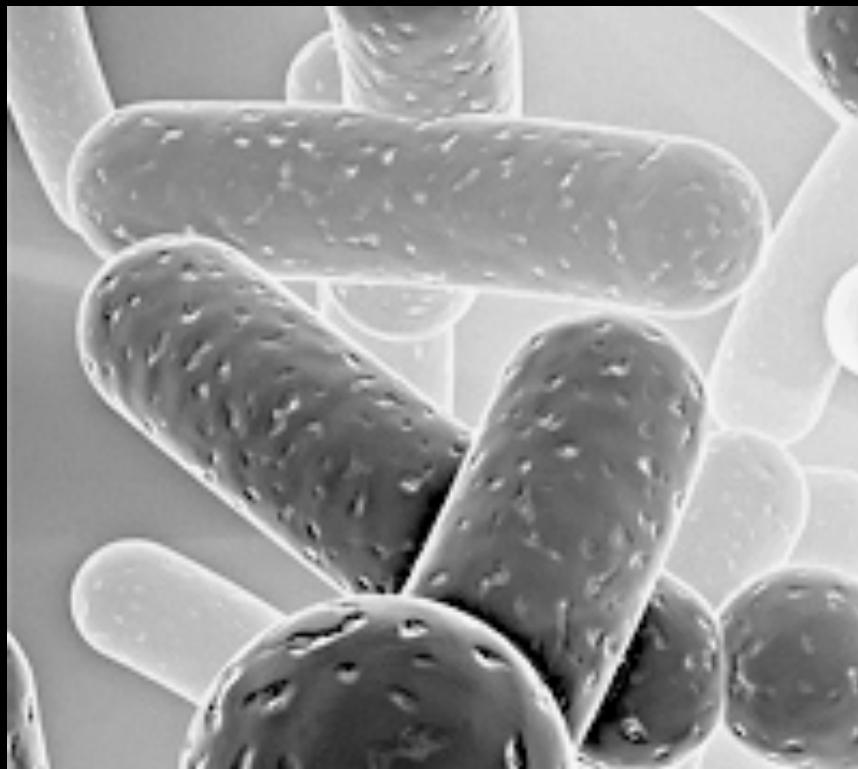


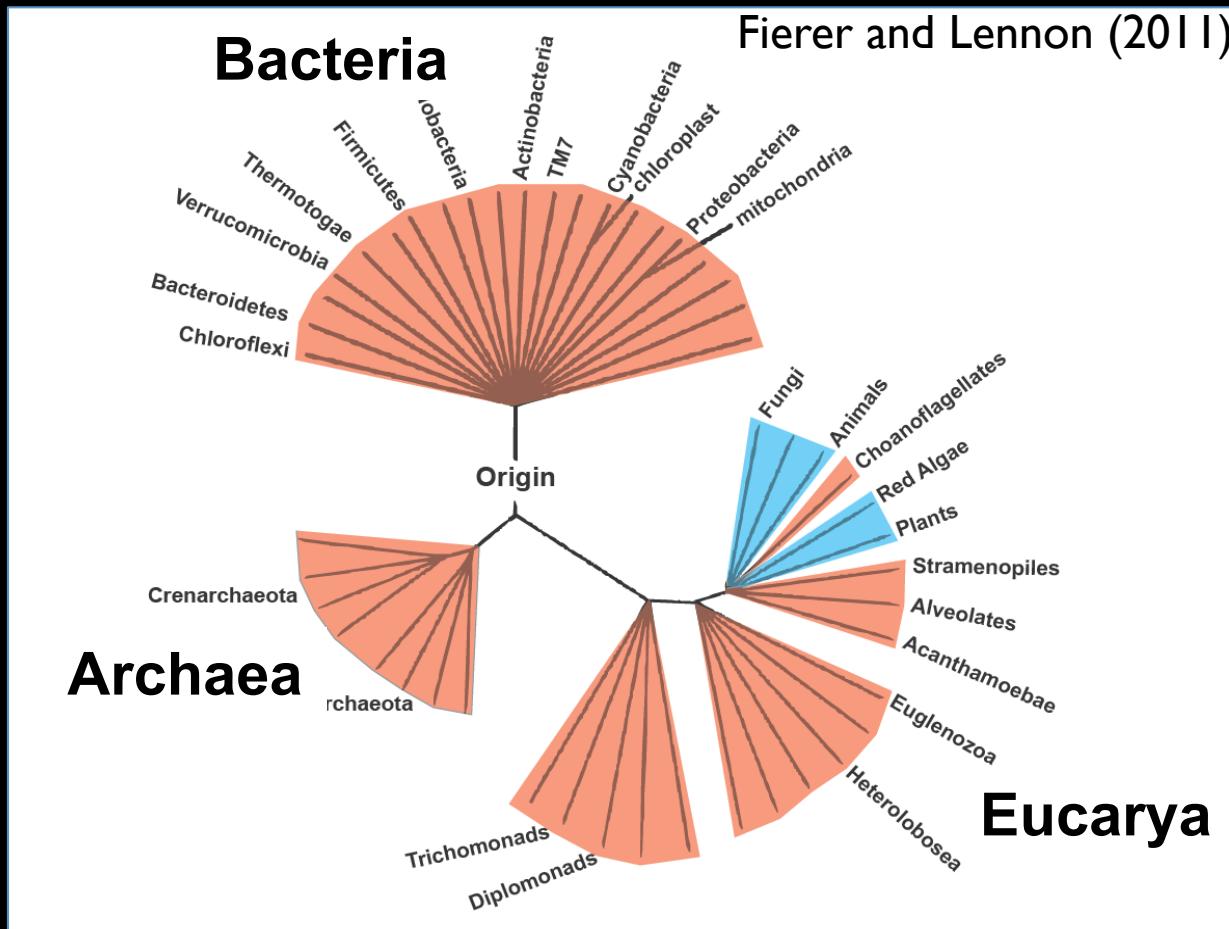
# Microbial Seed Banks:

## Ecological and Evolutionary Implications of Dormancy



Jay T. Lennon  
Indiana University

# What generates and maintains biodiversity?



## How does it affect ecosystem stability and function?

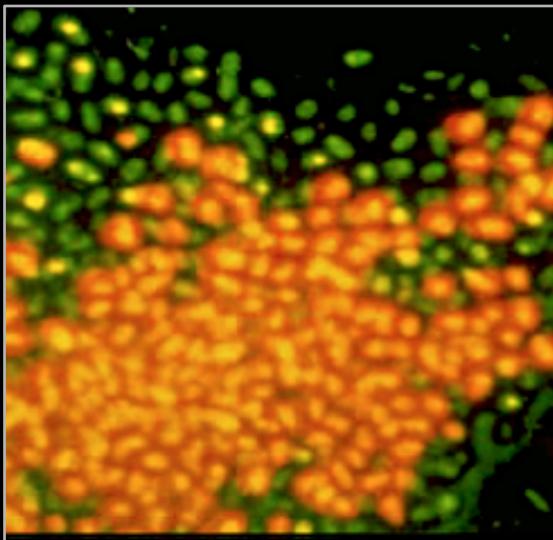
# Dormancy allows species to persist in unfavorable environments



# Dormancy is found in microbes, too

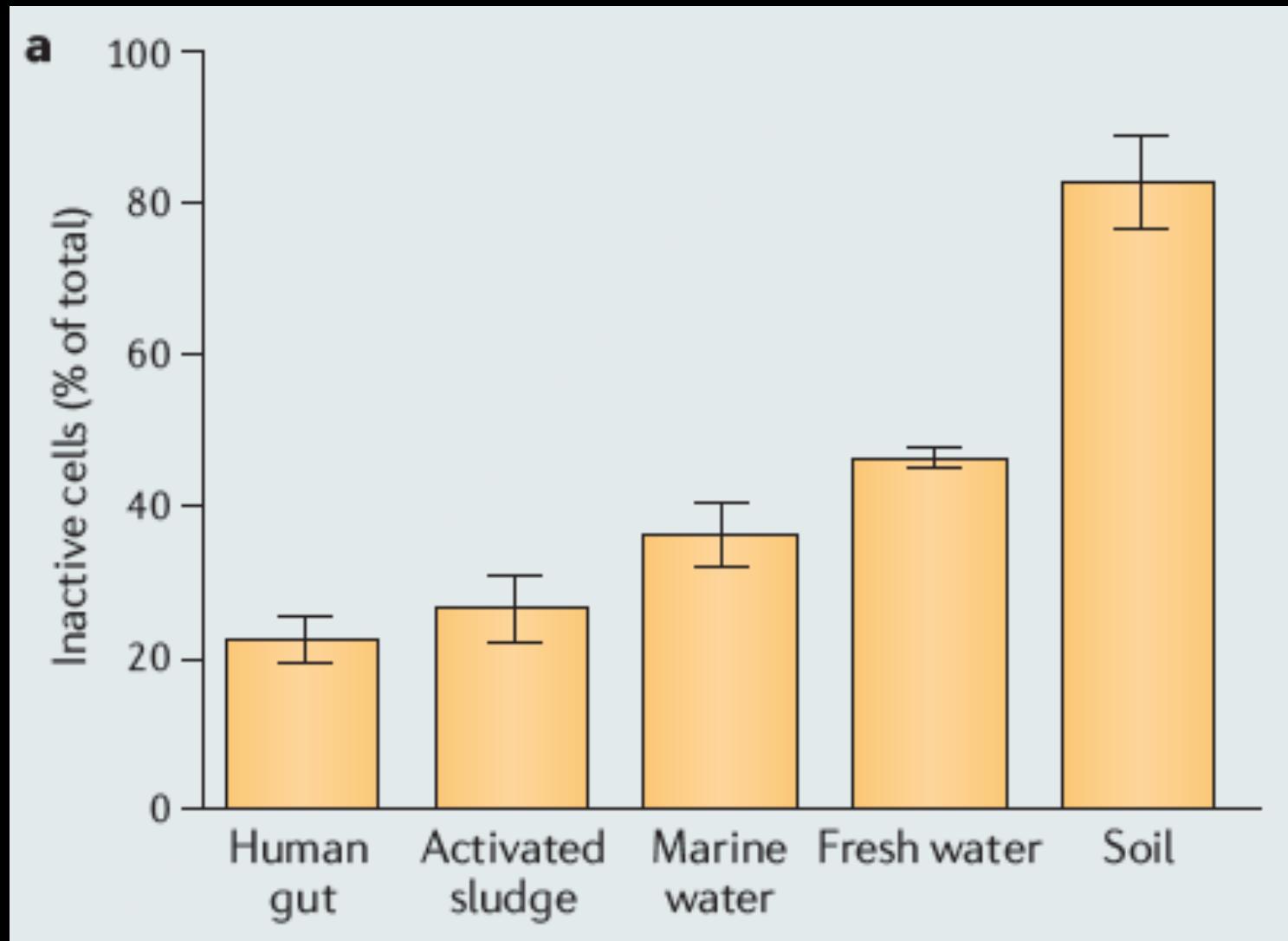


# Dormancy is found in microbes, too



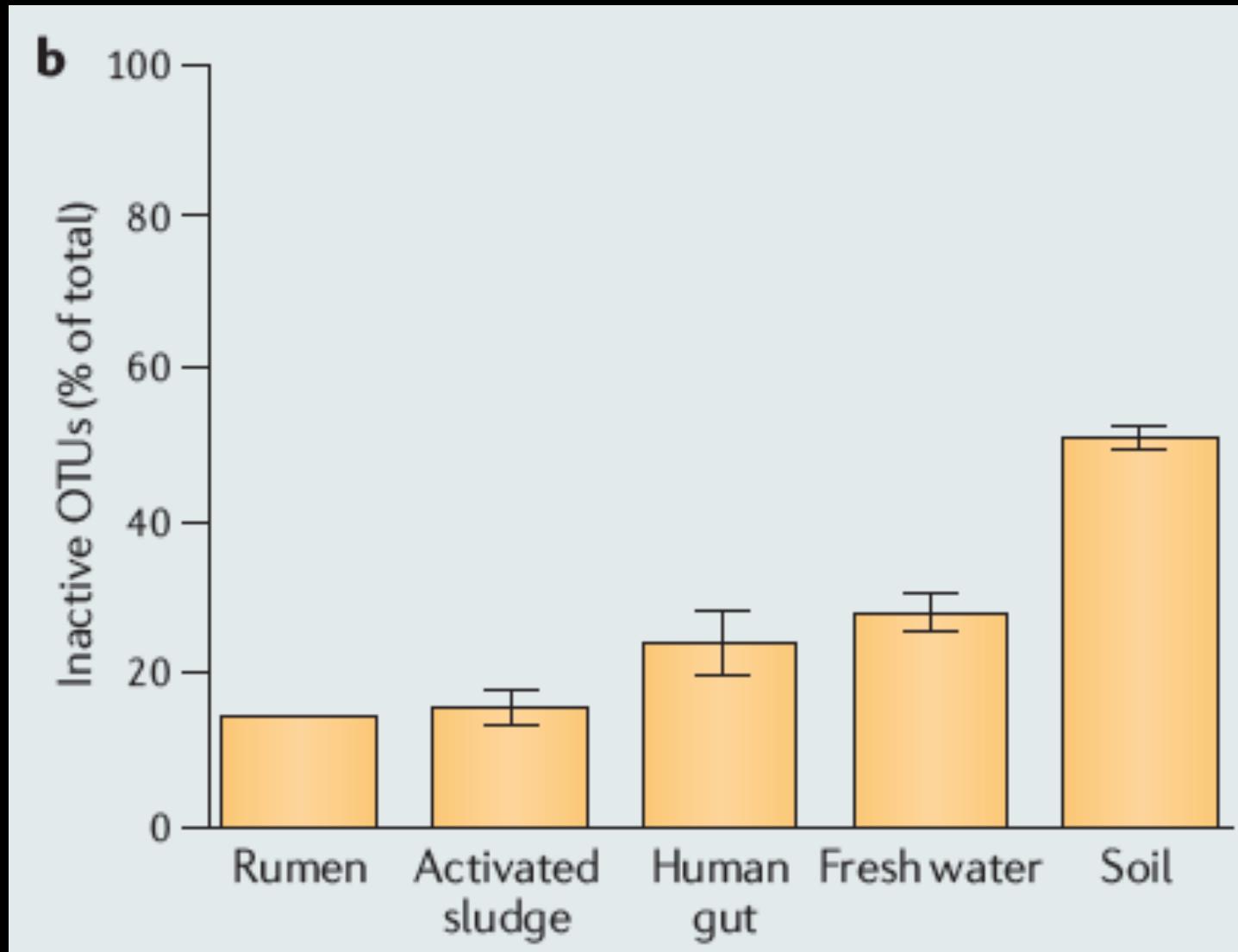
How prevalent is dormancy in nature?

# Dormant Cells in Different Ecosystems



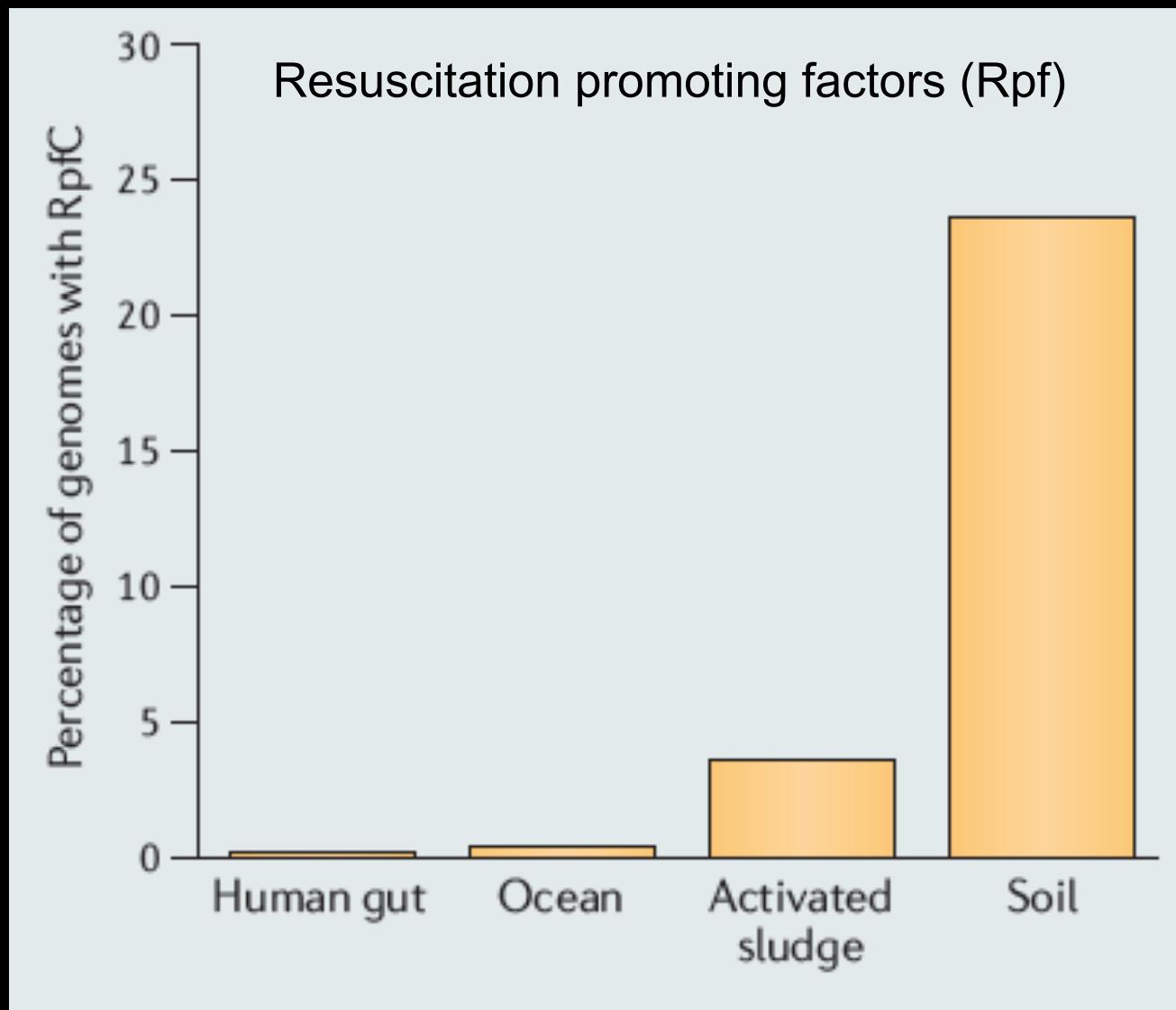
*Lennon and Jones (2011)*  
*Nature Reviews Microbiology*

# Dormant 'Species' in Different Ecosystems



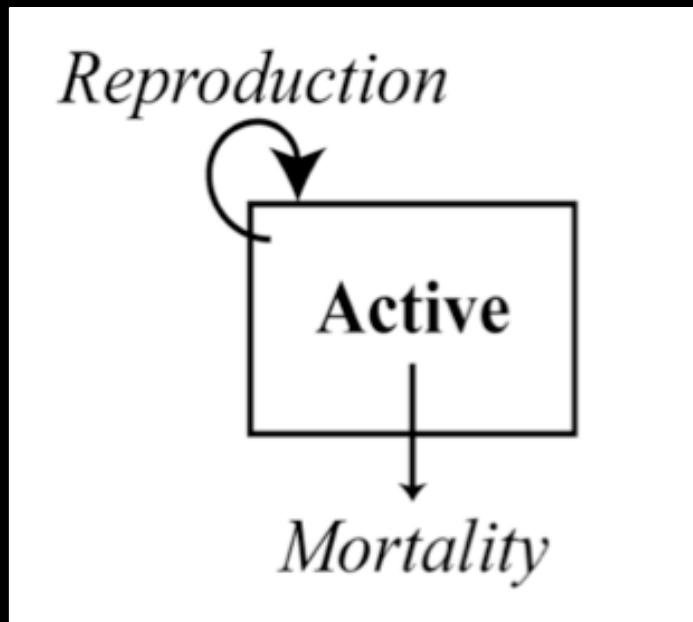
*Lennon and Jones (2011)*  
*Nature Reviews Microbiology*

# Dormancy Genes in Different Ecosystems

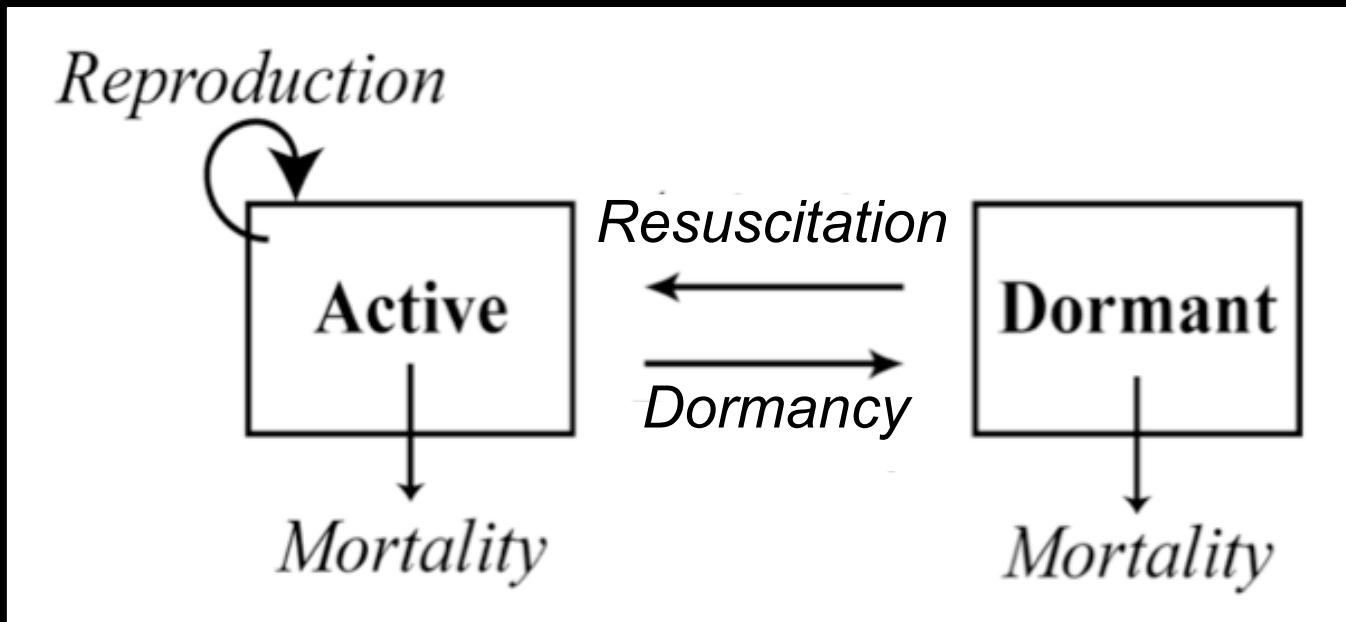


*Lennon and Jones (2011)*  
*Nature Reviews Microbiology*

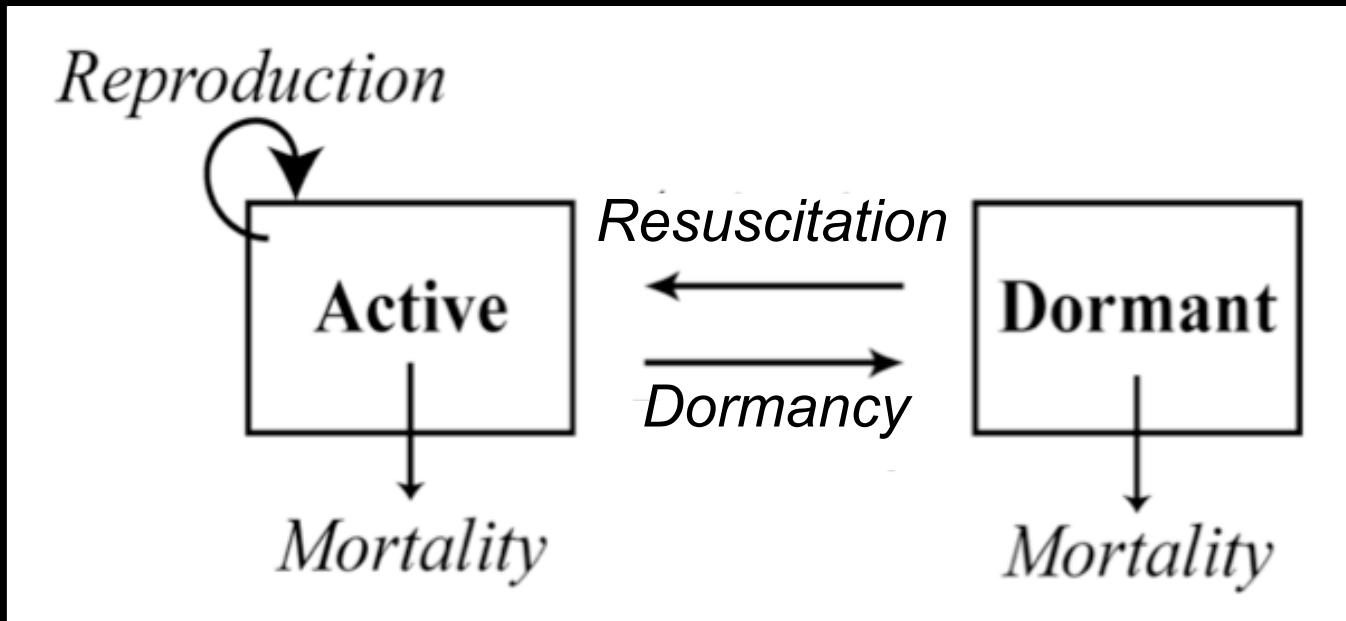
# Modeling microbial dormancy



# Modeling microbial dormancy



# Modeling microbial dormancy



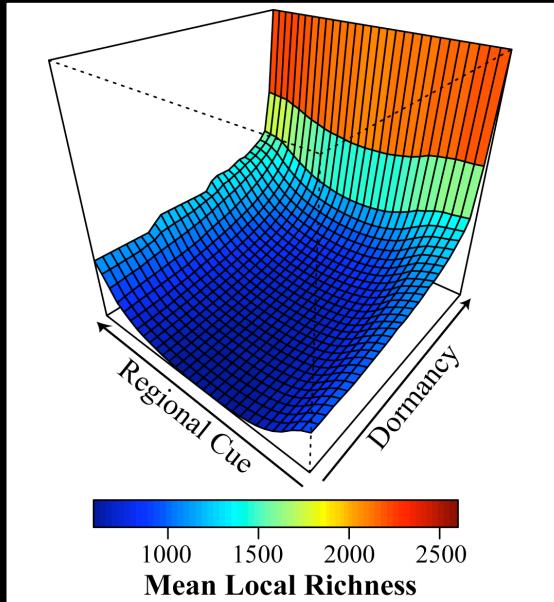
Active:  $\frac{dA}{dt} = \frac{rA}{K} + (D \cdot R) - m_a^{(1-R)A}$

Growth      Resuscitation      Mortality

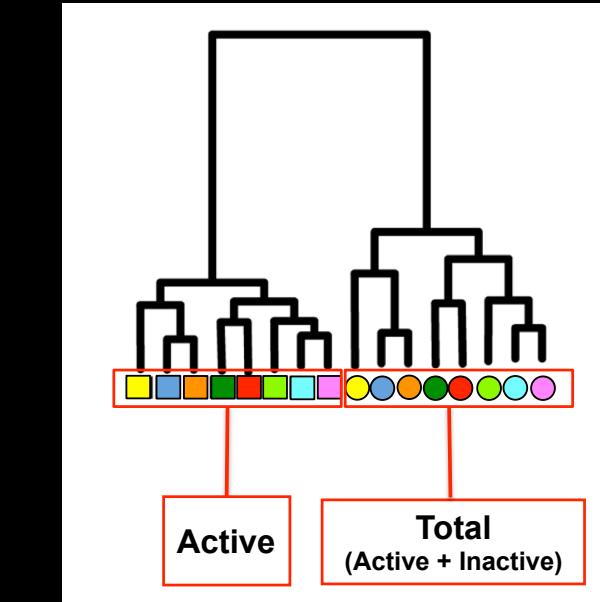
Dormant:  $\frac{dD}{dt} = (1 - R)A - (D \cdot R) - (D \cdot m_d)$

Dormancy      Resuscitation      Mortality

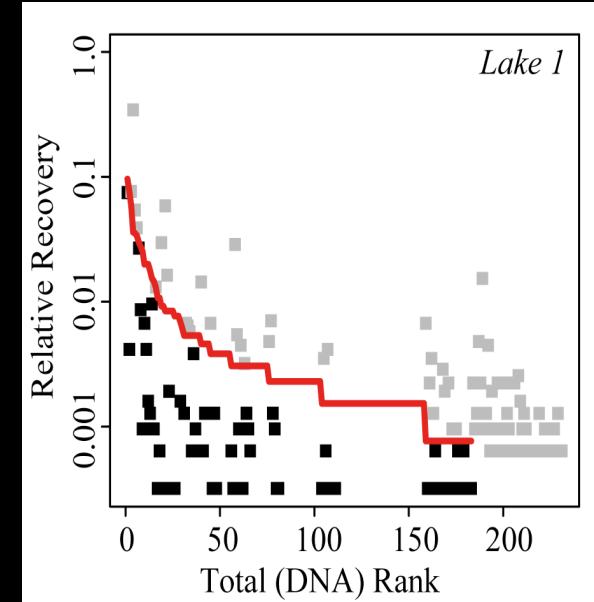
# Dormancy maintains microbial diversity



Richness



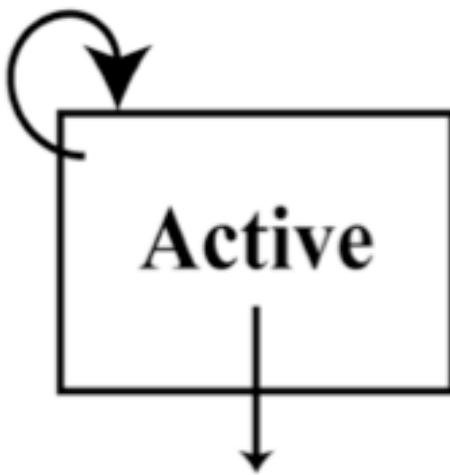
Composition



Rare Biosphere

**Transitions:**  
How long can bacteria survive during dormancy?

*Reproduction*

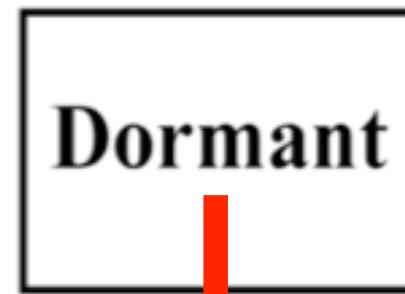


*Mortality*

*Resuscitation*

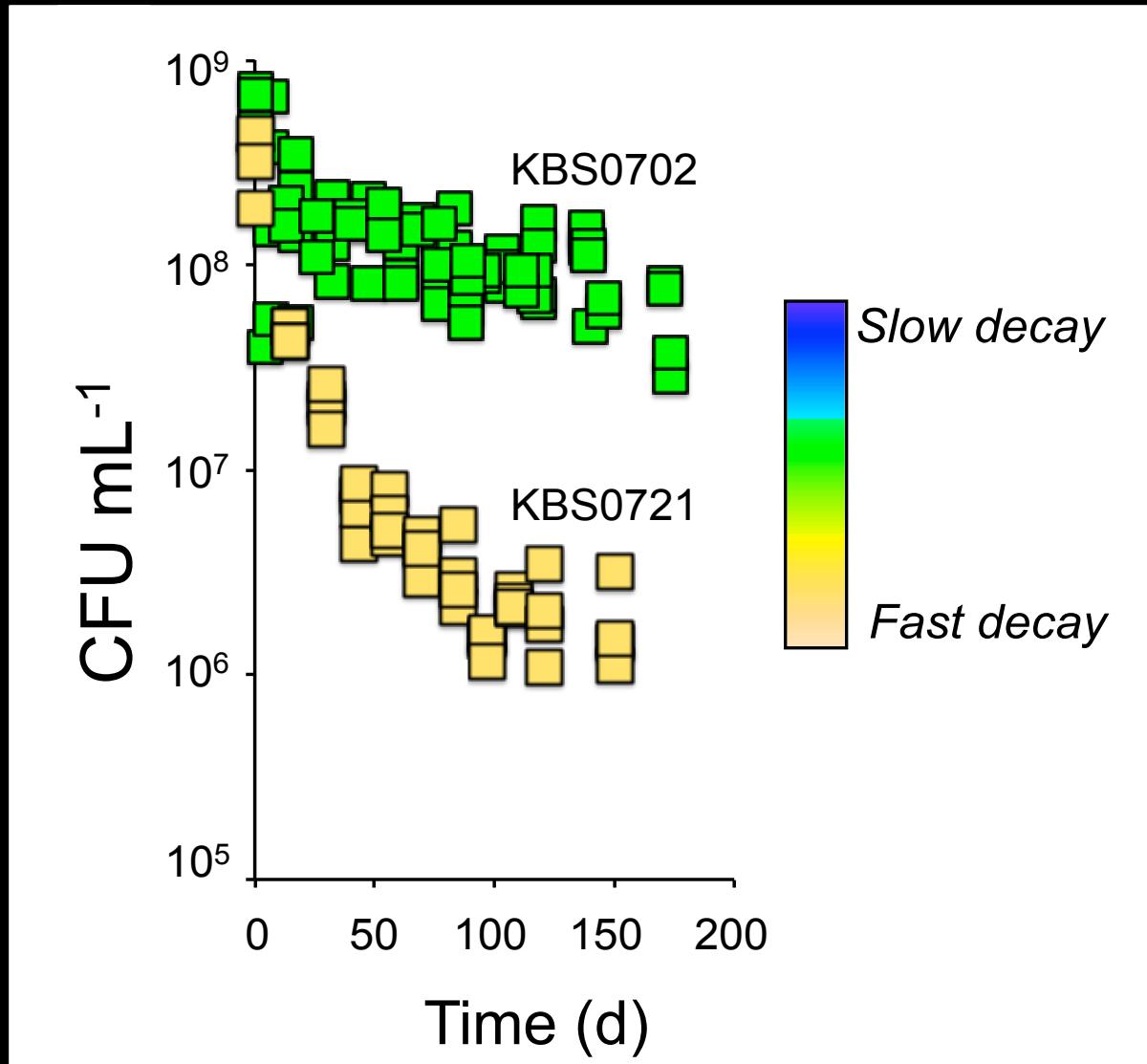


*Dormancy*

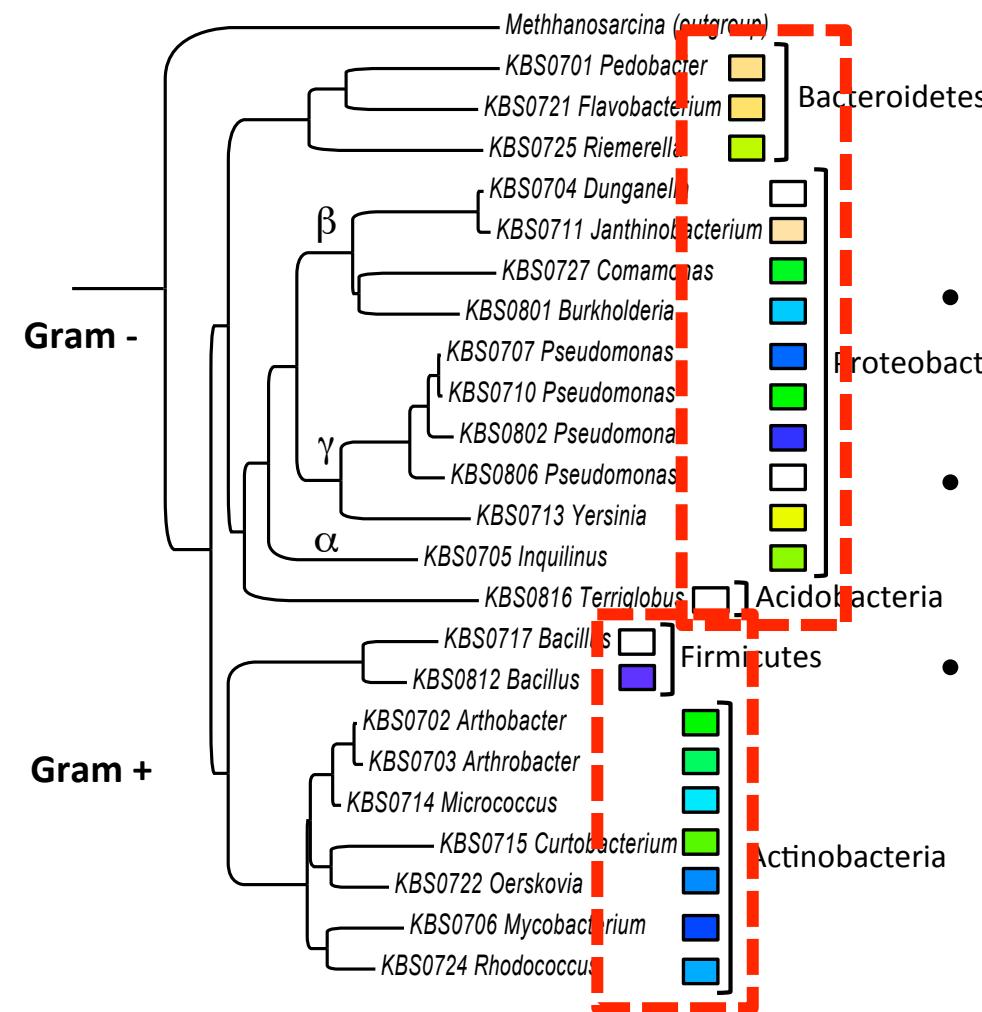


*Mortality*

# Survival during dormancy varies among bacteria



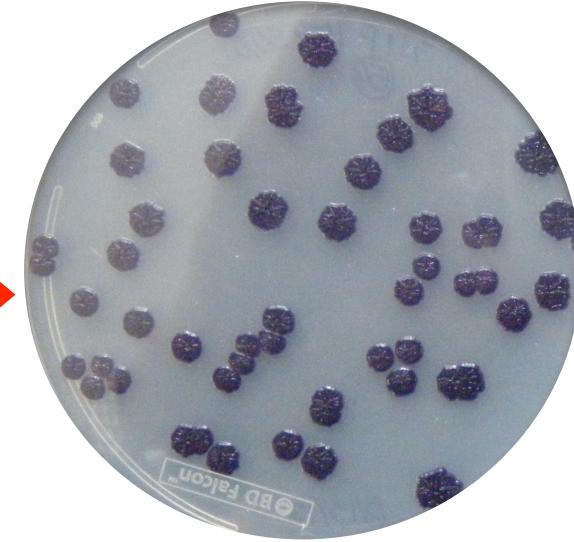
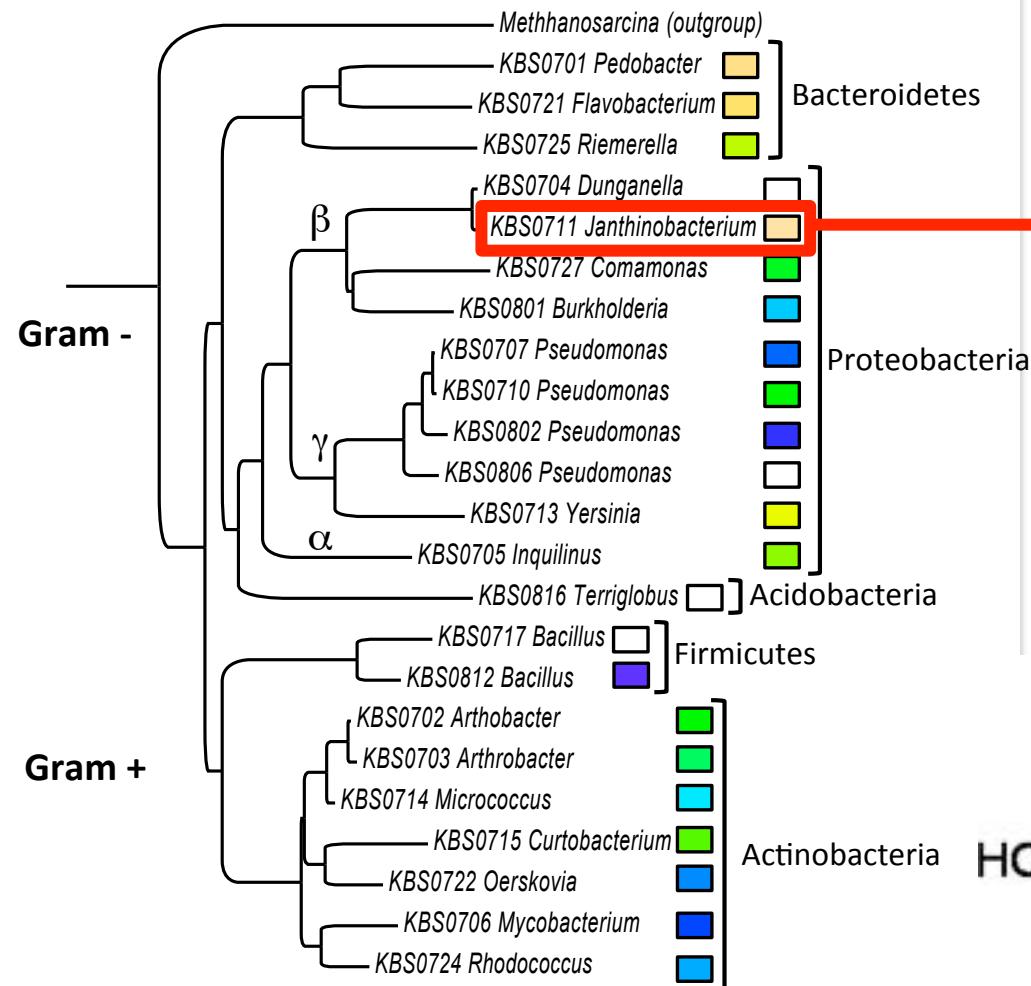
# Survival during dormancy varies among bacteria



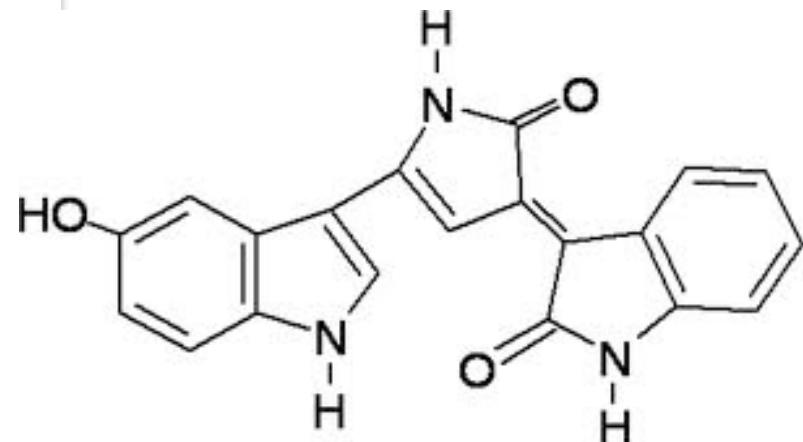
## Phylogenetic signal

- Coarse taxonomic scale
- Different types of dormancy?
- Trade-offs with other traits?

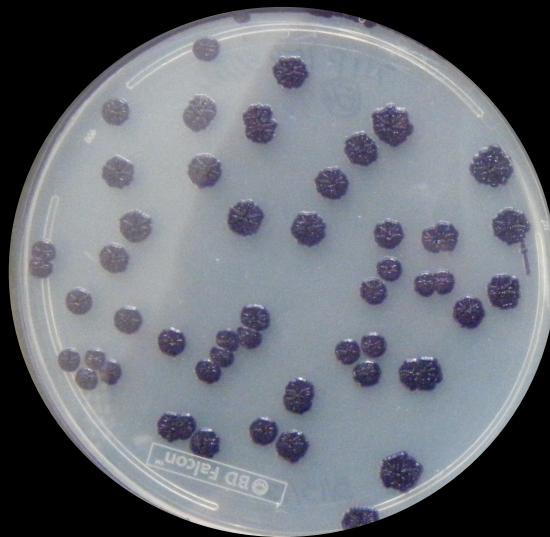
# Survival during dormancy varies among bacteria



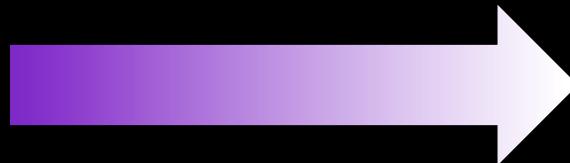
*Janthinobacterium*  
Violacein (antibiotic)



# Rapid evolution of dormancy?

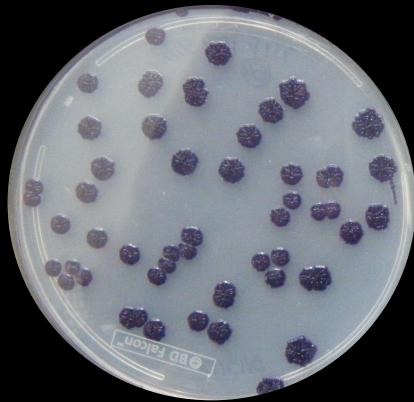


Ancestor

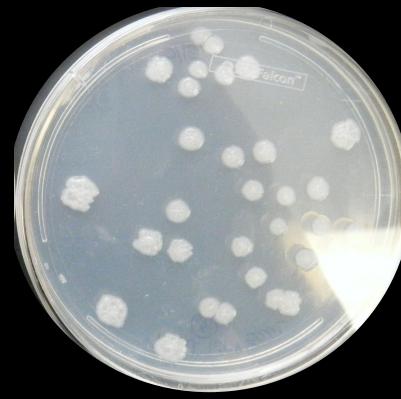


Mutant

# Rapid evolution of dormancy?

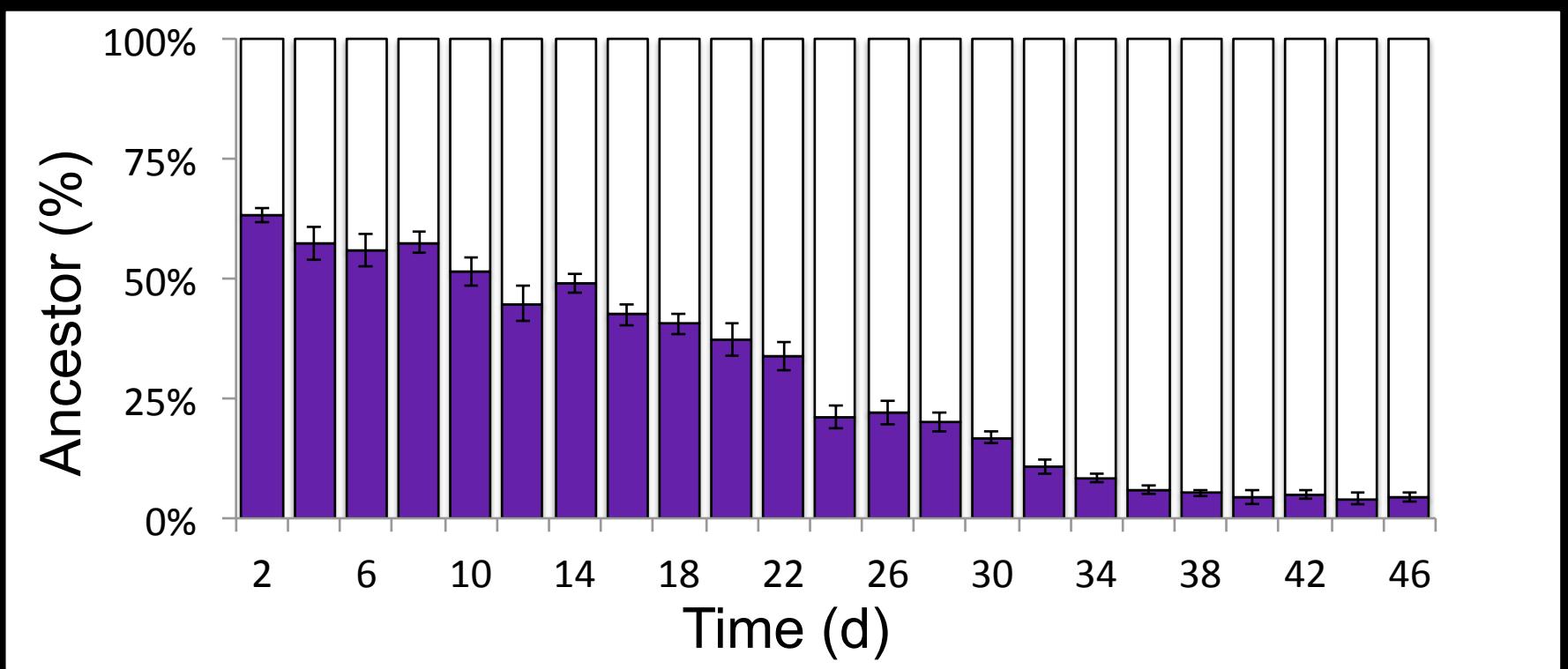


Vs.



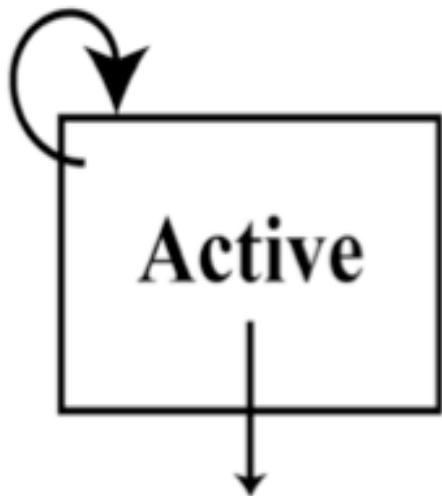
Ancestor

Mutant



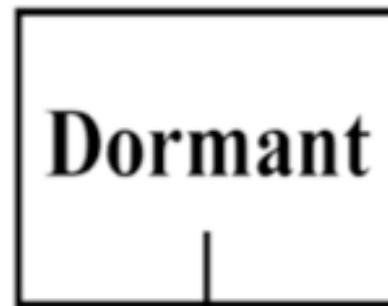
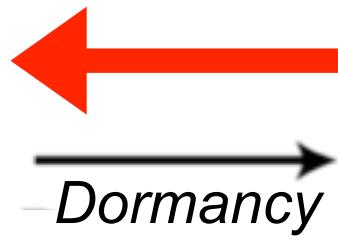
**Transitions:**  
**What wakes bacteria up from dormancy?**

*Reproduction*



*Mortality*

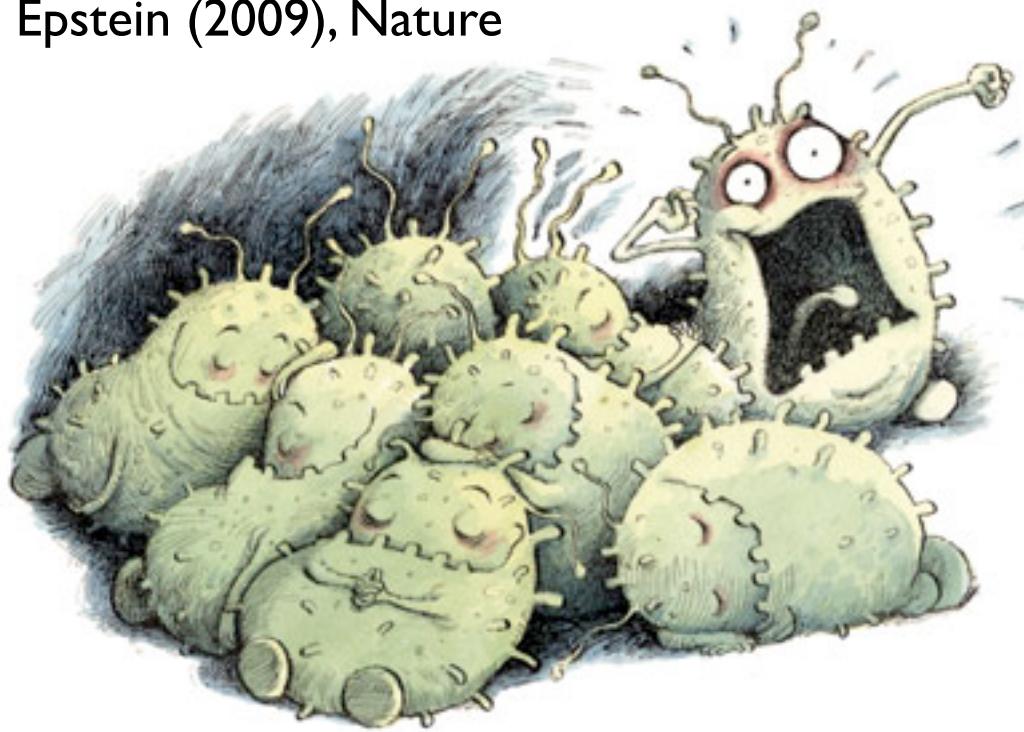
*Resuscitation*



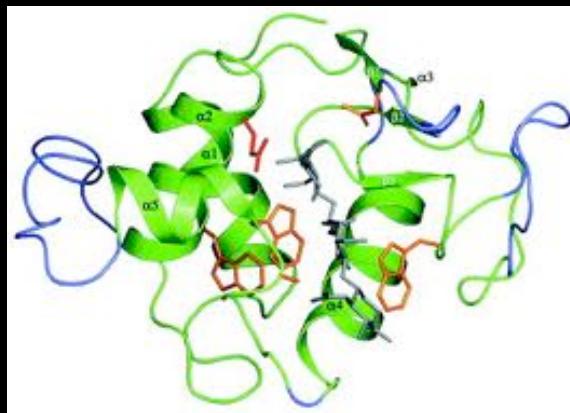
*Mortality*

# What wakes bacteria up from dormancy?

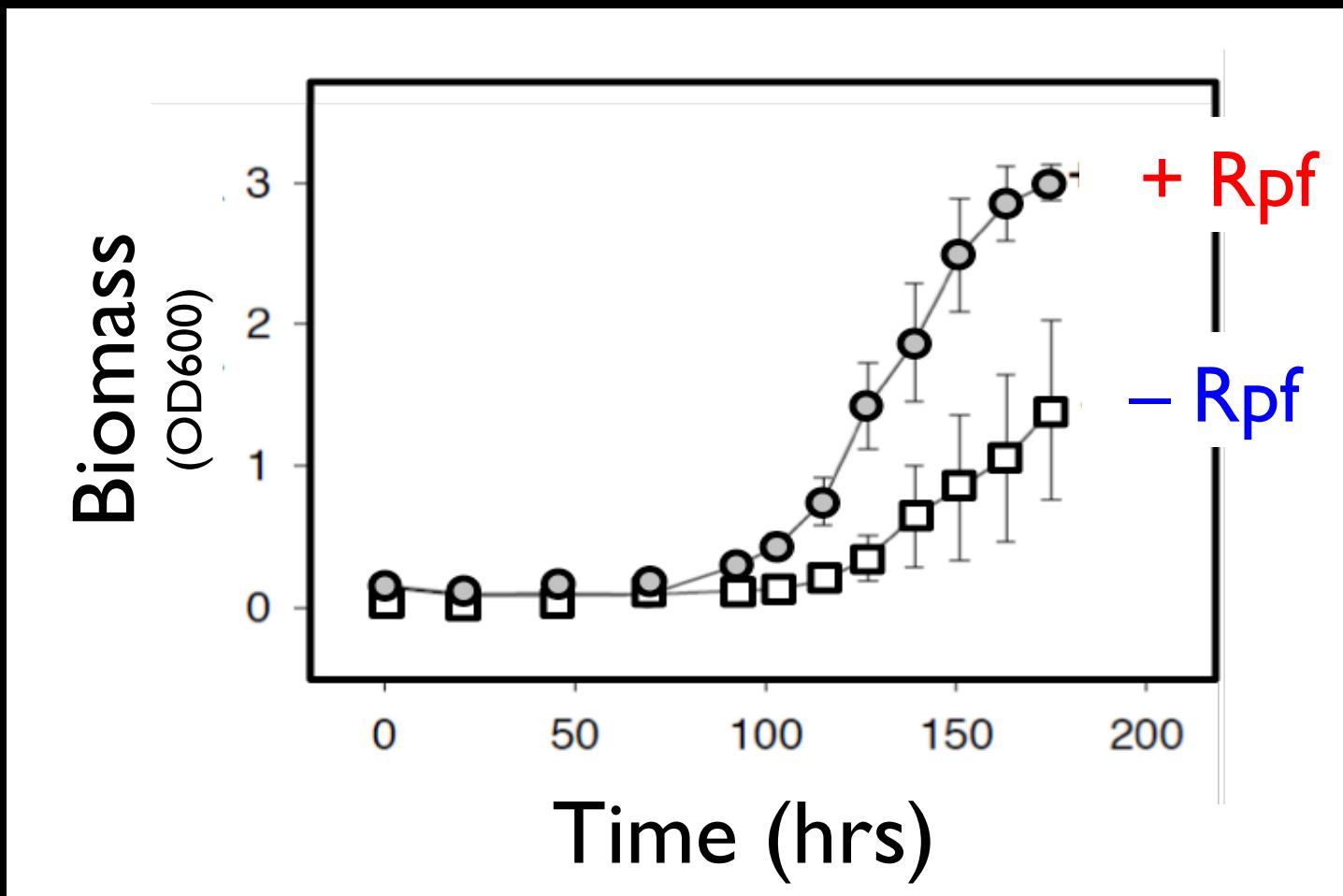
Epstein (2009), Nature



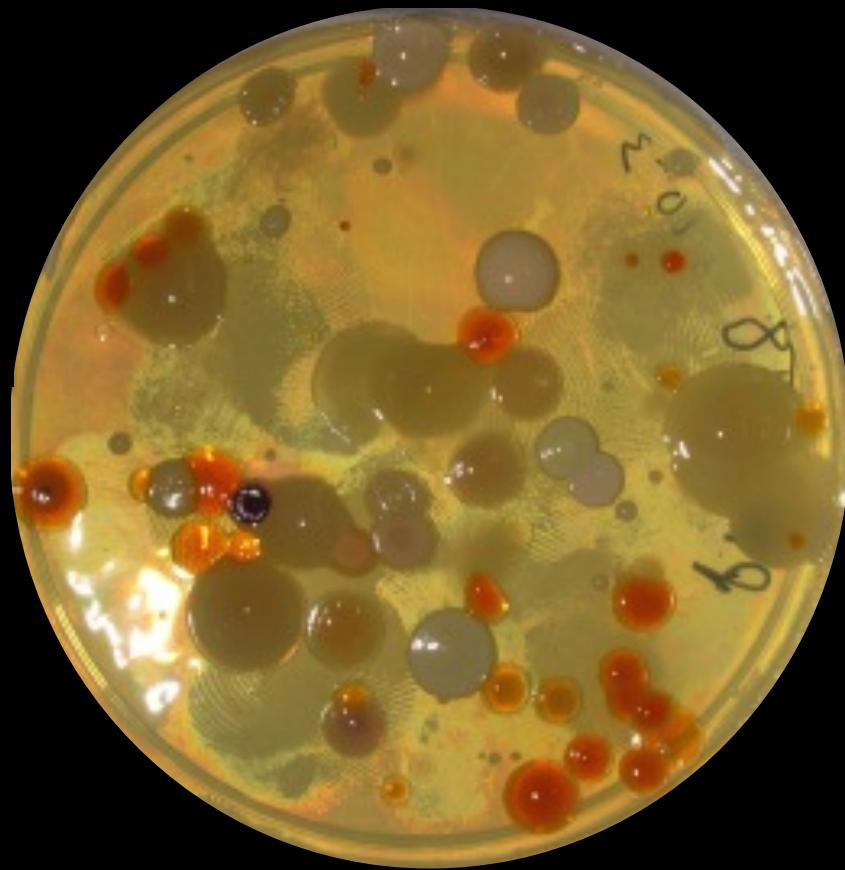
# Resuscitation promoting factors (Rpf)



Rpf reduces lag time, increases growth rate

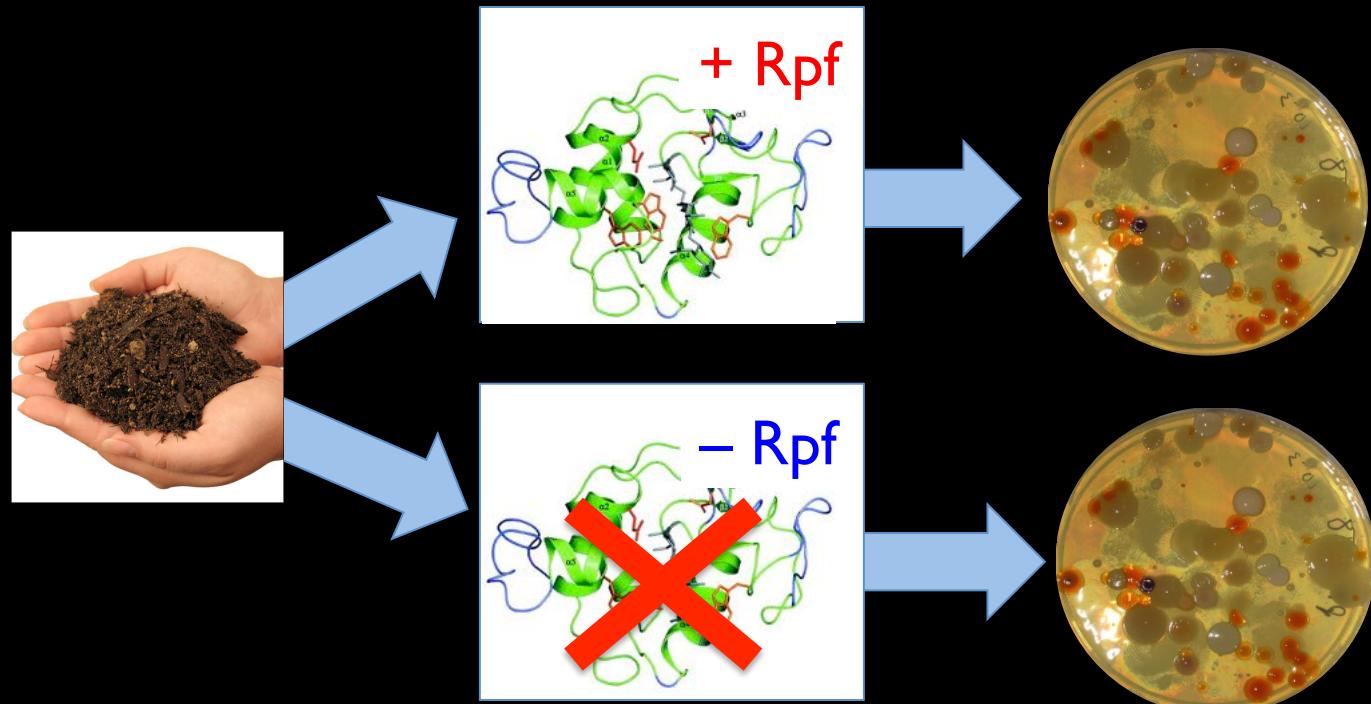


# “Great Plate Anomaly”

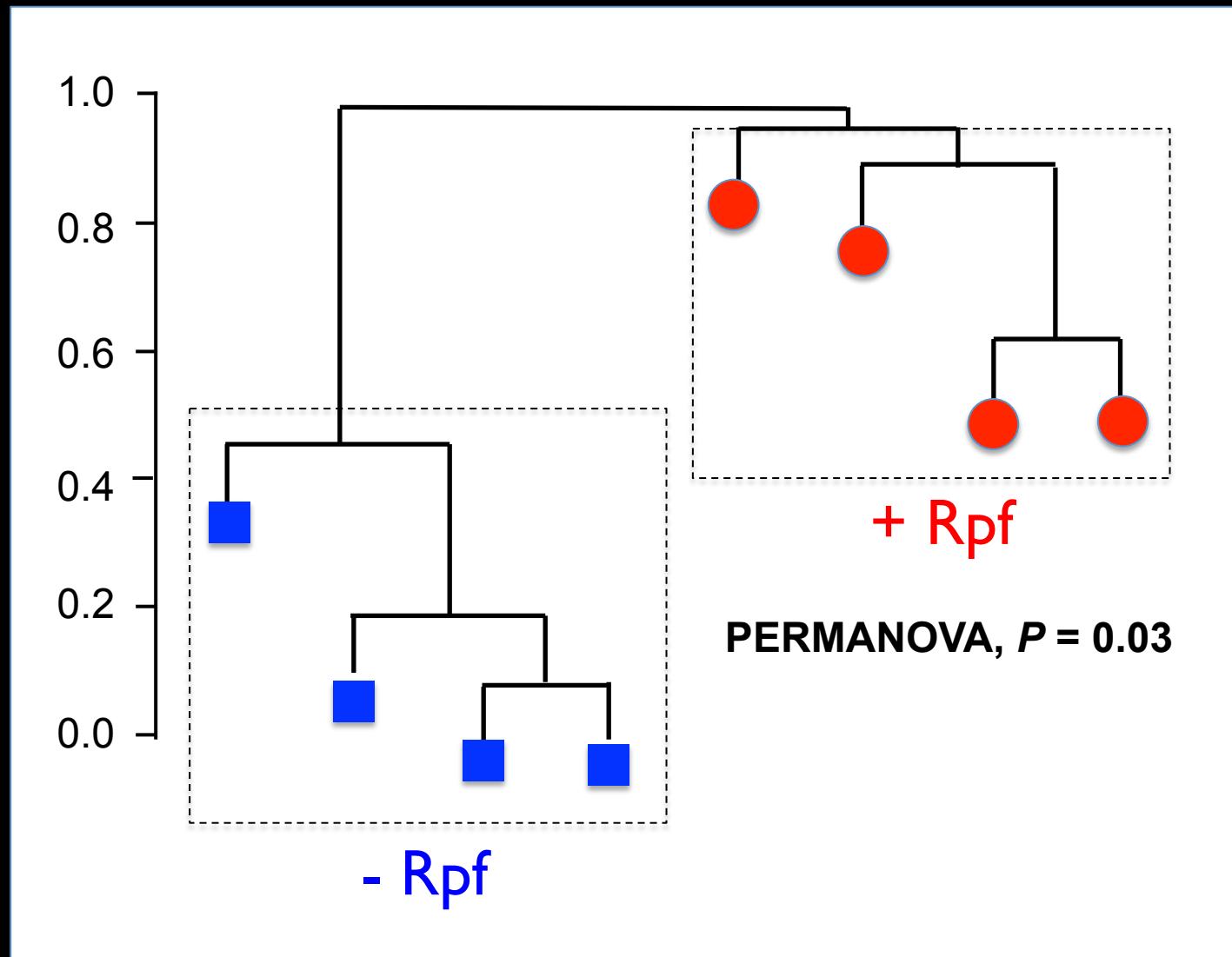


Does dormancy hamper cultivation?

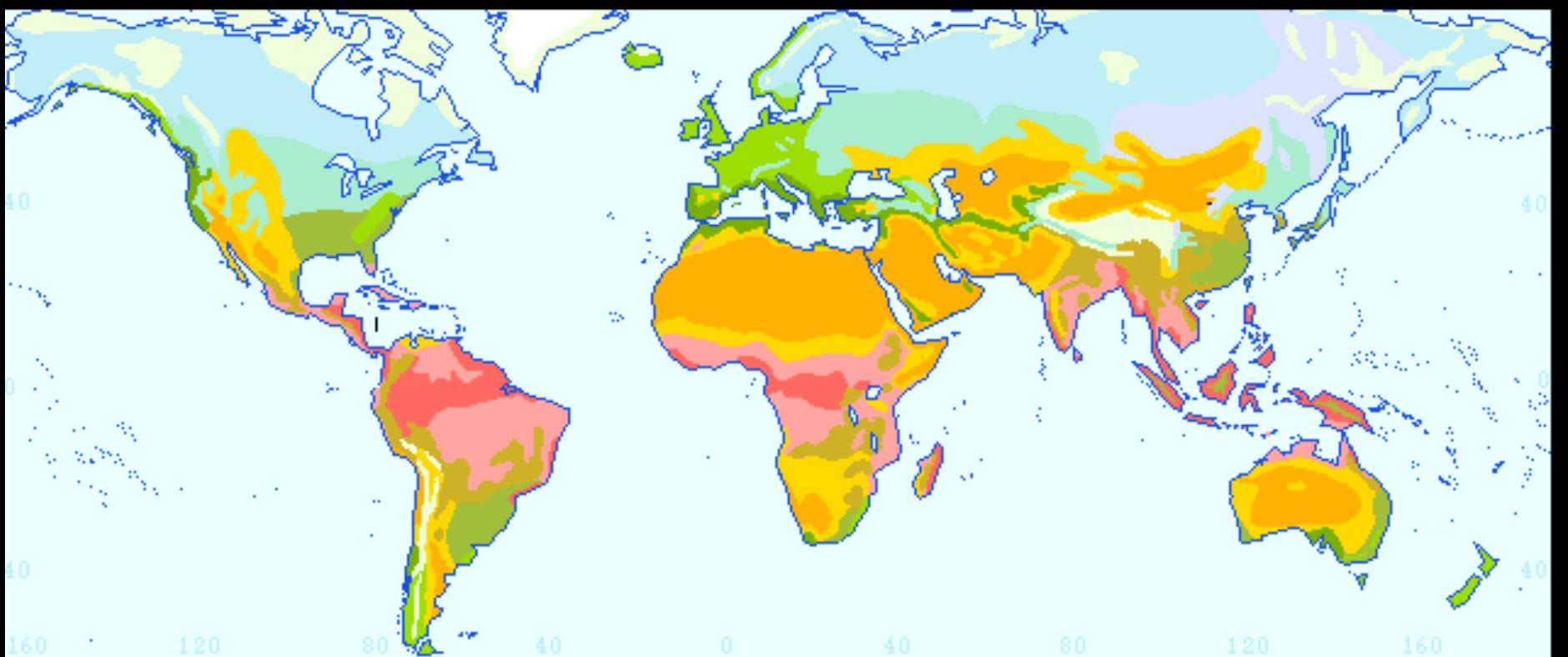
# Use Rpf to test “Great Plate Anomaly”



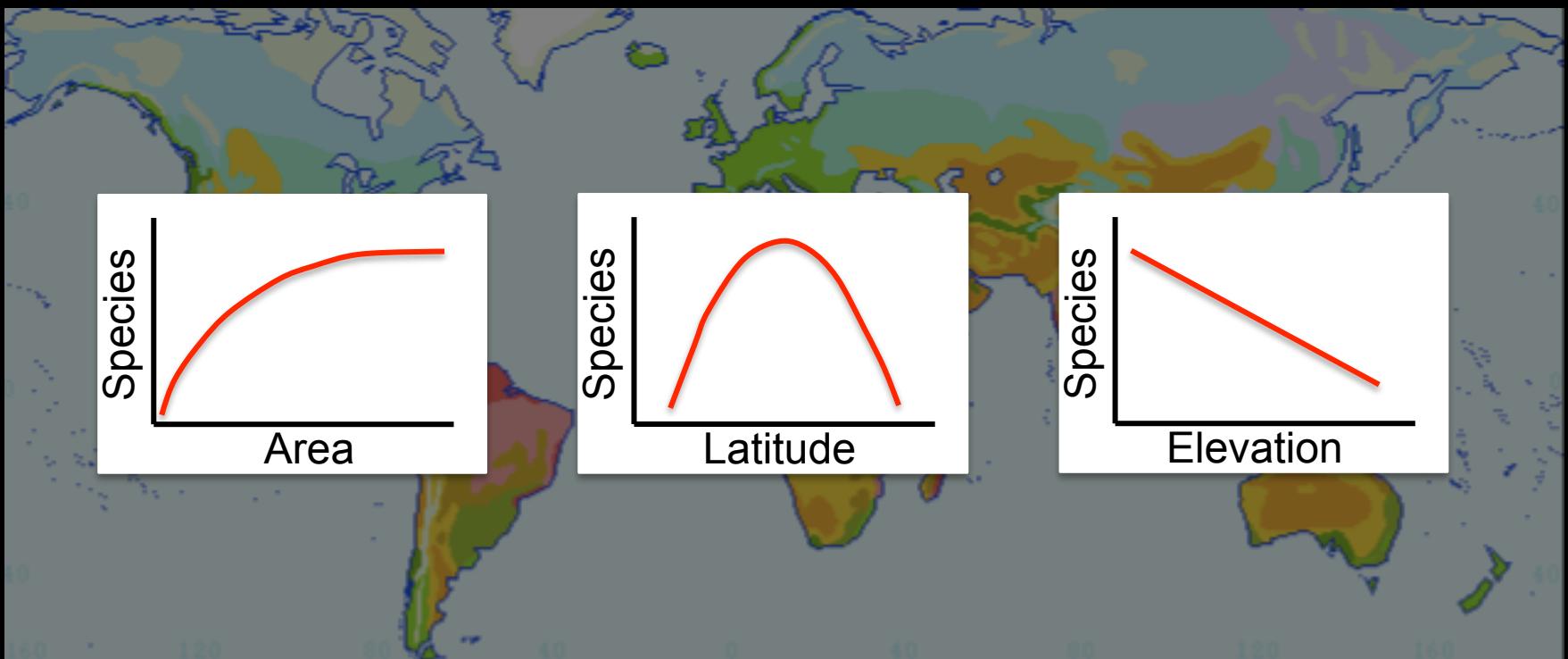
# Rpf alters composition of culturable bacteria



# Dormancy affect biogeography?



# General Patterns of Biogeography



# Do microbes break the rules?

*"Everything is everywhere, but the environment selects"*

-- Lourens Baas-Becking (1934)

*"When environmental conditions are closely comparable,  
the same type of organisms appear...we need not think in  
terms of local microfloras"*

-- Cornelis van Niel (1949)

*"There is no biogeography for anything smaller than 1 mm"*

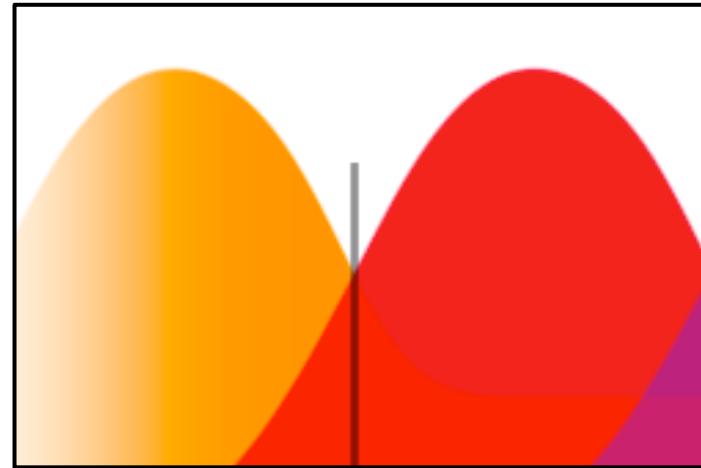
-- Bland Finlay (2005)

# Why weak biogeographic patterns?

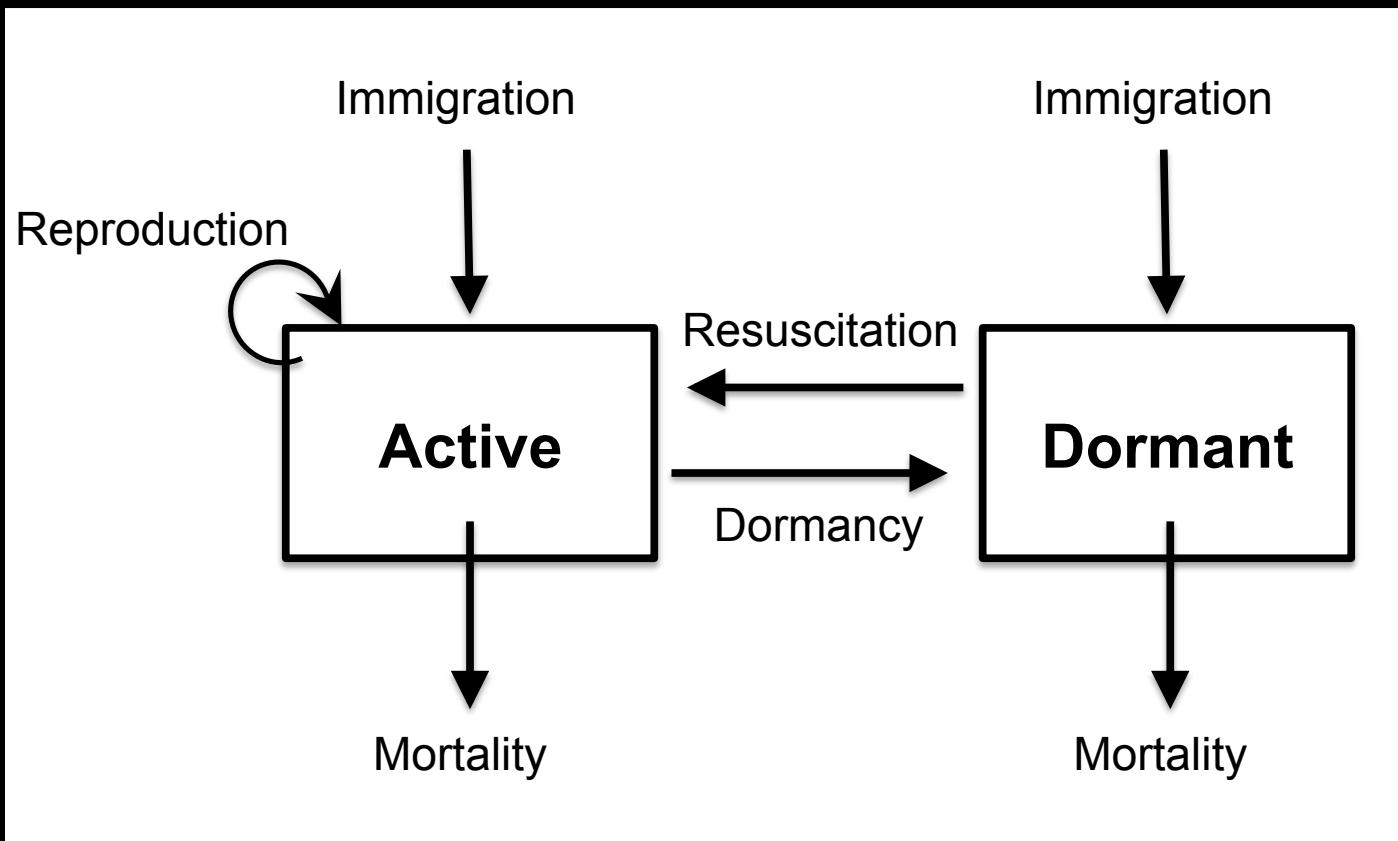
Dispersal



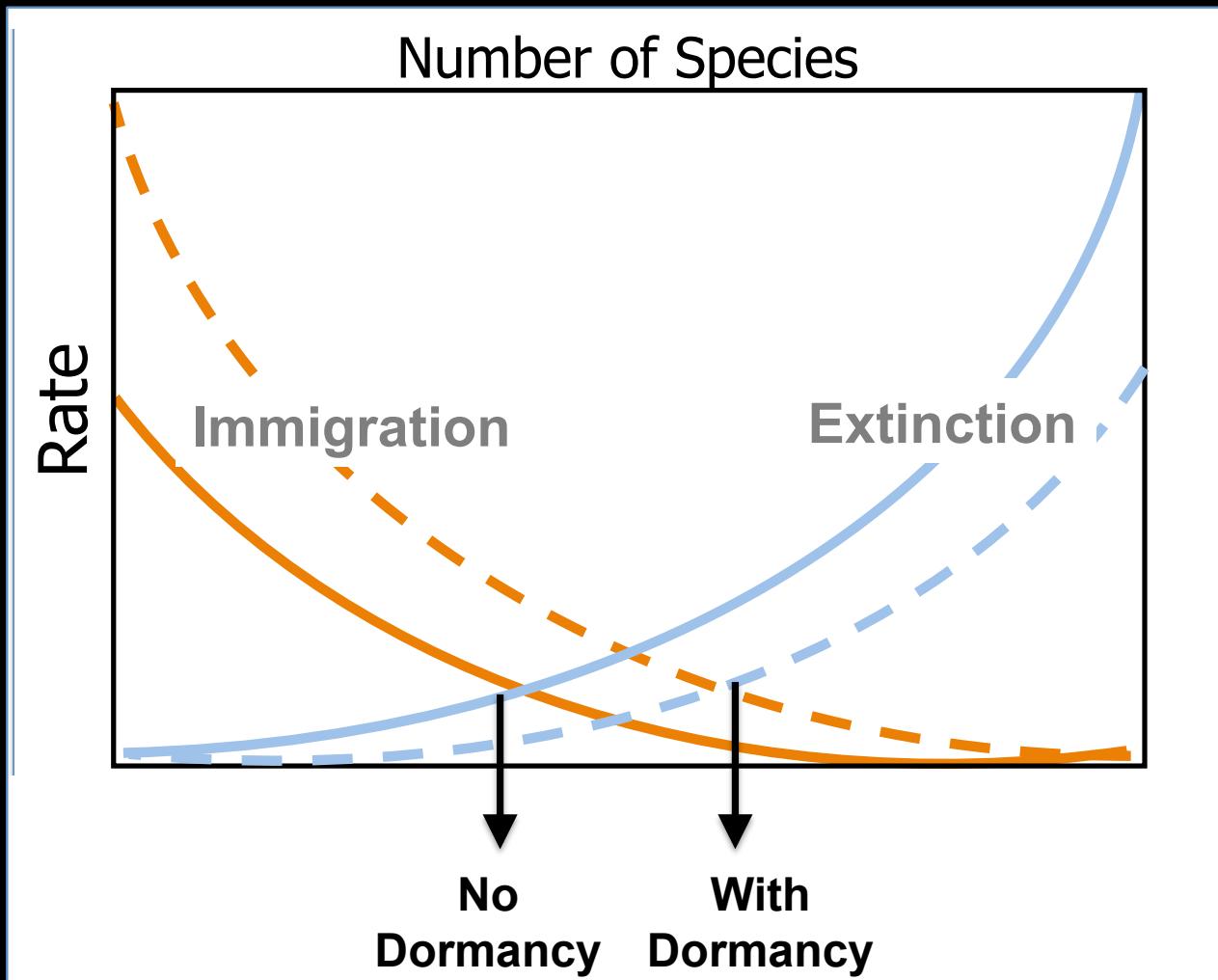
Selection



# Dormancy and biogeography

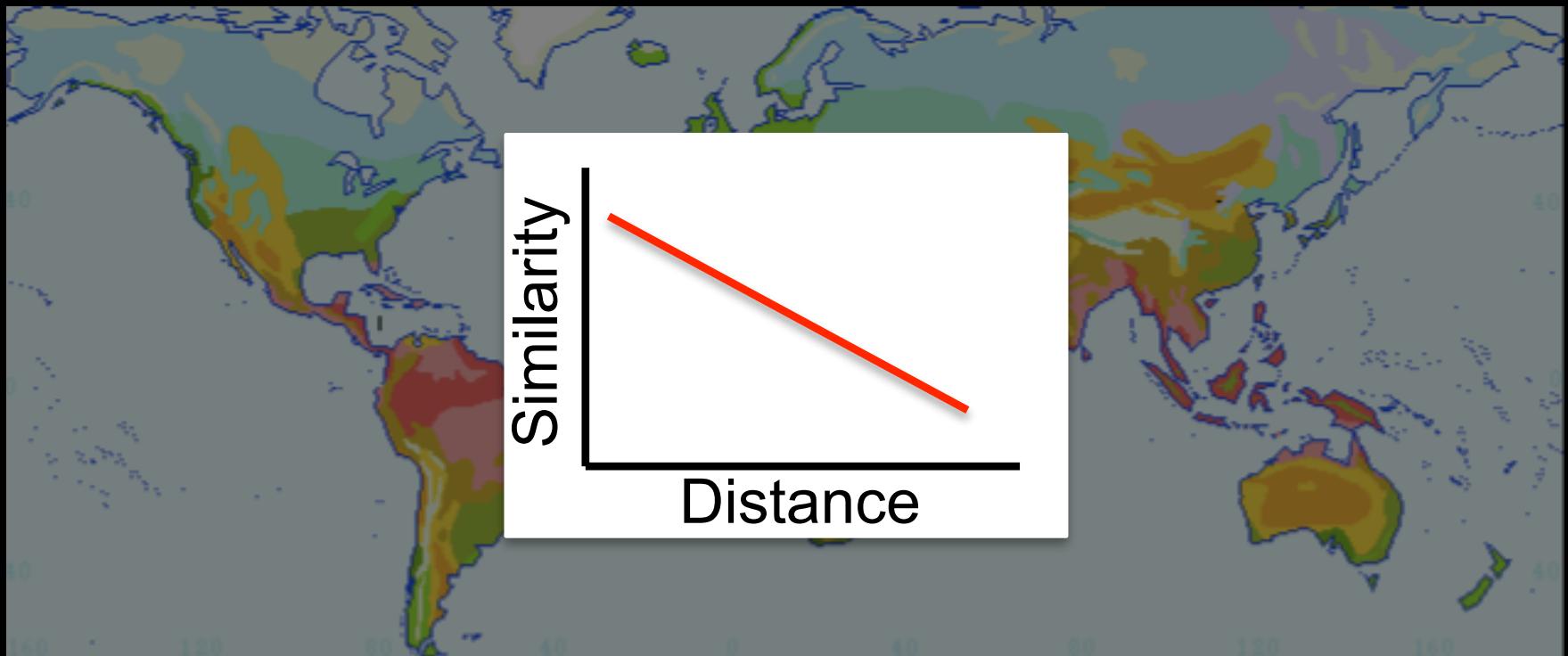


# Dormancy and biogeography

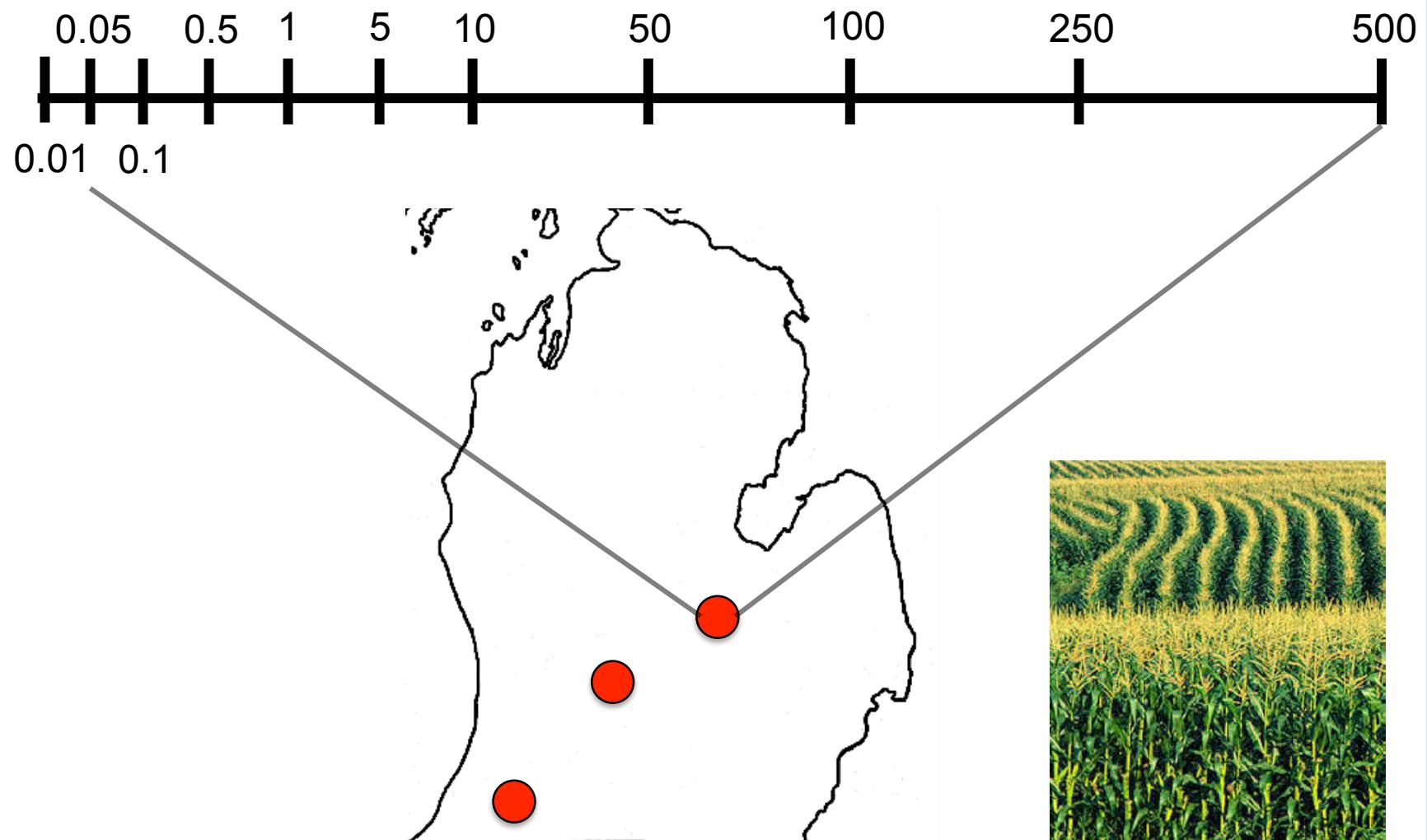


Locey 2010, Lennon and Jones 2011

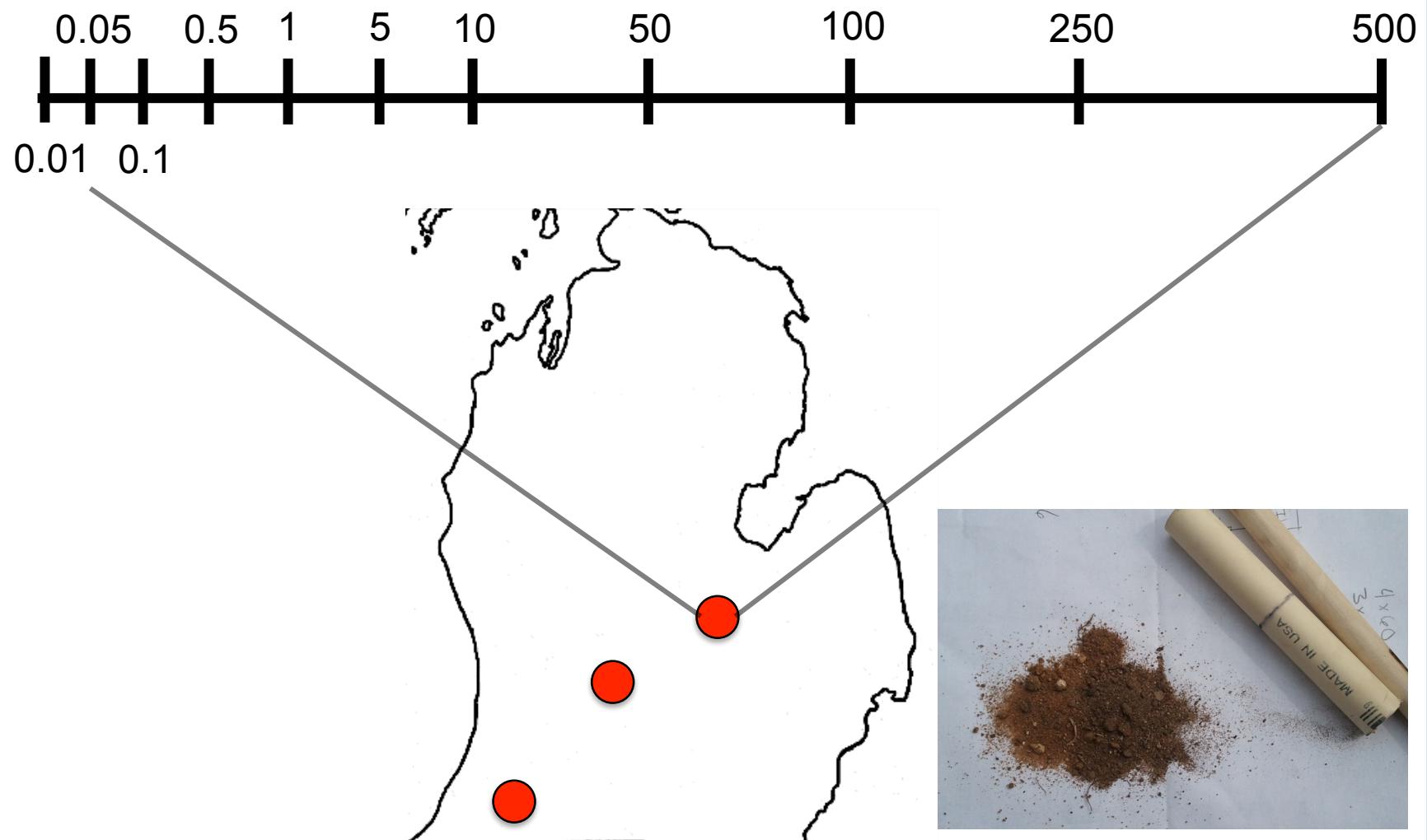
# Distance Decay



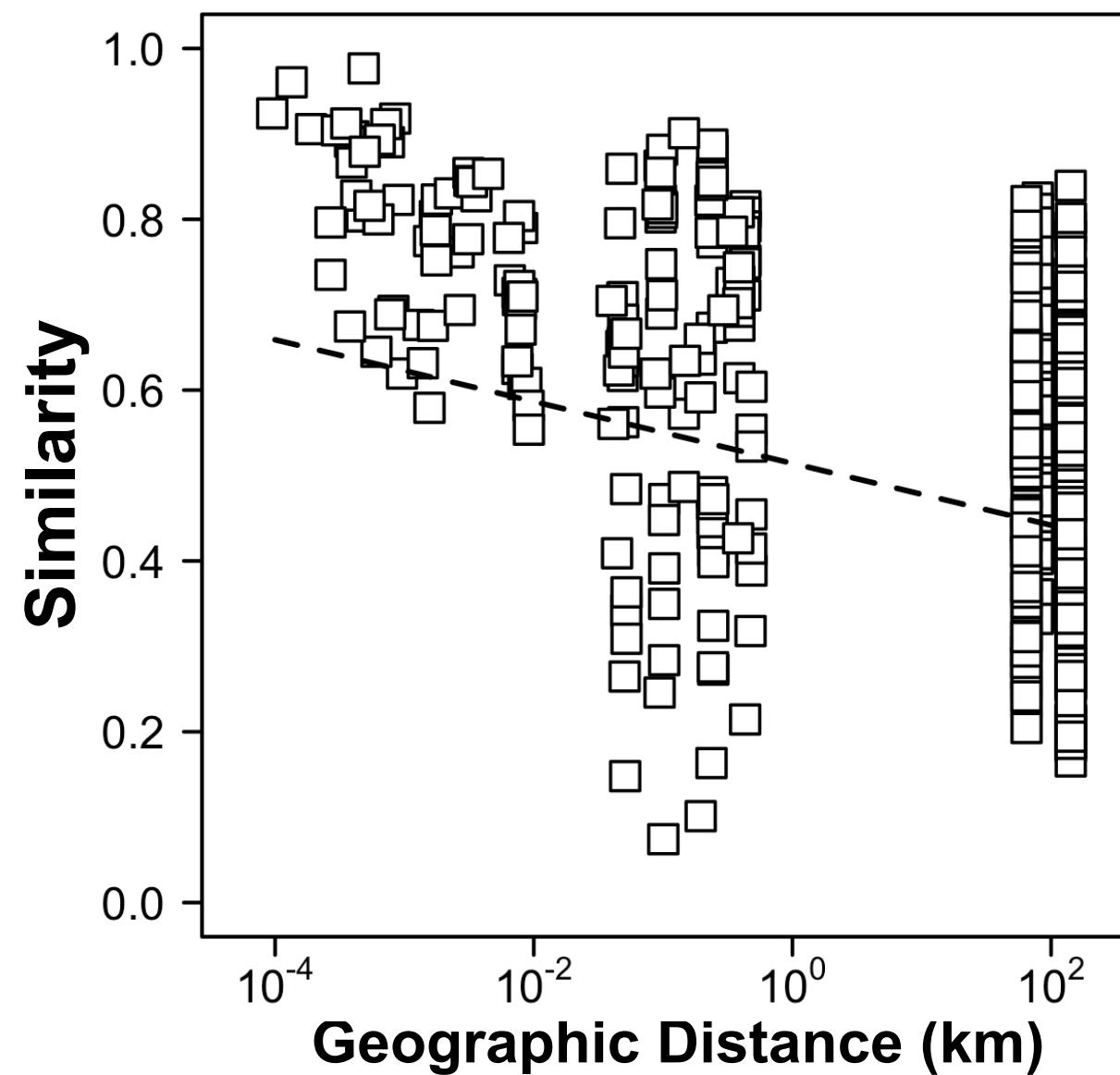
# Distance Decay Sampling



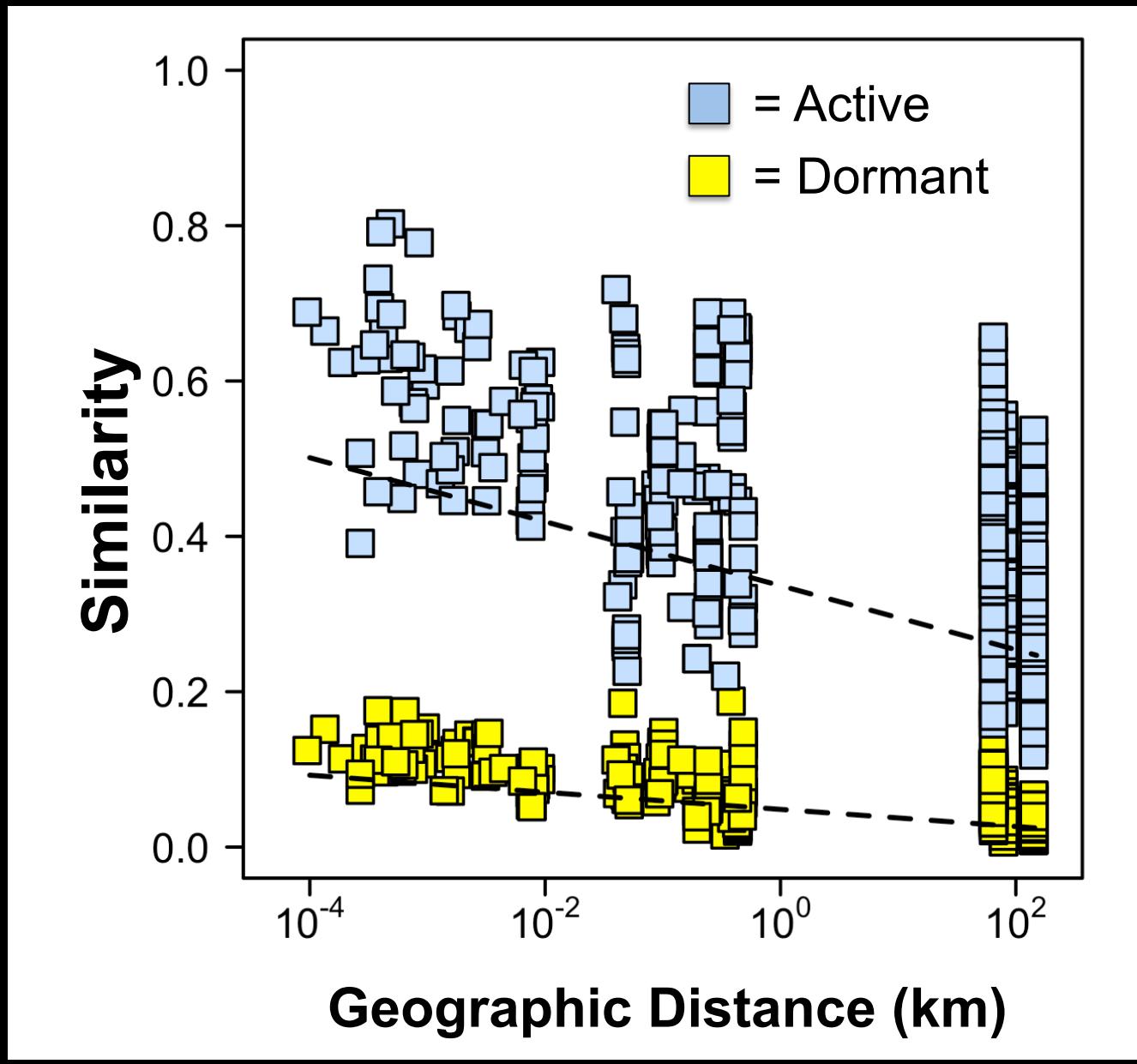
# Distance Decay Sampling



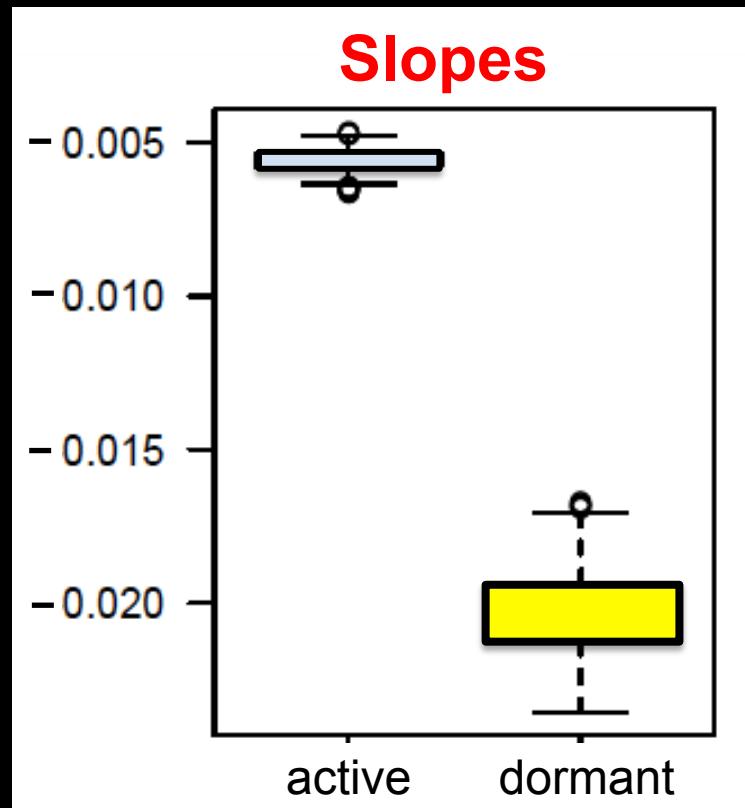
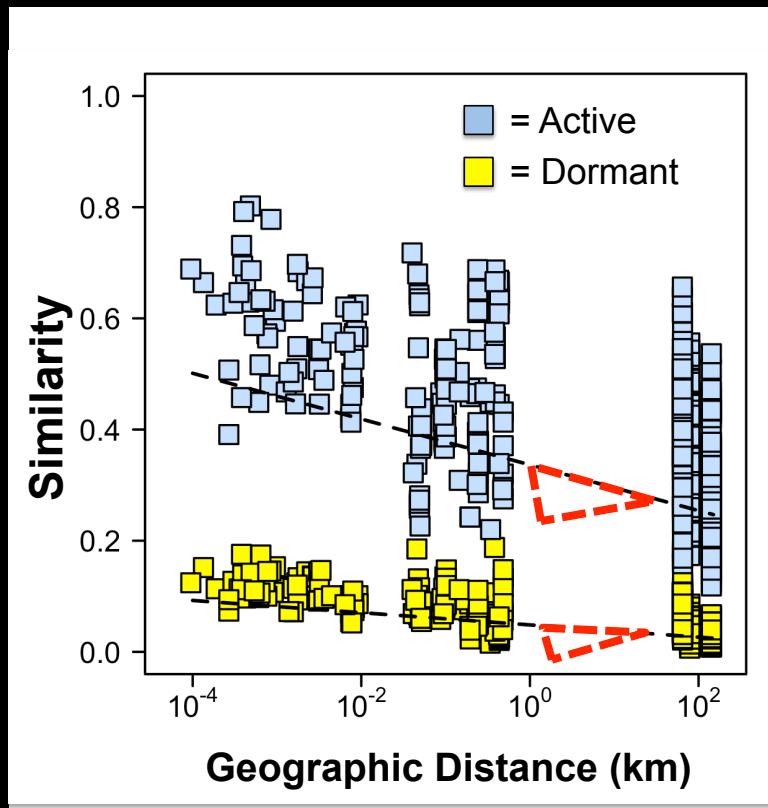
# Turnover of microbial habitat



# Turnover of bacterial composition

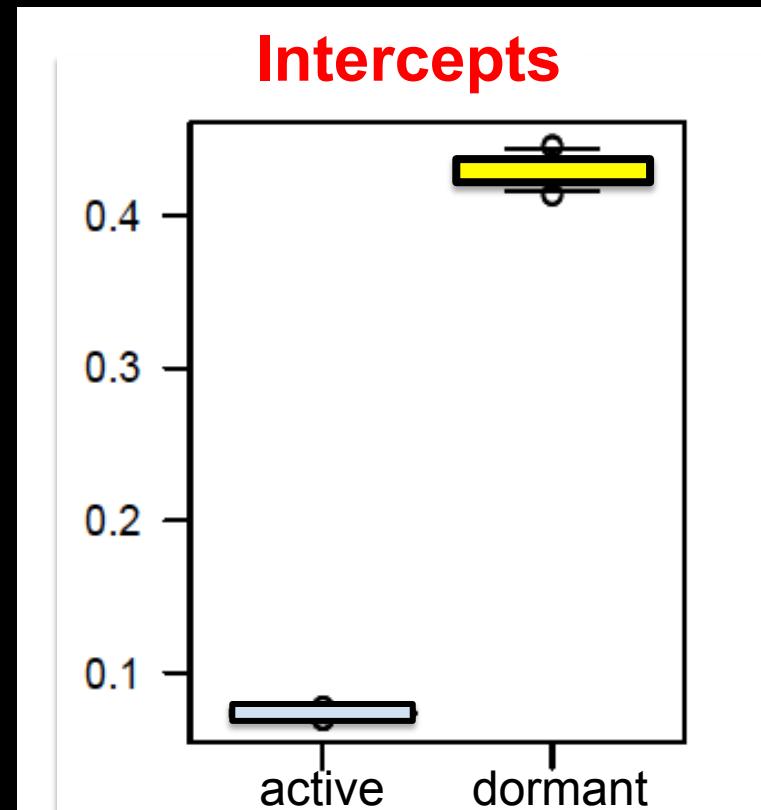
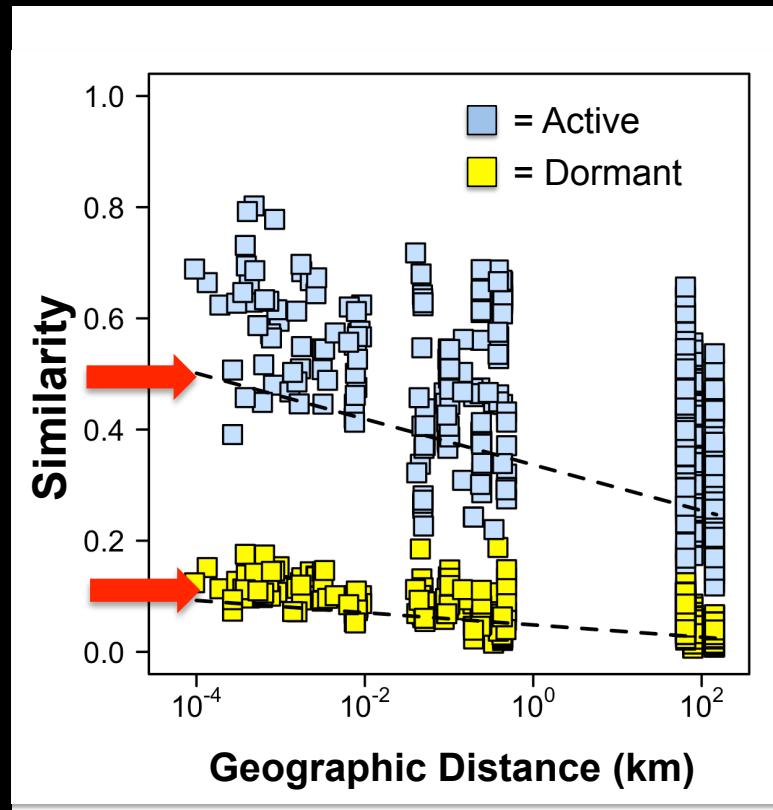


# Distance decay: different slopes



Dormant taxa turnover more slowly

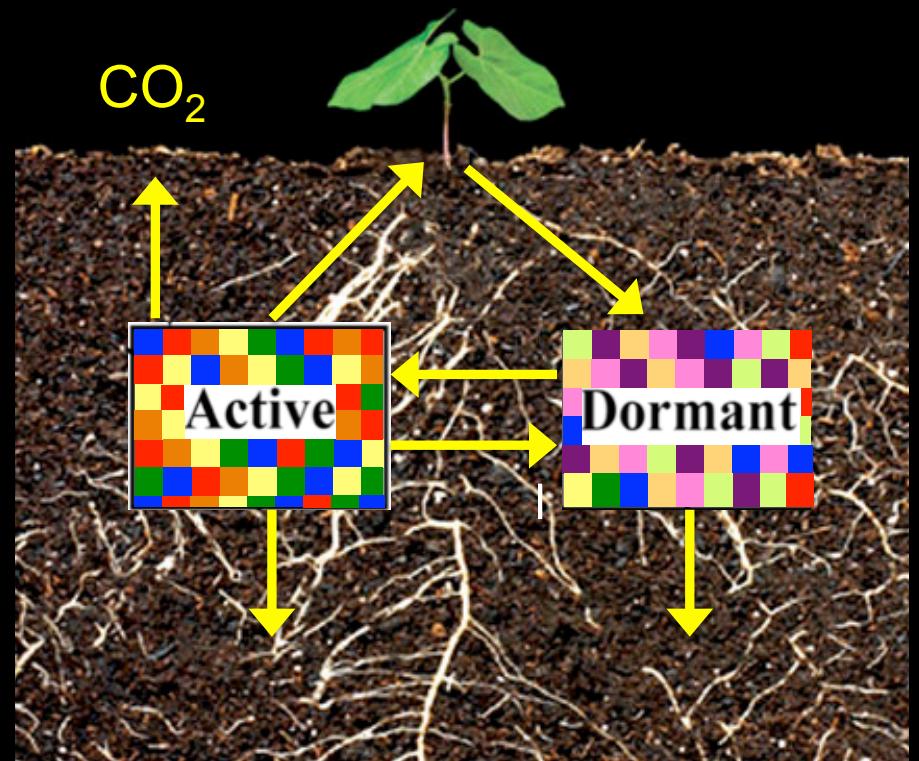
# Distance decay: different intercepts



Dormant taxa: high  $\beta$ -diversity at small spatial scales

# In summary, microbial dormancy:

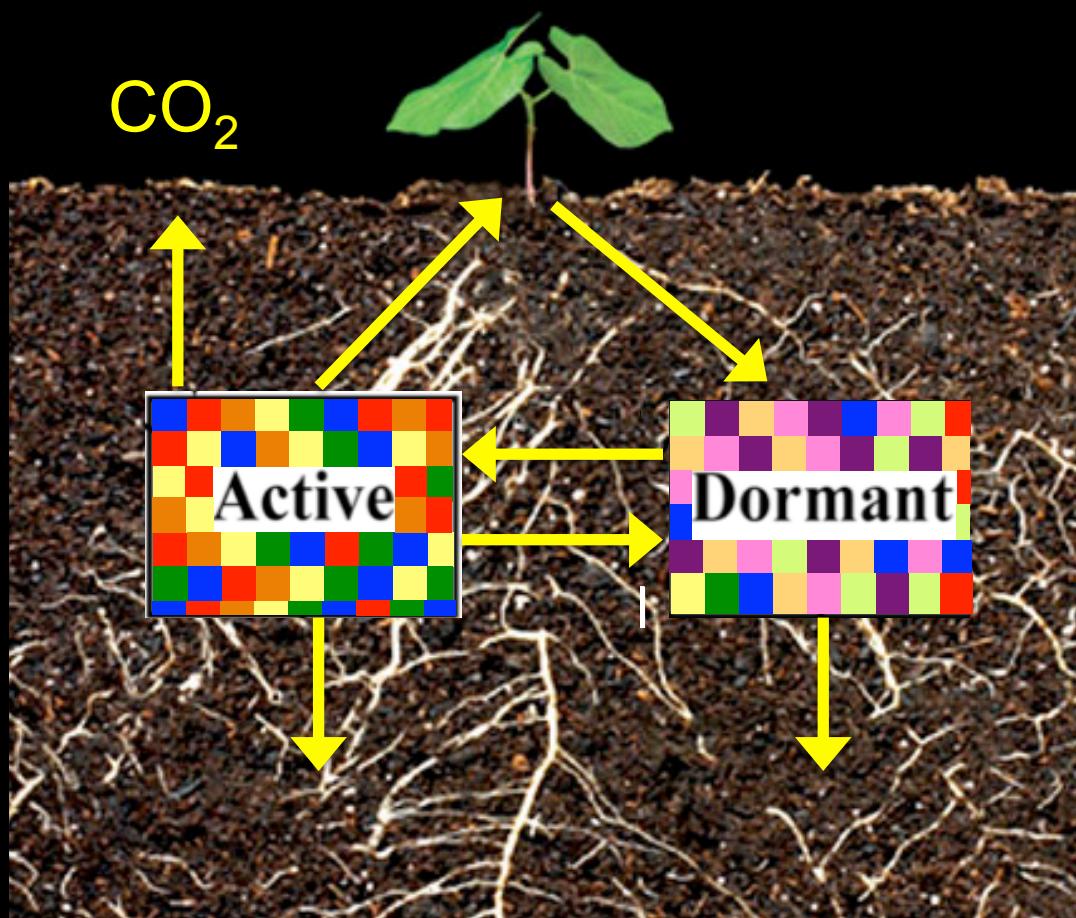
- ...is prevalent in nature
- ...maintains biodiversity
- ...affects ecosystem function



# Acknowledgments

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Kayla Miller  
Ariane Peralta  
Sarah Widney





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Wiki: [www.indiana.edu/~lennon](http://www.indiana.edu/~lennon)

Twitter: [@jaytlenon](https://twitter.com/jaytlenon)