

Urbanization of forests impacts the relationships between small mammal communities and their gut microbiota



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Impact of anthropization on ecological communities



Landscape



Urban species

- This phenomenon is even more important in cities where many species cannot survive in such disturbed conditions.
- Urban species can colonize and dominate the city in significant abundance.



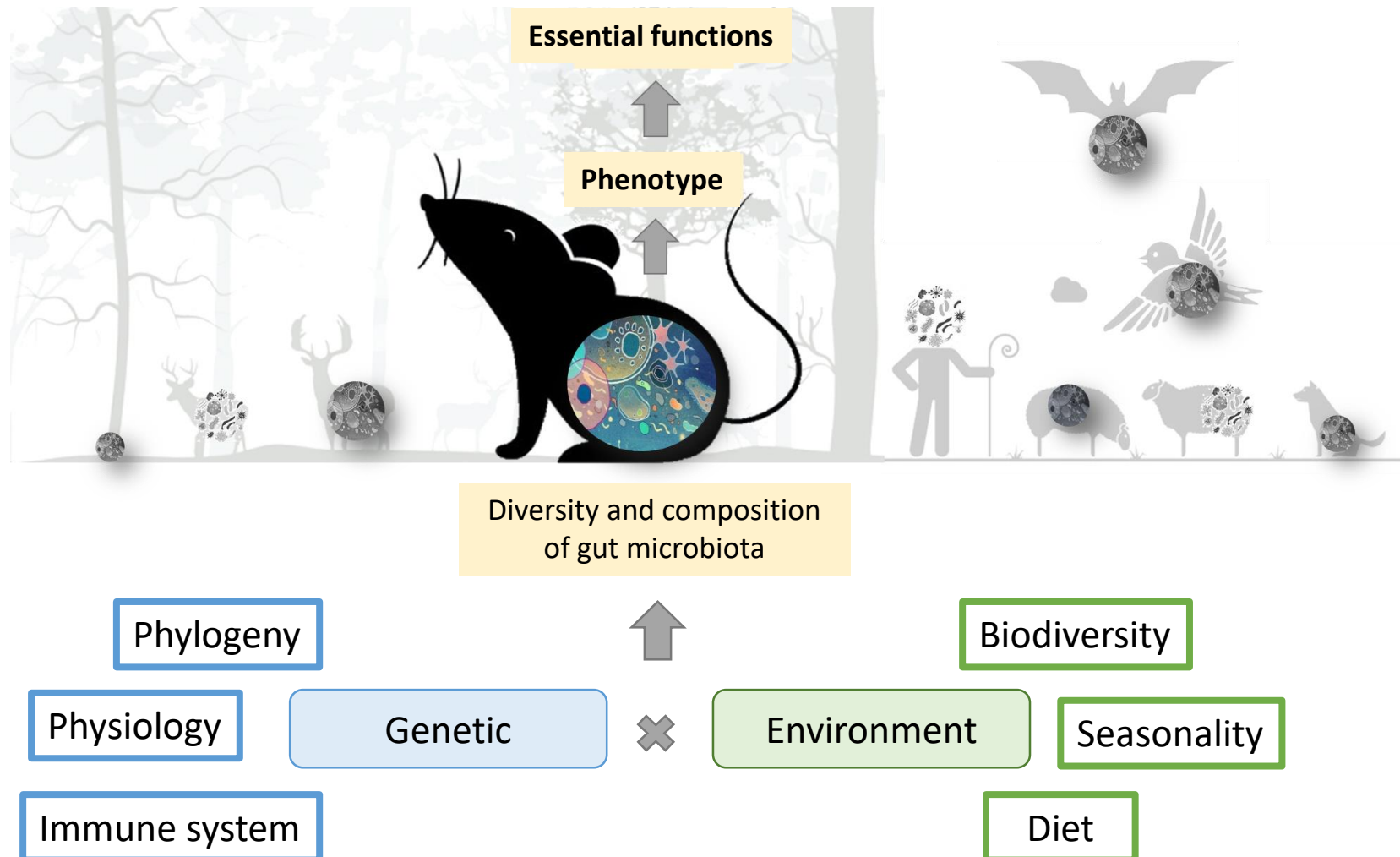
How can these species adapt to such rapid and abrupt changes?



The gut microbiota allows fast adaptation

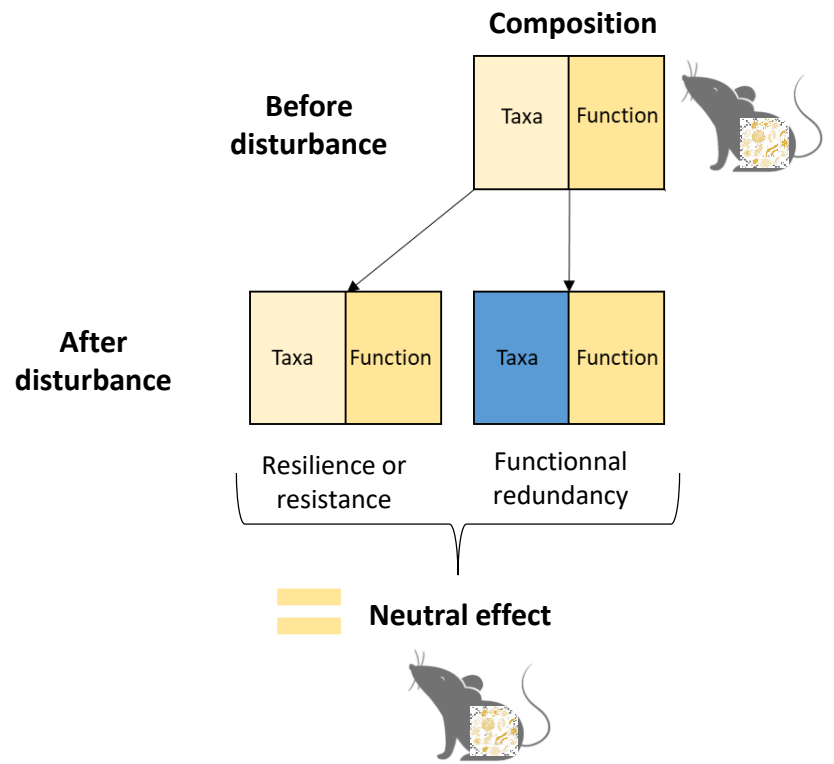
« The microbiota could modulate the phenotype and allow some species to adapt to a new environment. »

Alberdi et al. 2016



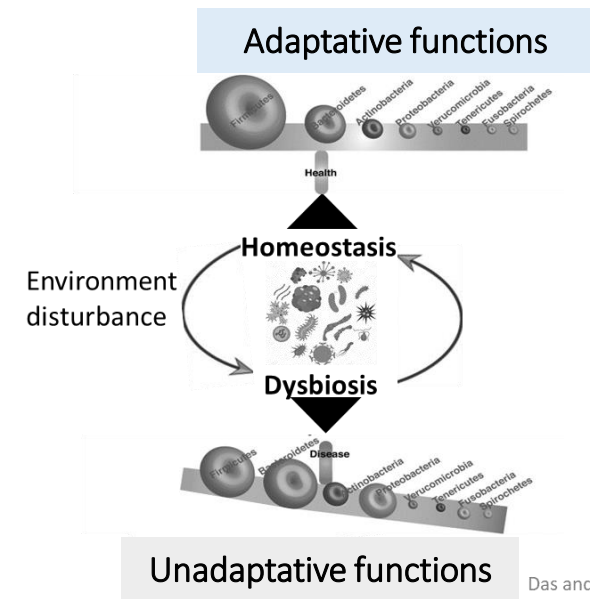
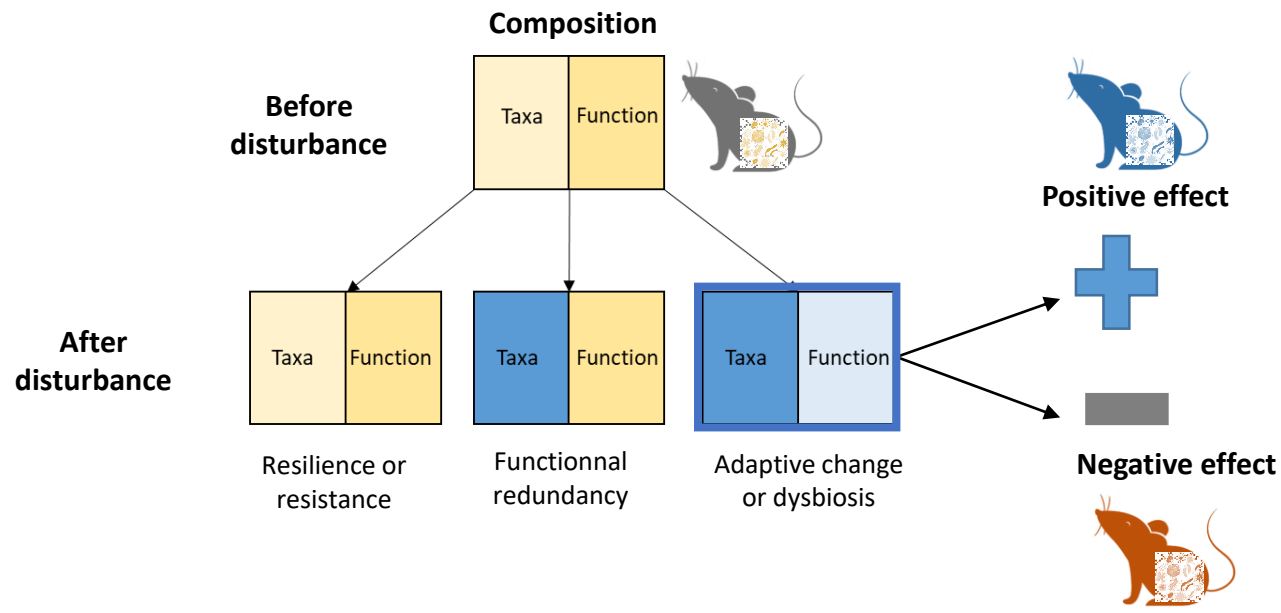


Responses of the microbiota against disturbances



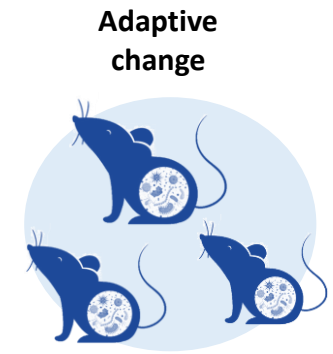
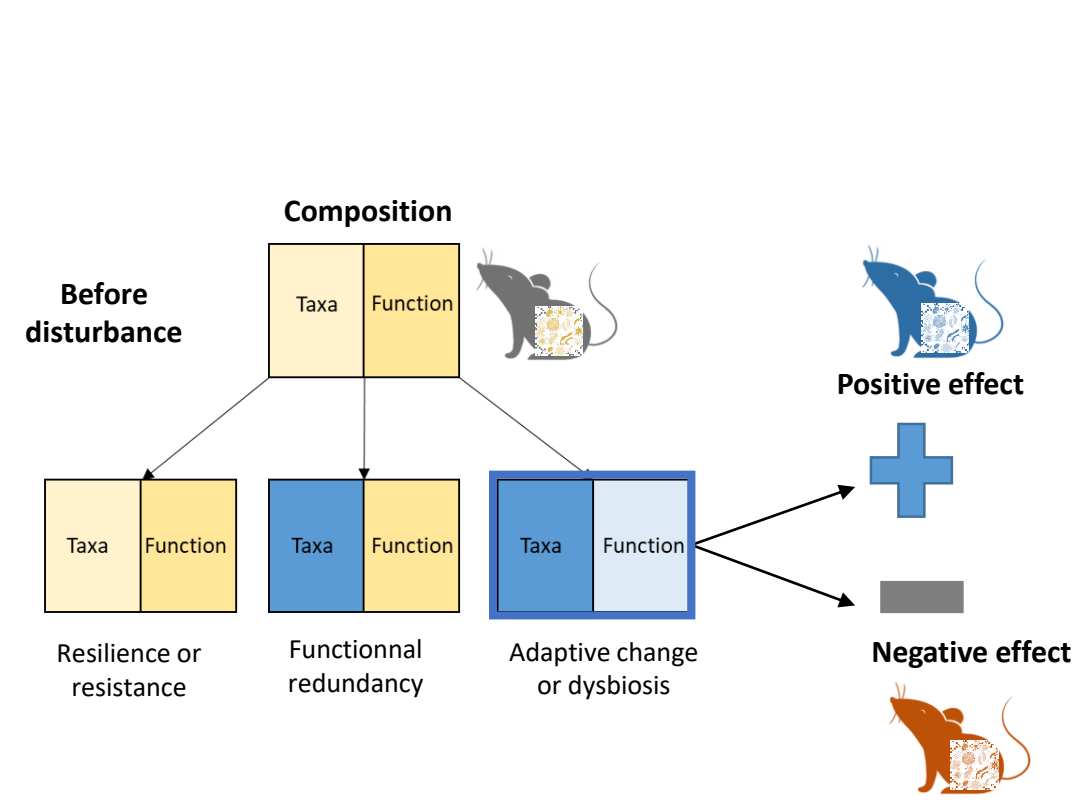


Responses of the microbiota against disturbances





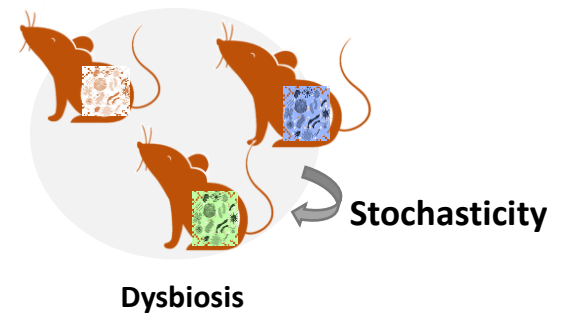
Responses of the microbiota against disturbances



Individuals have the same microbial composition

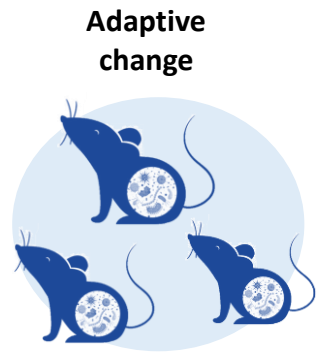
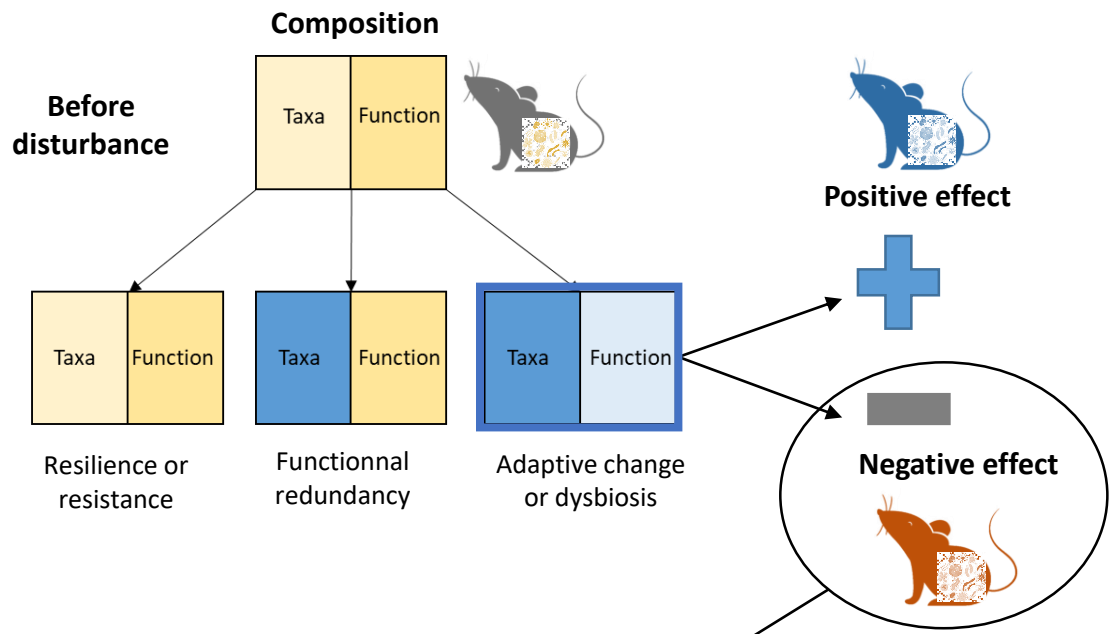
Anna Karenina Principle
Zaneveld et al. 2017

Individuals have a different microbial composition





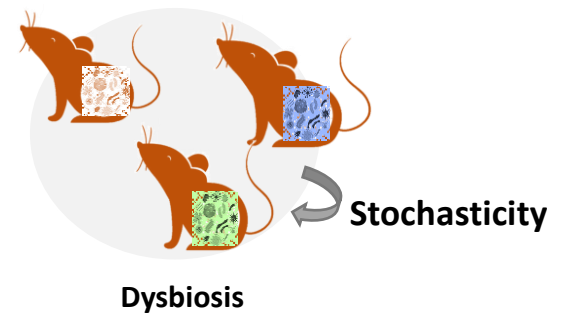
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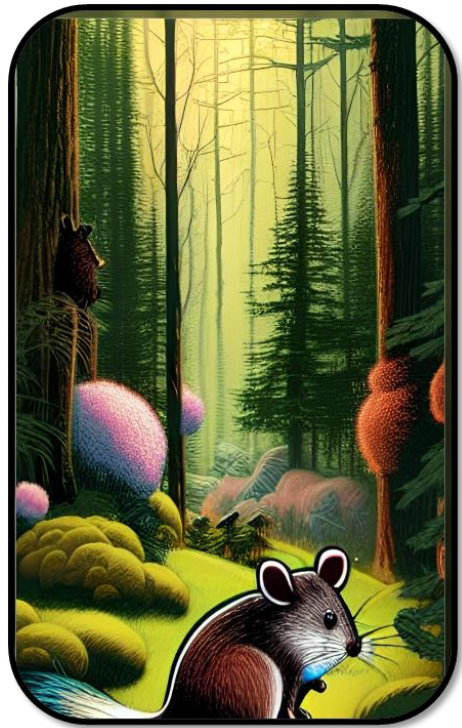


What has been most often observed in the literature: losses of diversity and compositional changes rather negative for the host with urban disturbance



Small mammals, a good model for urbanization study

Small mammals have colonized every habitat in the world.



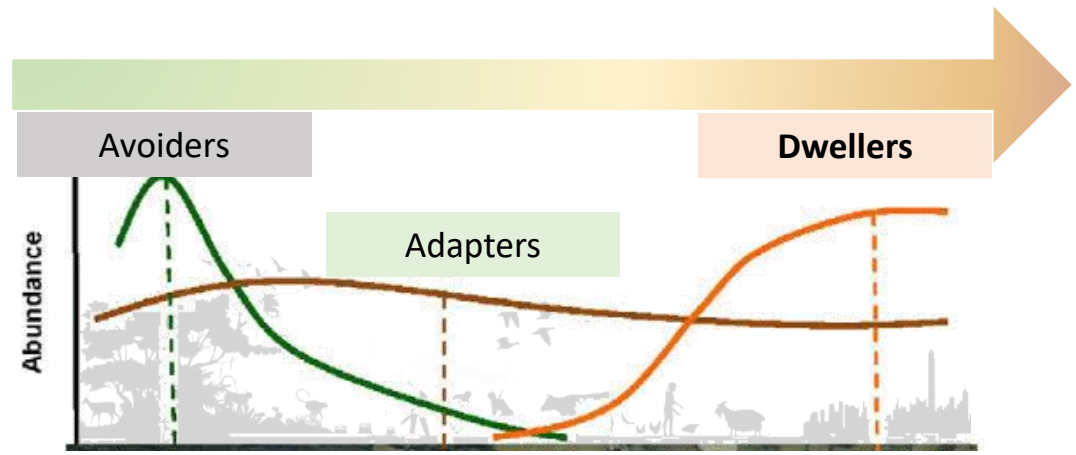
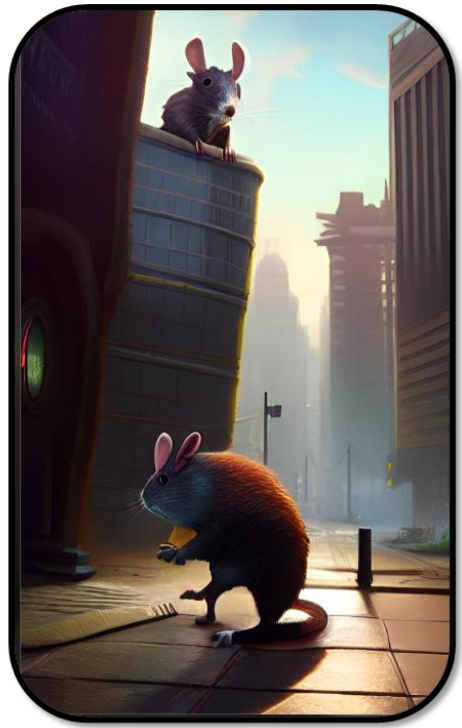
Some species are absent from urban forests



Some species are present in both habitats



Some species are only found in cities

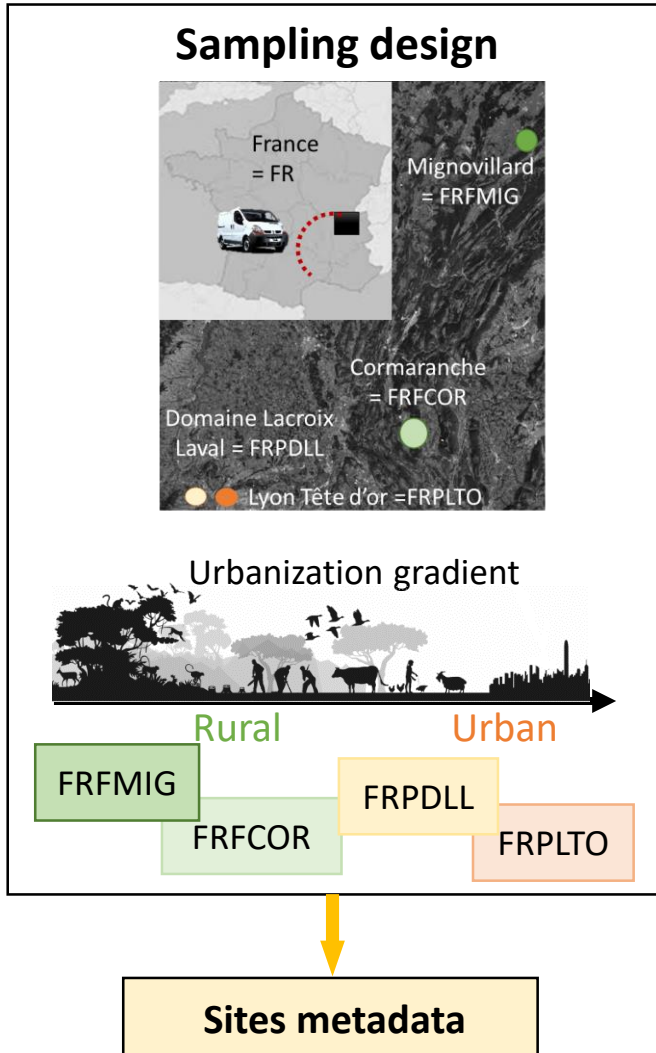


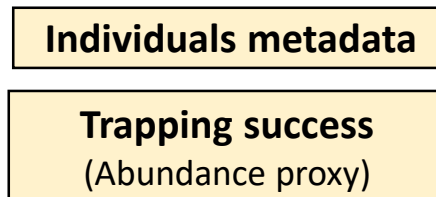
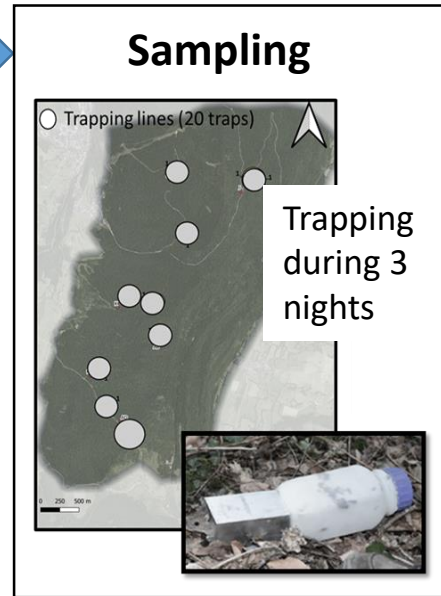
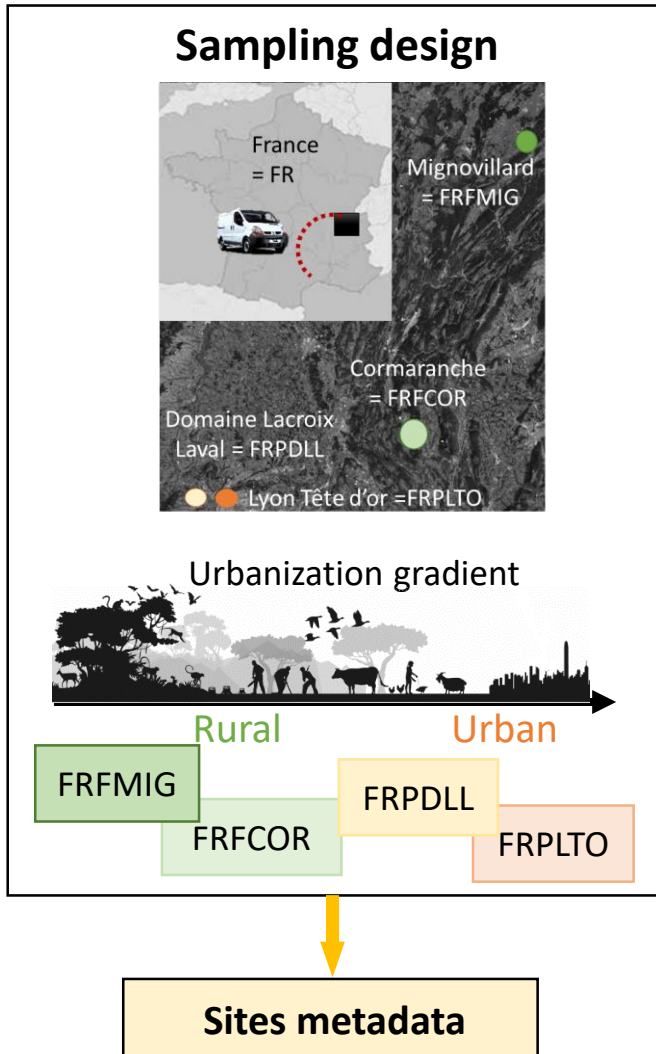
1) What are the impacts of urbanization on the links between small mammal communities and their microbiota?



2) What are the responses of the gut microbiota to urban disturbances?

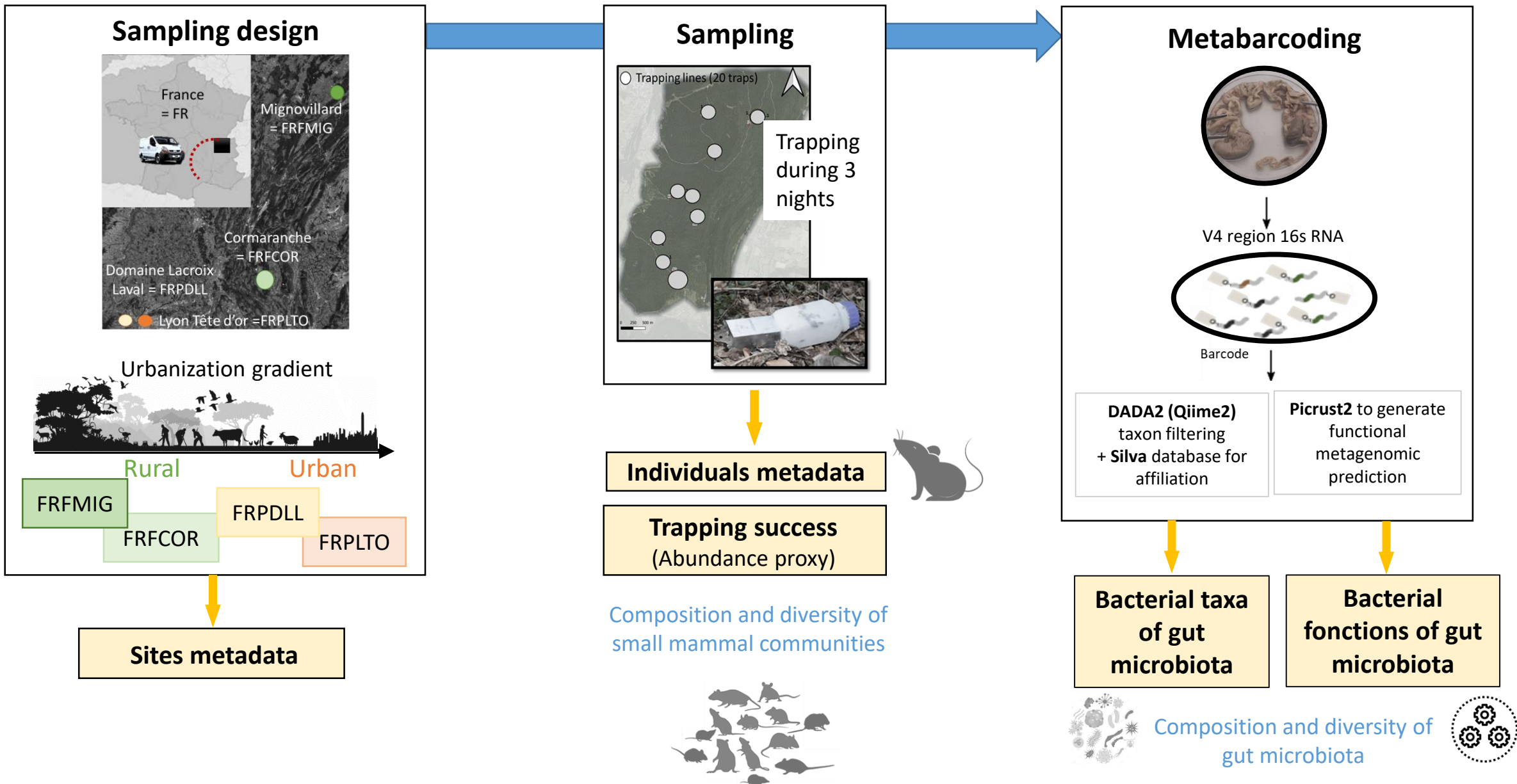


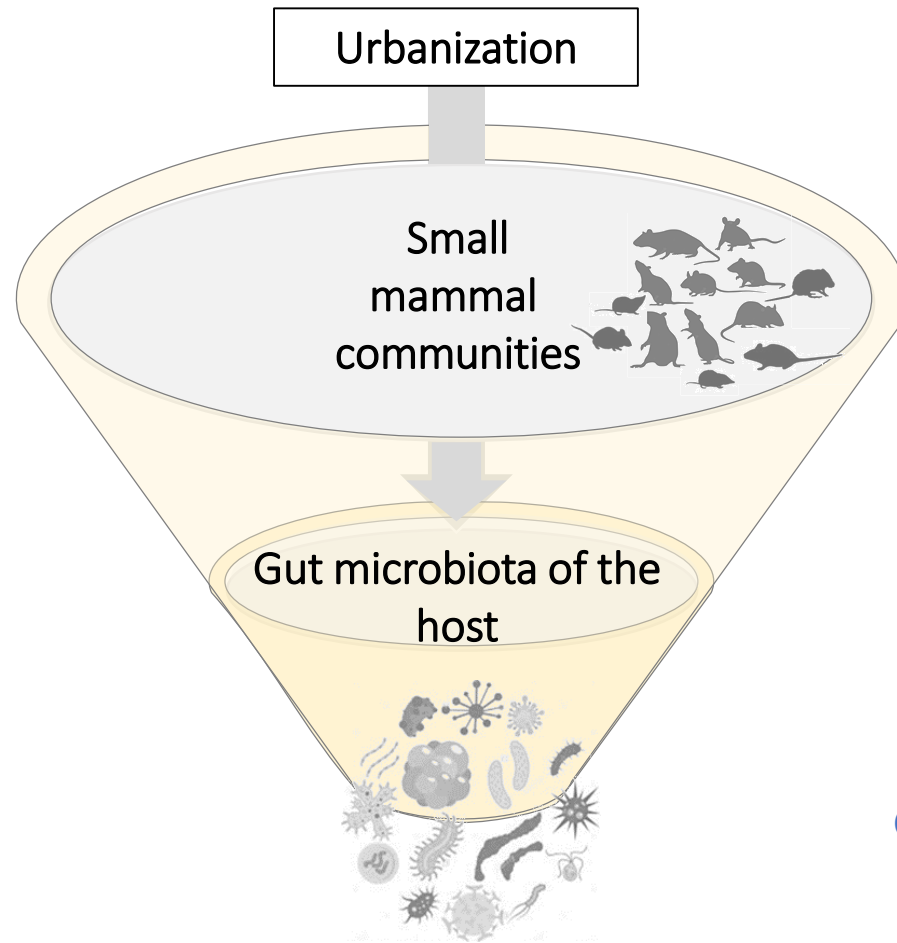




Composition and diversity of small mammal communities







1. Analyze if urbanization affects the composition of small mammal communities

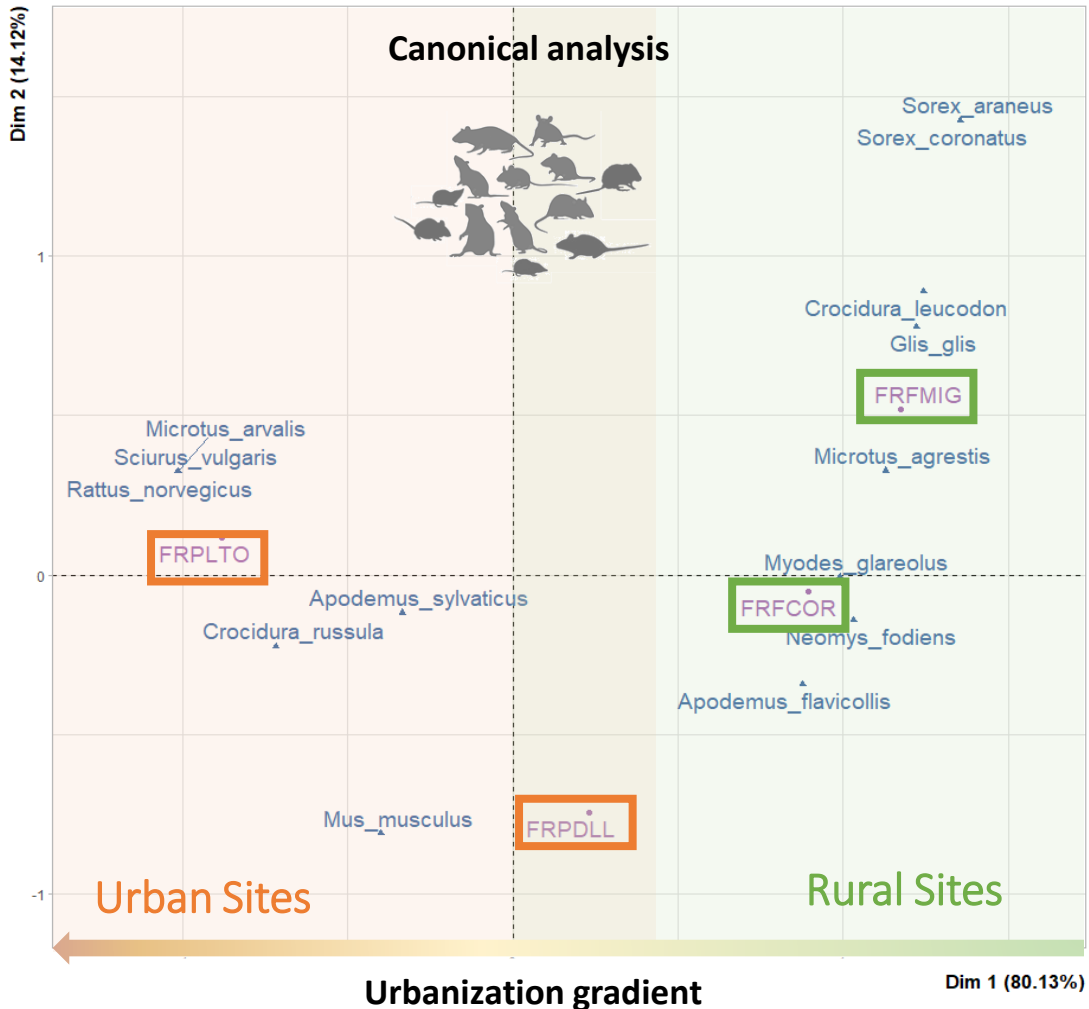
Composition communities ~ Urbanization

2. Analyze the effects of small mammals communities on the composition and diversity of gut microbiota.

Gut microbiota diversity ~ Sites * Host species + Gender + Maturity

1. Effects of urbanization on small mammals communities

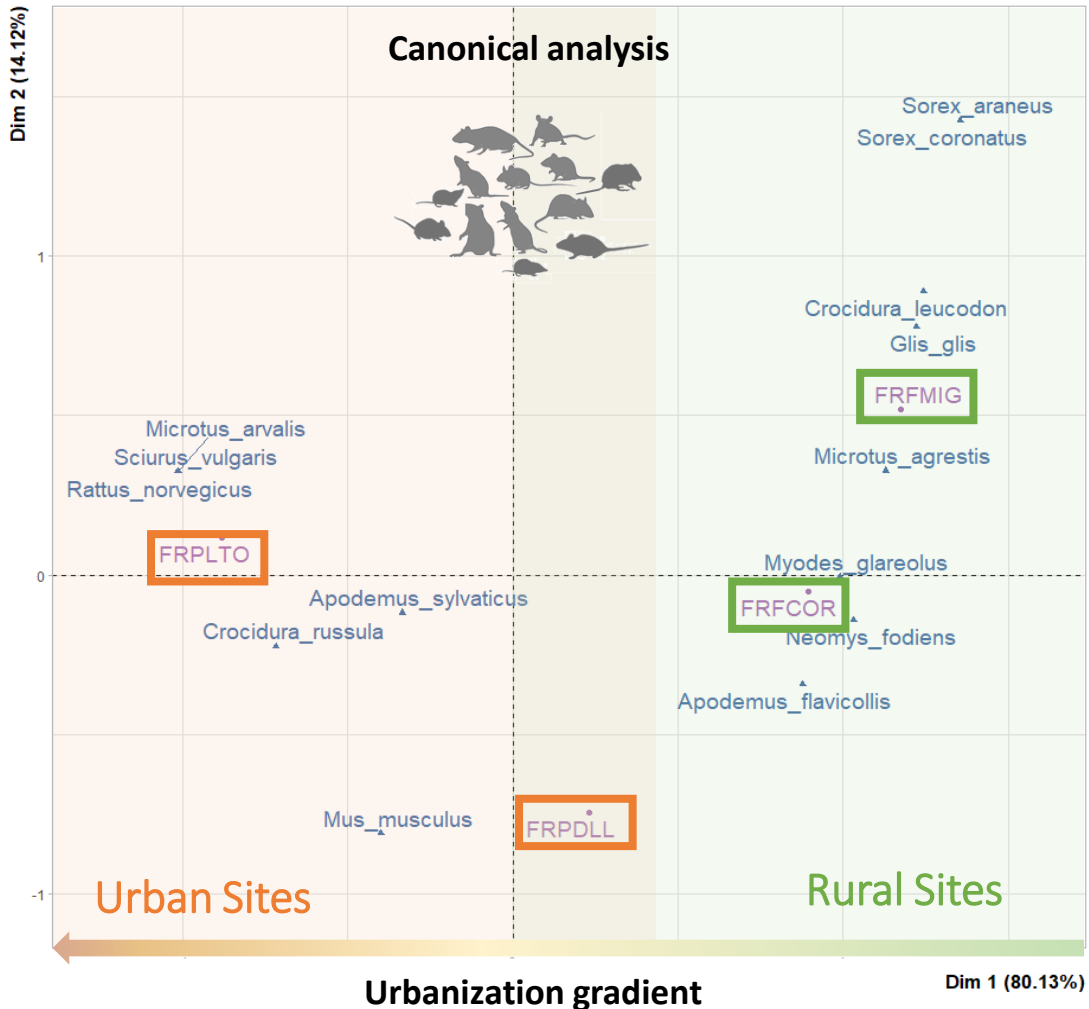
Composition of host species in the sites



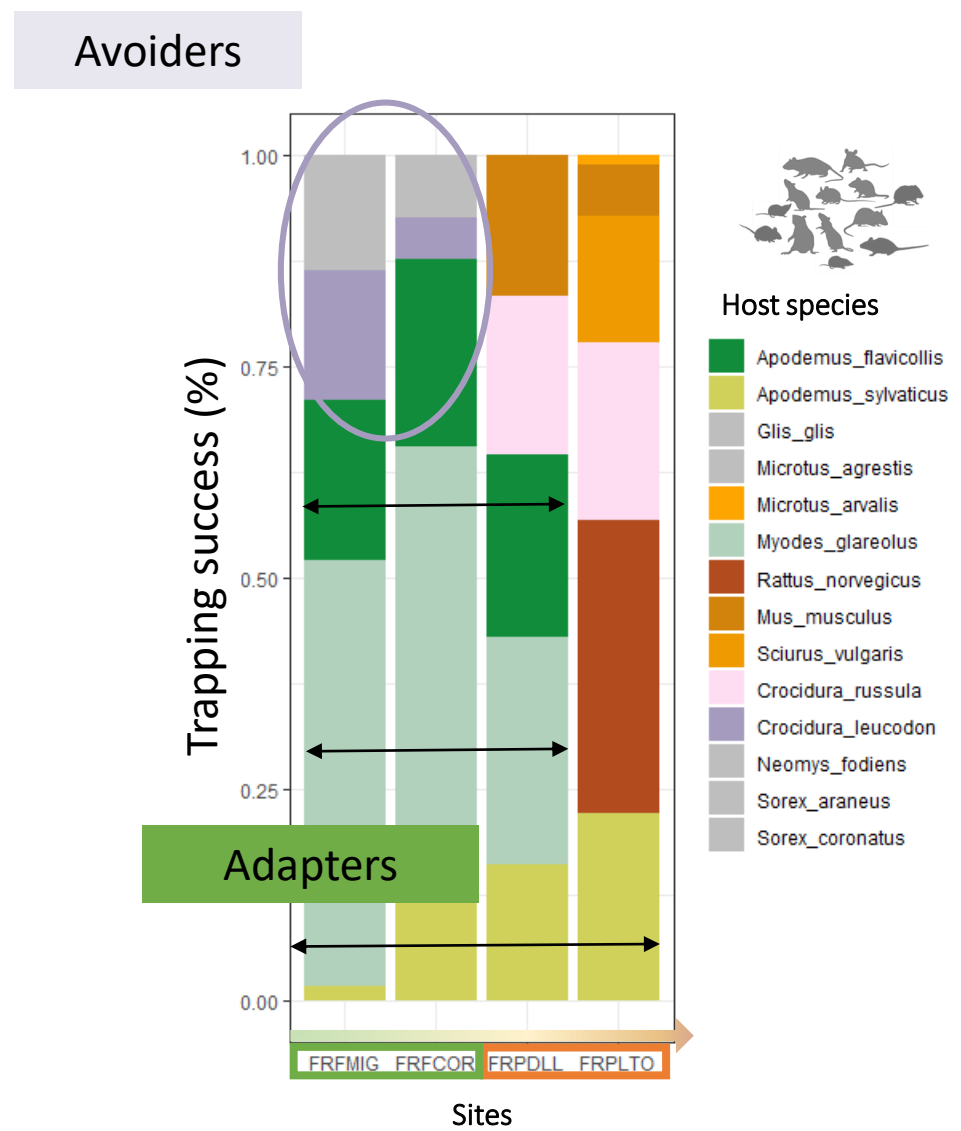
Host species communities composition is significantly explained by the urbanization gradient.

1. Effects of urbanization on small mammals communities

Composition of host species in the sites



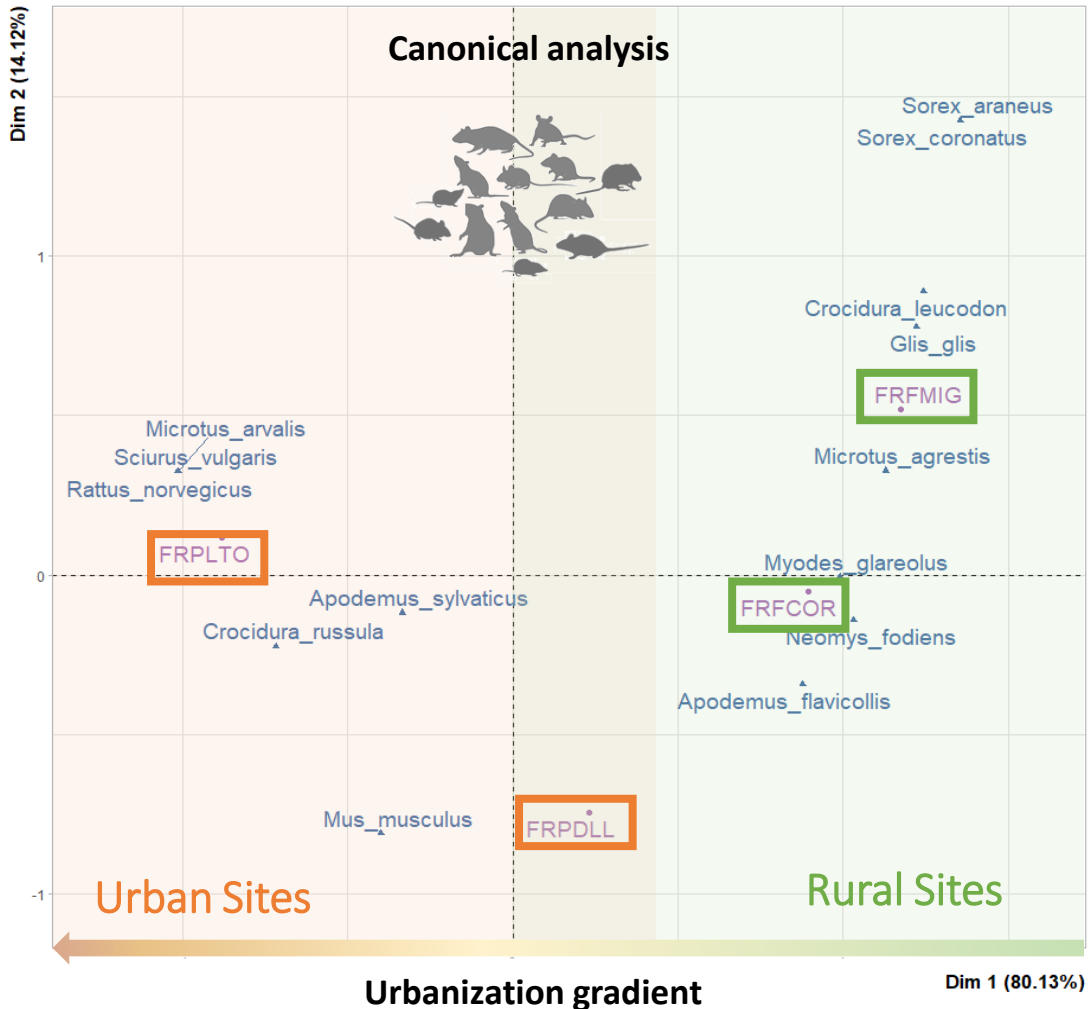
Relative abundance of host species in the sites



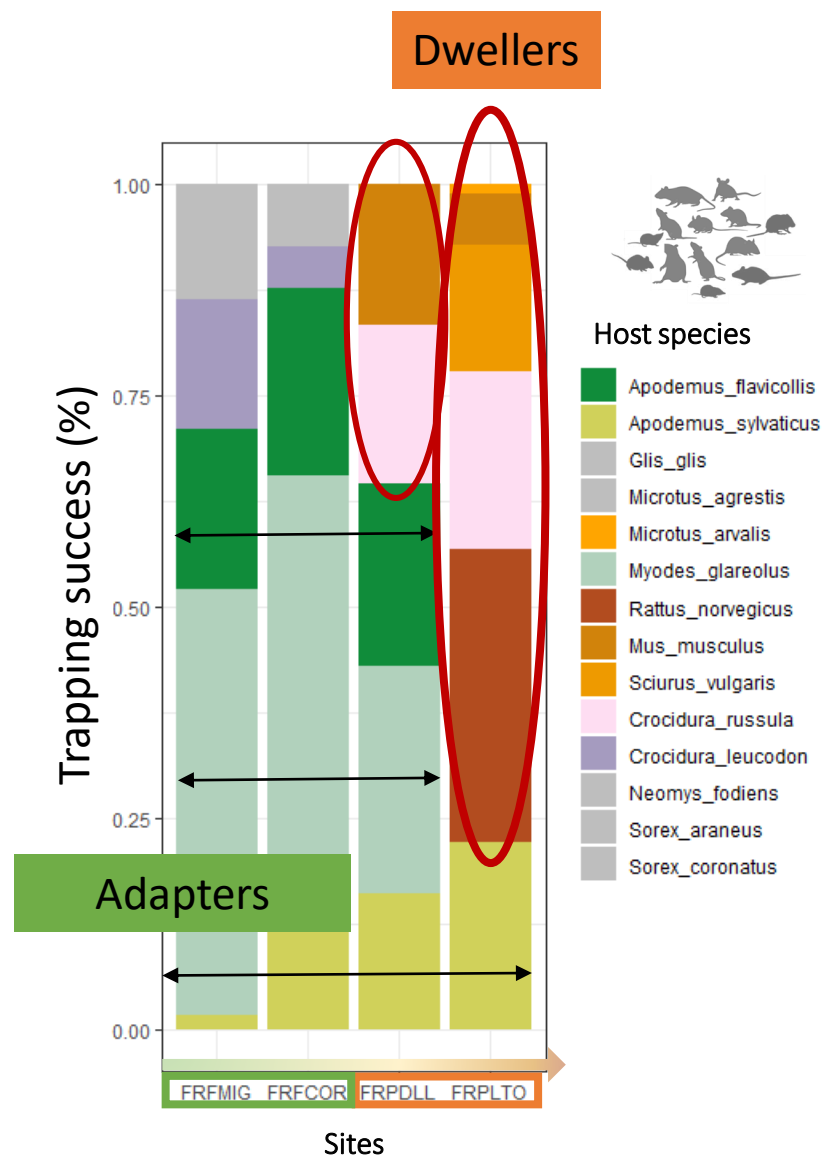
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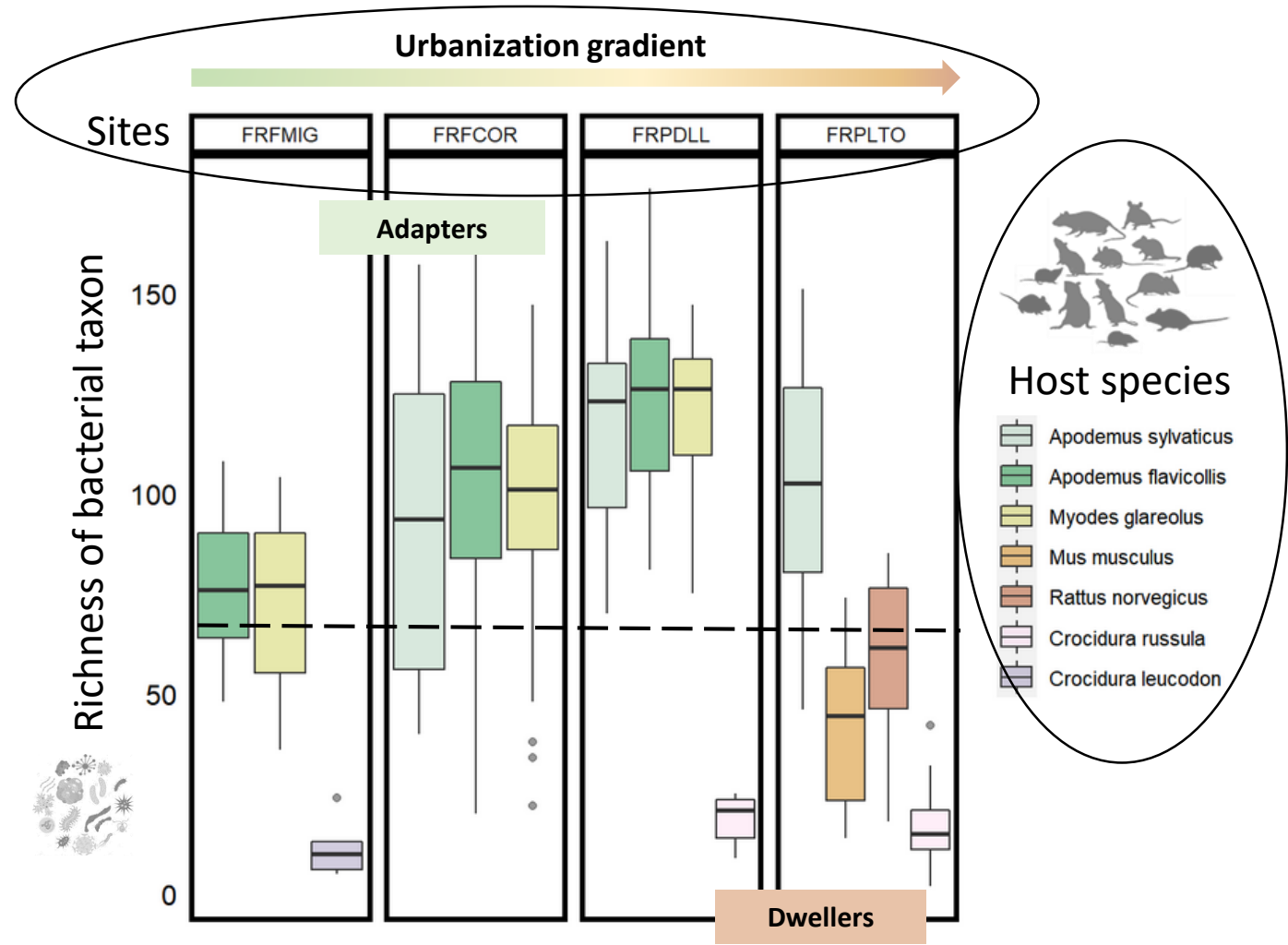
Relative abundance of host species in the sites



Host species communities composition is significantly explained by the urbanization gradient.

2. Effects of small mammals communities on diversity of gut microbiota

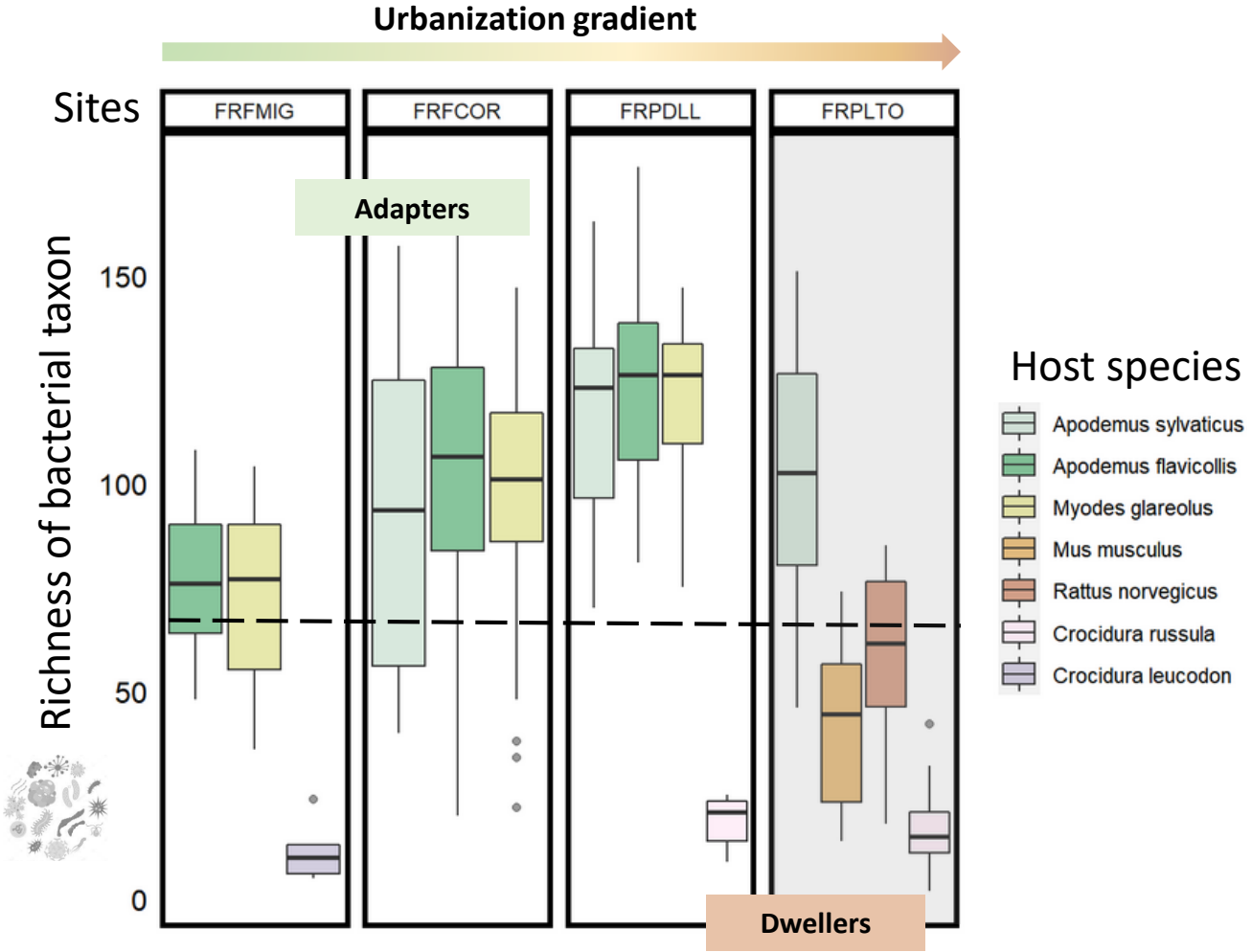
Diversity of gut microbiota ~ Sites * Host species + Gender + Maturity



Host species and the urbanization gradient significantly modulate the diversity of the gut microbiota

2. Effects of small mammals communities on diversity of gut microbiota

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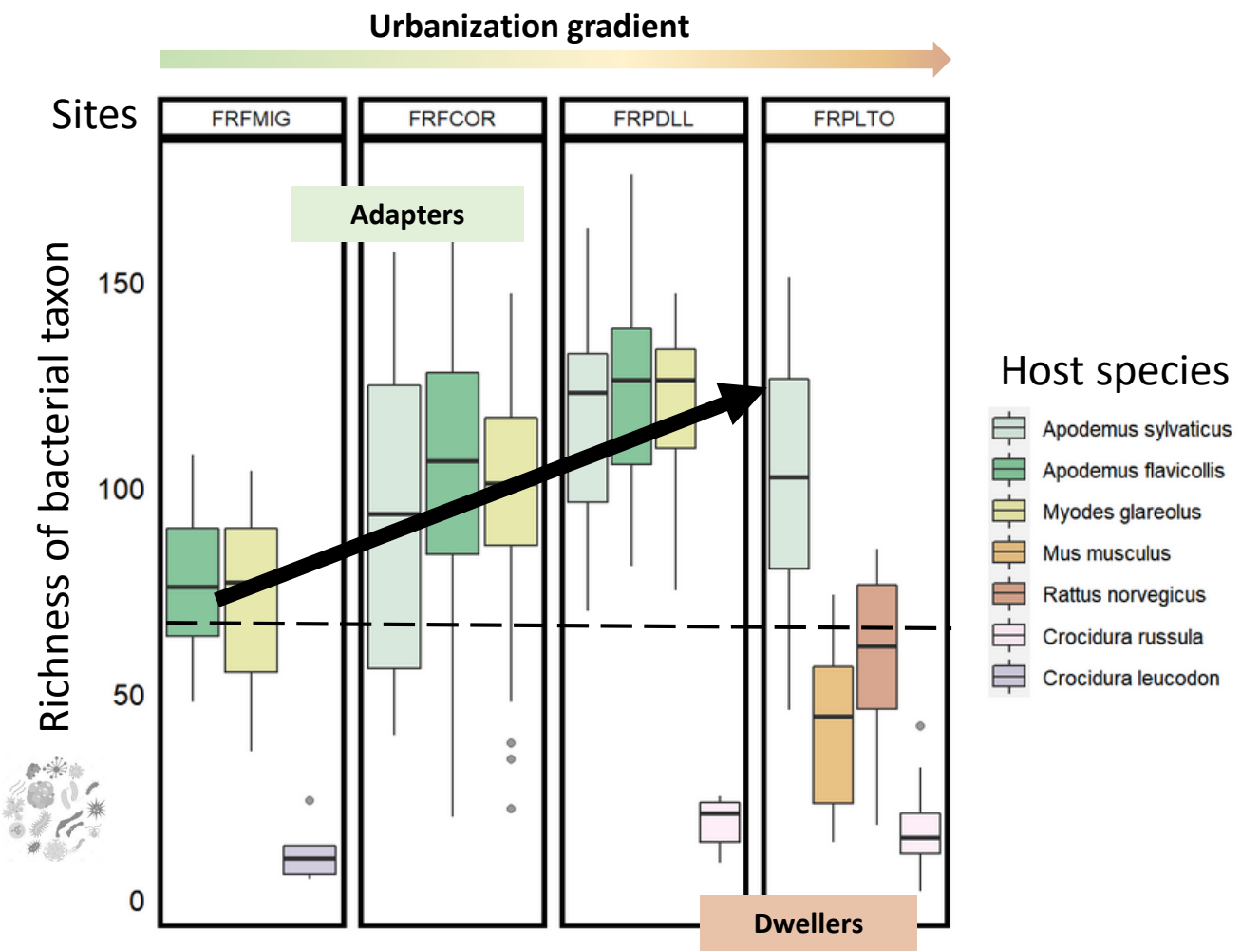


Host species and the urbanization gradient significantly modulate the diversity of the gut microbiota.

Host species - sites interaction effect
 → Individuals from the same sympatric community do not have the same diversity: the dwellers species have a lower diversity.

2. Effects of small mammals communities on diversity of gut microbiota

Diversity of gut microbiota ~ Sites * Host species + Gender + Maturity




Host species and the anthropization gradient significantly modulate the diversity of the gut microbiota

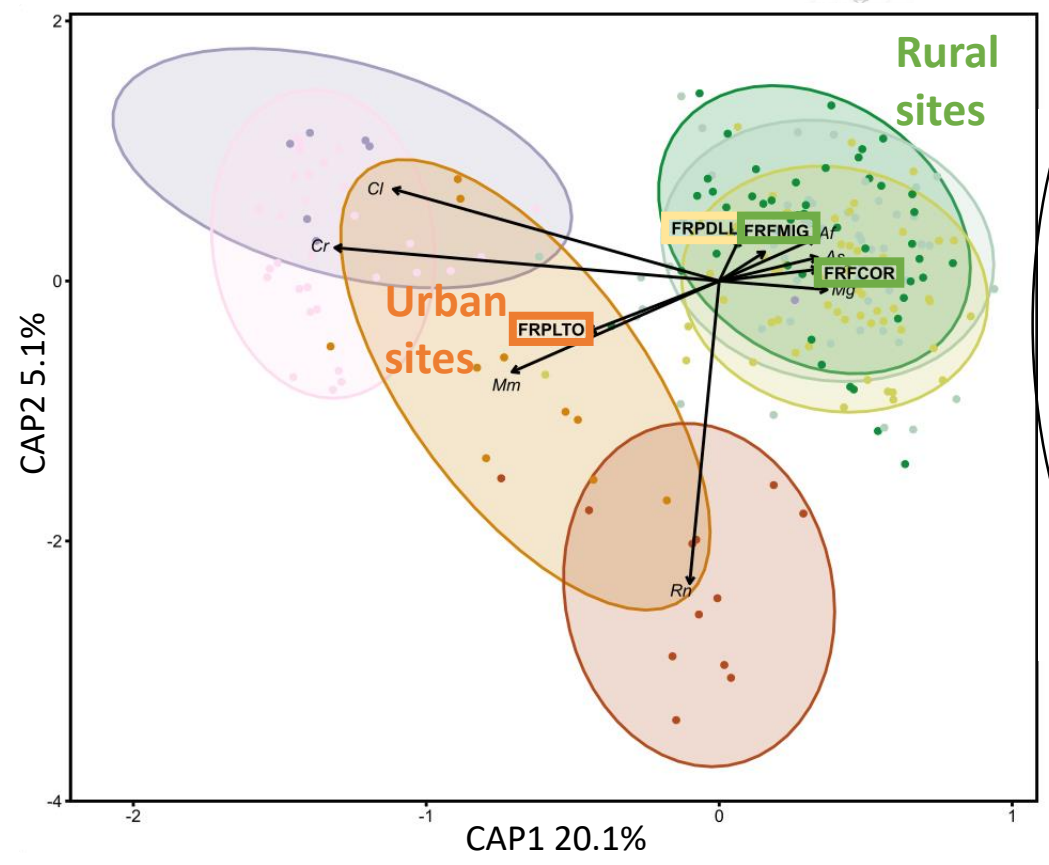
Host species - sites interaction effect


- Individuals from the same sympatric community do not have the same diversity: the dwellers species have a lower diversity.
- Species do not have the same diversity according to the gradient of urbanization: the diversity increases with gradient.

2. Effects of small mammals communities on composition of gut microbiota

Composition of gut microbiota ~ Sites * Host species + Gender + Maturity

Composition of bacterial taxa (dbRDA) 




Host species 

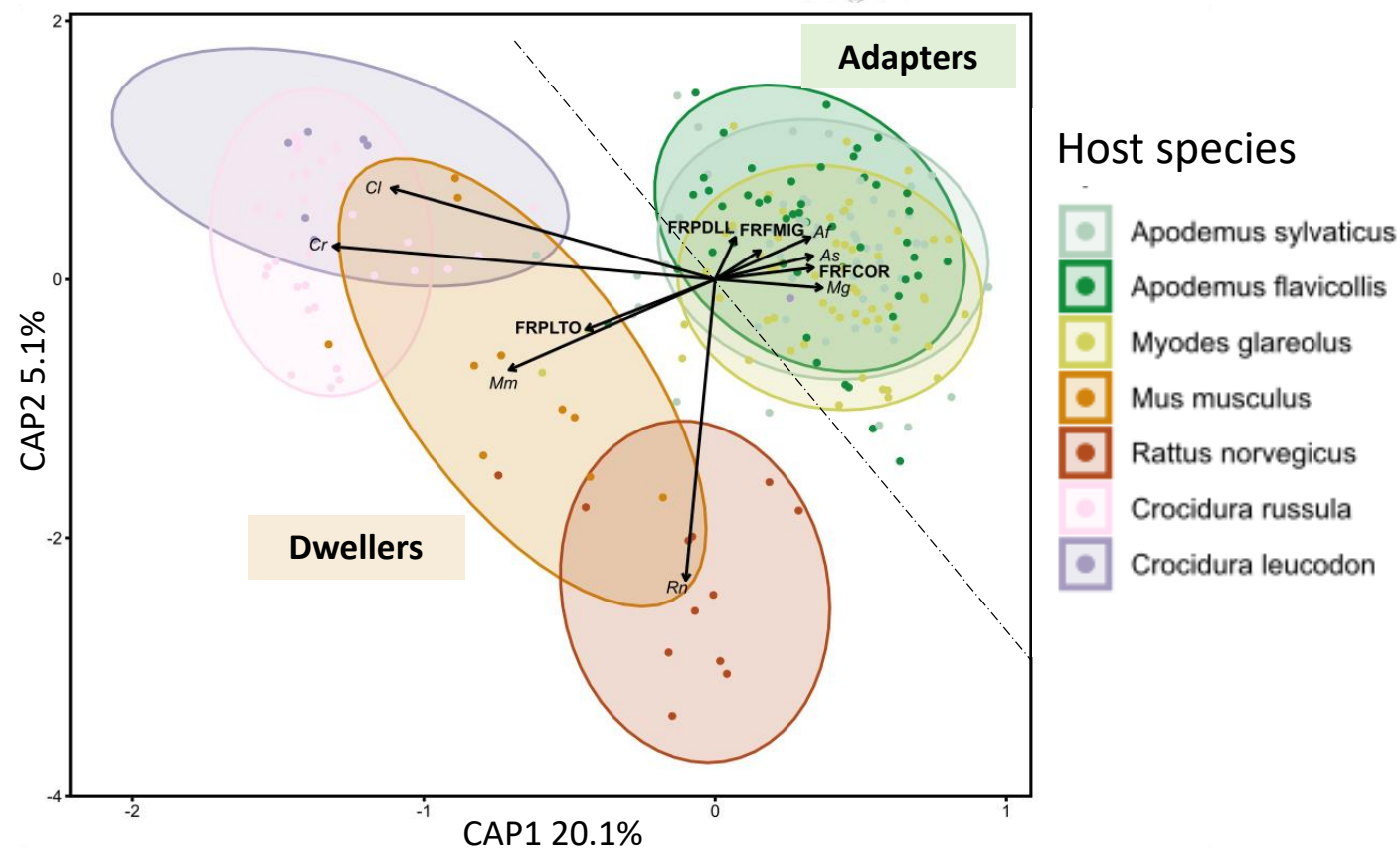
- Apodemus sylvaticus
- Apodemus flavicollis
- Myodes glareolus
- Mus musculus
- Rattus norvegicus
- Crocidura russula
- Crocidura leucodon

The species and sites explain significantly the composition of gut microbiota.

2. Effects of small mammals communities on composition of gut microbiota

Composition of gut microbiota ~ Sites * Host species + Gender + Maturity

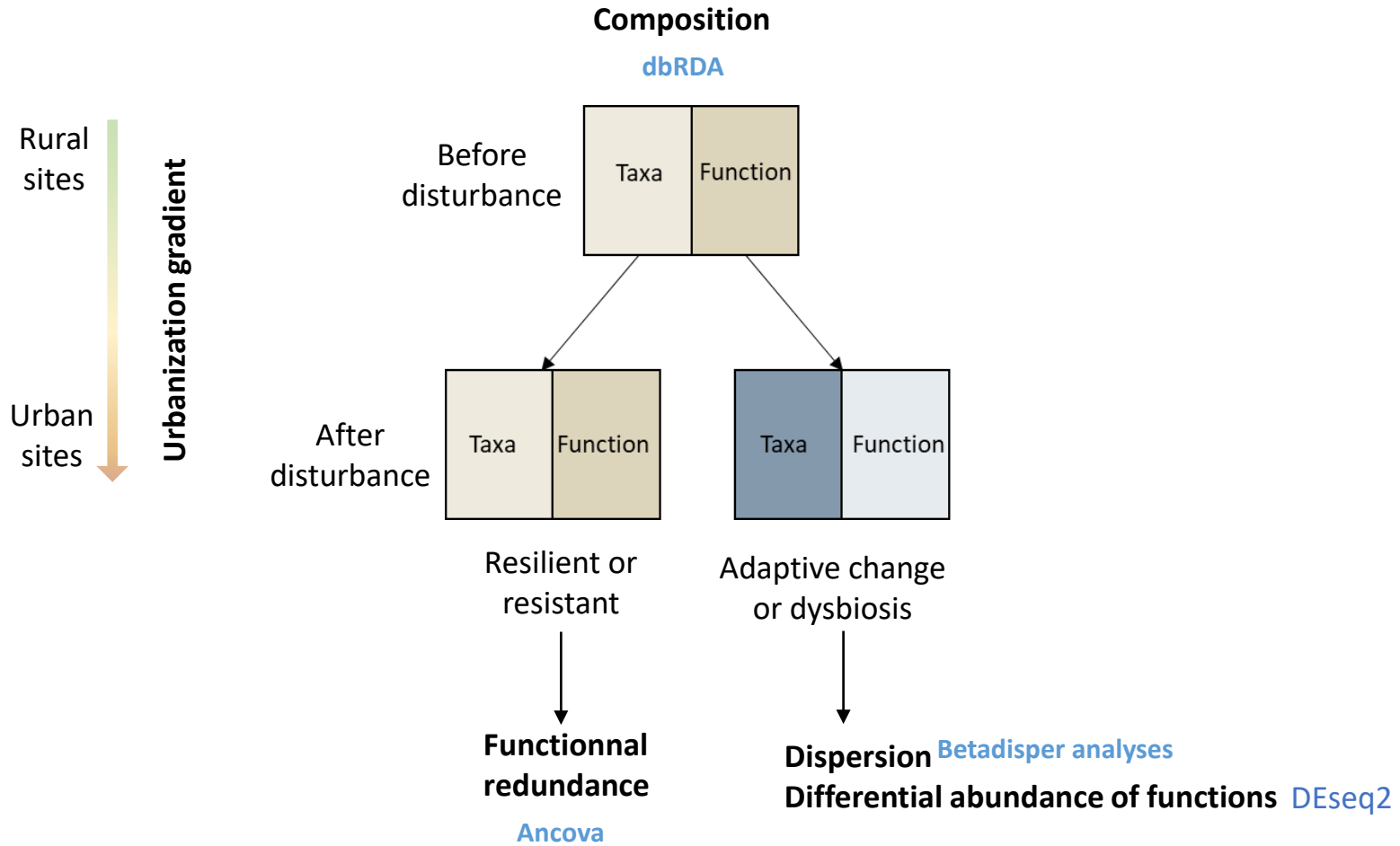
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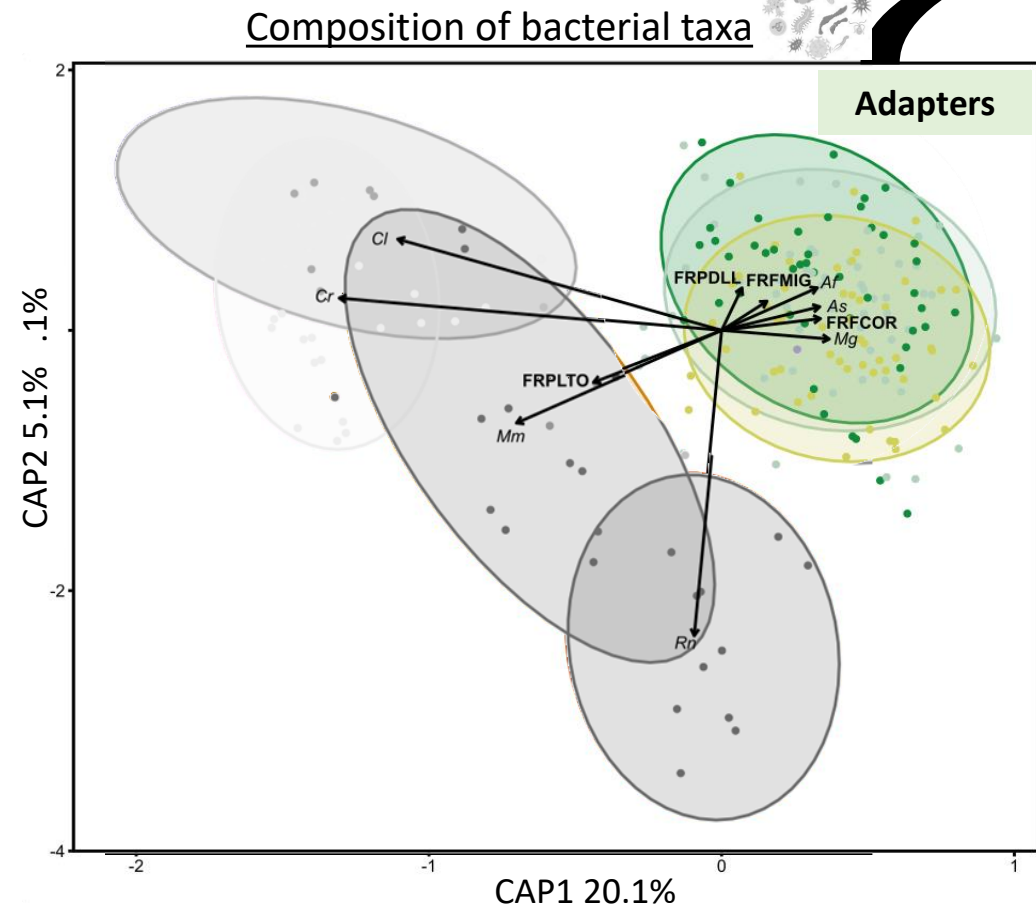
The composition of the gut microbiota depends mainly on the category of host species: adapters or dwellers.


What are the responses of the gut microbiota to urban disturbances?

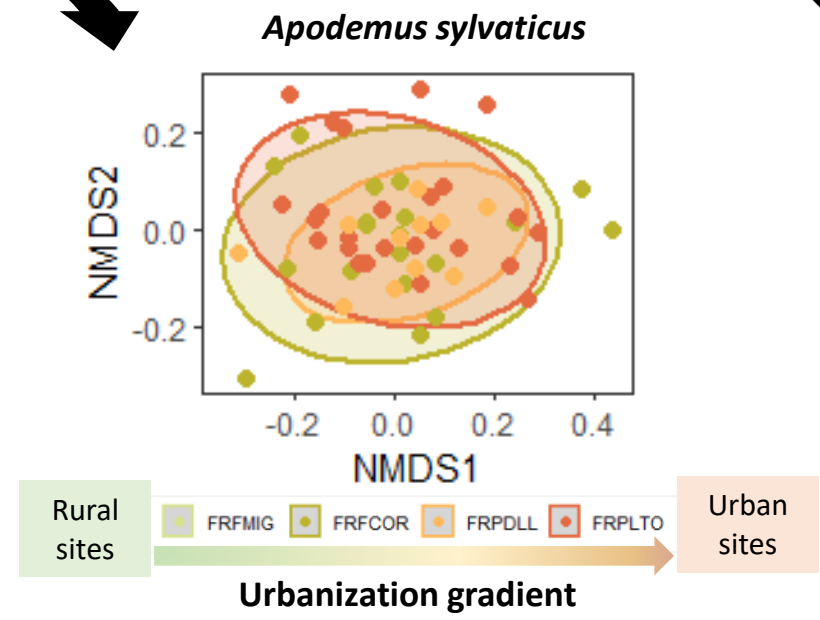


« Decision tree »

3. Describe the responses of the gut microbiota against disturbances



Focus on adapter species 

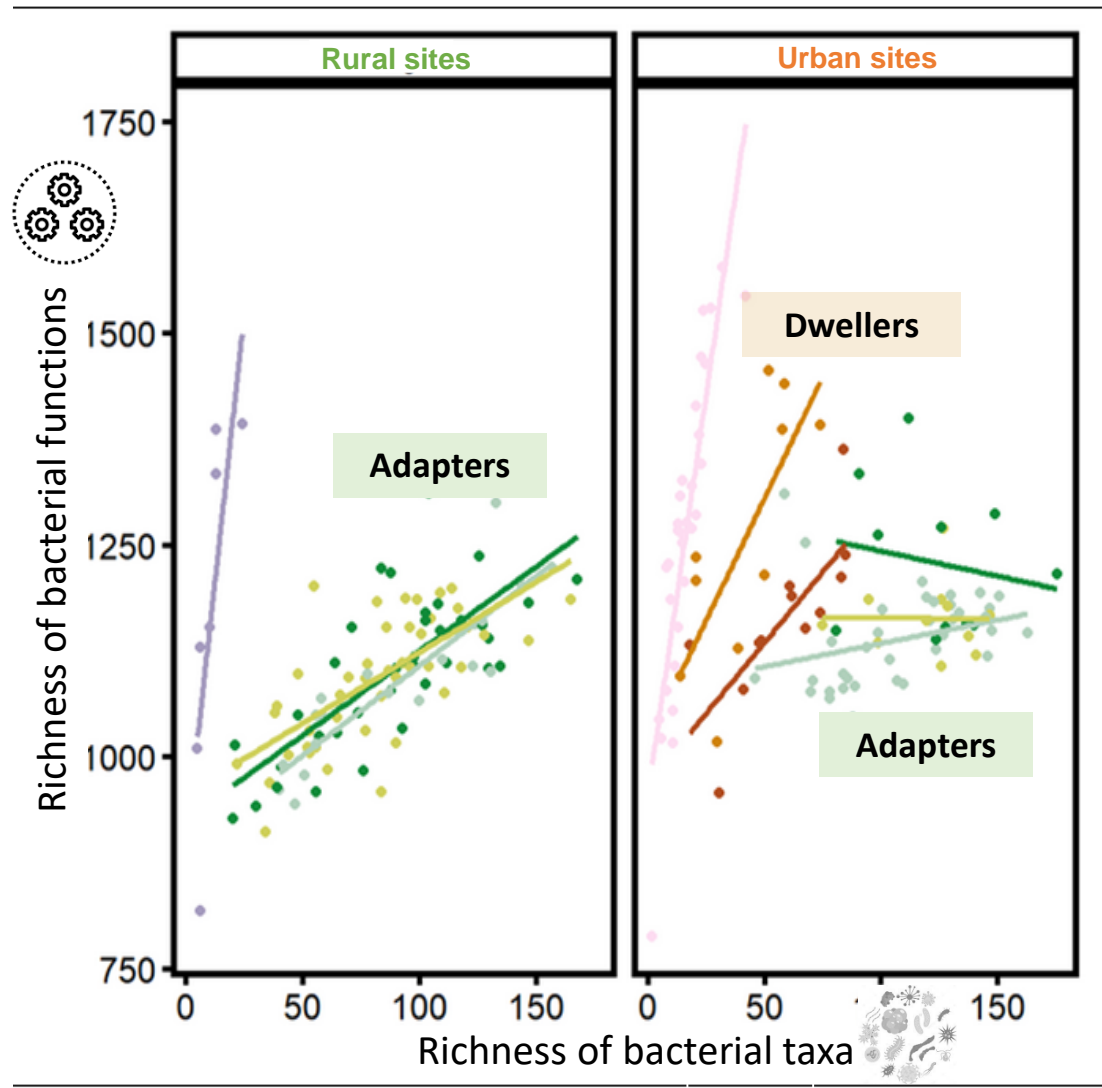
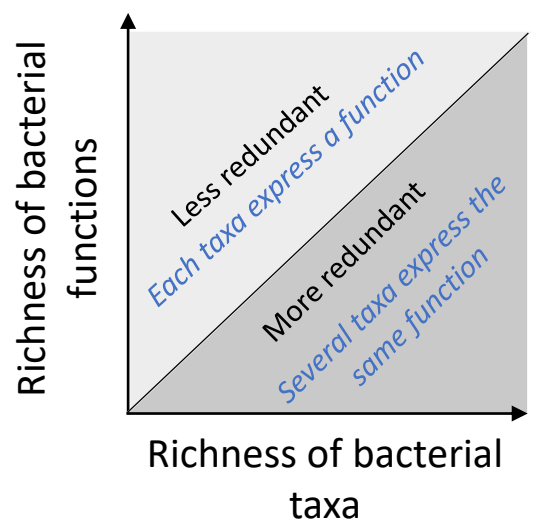


The differences of composition along gradient are significant but the effects are very low.

→ Gut microbiota of adapter species seems resilient or resistant to urban disturbance.

3. Describe the responses of the gut microbiota against disturbances


Functional redundancy theory

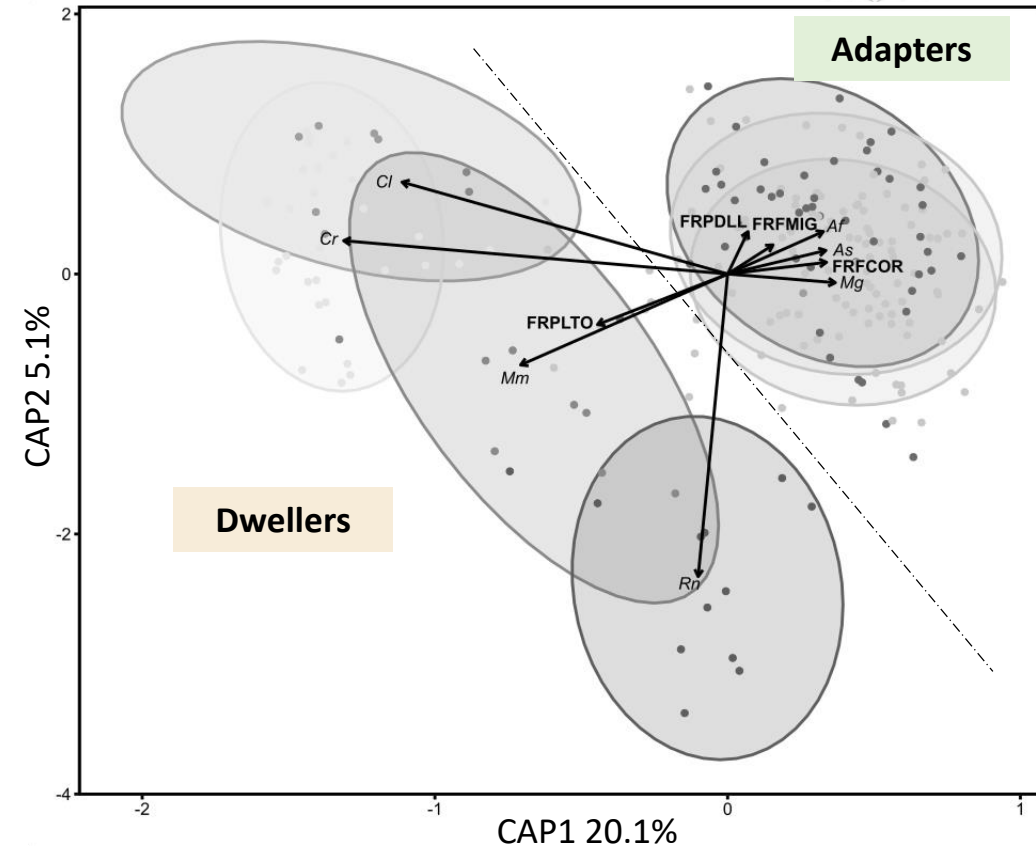



- Host species
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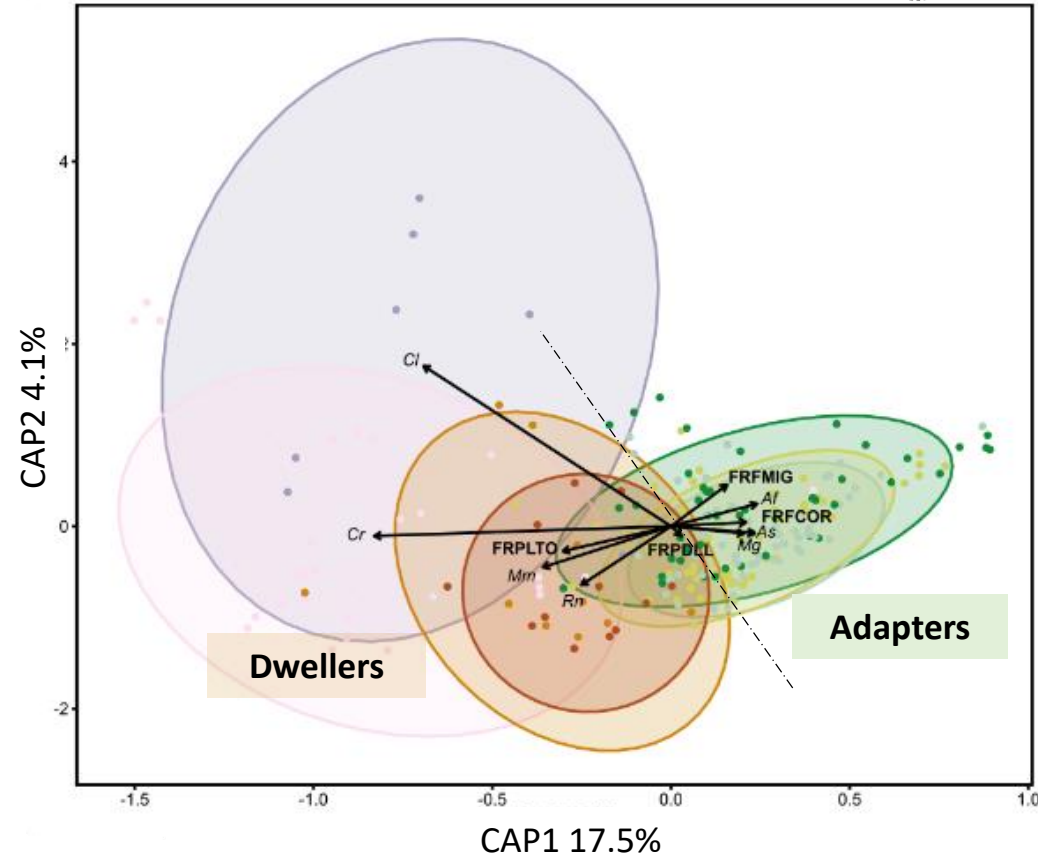
Significantly higher redundancy effect in adapter species and enhanced species in urban environments.

3. Describe the responses of the gut microbiota against disturbances

Composition of bacterial taxa 



Composition of bacterial function 

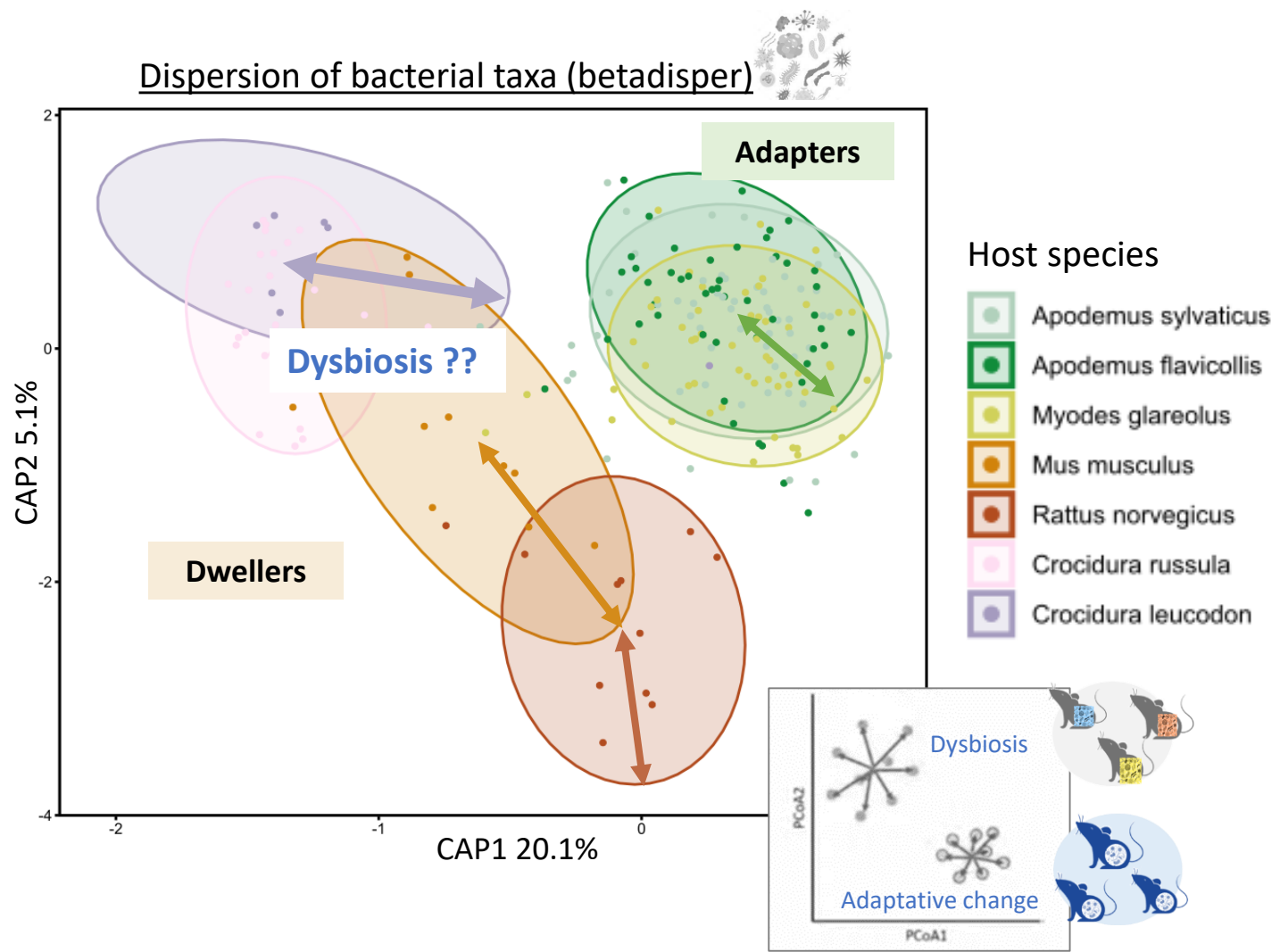


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Dwellers do not have the same functional and taxonomic composition as adapters (regardless of disturbance).

→ Gut microbiota of dwellers species seems have adaptive change or dysbiosis process.

3. Describe the responses of the gut microbiota against disturbances

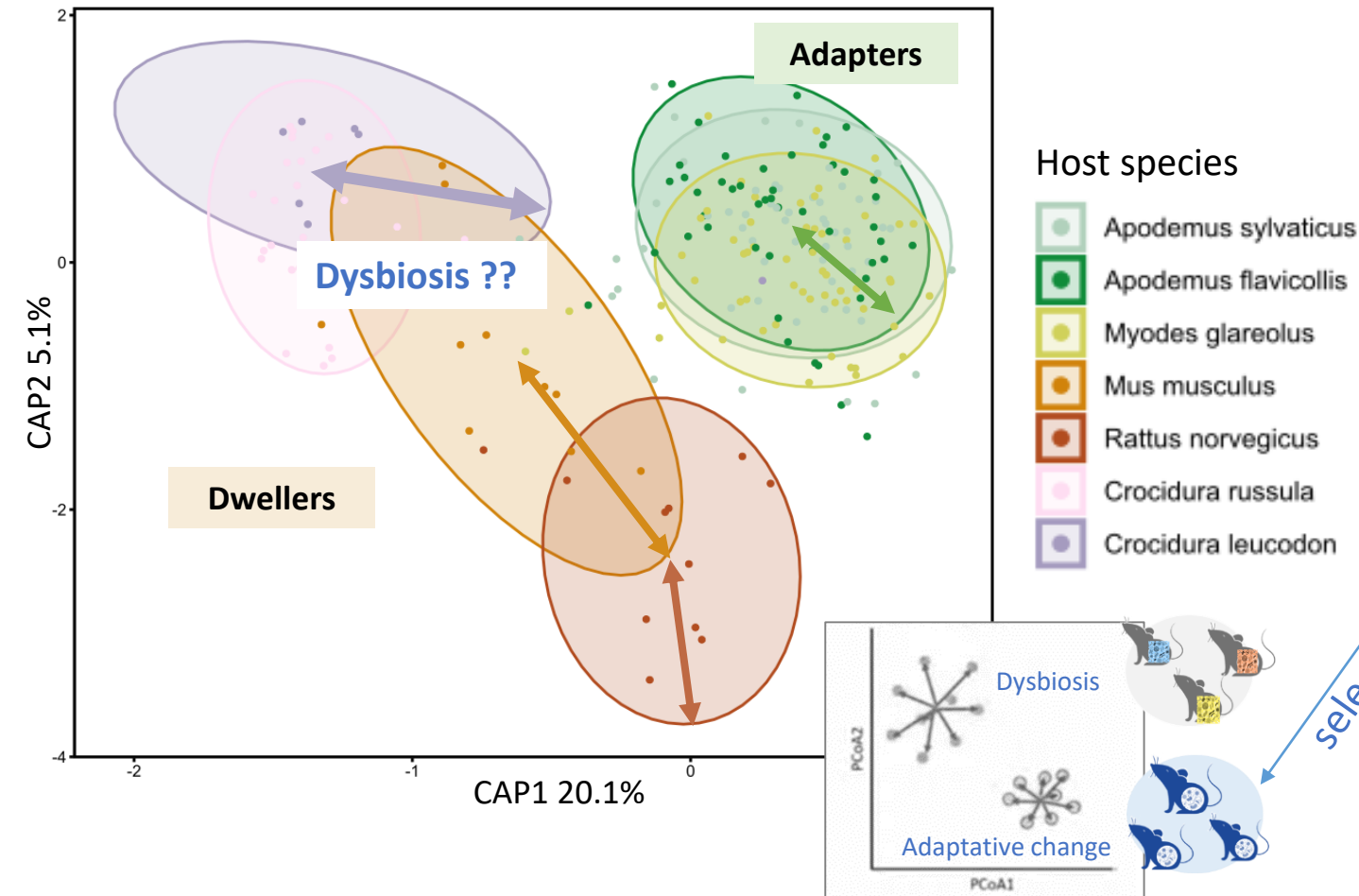


Dispersion higher but not significantly different for urban dwellers

→ The gut microbiota of dwellers species appears to be in favor of a dysbiosis process.

3. Describe the responses of the gut microbiota against disturbances

Dispersion of bacterial taxa (betadisper)





Dispersion higher but not significantly different for urban dwellers

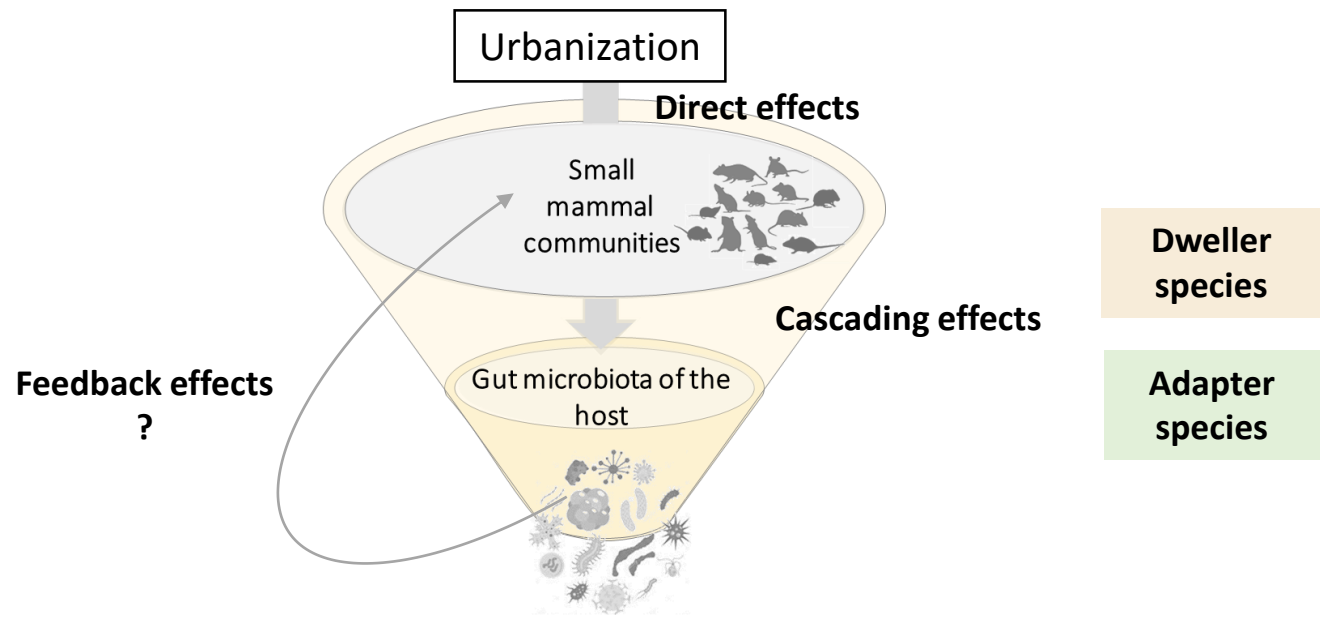
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Differential abundance analysis (DEseq2)

The abundance of several functions is significantly different in all *Rattus norvegicus* and *Mus musculus*

→ Some functions may be the result of adaptive change due to urbanization.

-  Evidence for the impact of urbanization on the links between small mammal communities and their microbiota.
-  The urbanization affects differently the microbial composition and diversity differ among host species.



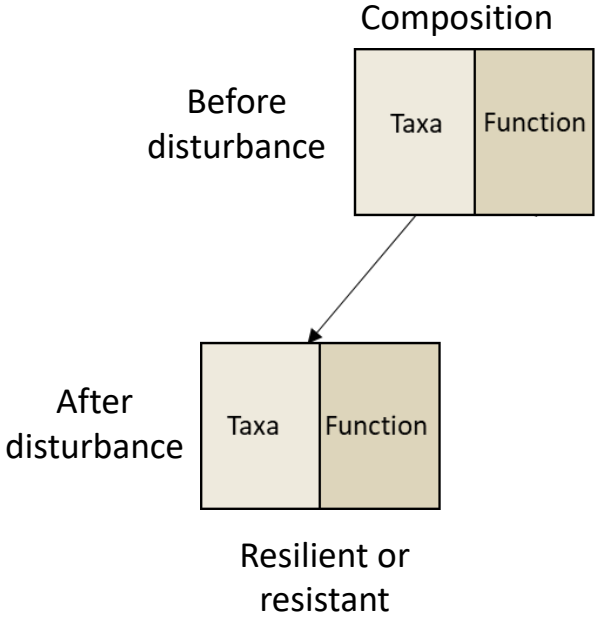
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For the adapter species



- The urbanization impact the diversity of gut microbiota
- Not evidence of impact on composition of taxa and function.



The gut microbiota is resilient or resistant to urbanization with a functional redundancy mechanism.



Could this confer phenotypic plasticity on the hosts and allow them to remain in urban areas?

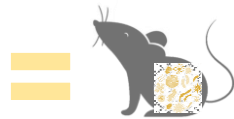
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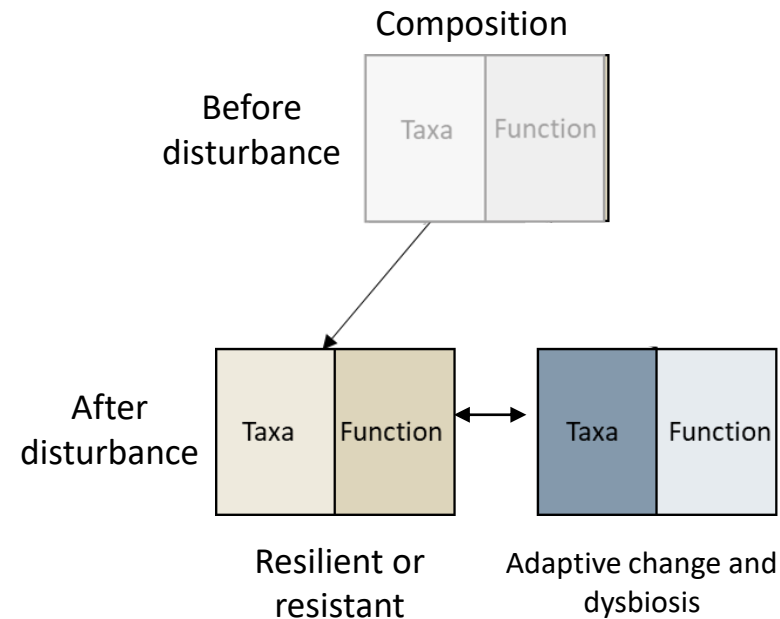
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For the dweller species

- Diversity is lower and composition is different compared to adapter species.
- Dispersal analysis suggests dysbiosis while differential abundance analysis shows selection for adaptive functions.



Urbanization appears to have stochastic and selective effects at the same time.

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For the adapter species

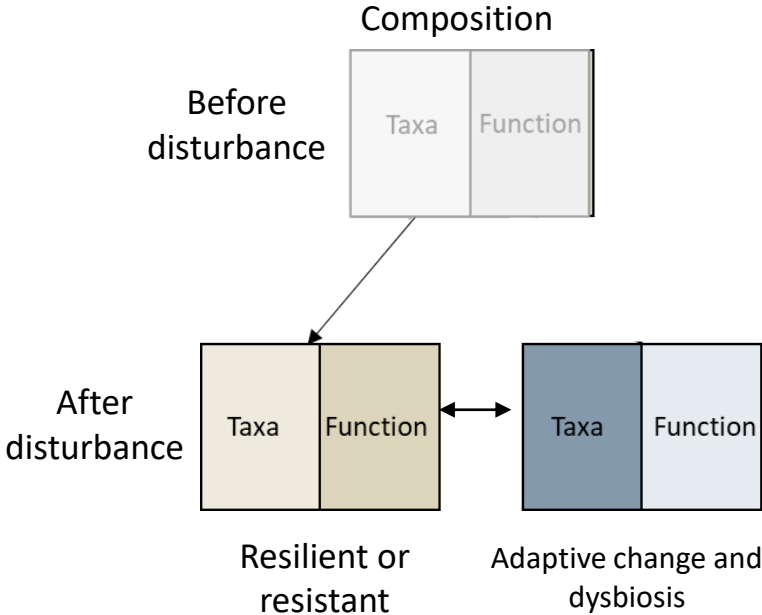
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The new functions selected could be associated with adaptation to urbanization, despite their adverse effects.



Thank you for your
attention



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