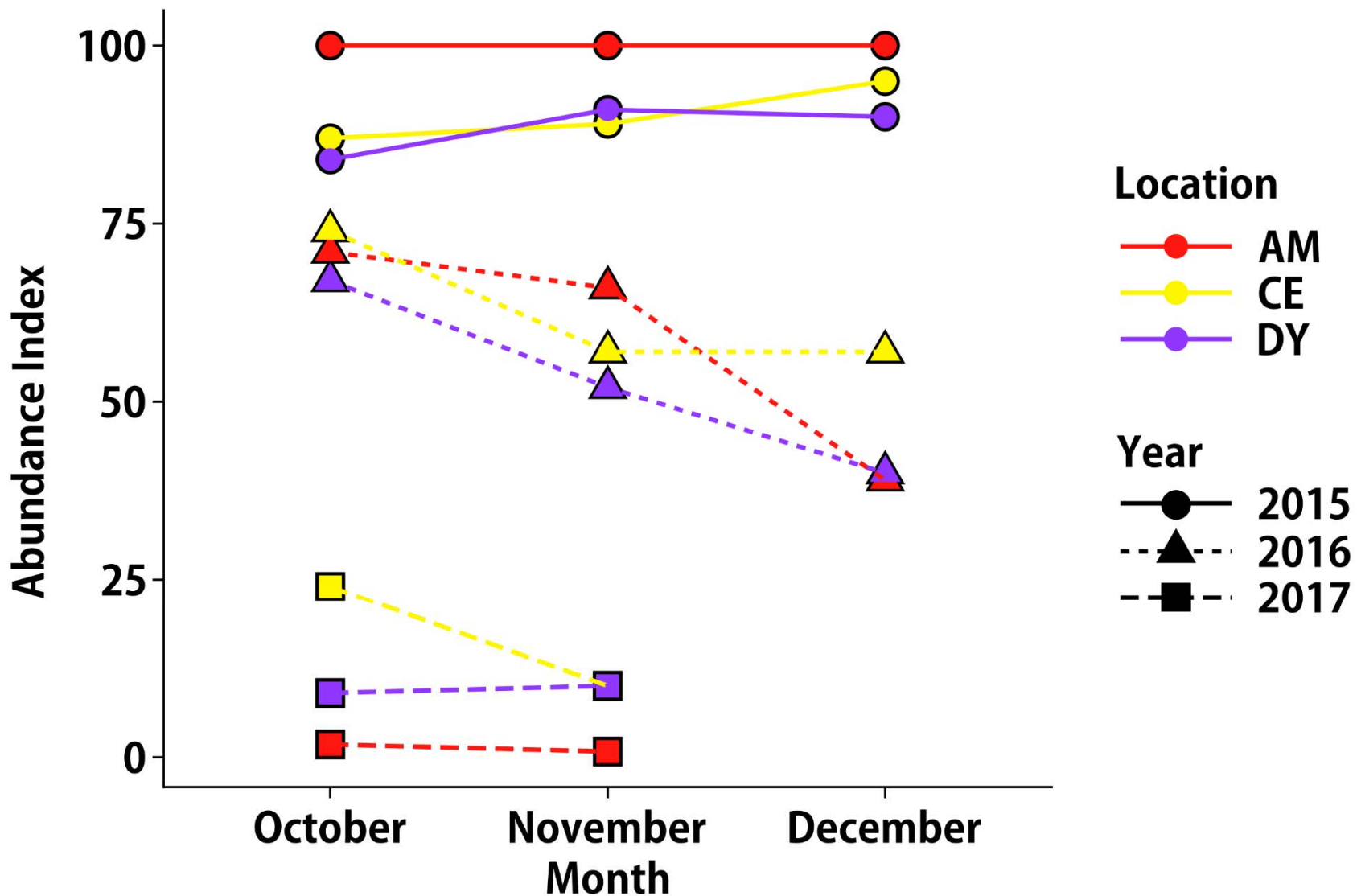
# Future Directions - Decline





# Future Directions - Decline

How fast do changes occur?



# Thanks for all the help!

- Amaël Dupaix
- Aurélie Guislain-Vitek
- Aurélien Levret
- Bérangère Foscarin
- Caroline Tataro
- Dominique Rieffel
- Eve Afonso
- Geoffroy Couval
- Herminie Piernavieja
- Javier Fernandez-de-Simon
- Jean-Baptiste Pons
- Jean-Francois Cosson
- José Gonzalo Zapata Carbonell
- Julie Montas
- Lexa Villette
- Marilyne Fontanier
- Maxime Galan
- Nathalie Charbonnel
- Nicolas Bassin
- Patrick Giraudoux
- Thibault Moulin
- Virgile Baudrot
- Vincent Driget



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CHRONO  
ENVIRONNEMENT

INRA  
SCIENCE & IMPACT

UMR CBGP



LTER FRANCE ARC JURASSIEN

Zone  
Atelier

# Merci!



RÉGION  
BOURGOGNE  
FRANCHE  
COMTÉ



# **IndVal - An Indicator**

$$\text{IndVal} = A \times B$$



# IndVal - An Indicator

$$\text{IndVal} = A \times B$$



**Fidelity of taxon to group**  
(Relative abundance or prevalence)

**0** ←————→ **1**

Taxon is not  
in group

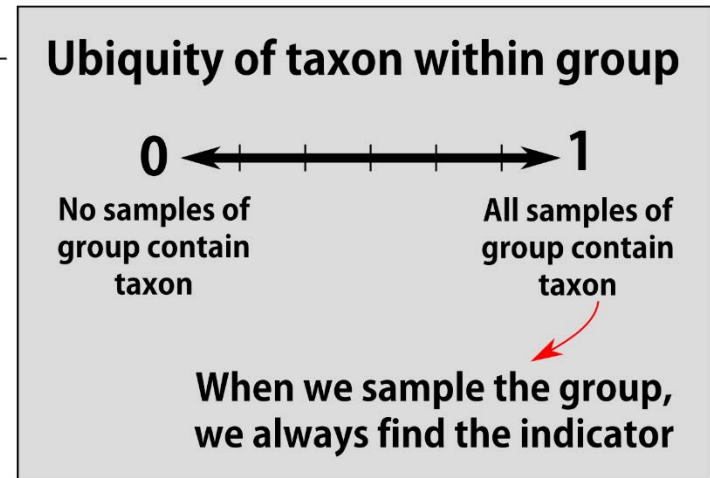
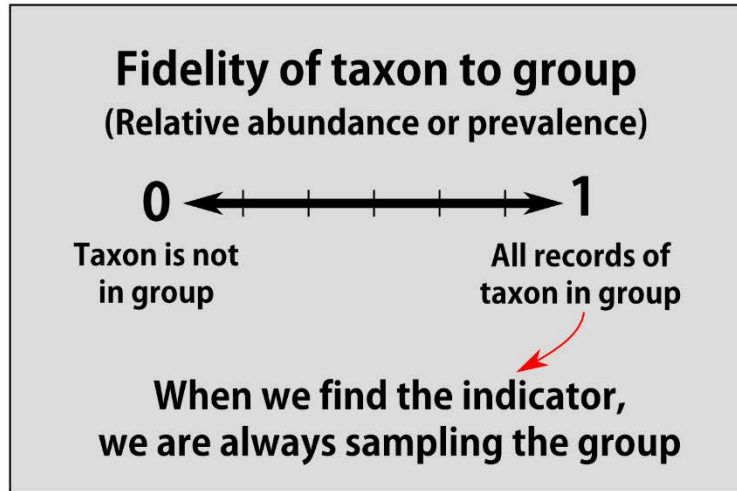
All records of  
taxon in group



**When we find the indicator,  
we are always sampling the group**

# IndVal - An Indicator

$$\text{IndVal} = A \times B$$



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**Target Group :  
Late High-Abundance Phase**

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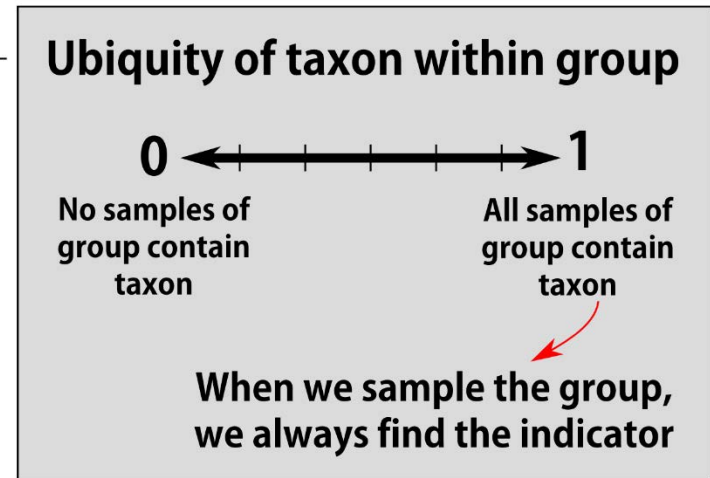
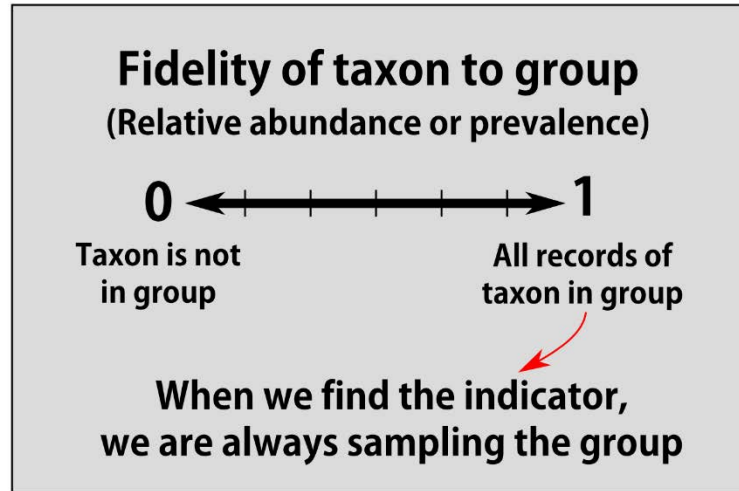
**Target Group :**  
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2003-2005

Calculate IndVal for each taxon for each group  
Select taxa with largest IndVal in target group

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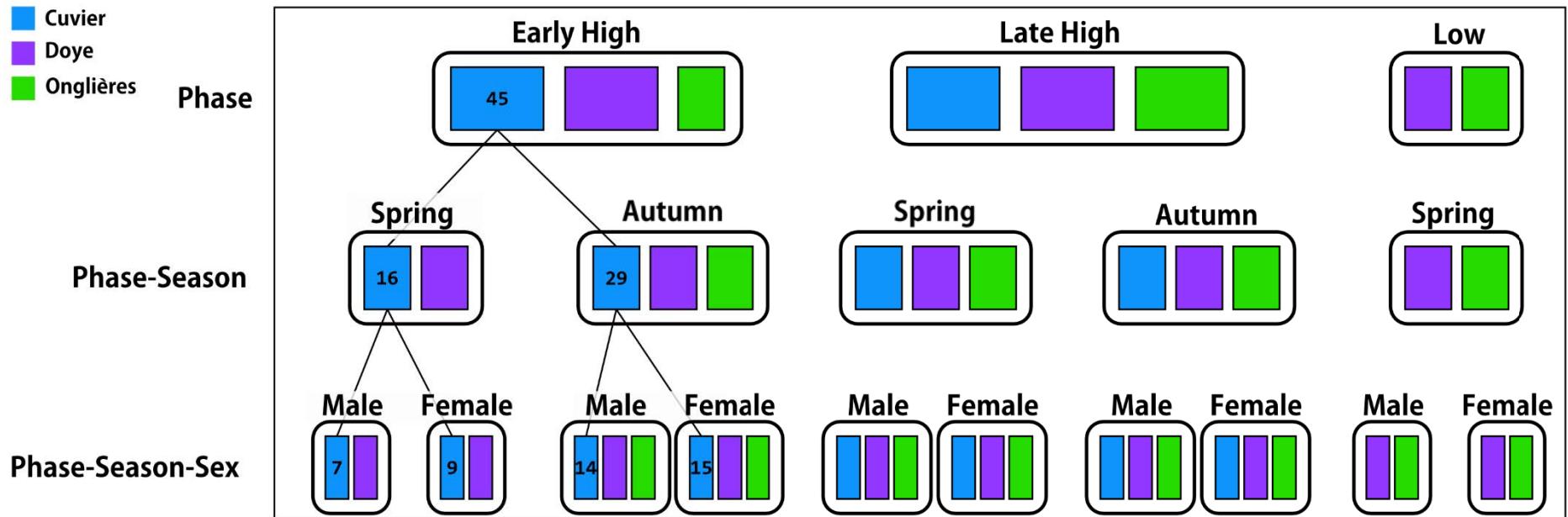
**2003-2005**  
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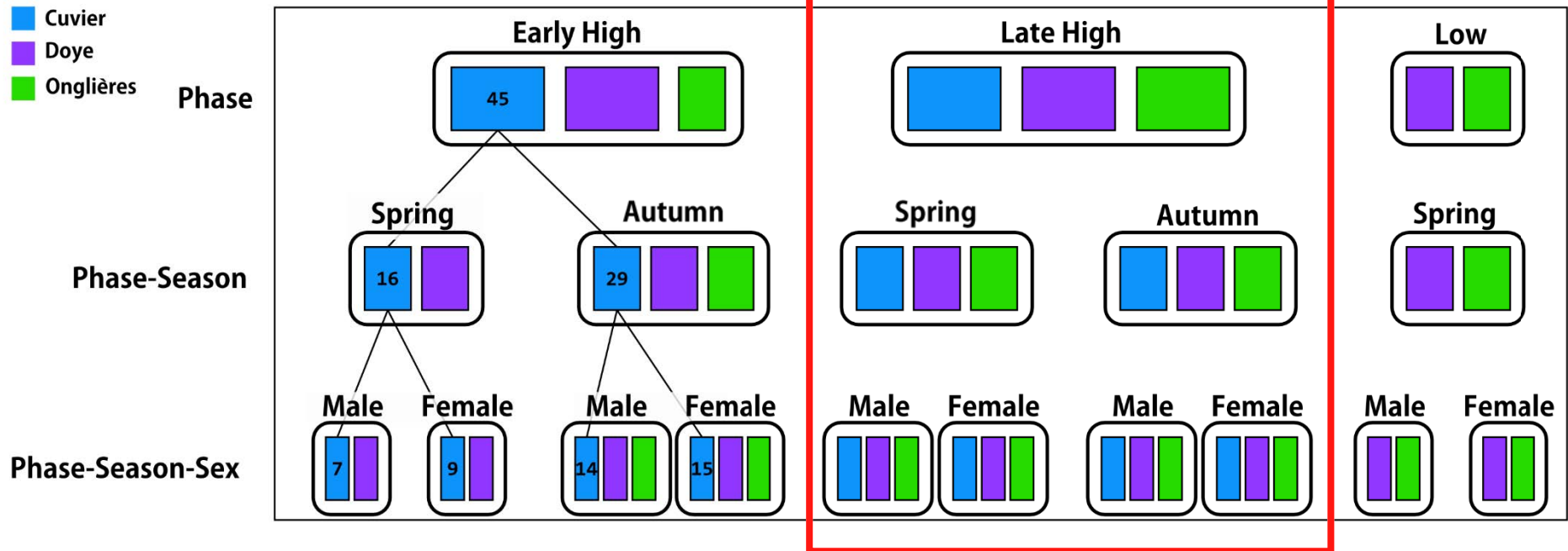
**2015-2016**  
Any 2003-2005 indicators retained?



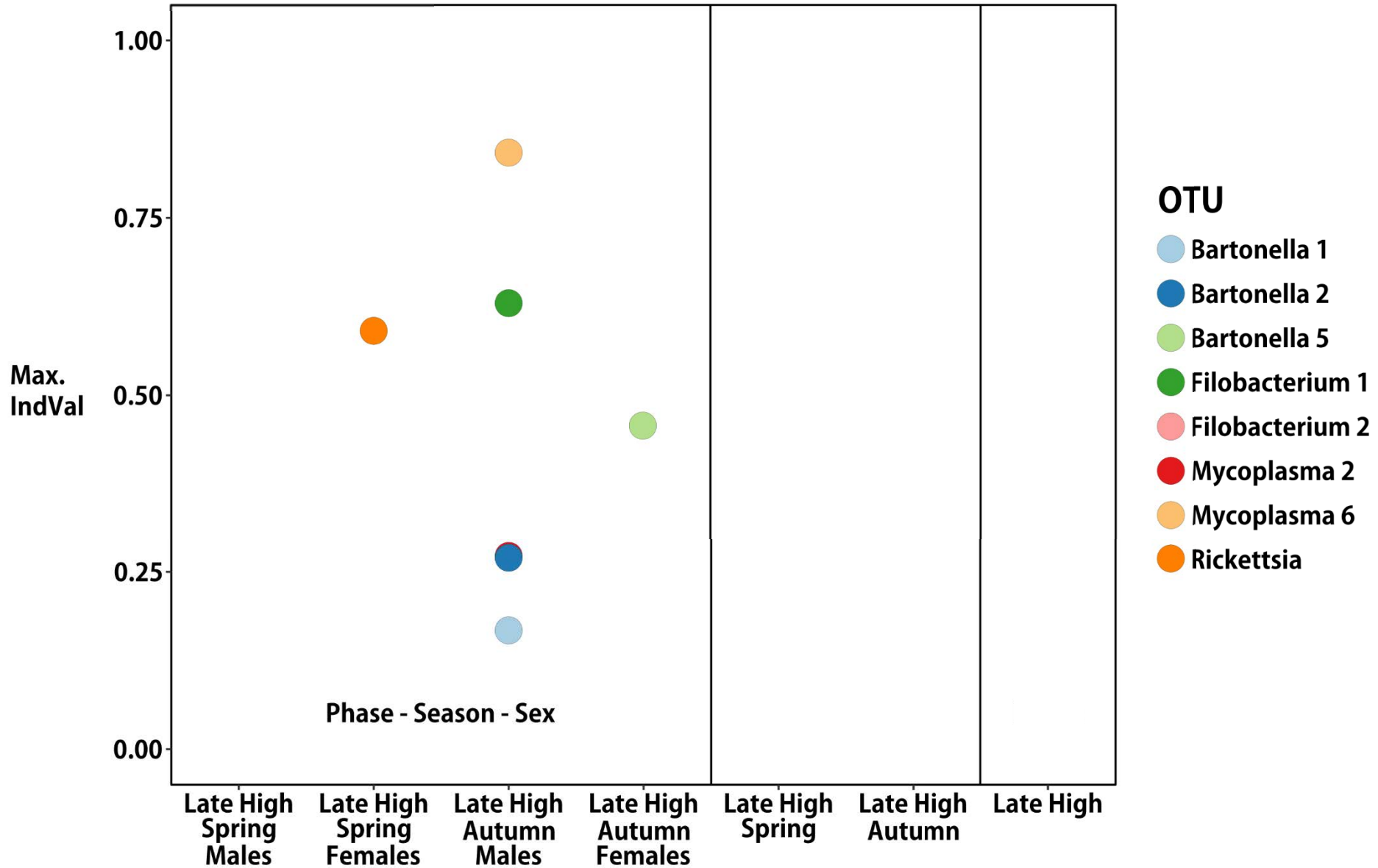
# Group scales



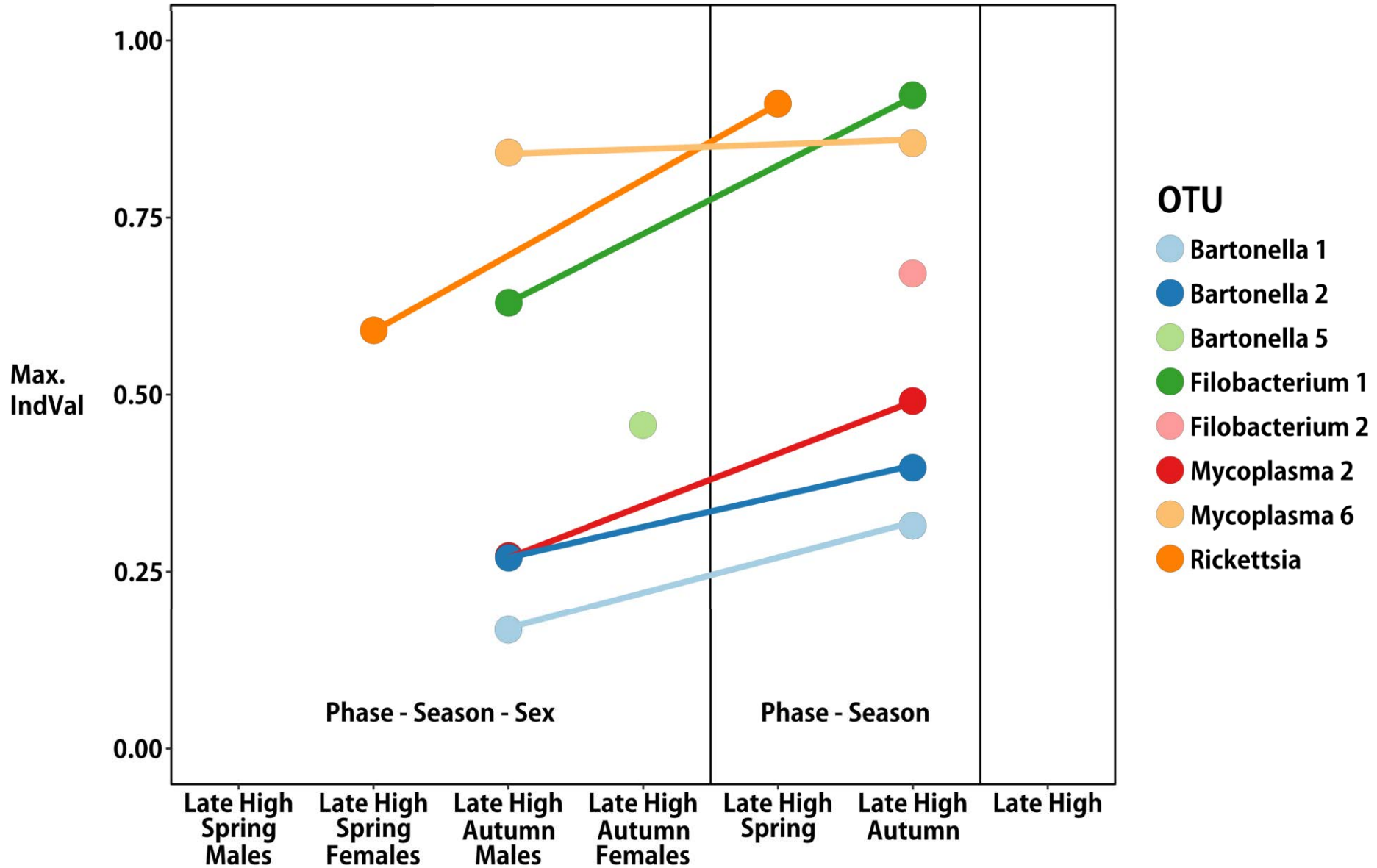
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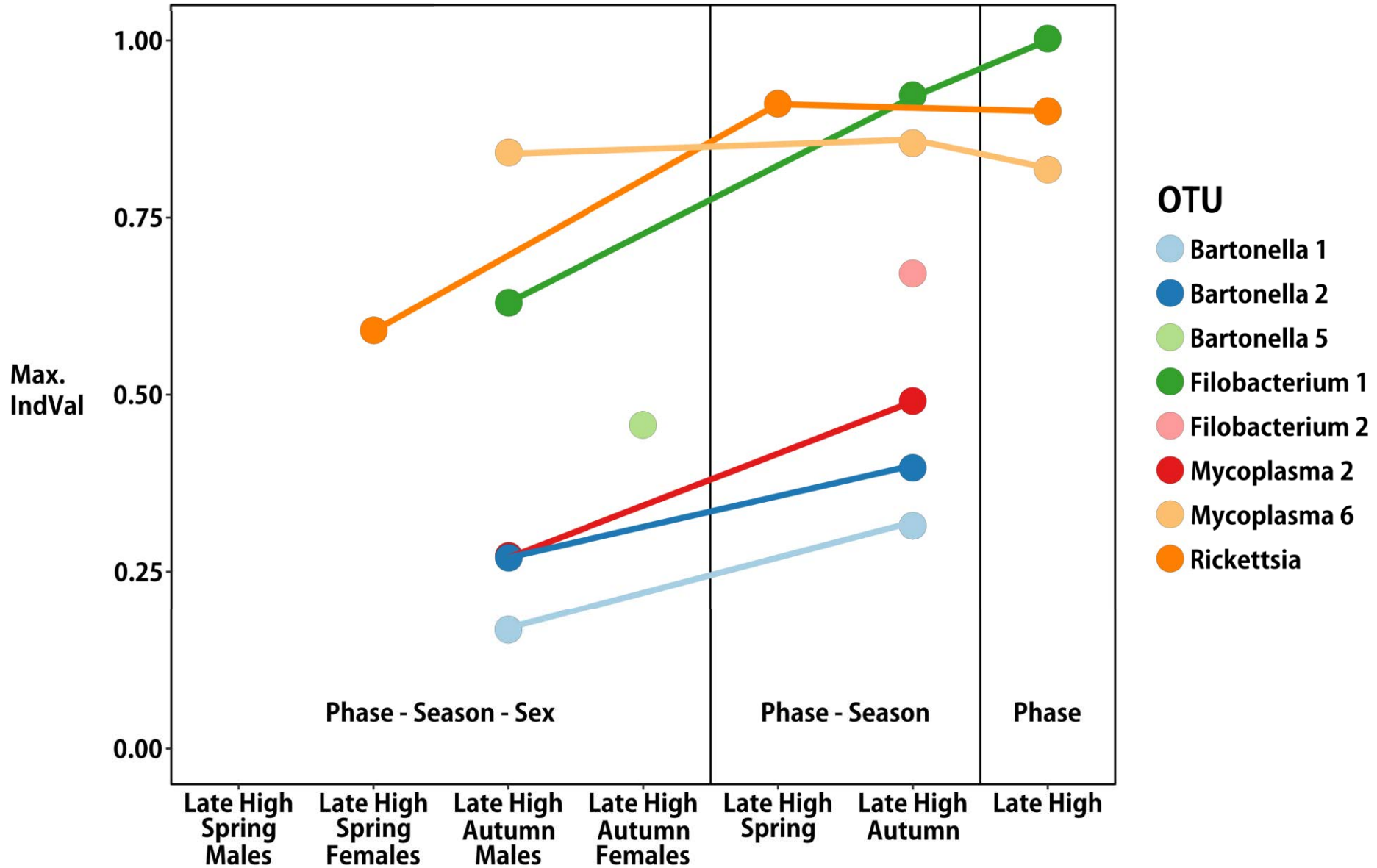
# IndVals



# IndVals



# IndVals





# IndVals

