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# Bacterial Parasite Communities of the Fossorial Water Vole *Arvicola terrestris* During a Period of High Abundance: Richness and Similarity in a Dynamic World

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

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# Bacterial Parasite Communities of the Fossorial Water Vole *Arvicola terrestris* during a period of high abundance: richness and similarity in a dynamic world

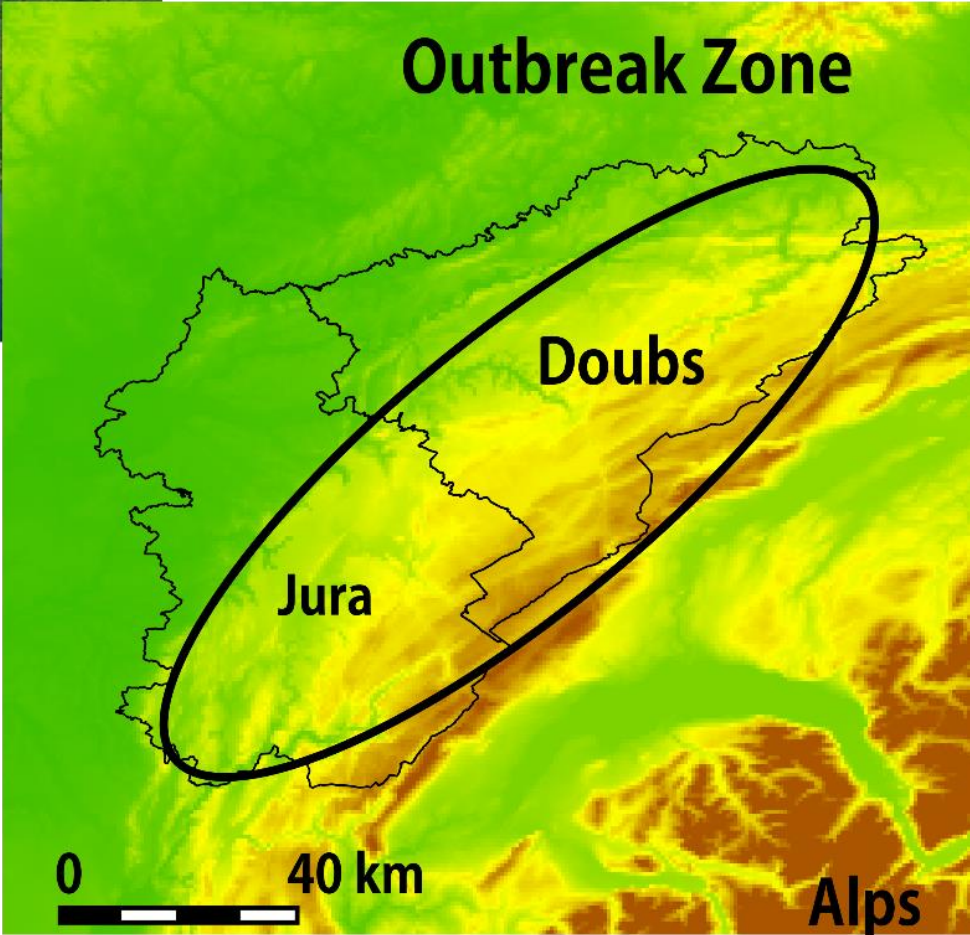
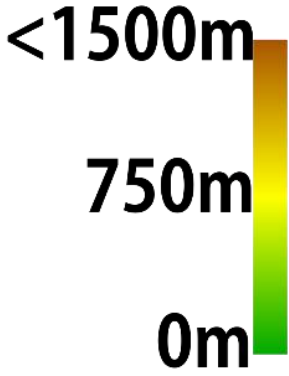


Petra Villette, Eve Afonso,  
Geoffroy Couval,  
Aurélien Levret, Jean-François  
Cosson, Patrick Giraudoux

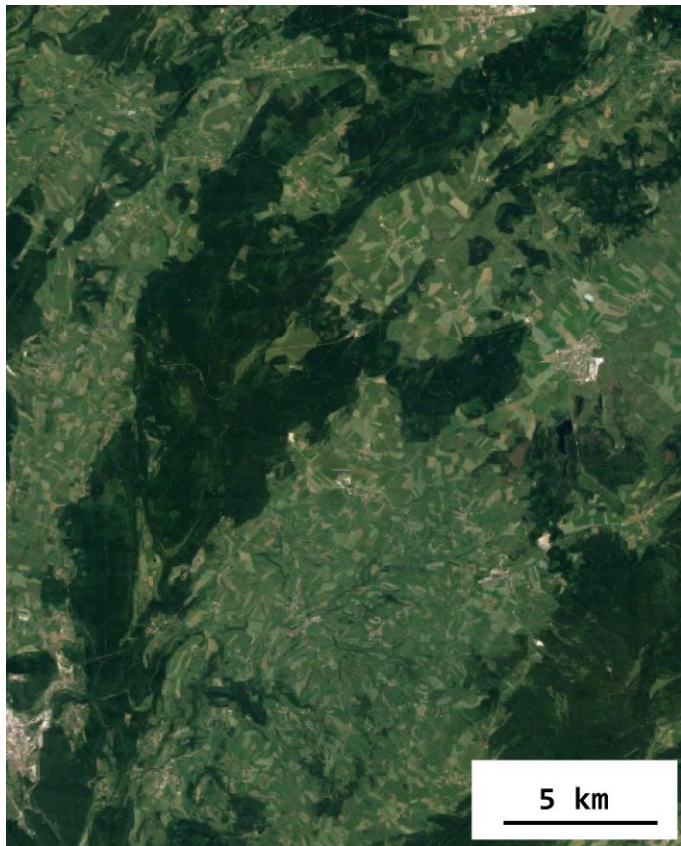




# *Arvicola terrestris* in Franche-Comtè

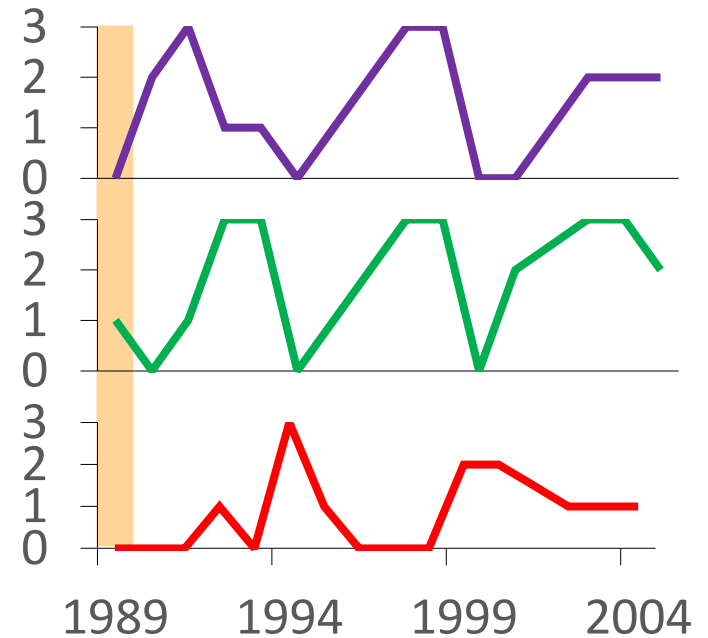
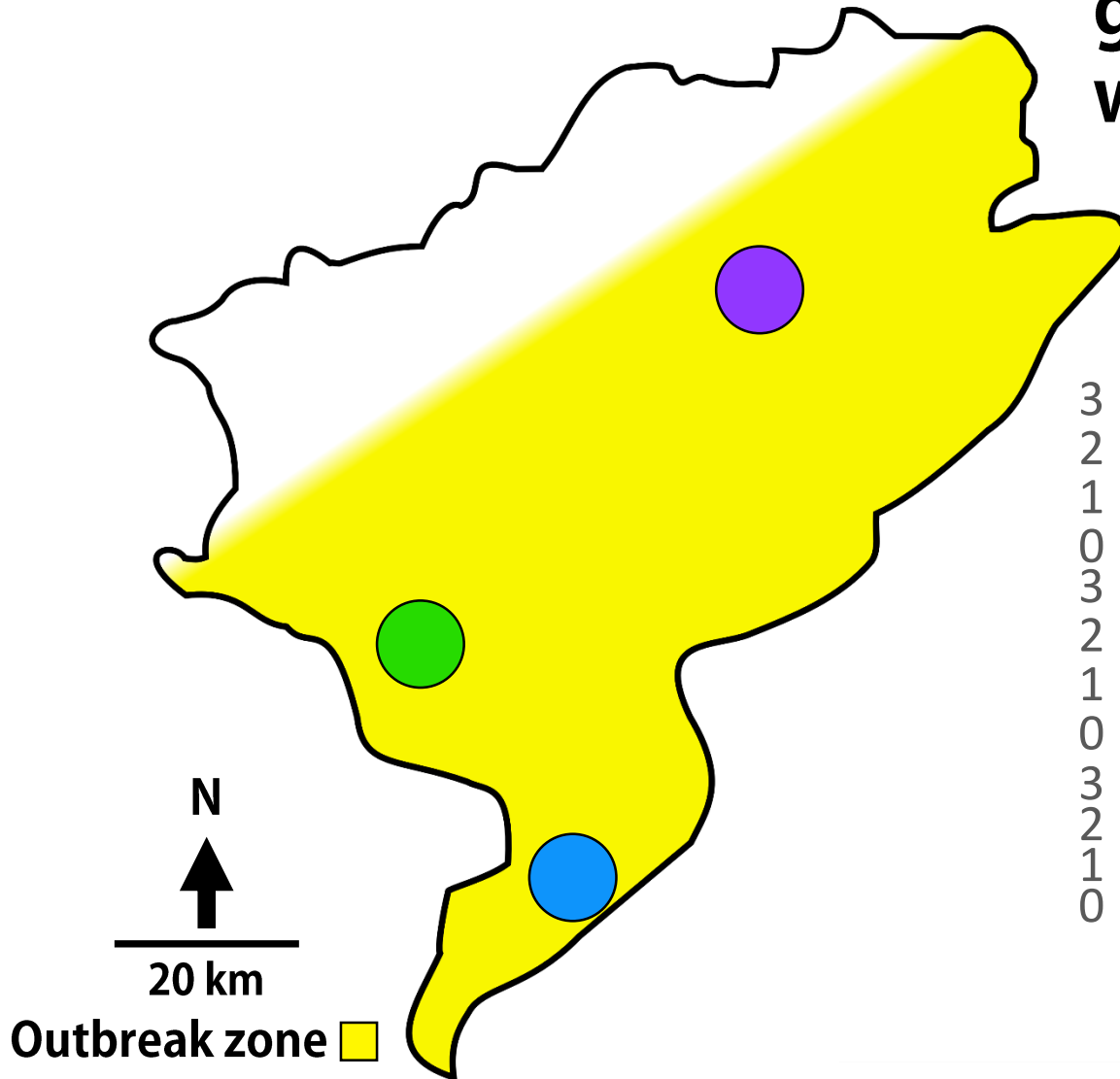






# Spatial Dynamics

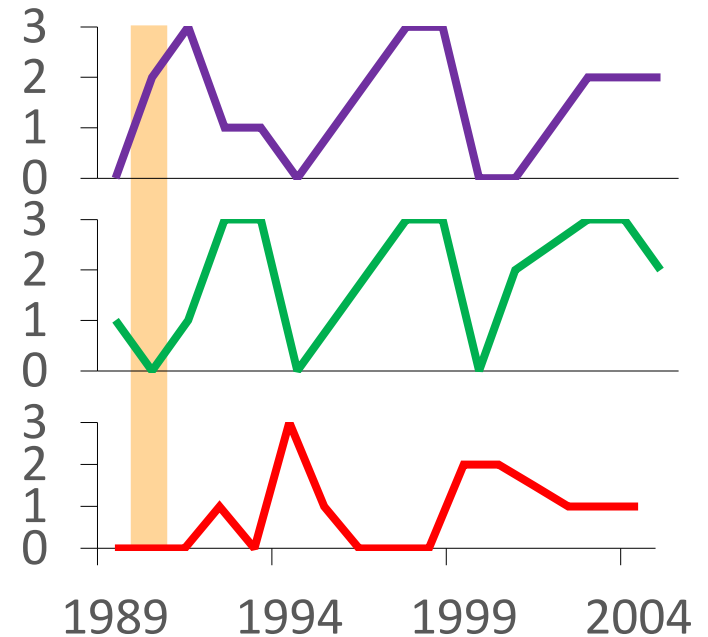
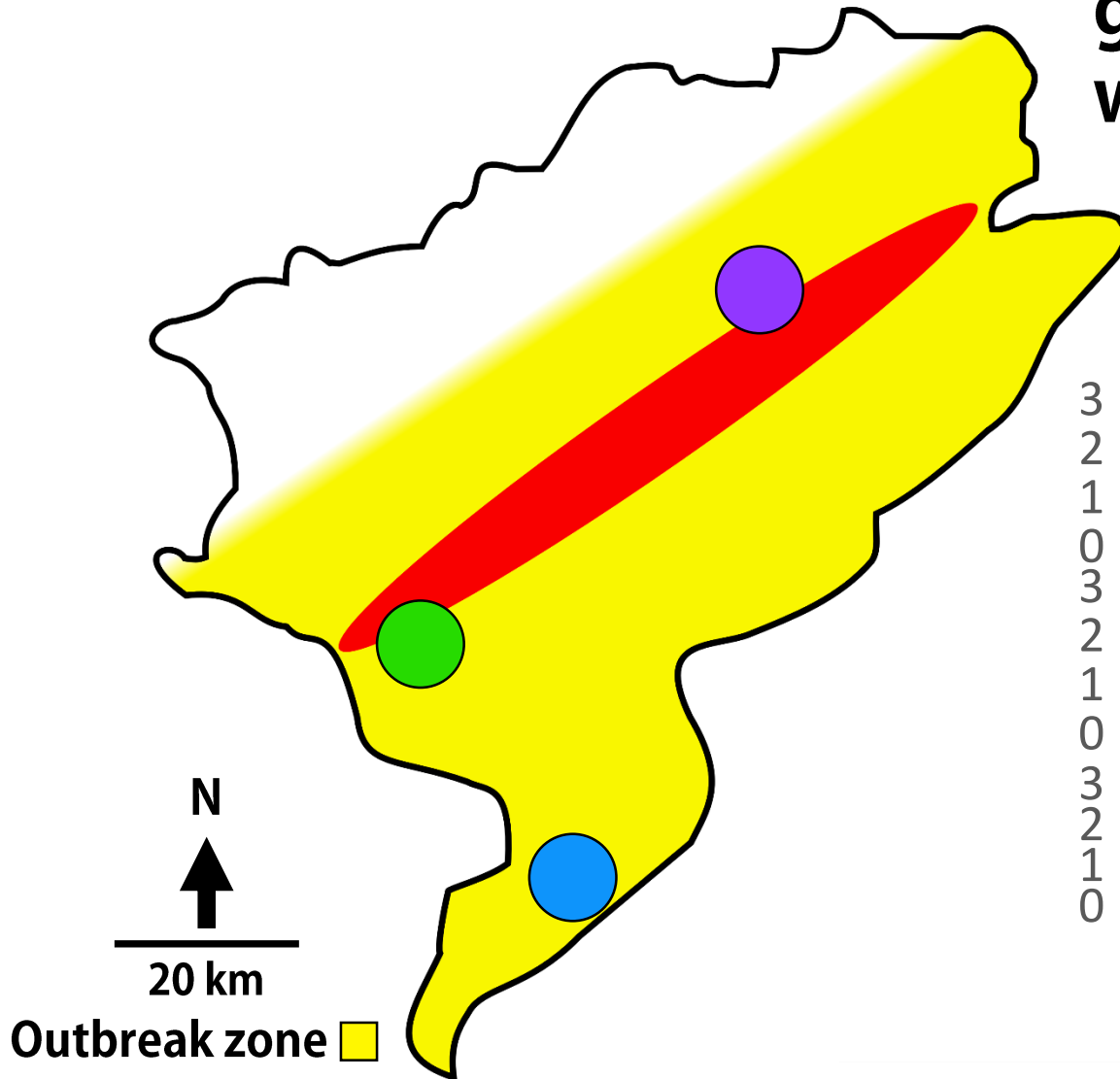
Lagged synchrony  
generates travelling  
wave



(Berthier et al 2014)

# Spatial Dynamics

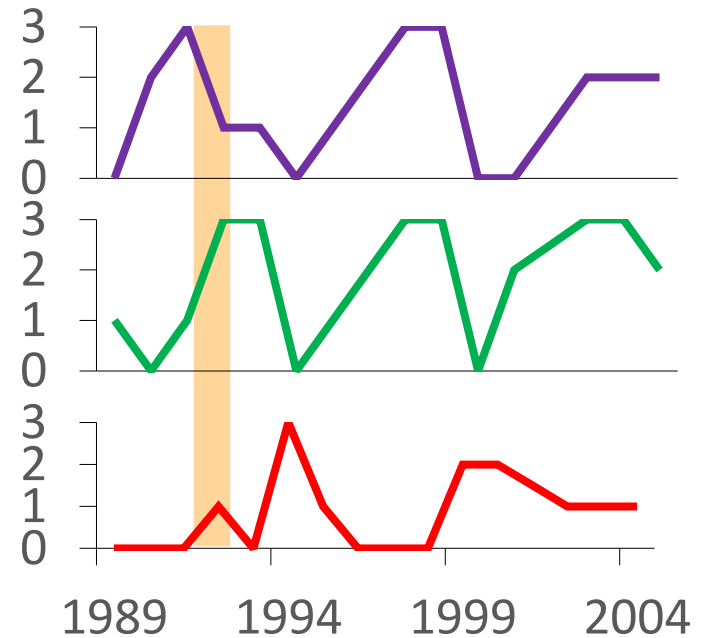
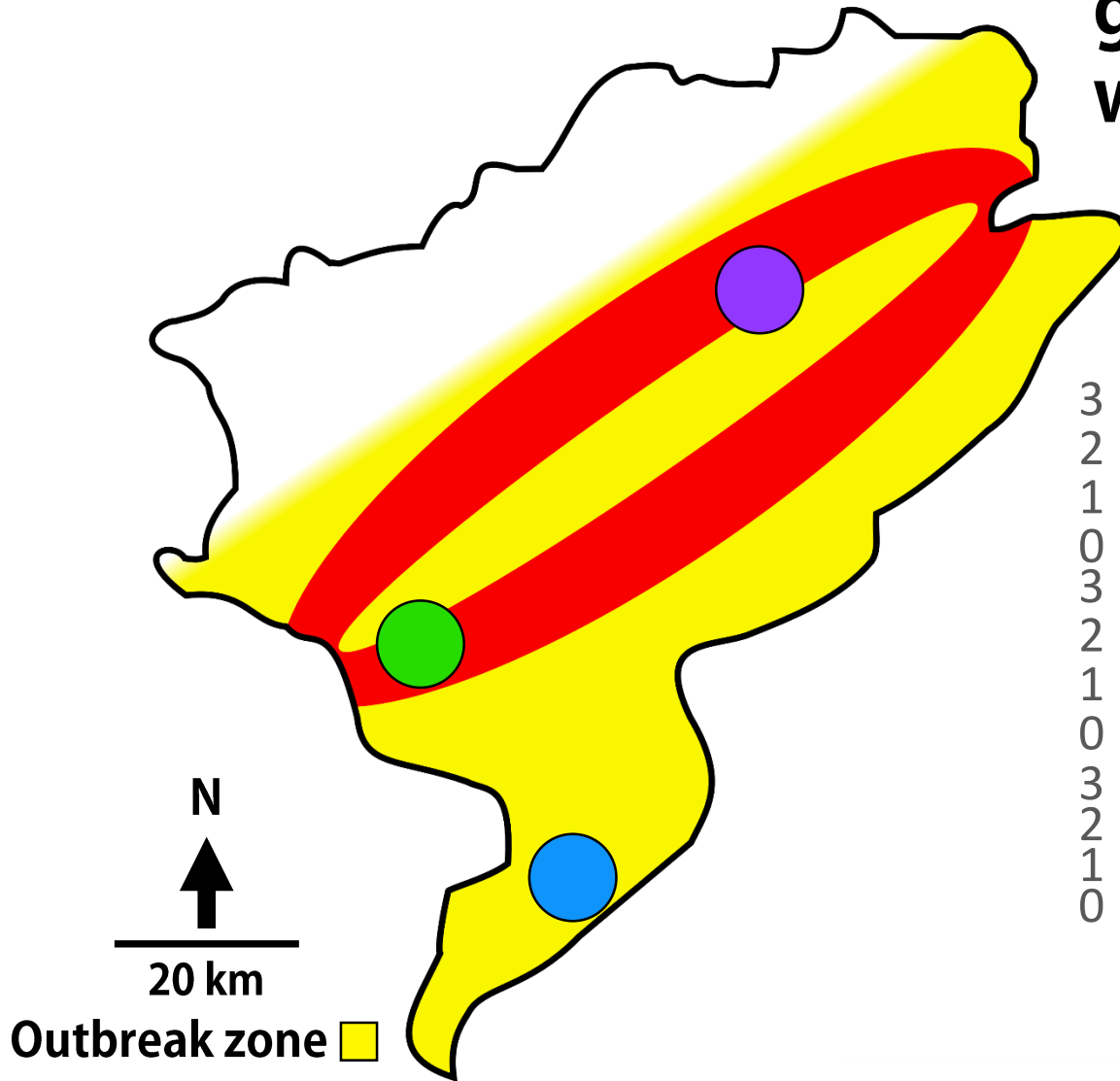
Lagged synchrony  
generates travelling  
wave



(Berthier et al 2014)

# Spatial Dynamics

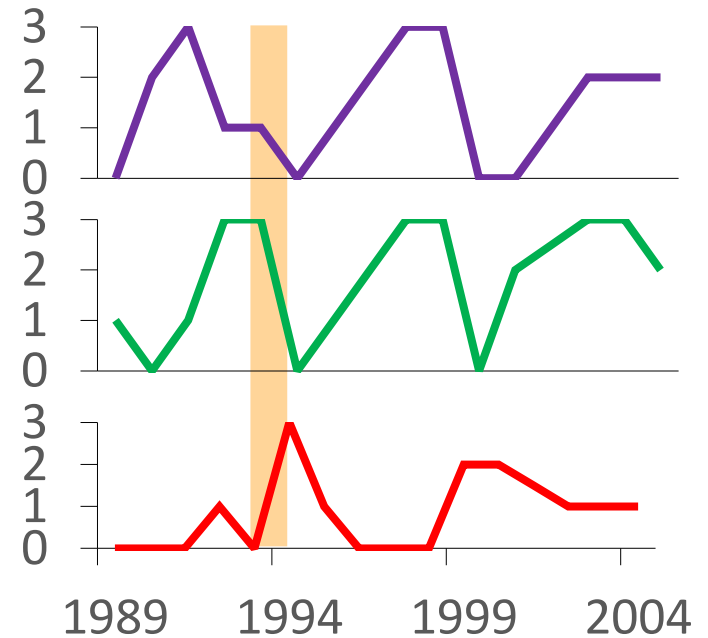
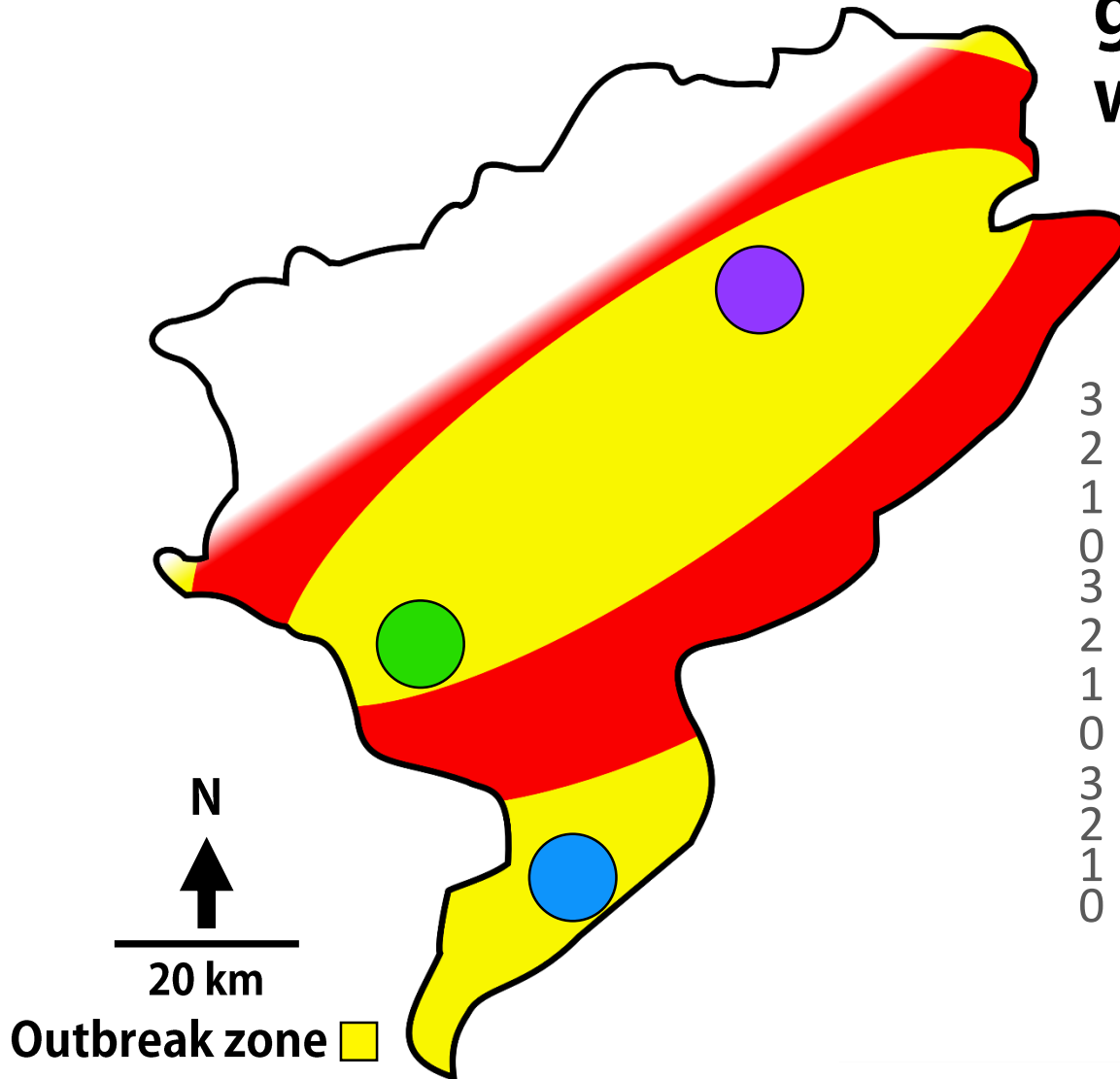
Lagged synchrony  
generates travelling  
wave



(Berthier et al 2014)

# Spatial Dynamics

Lagged synchrony  
generates travelling  
wave

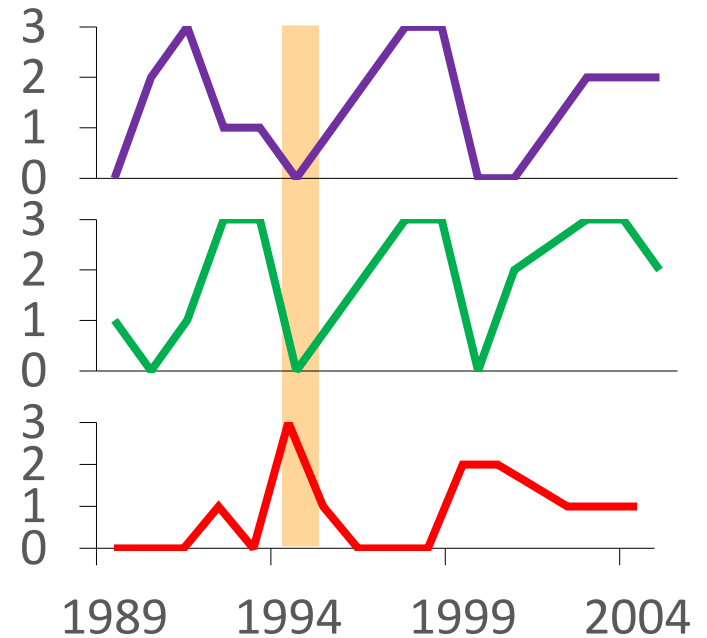
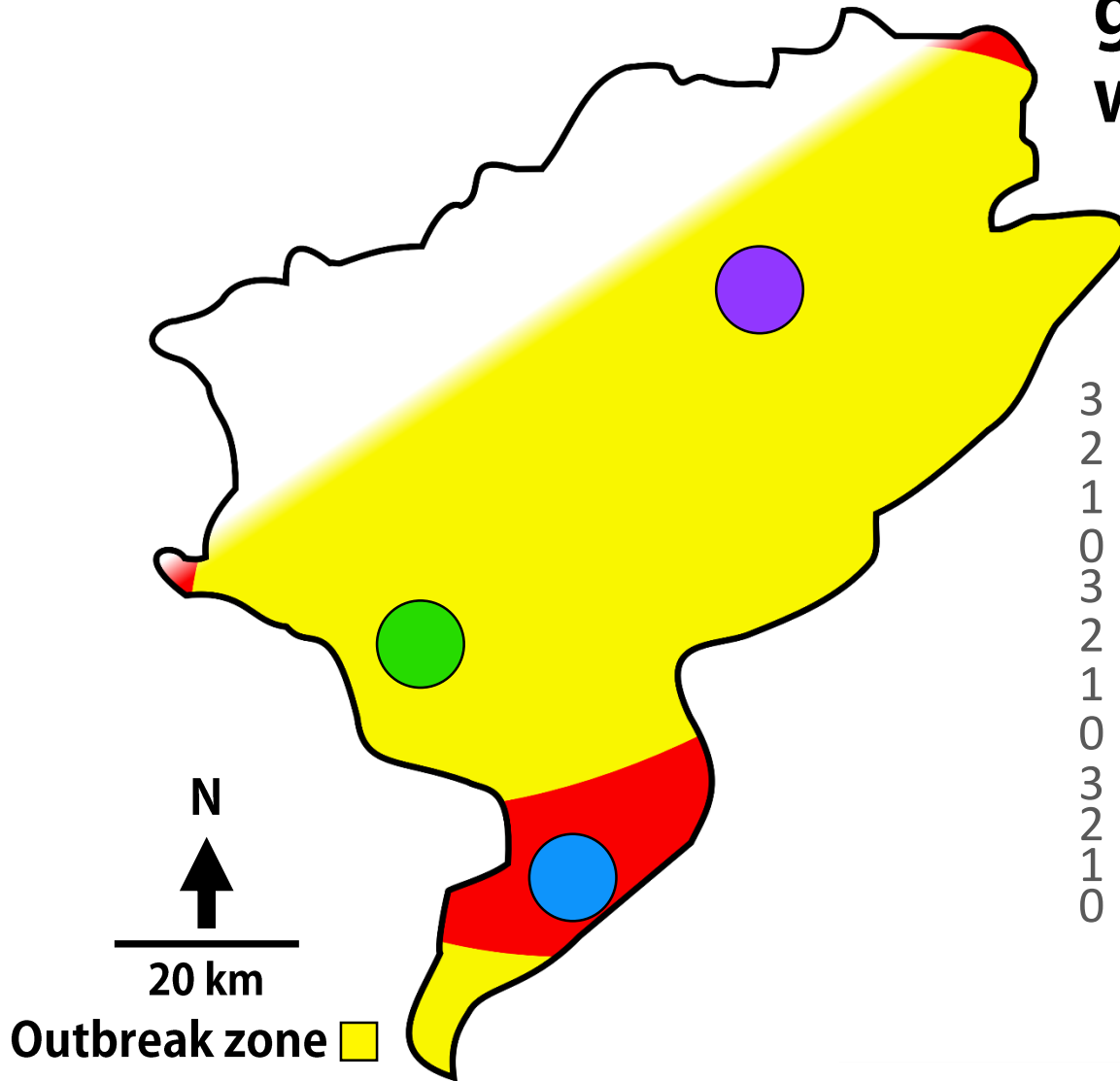


(Berthier et al 2014)



# Spatial Dynamics

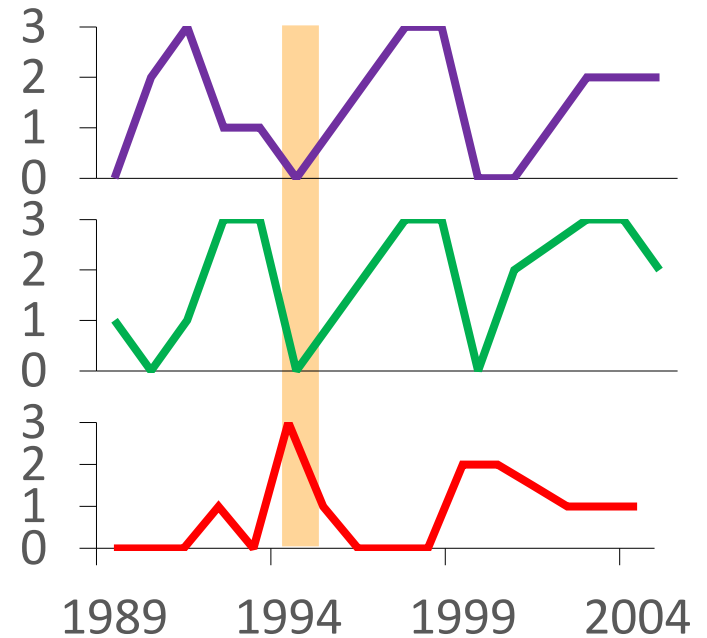
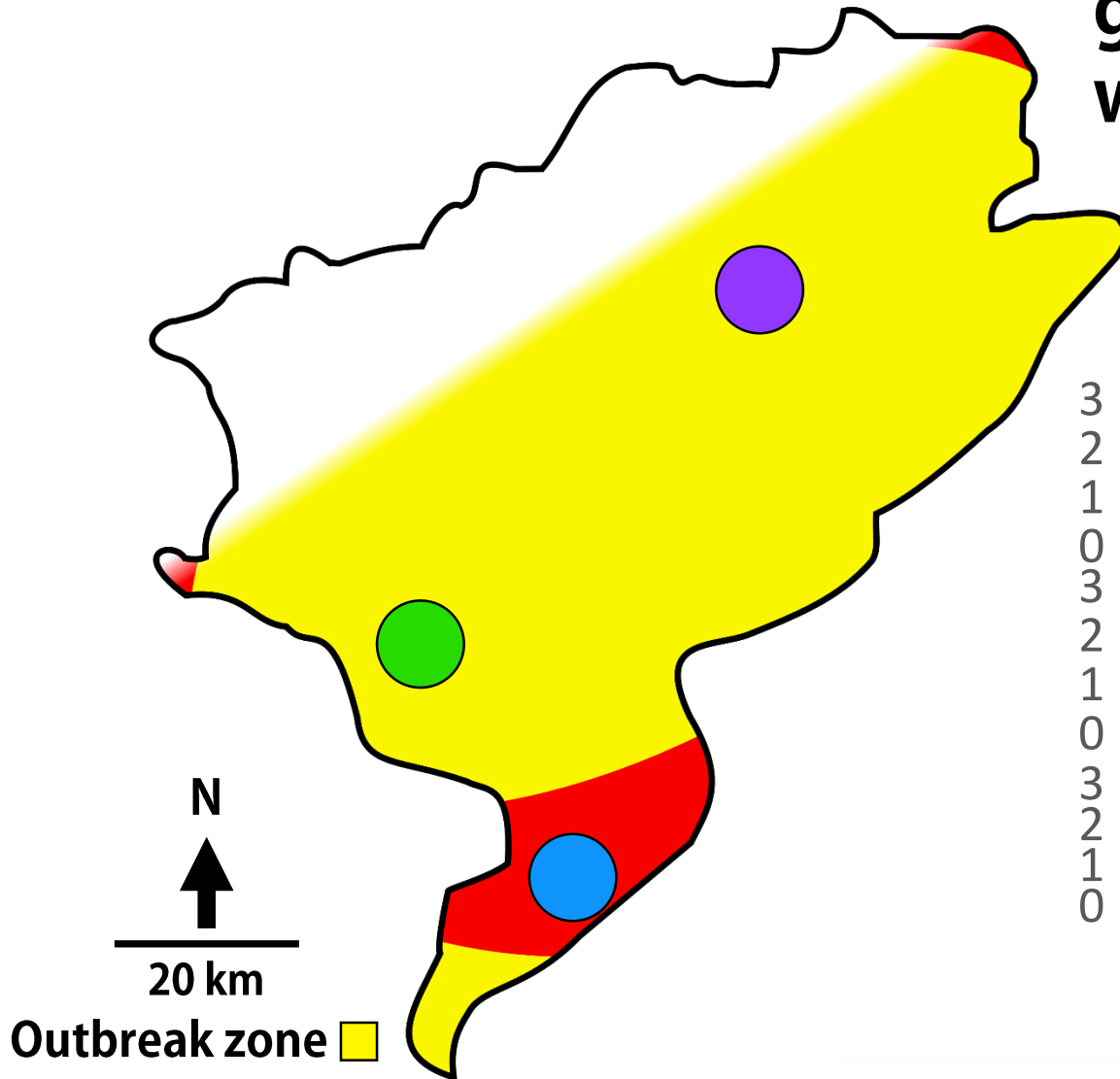
Lagged synchrony  
generates travelling  
wave



(Berthier et al 2014)

# Spatial Dynamics

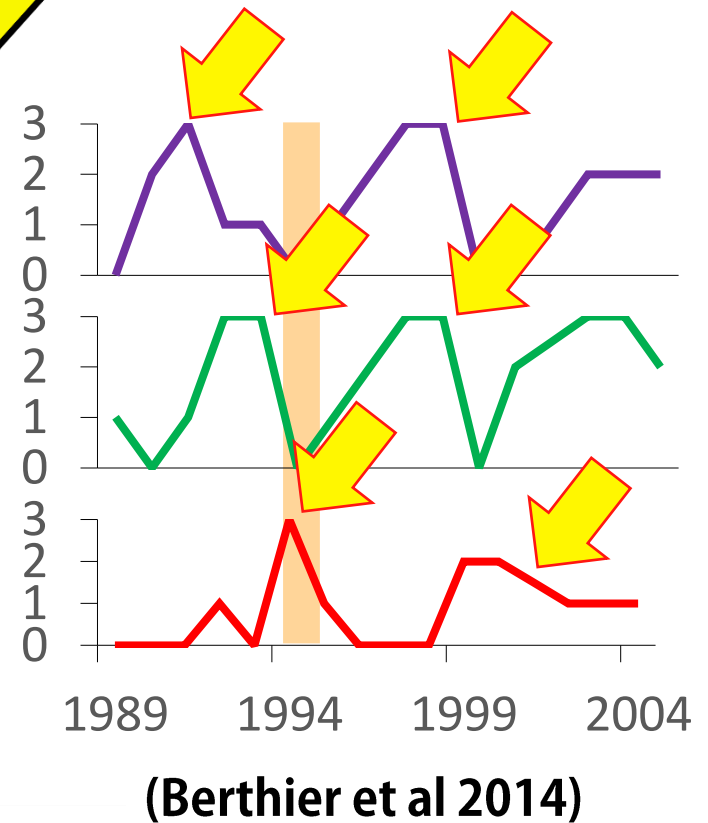
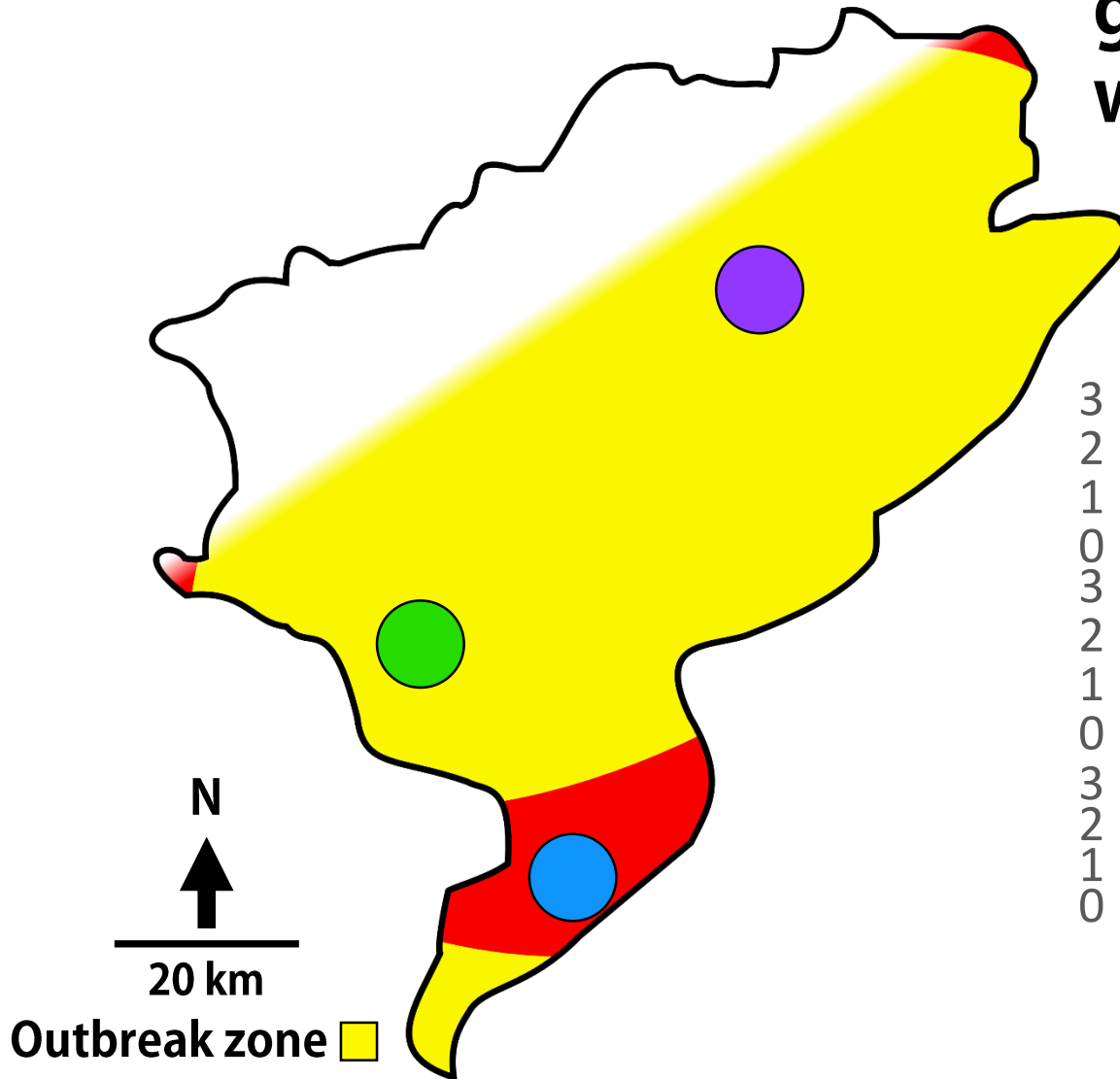
Lagged synchrony  
generates travelling  
wave



(Berthier et al 2014)

# Spatial Dynamics

Lagged synchrony  
generates travelling  
wave





# Decline hypotheses

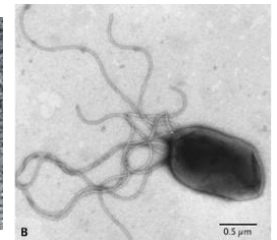
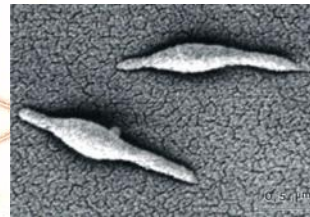
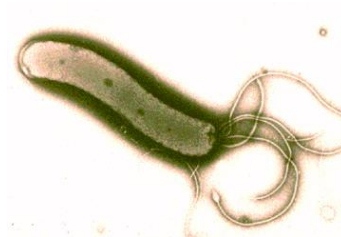
**Predation -**



**Food limitation -**



**Parasites and Diseases -**



# Decline hypotheses

Predation -

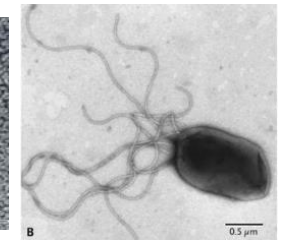
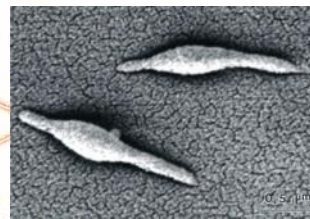
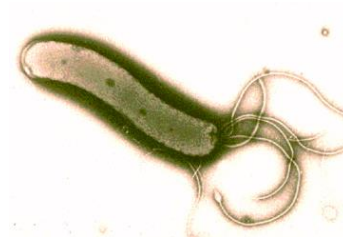


Food limitation -

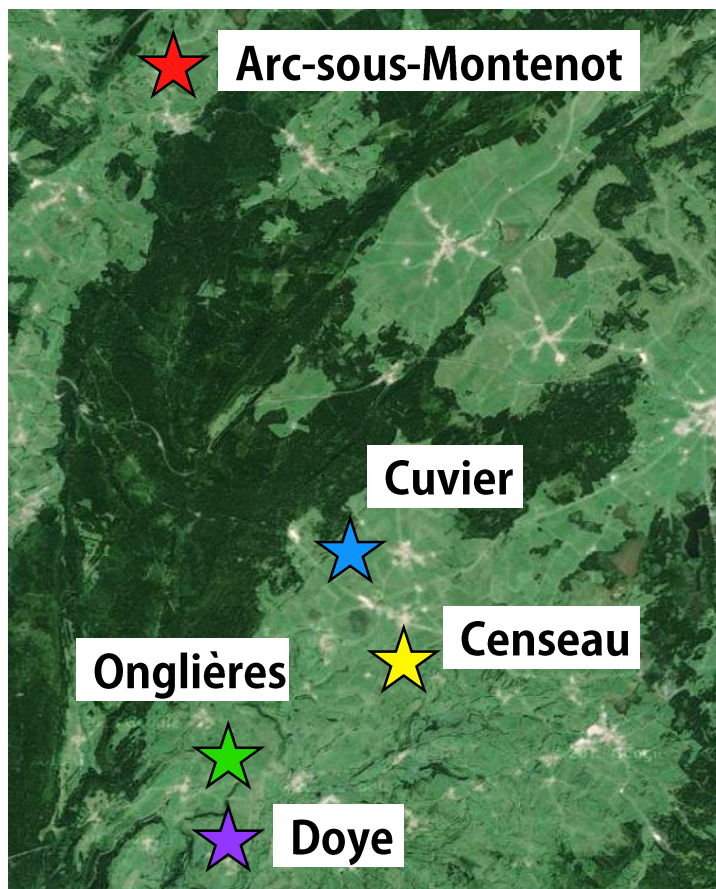


Parasites and Diseases

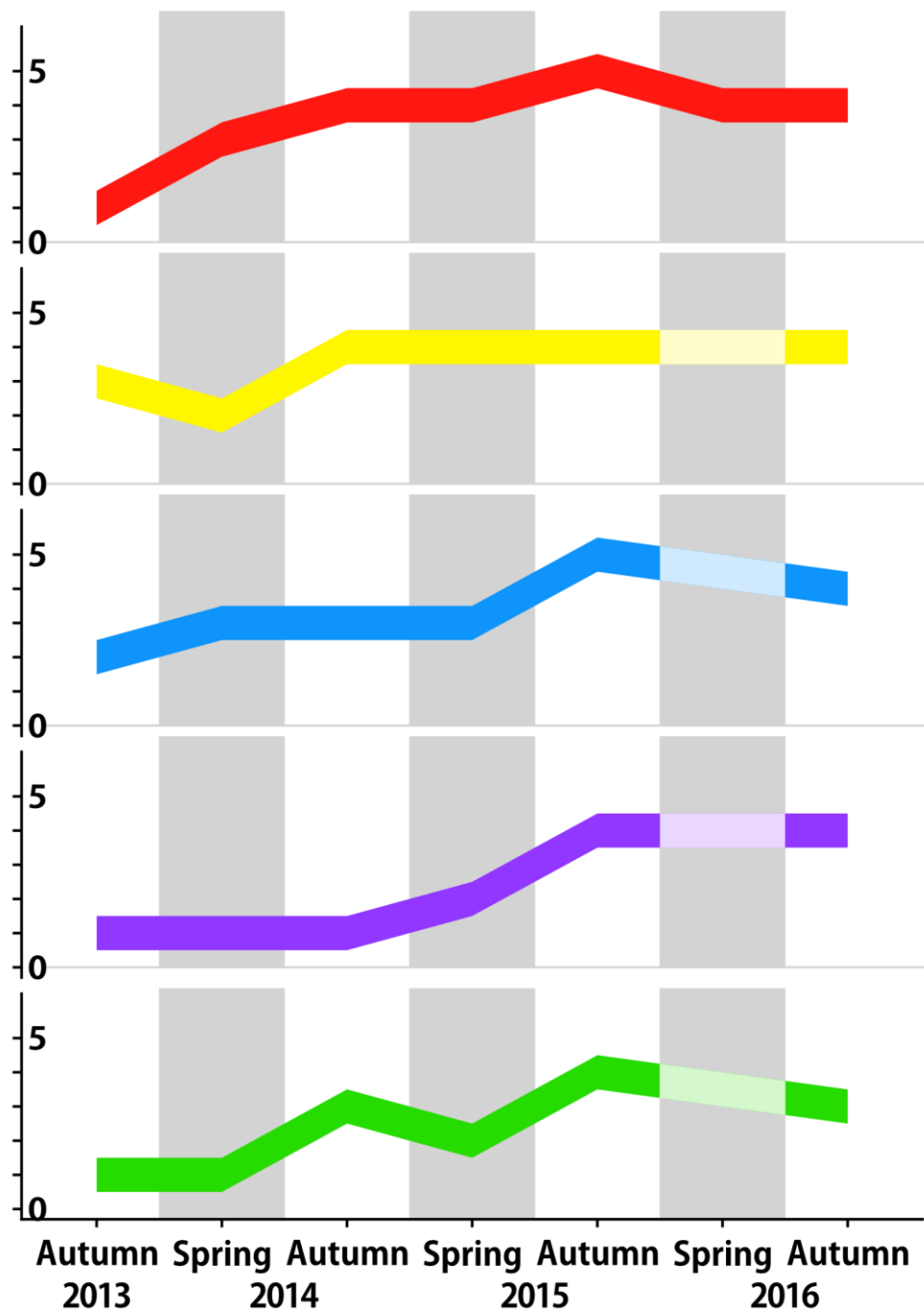
- **Communities**
- **Bacteria**



8 km

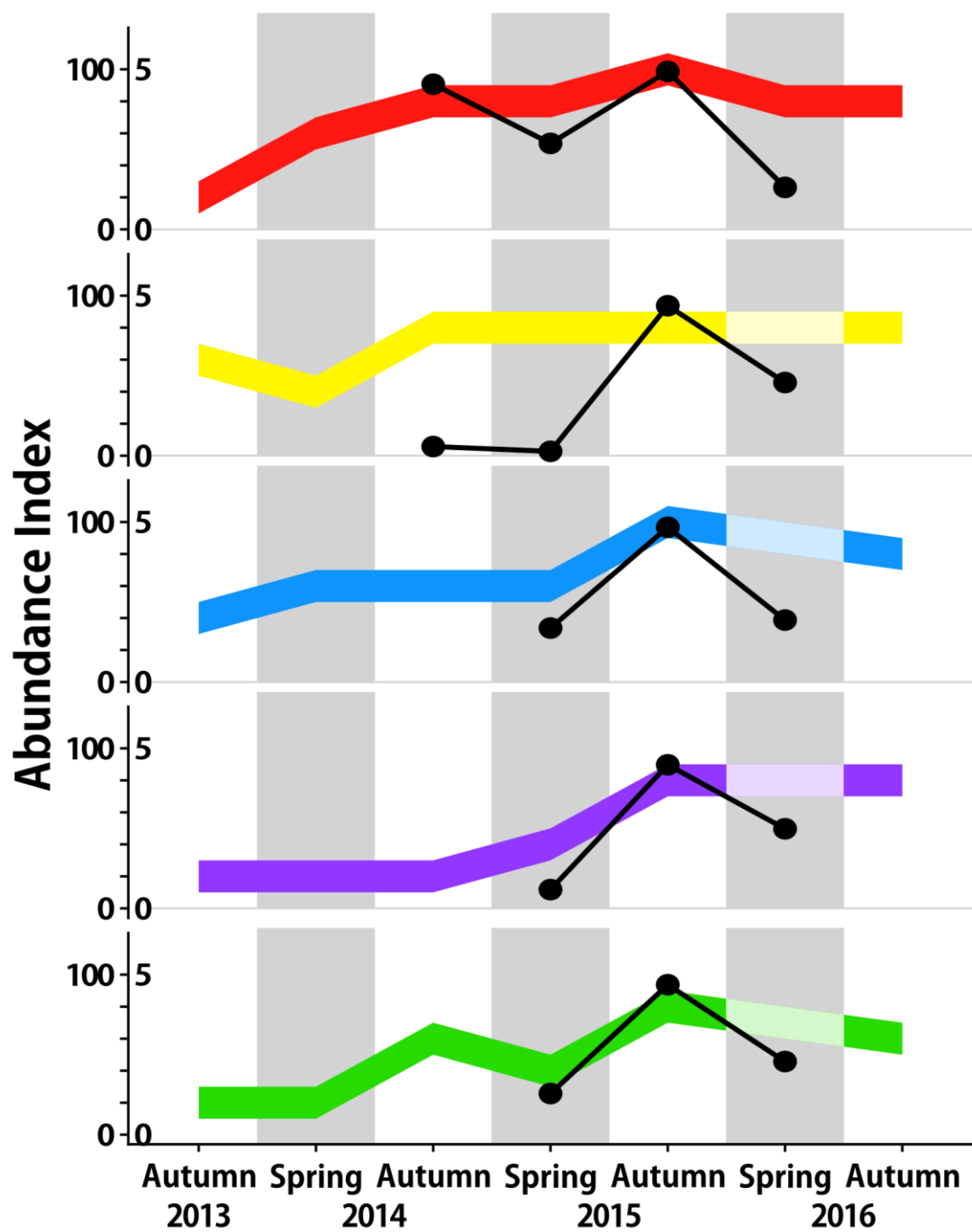
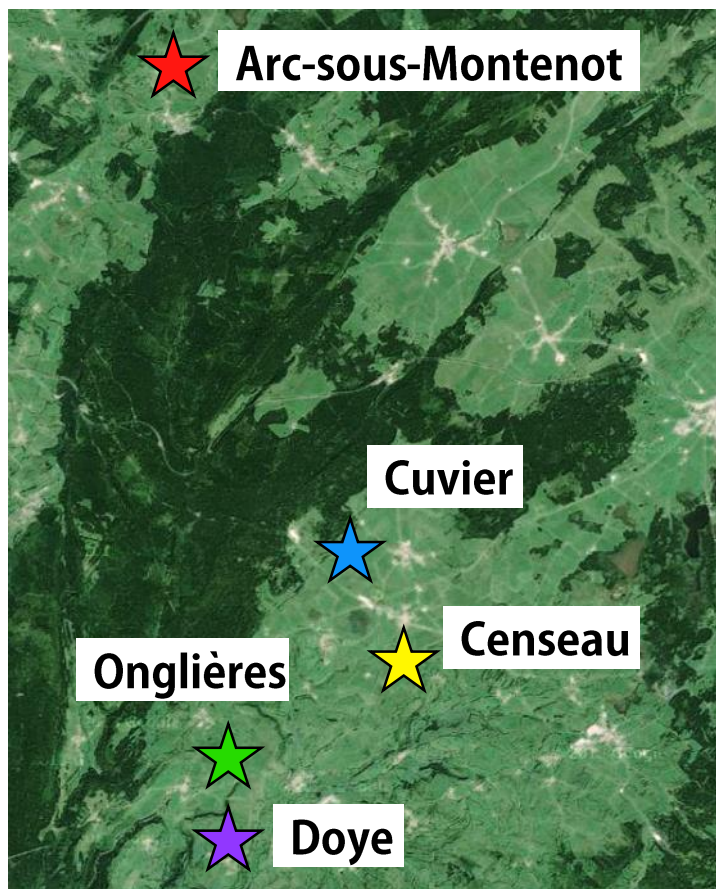


Abundance Index





8 km



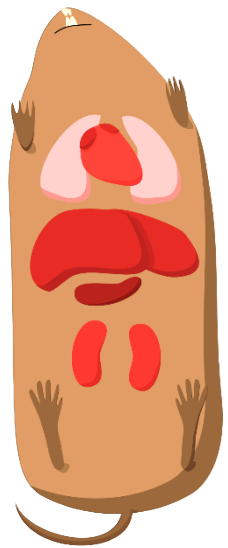




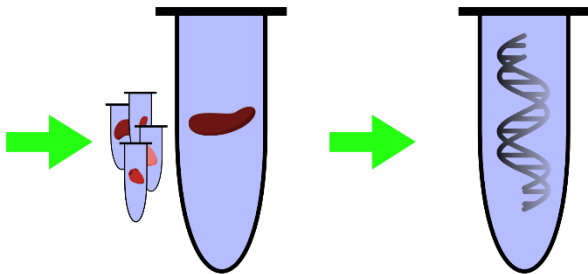




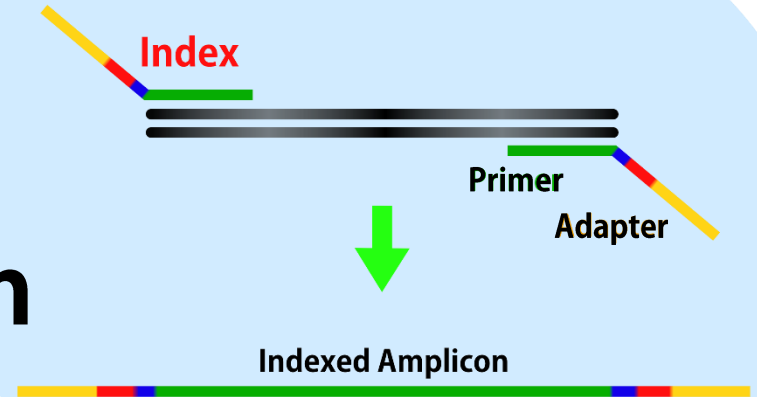




DNA extraction

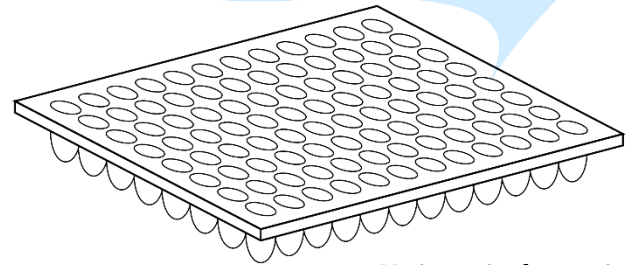
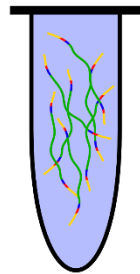


PCR amplification of V4 region of 16s rRNA gene

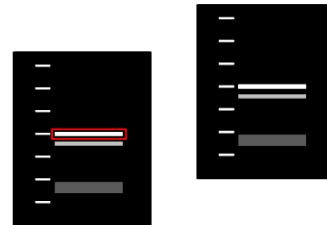


# Next Generation Sequencing

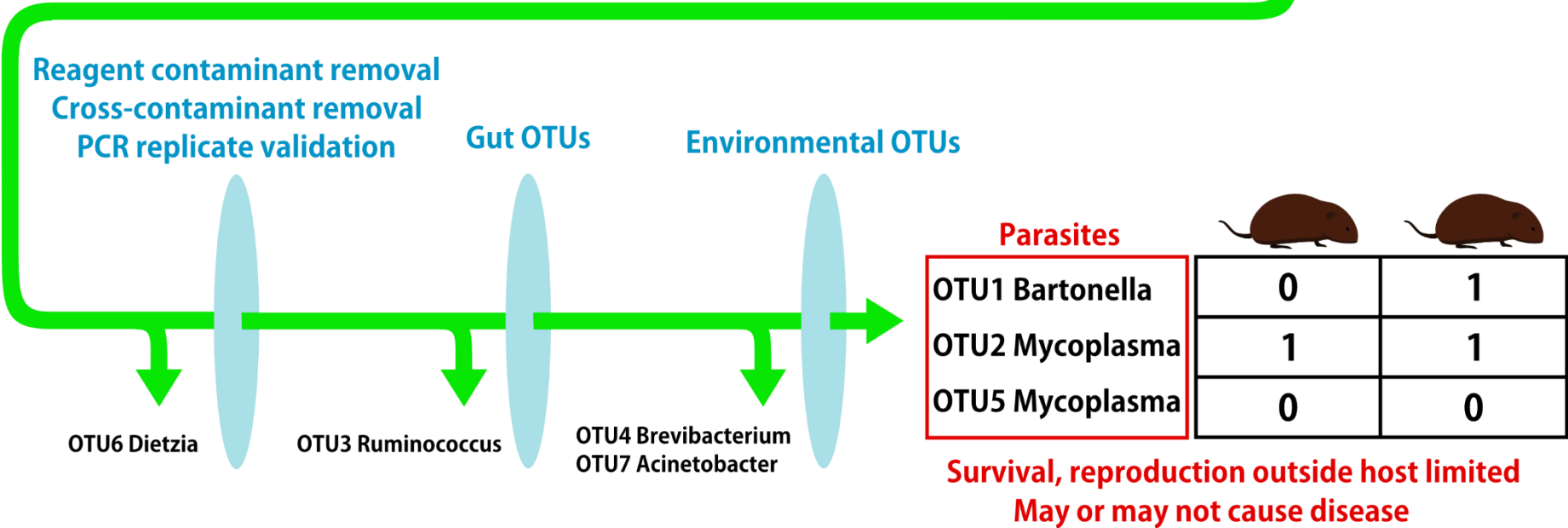
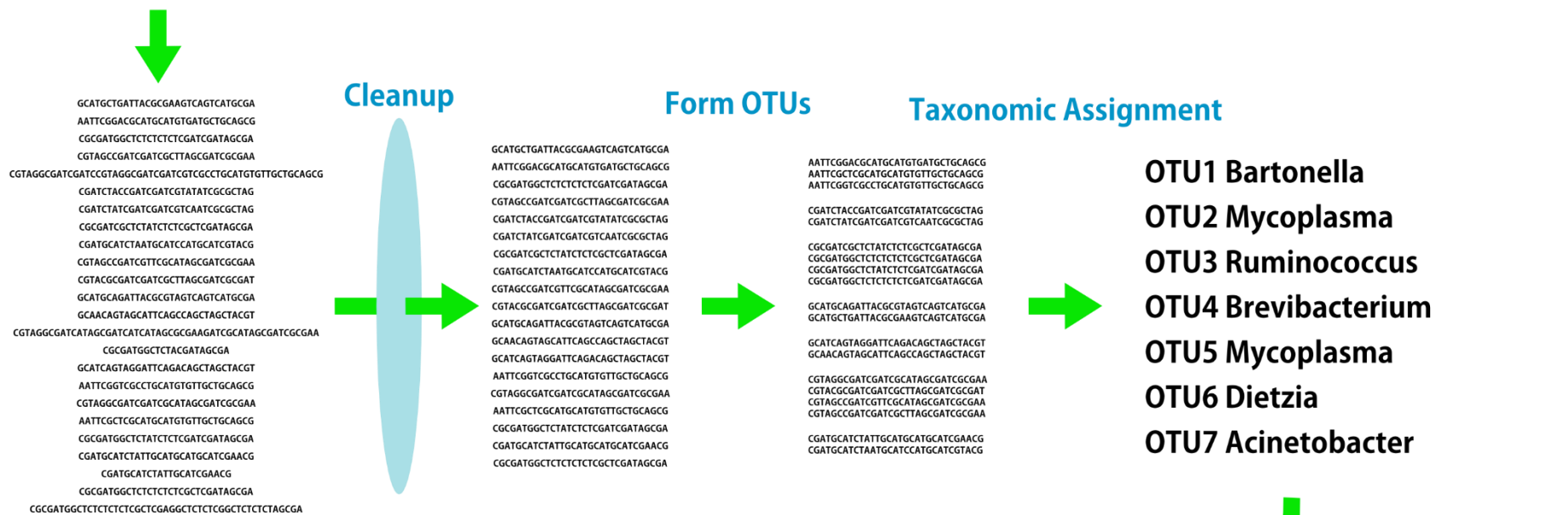
Pooled amplicons sent to sequencer



Unique index pairs in each well



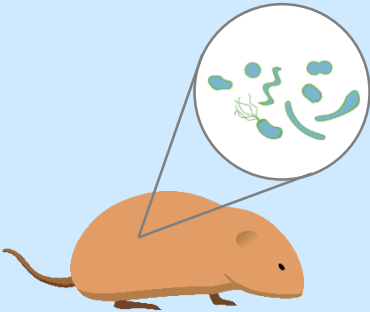
Amplicons pooled, purified



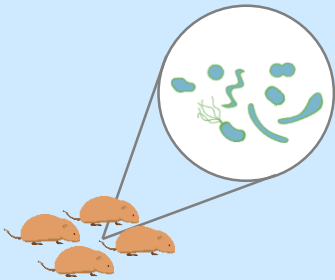
# Peak Phase: Bacterial Parasite Richness Bacterial Parasite Community Similarity

## Scales

### Infracommunity



### Component Community



## Intrinsic Factors

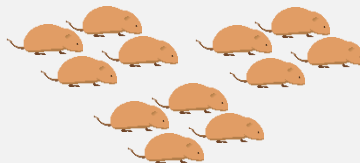
### Age Class



### Sex



### Abundance (Local, Commune)



## Extrinsic Factors

### Location



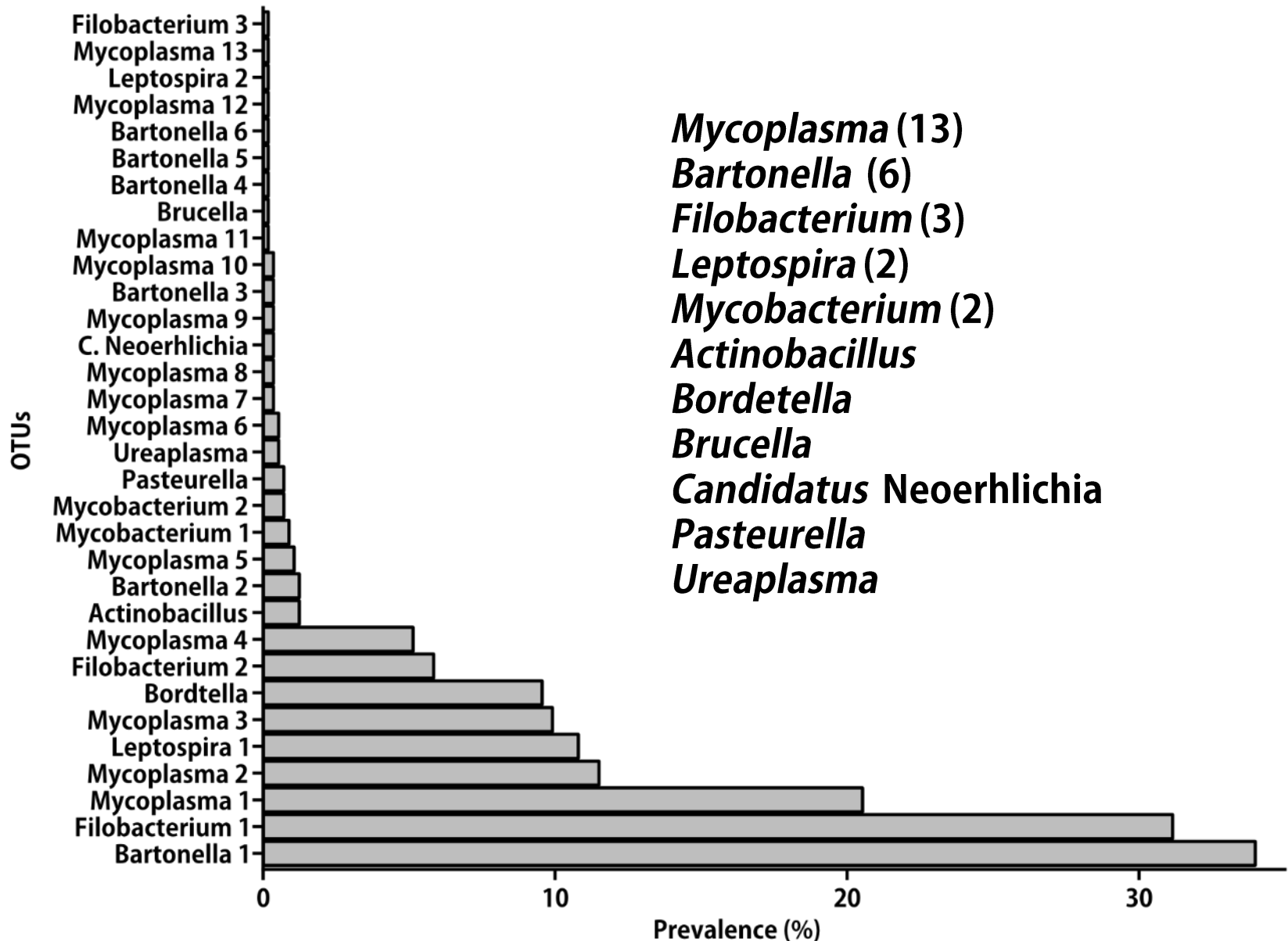
### Date (Season, Year)



2014 2015 2016



# Bacteria



# Questions:

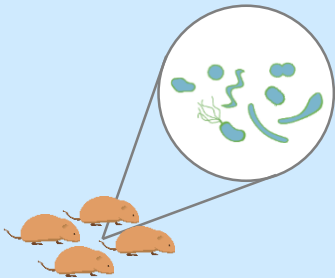
Parasite Richness  
Parasite Community Similarity

## Scales

### Infracommunity



### Component Community



## Intrinsic Factors

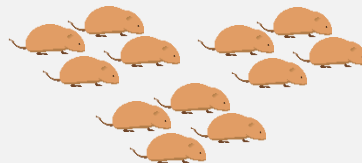
### Age Class



### Sex



### Abundance (Local, Commune)



## Extrinsic Factors

### Location

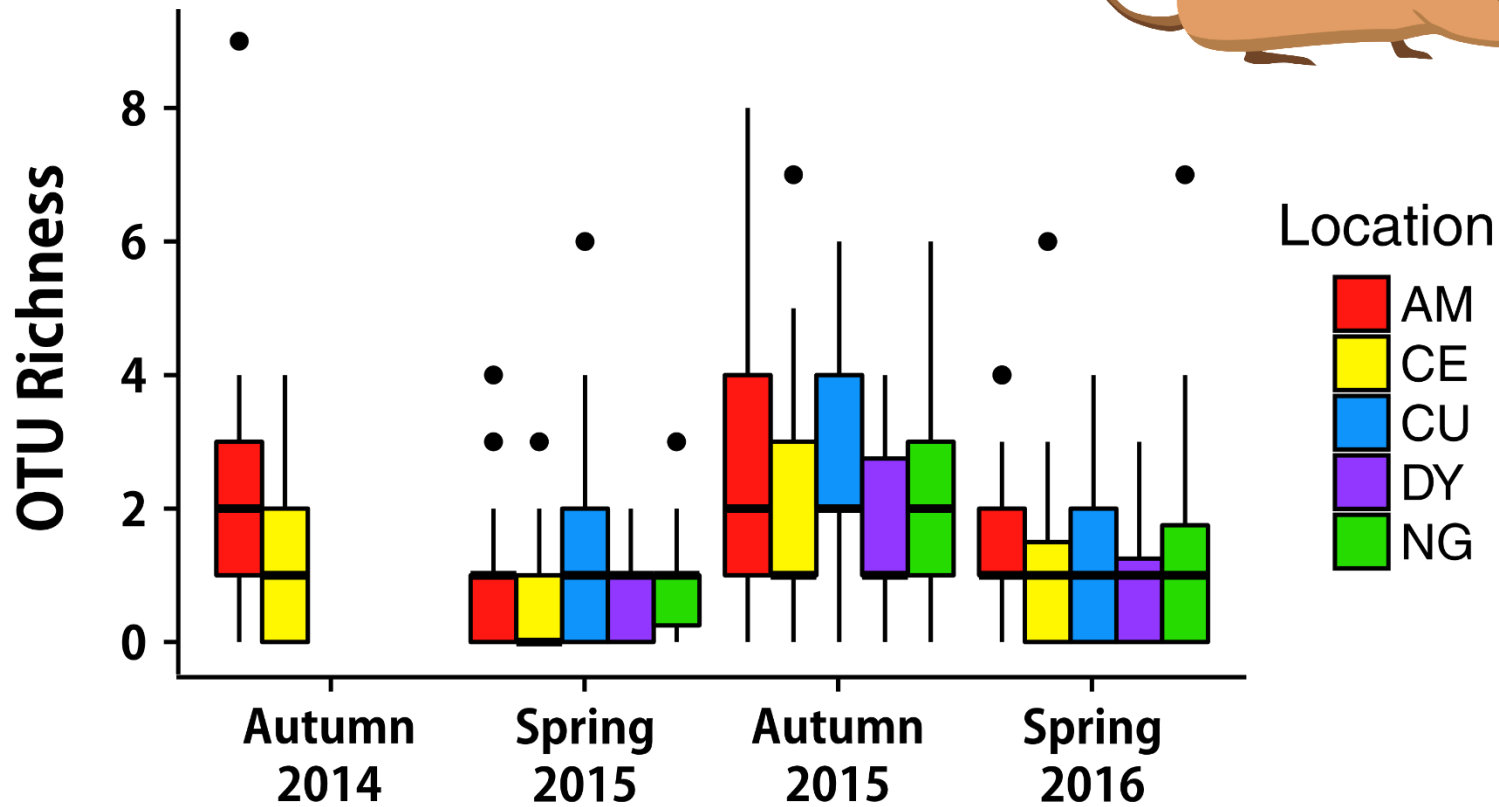
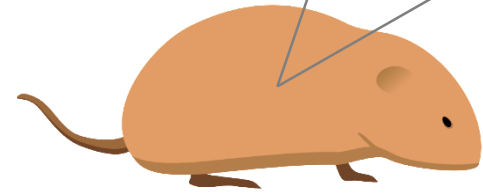
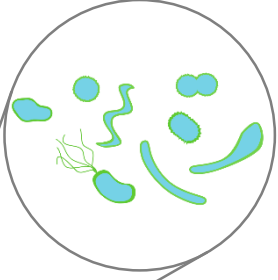


### Date (Season, Year)



2014 2015 2016

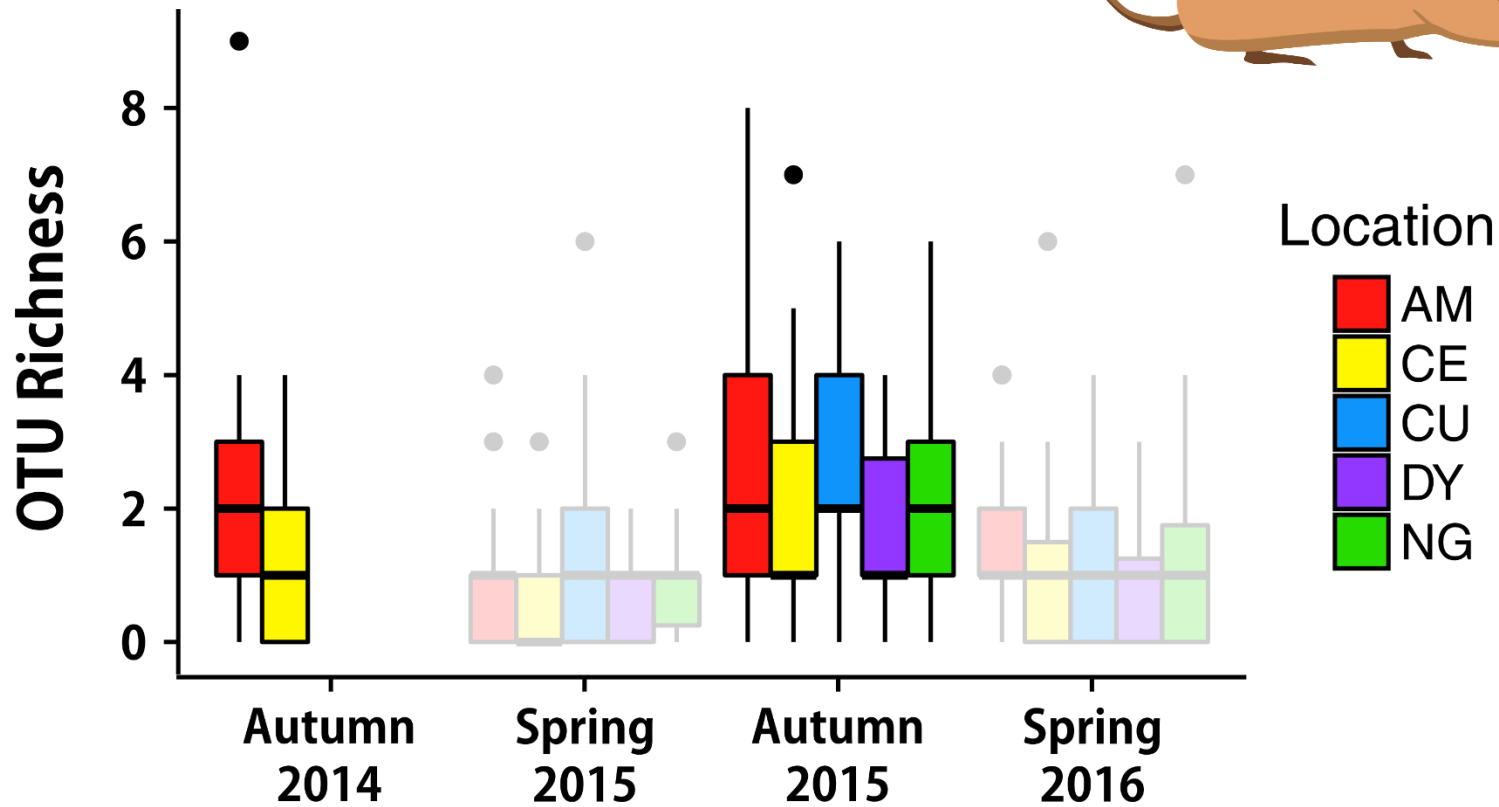
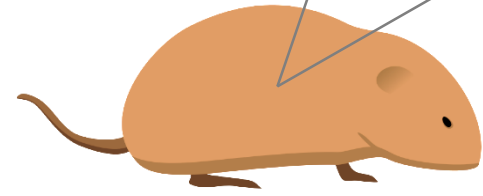
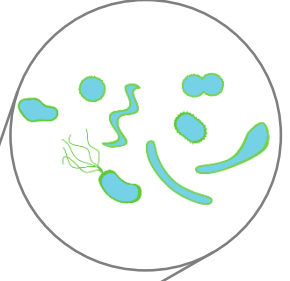
# Infracommunity richness



Zero-inflated Poisson Regression, AIC model selection

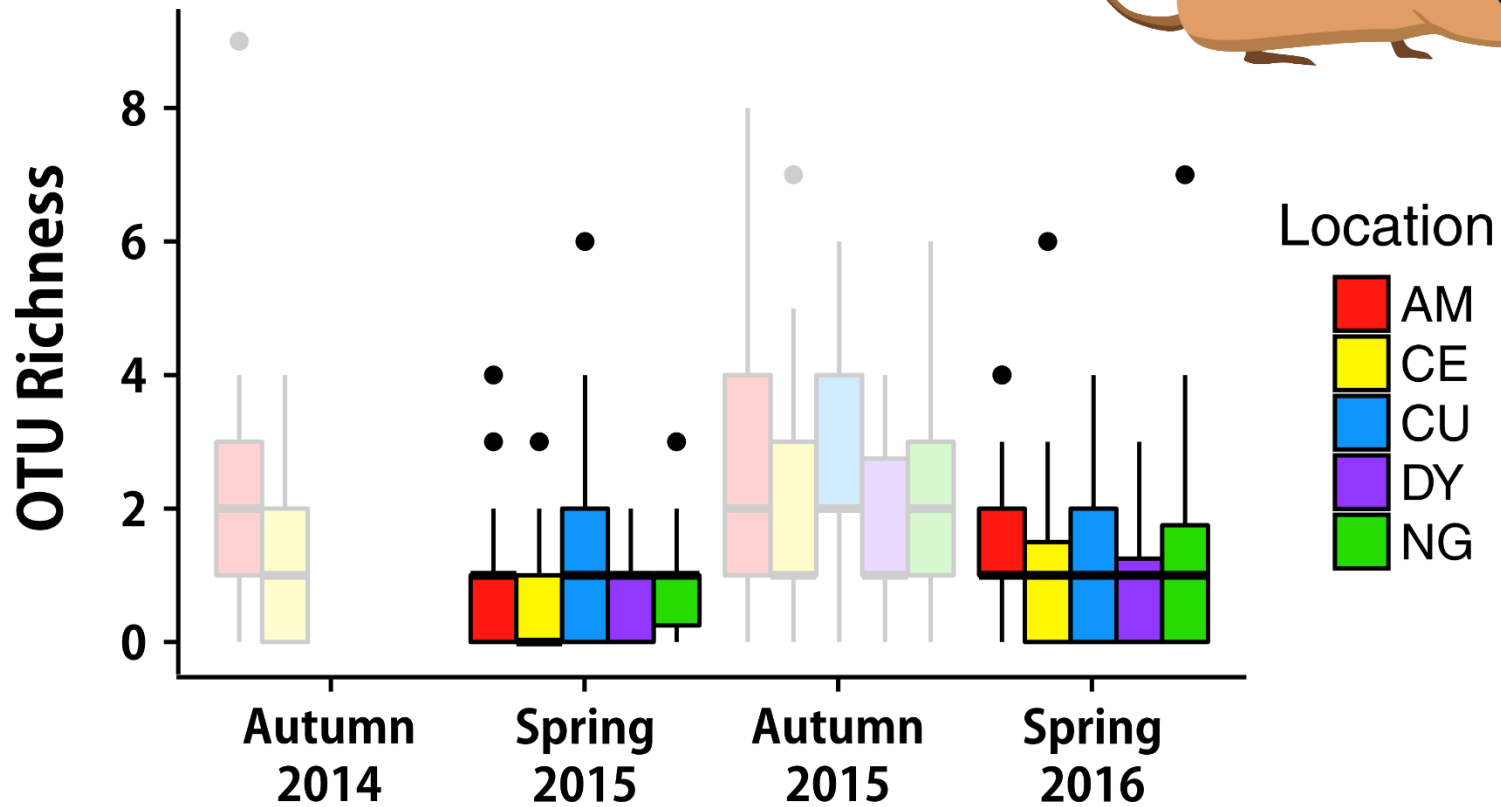
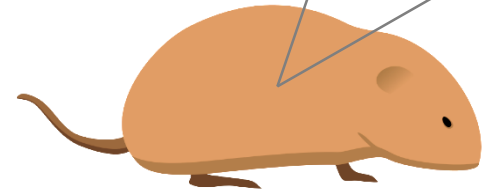
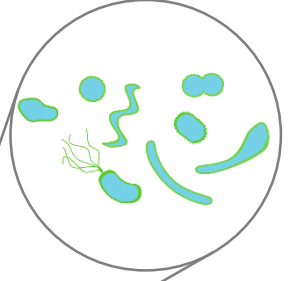


# Infracommunity richness

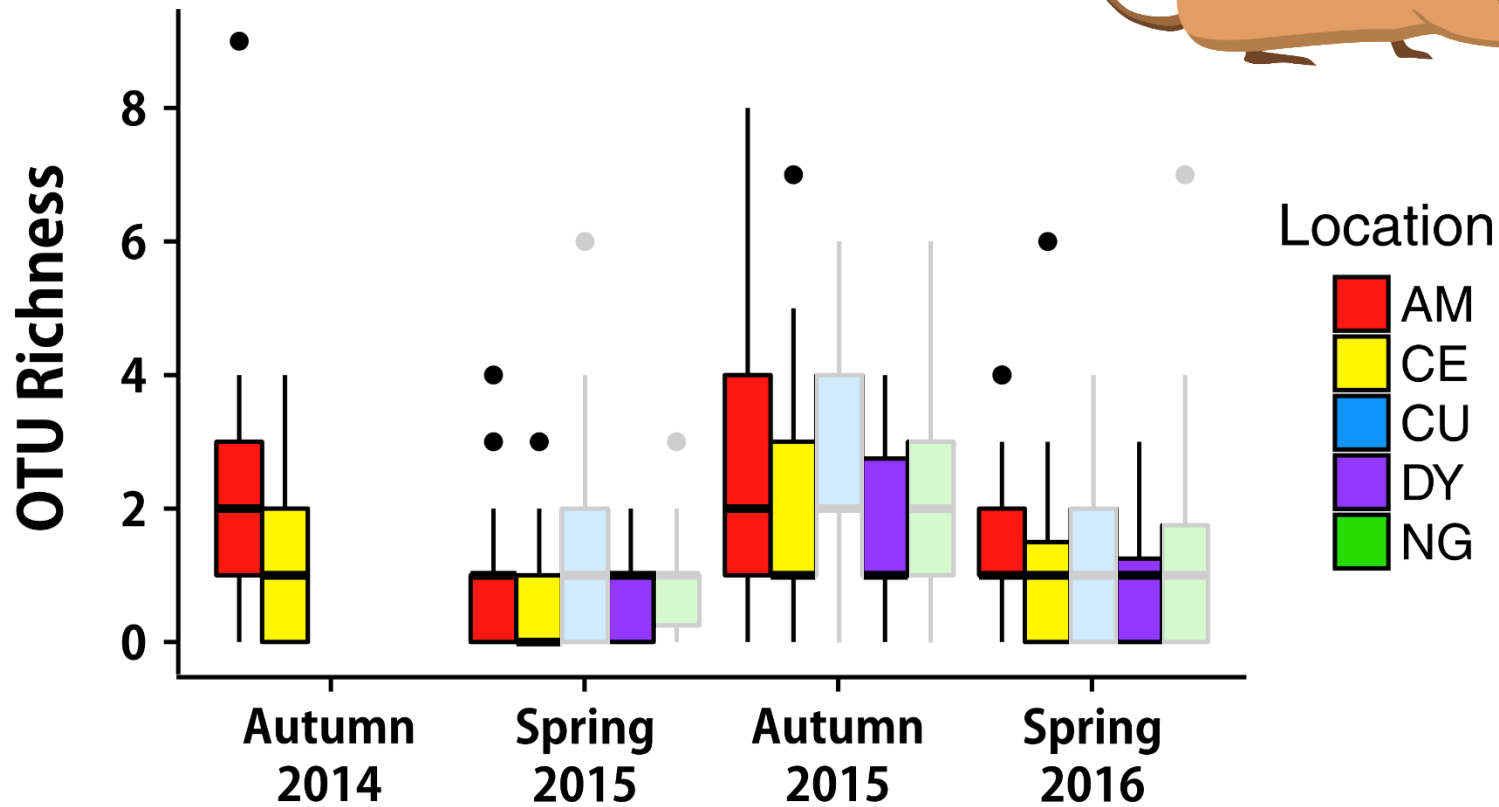
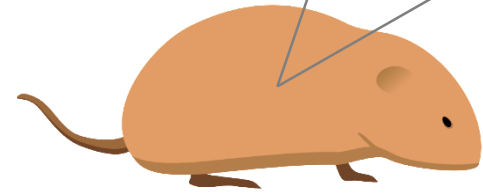
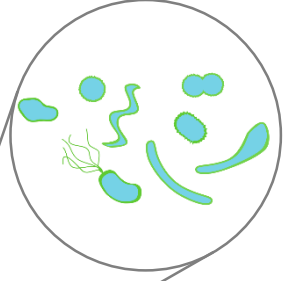


Zero-inflated Poisson Regression, AIC model selection

# Infracommunity richness

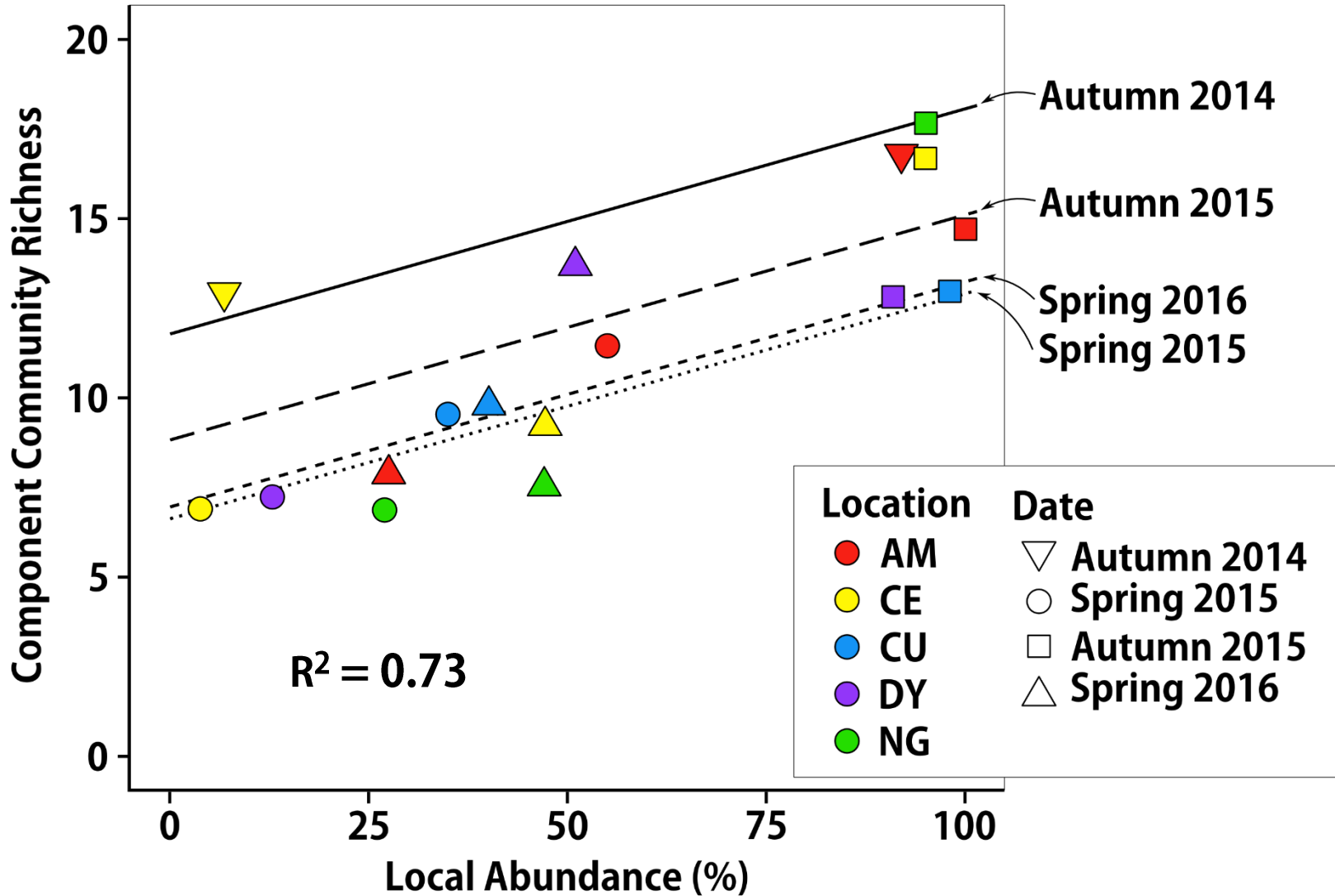
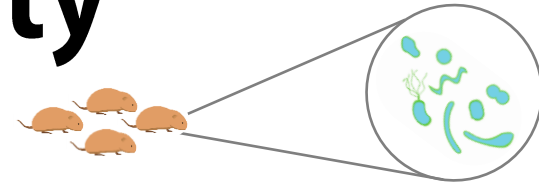


# Infracommunity richness



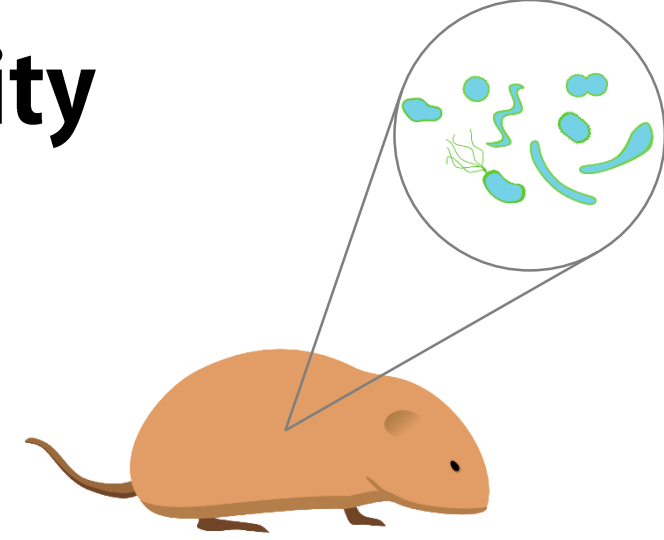
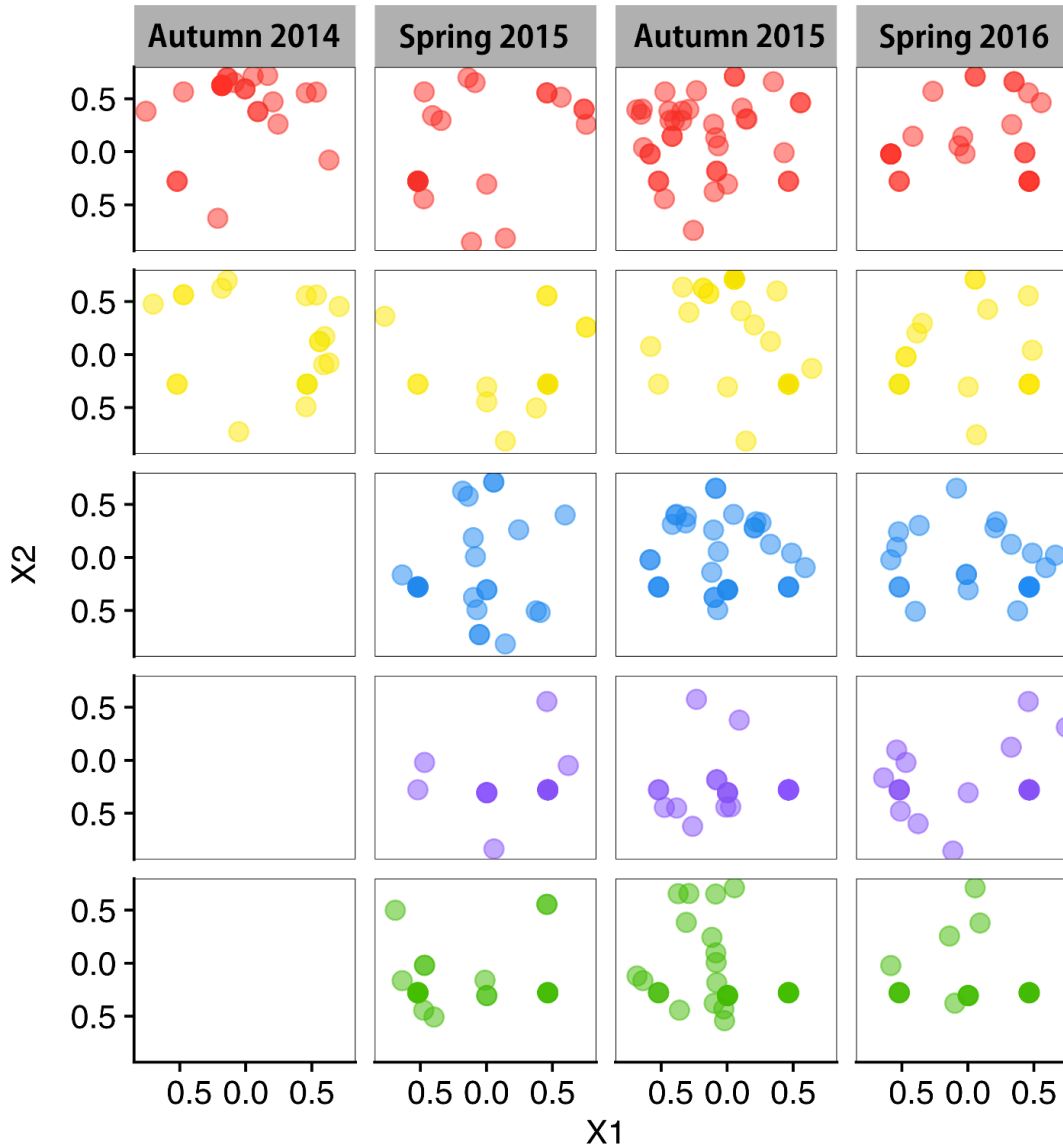


# Component Community richness



GLM, AIC model selection

# Infracommunity Similarity



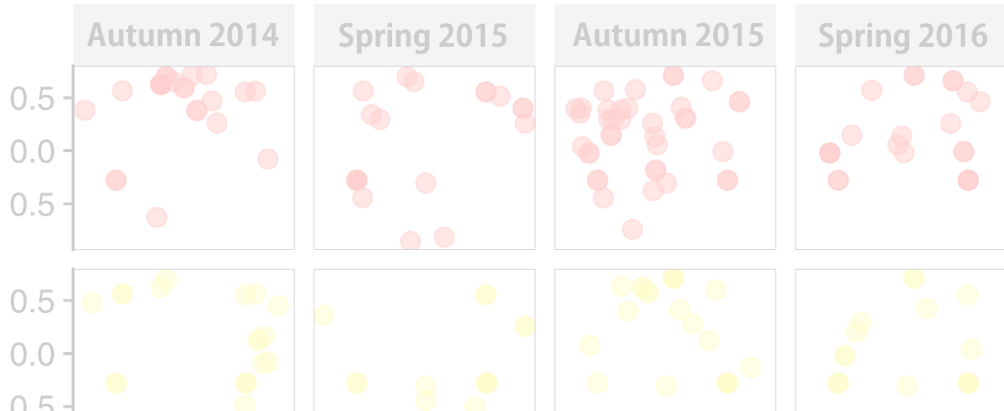
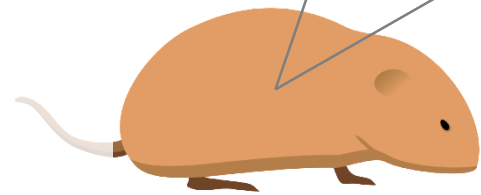
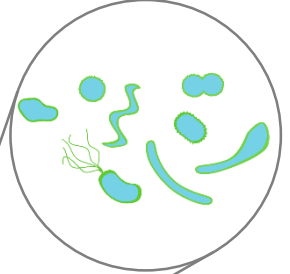
## Location

- AM
- CE
- CU
- DY
- NG

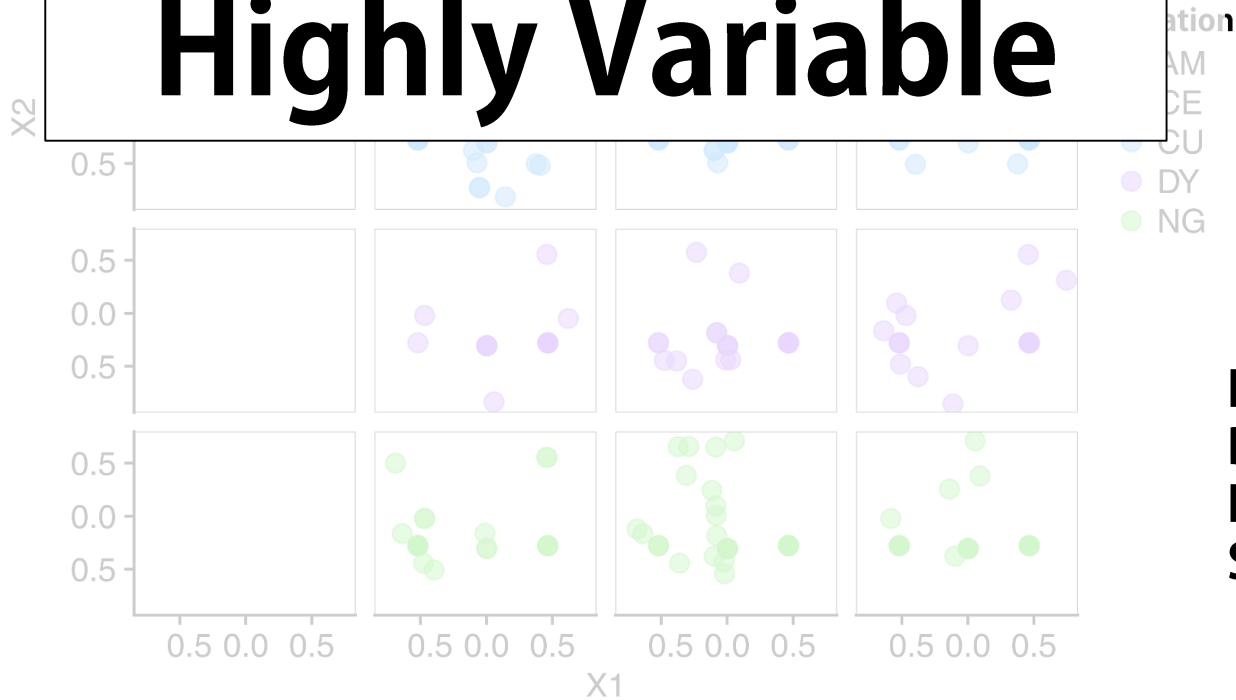
## PERMANOVA

**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



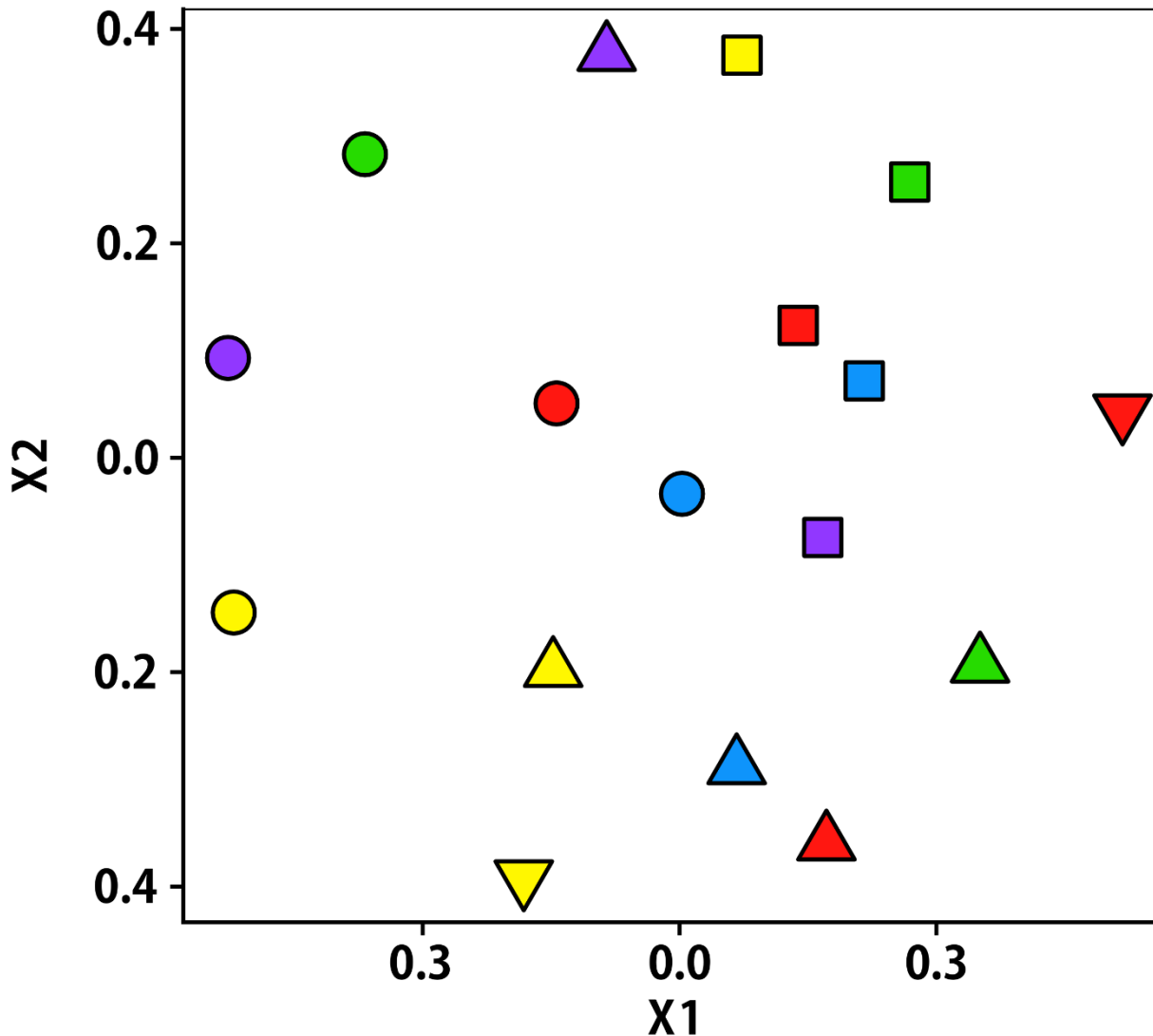
## Date

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

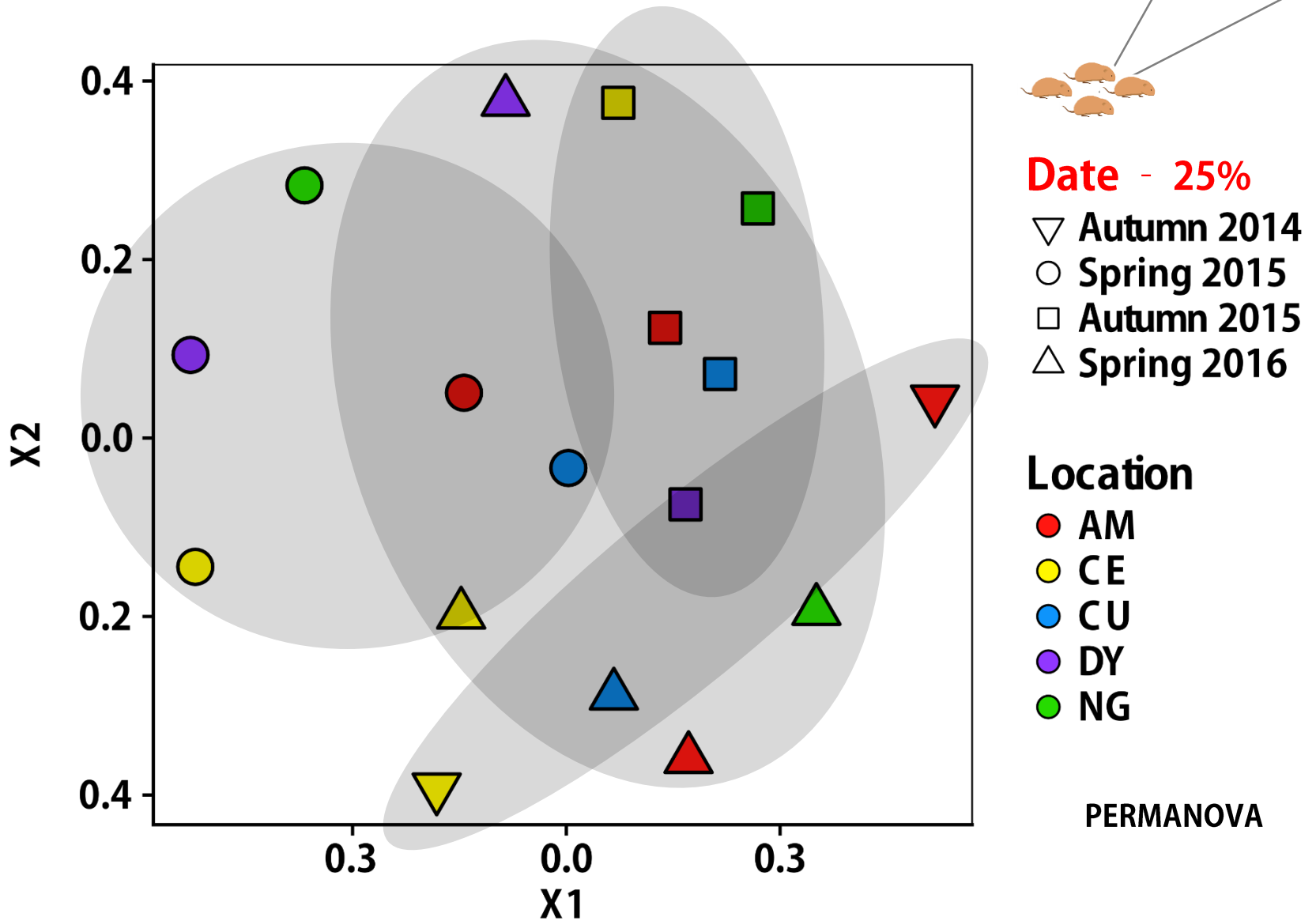
## Location

- AM
- CE
- CU
- DY
- NG

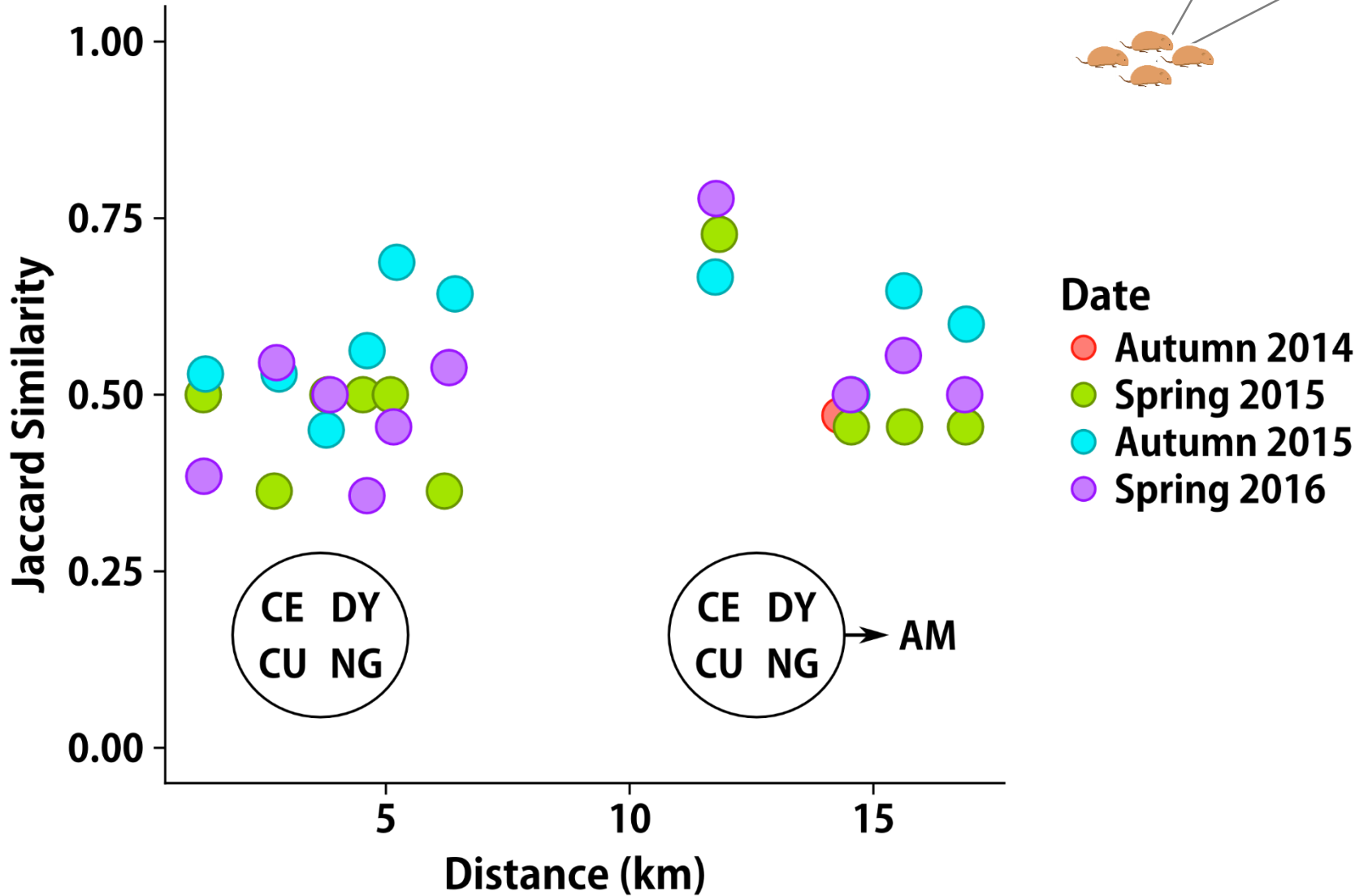
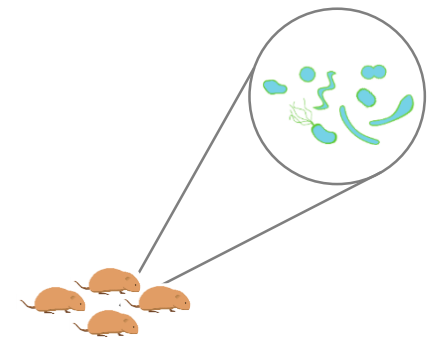
PERMANOVA



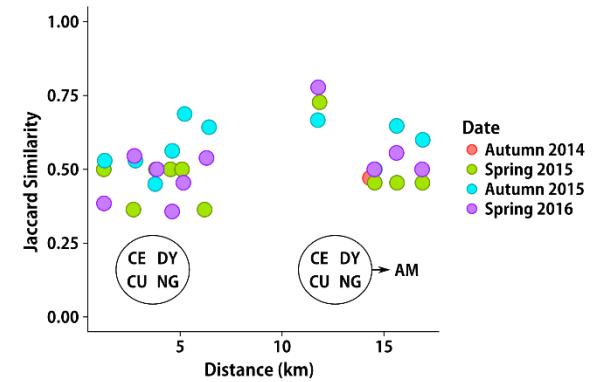
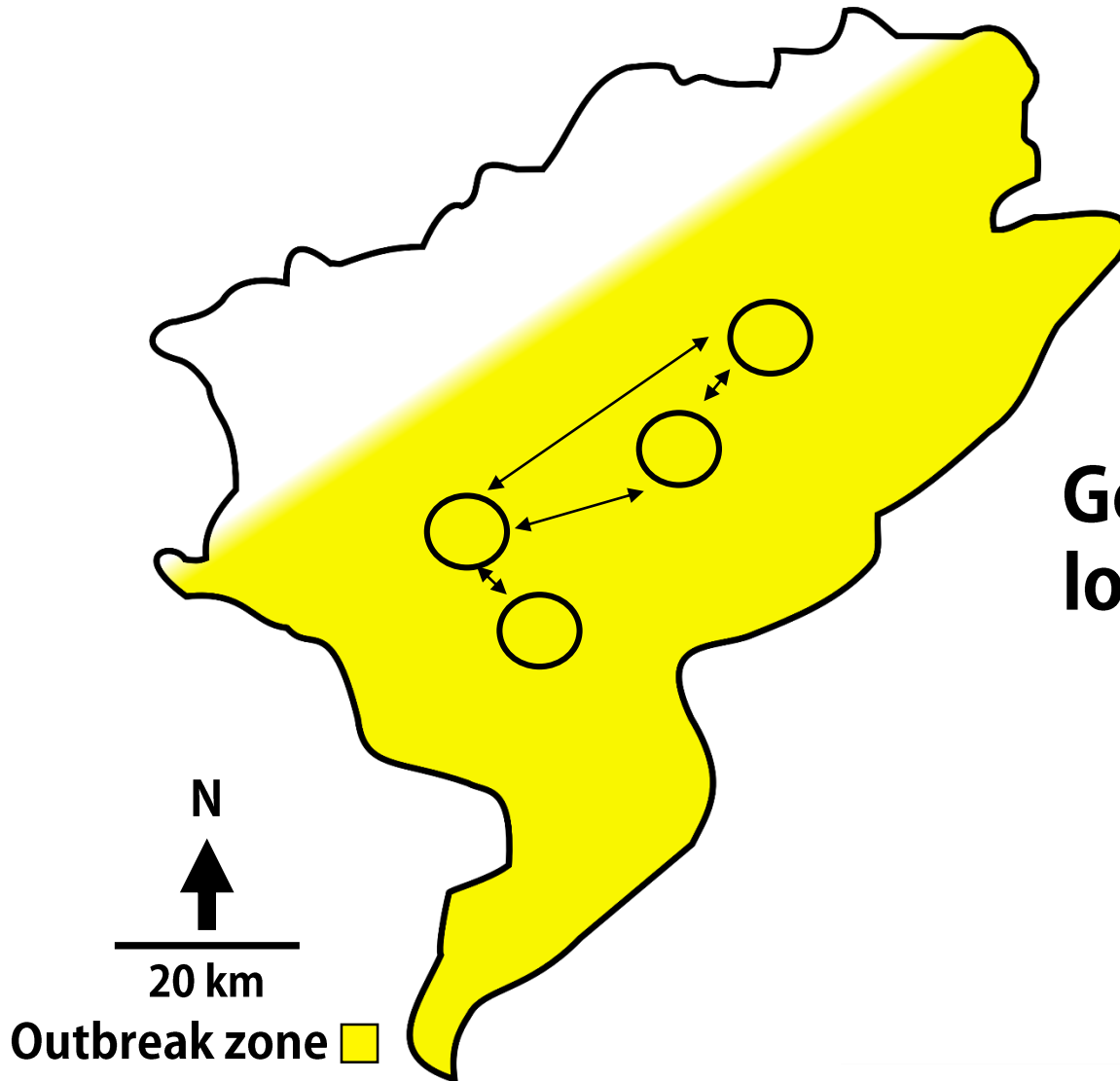
# Component Community Similarity



# Geographic Distance



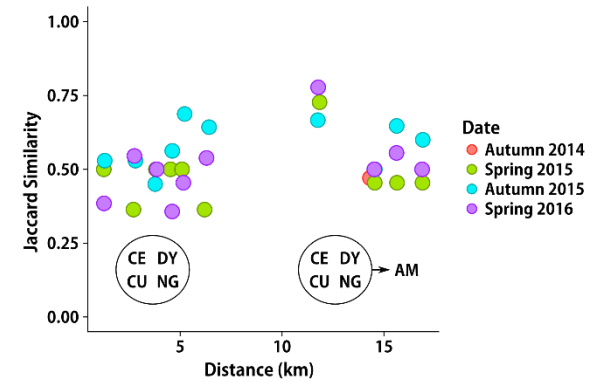
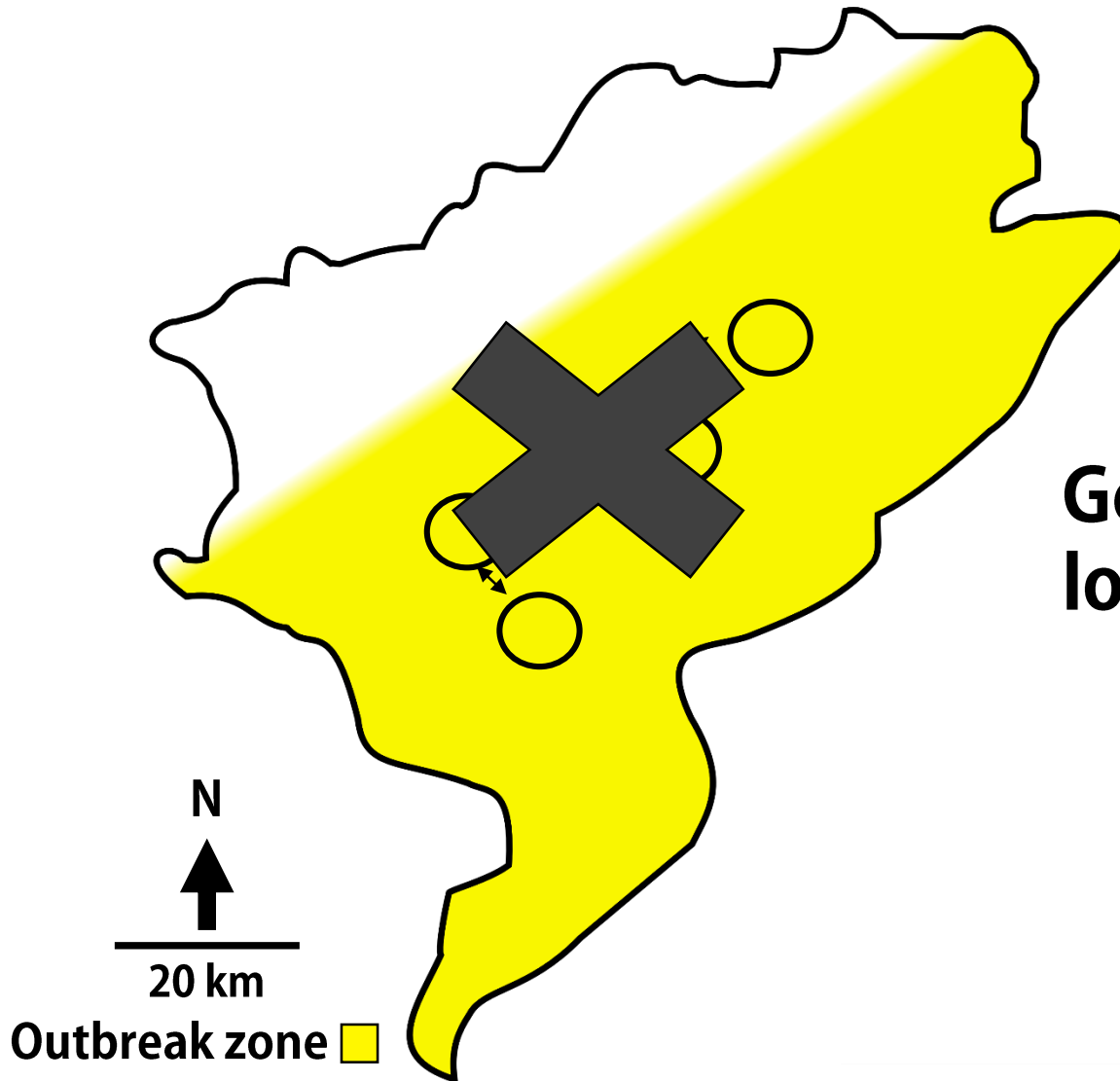
# Geographic Distance



**Gene flow low at low density**

(Berthier et al 2005, 2006)

# Geographic Distance

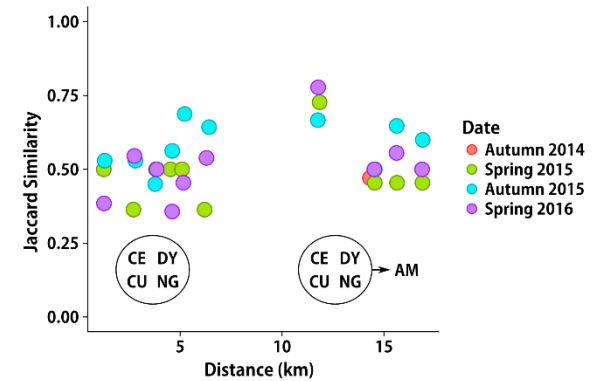
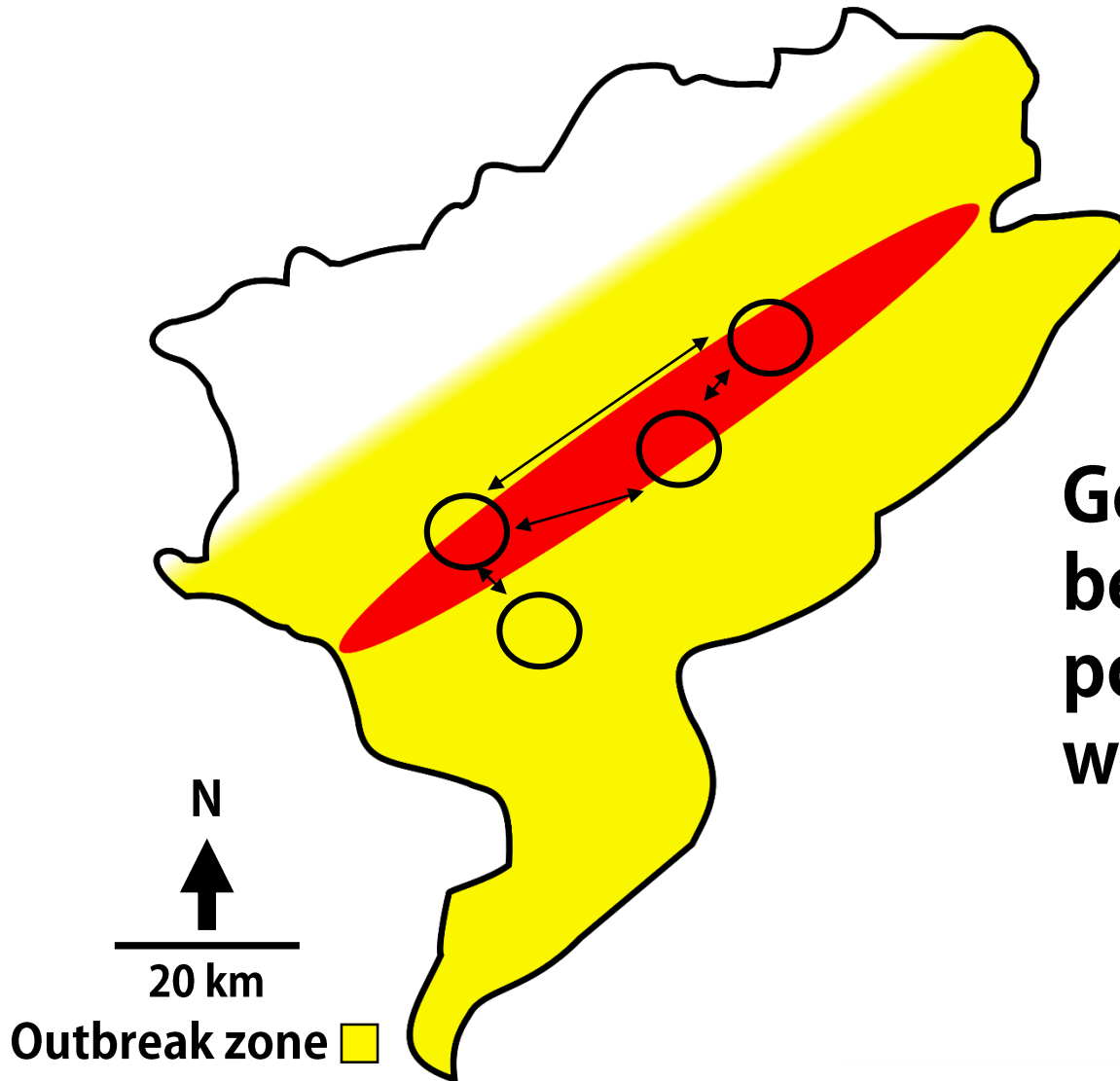


**Gene flow low at low density**

(Berthier et al 2005, 2006)



# Geographic Distance



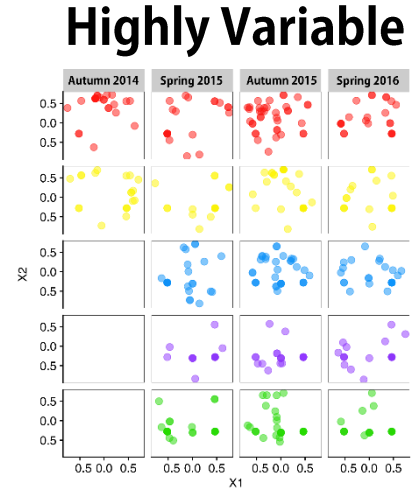
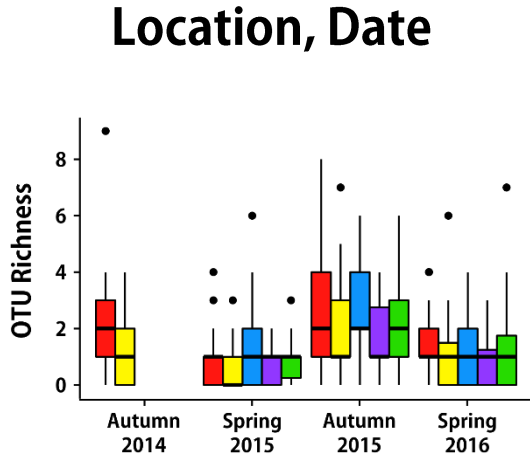
**Gene flow high between peak populations, decays with distance**

(Berthier et al 2005, 2006)

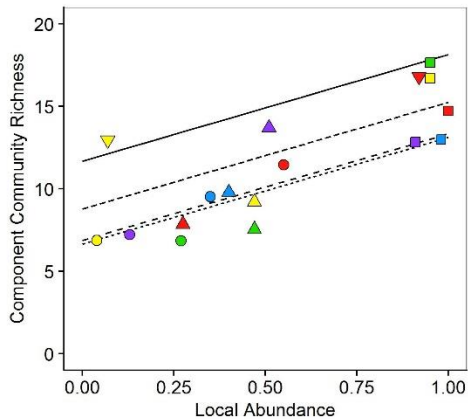
# Summary

## Richness

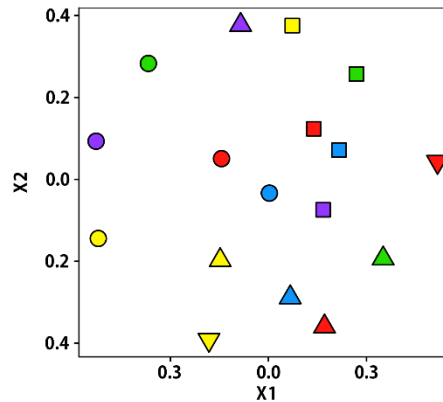
## Community Similarity



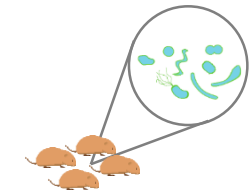
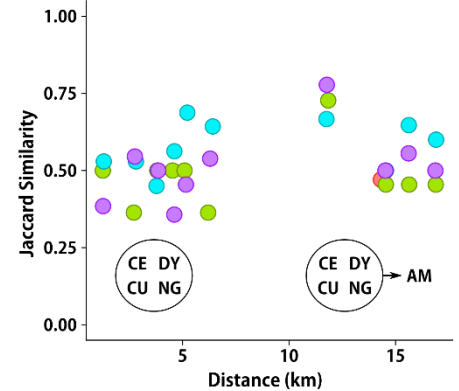
### Local Abundance, Date



### Date



### Geographic Distance



# Thanks for all the help!

- Amaël Dupaix
- Aurélie Guislain-Vitek
- Aurélien Levret
- Bérangère Foscarin
- Caroline Tatard
- 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



UNIVERSITÉ  
BOURGOGNE FRANCHE-COMTE



CHRONO  
ENVIRONNEMENT

INRA  
SCIENCE & IMPACT

UMR CBGP



Zone  
Atelier

LTER FRANCE ARC JURASSIEN

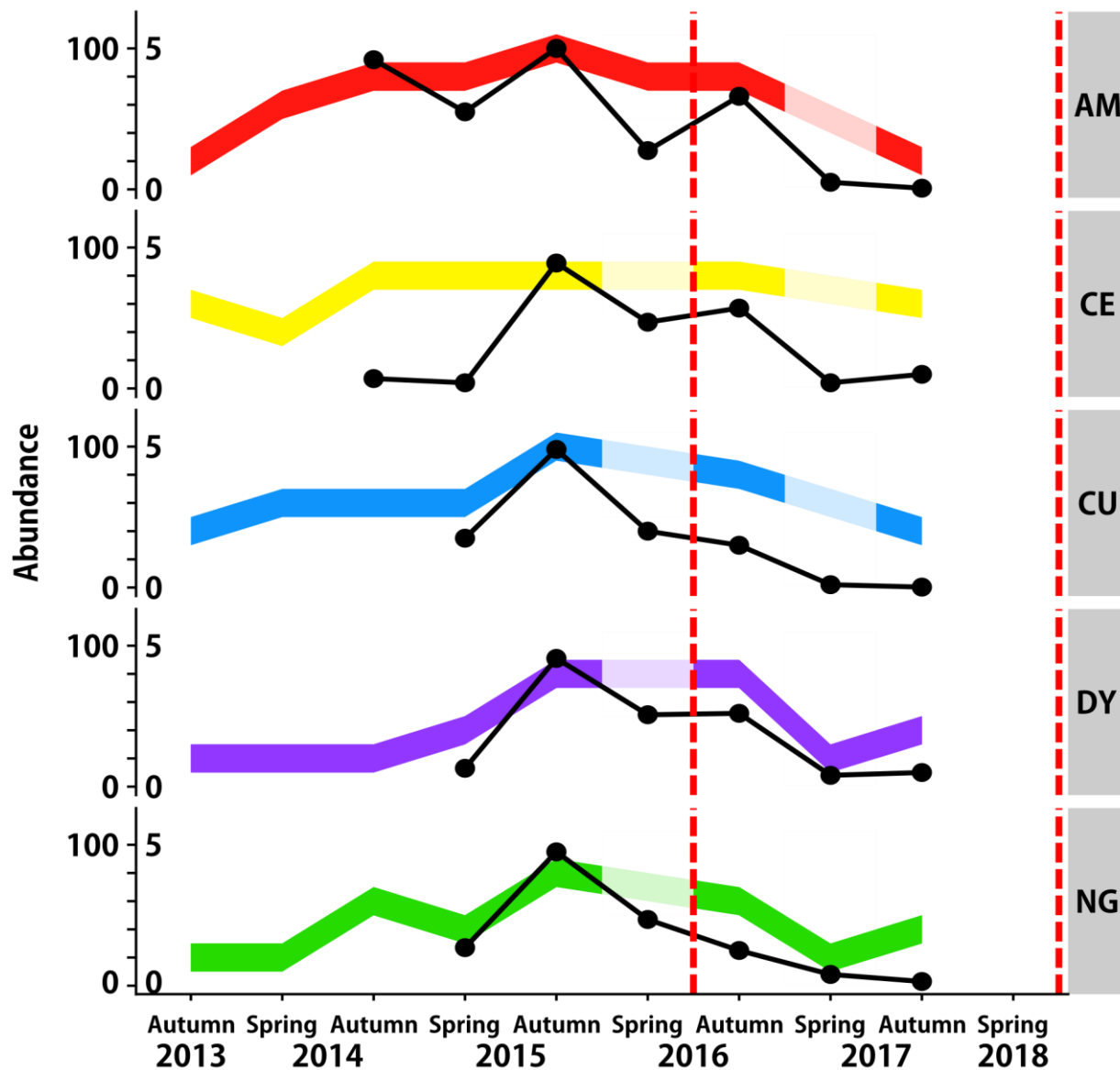
# Merci!



RÉGION  
BOURGOGNE  
FRANCHE  
COMTÉ



# Future Directions - Decline



What happens after spring 2016?

Richness

Community  
Composition