Integrating genomic data as a new layer in long-term life-history studies of endangered viviparous lizards of the Cévennes

DevOCGen week

01/12/2025

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Responses of organisms to climate change

Dispersal

Acclimation

Adaptation

Responses of organisms to climate change

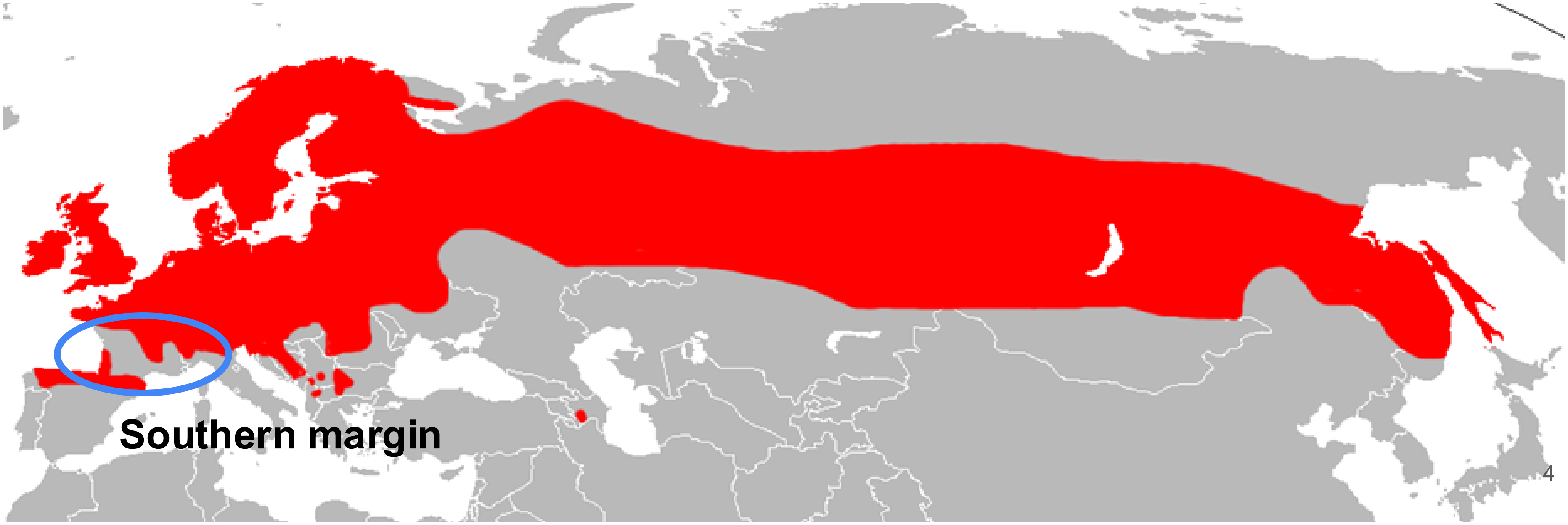
Dispersal

Acclimation

Adaptation

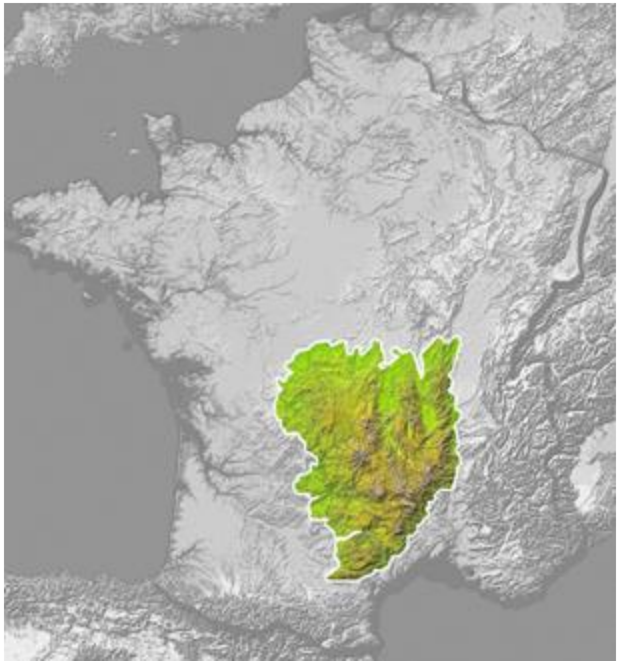
The common lizard (*Zootoca vivipara*)

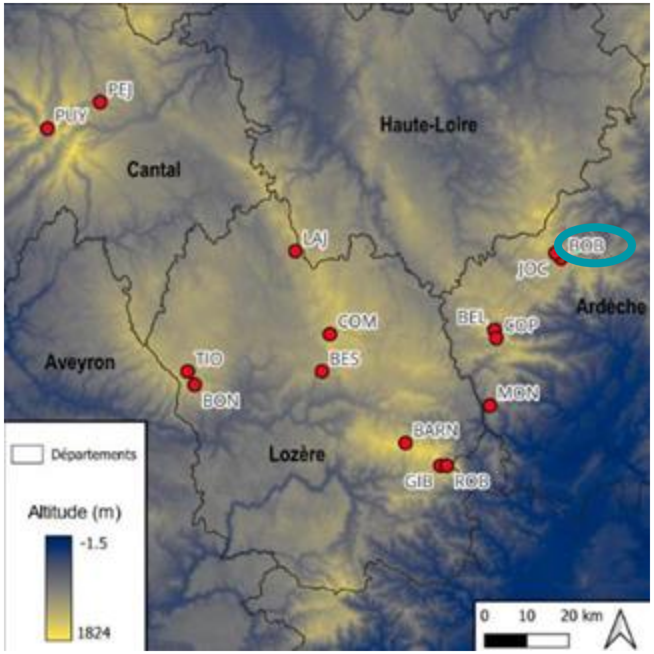
- Cold-humid habitat, ectotherm
- Viviparous (some pop. oviparous)
- Very wide range
- Threatened in the southern margin (e.g. France)
- Model species in evolutionary ecology (easy to work with, viviparity…)



Long-term wild population surveys in the Massif Central

- Longitudinal survey of **2 populations since 1989** at Mt Lozère
  - Annual survey of the population with phenotyping of individuals
  - Mark and recapture surveys
  - One population pedigreed using micro-satellites for paternities





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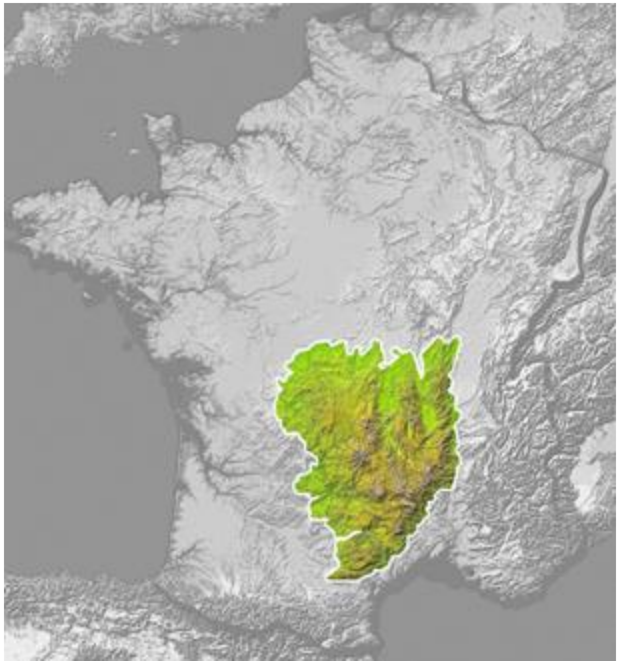
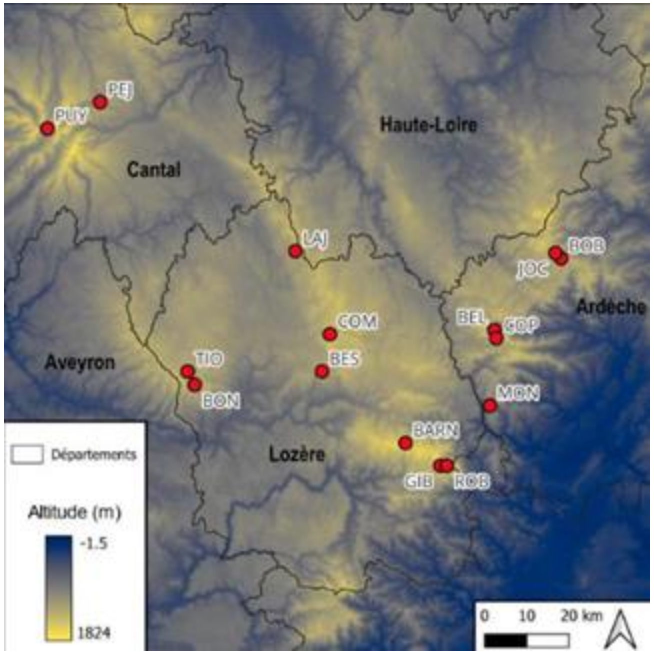
- **Cross-population survey since 2001** through the Massif Central
    - Strong environmental differences between populations
    - Survey every two years until 2019 + opportunistic surveys since 2019





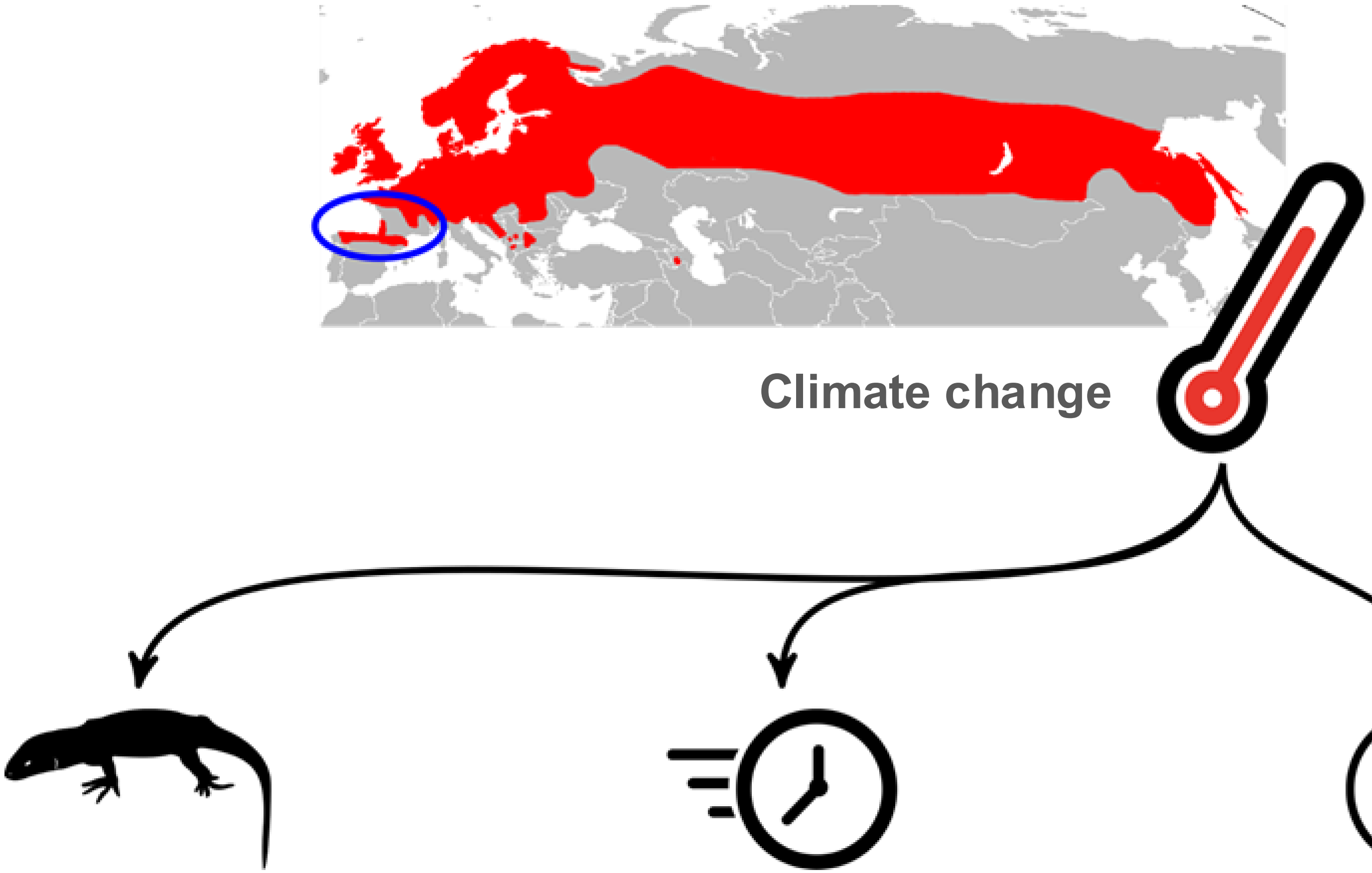
Experimental enclosed population in Moulis

- Individuals from the Massif Central populations

- 2 different experiments
  - 2012-2021: mixed populations in different ecological contexts mimicking future climate change or present climate
  - 2022-2024: common garden experiment comparing individuals from various populations across different experimental climates

Metatron experimental mesocosm

Current results on the ecological and phenotypic impacts of climate change



Climate change

↗ growth

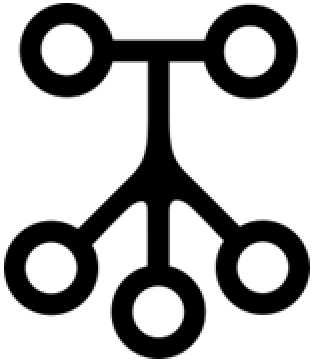
↗ maturity

↗ mortality

Net negative impact on population dynamics = ↗ population extinction

What about genetic adaptation?

Pedigree &
Quantitative genetics



Population genomics

- Measures of additive genetic variances and heritabilities

What about genetic adaptation?

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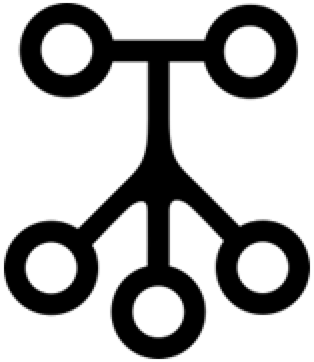
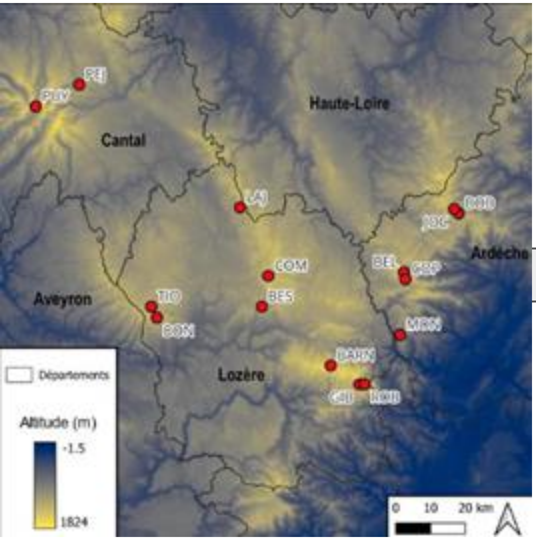


Population genomics

- Measures of additive genetic variances and heritabilities
- Genome scale sequencing on wild populations (2005 & 2015)
  - Population structure
  - **Scans for selection**
- Whole-genome linked reads
  - **Inference of population structure & genetic diversity**
  - Phenotype-genotype link inference (genetic architecture of traits)
  - Scans for selection

Haplotagging in wild lizard populations

14 populations (~192 female ind.)



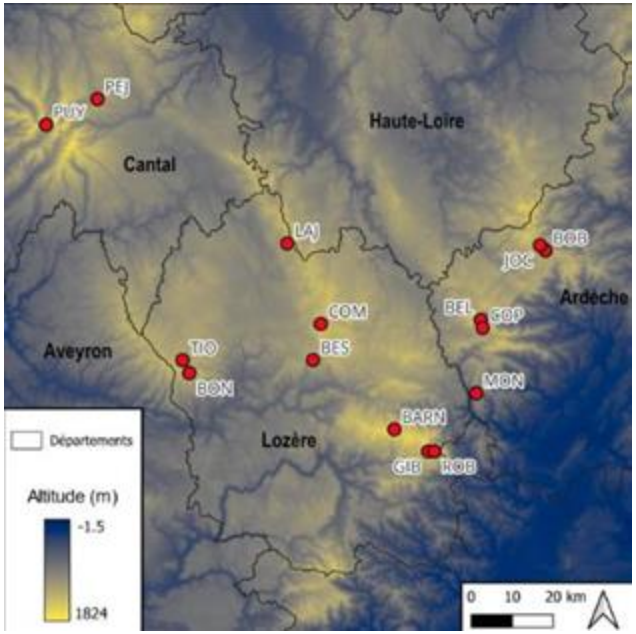
Haplotagging

- Pipeline optimization (see you on Thursday)
- Preliminary results on diversity and population structure
  Louna Cohu Puel, M2 Internship

Haplotagging in wild lizard populations

M2 Internship: Are the genetic structure and diversity of viviparous lizard populations in the Massif Central consistent with the hypotheses formulated based on their ecology?

Given that this species has low dispersal ability and occupies relatively isolated habitats, a strong population structure is expected.



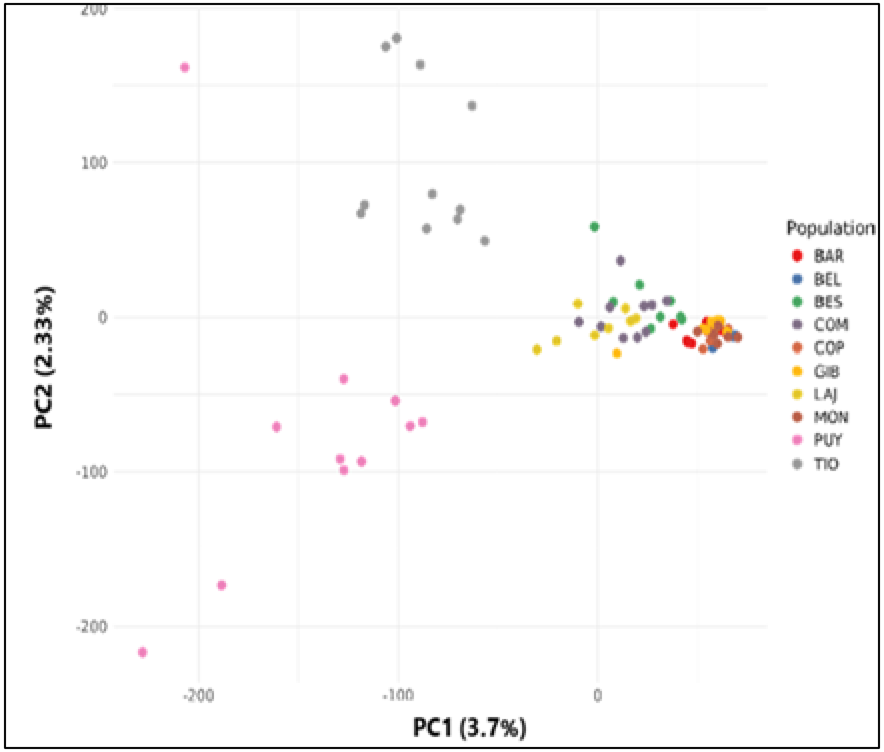
First runs of 96 females individuals

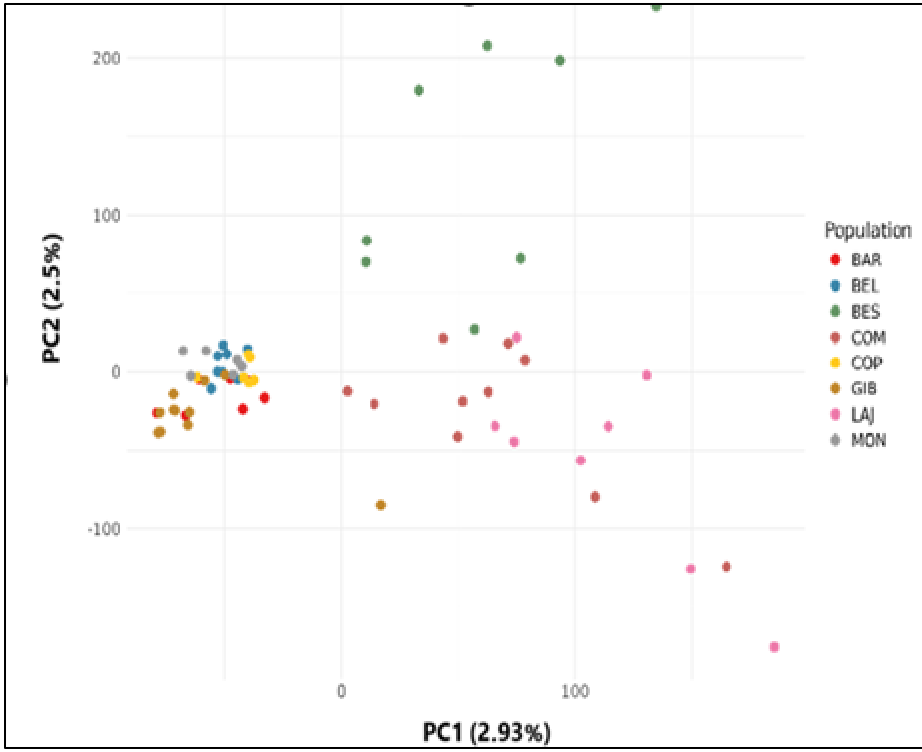
Filtering out populations with fewer than 5 individuals :

- 86 individuals from 10 populations
- VCF: 24,254,638 SNPs

Population structure

Principal Component Analysis



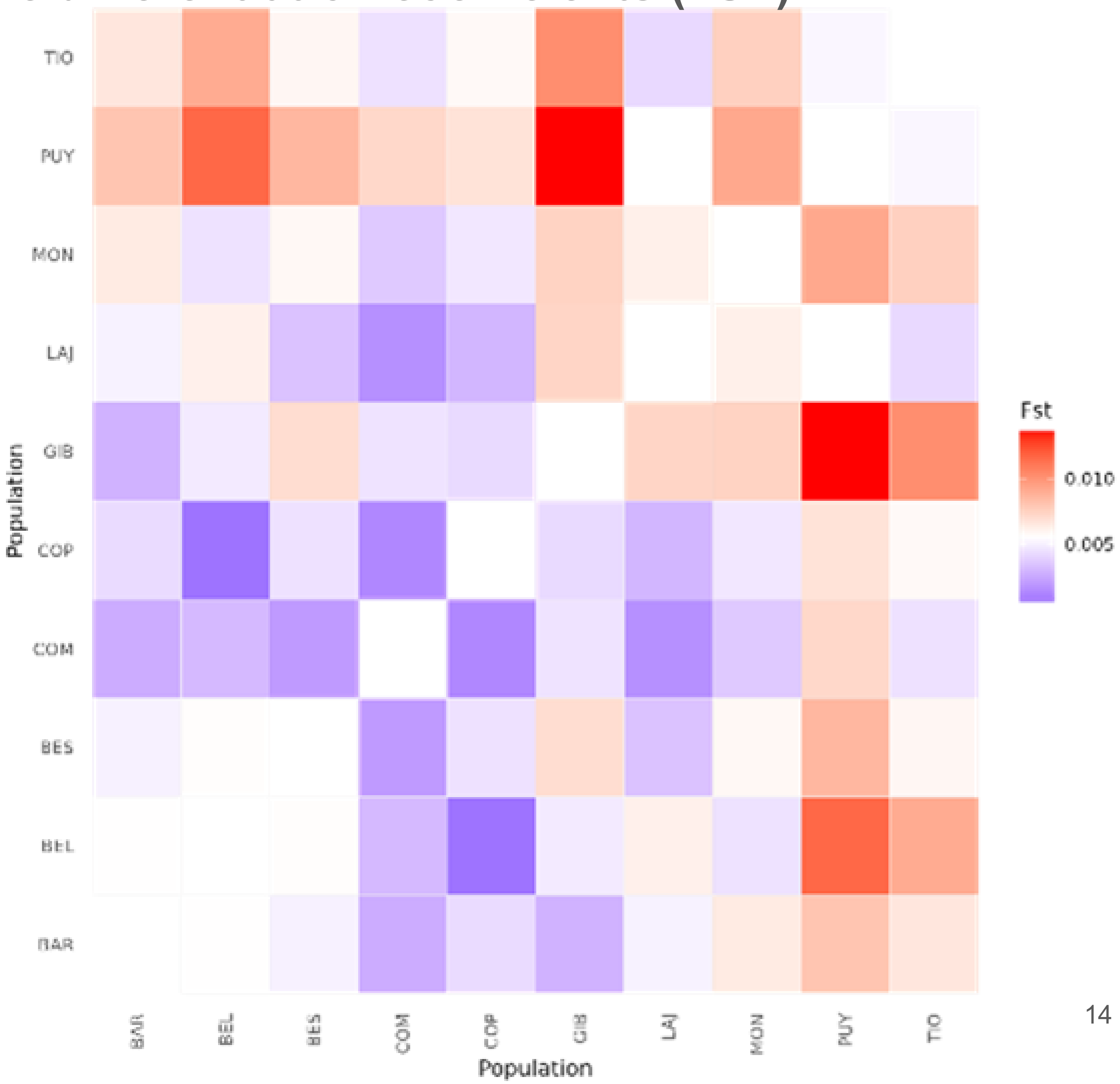


- Low percentage of variance explained by the axes
- Weak population structure, mainly driven by PUY and TIO

- Low percentage of variance explained by the axes
- Weak population structure

Population structure

Heatmap of genetic differentiation coefficients (FST)

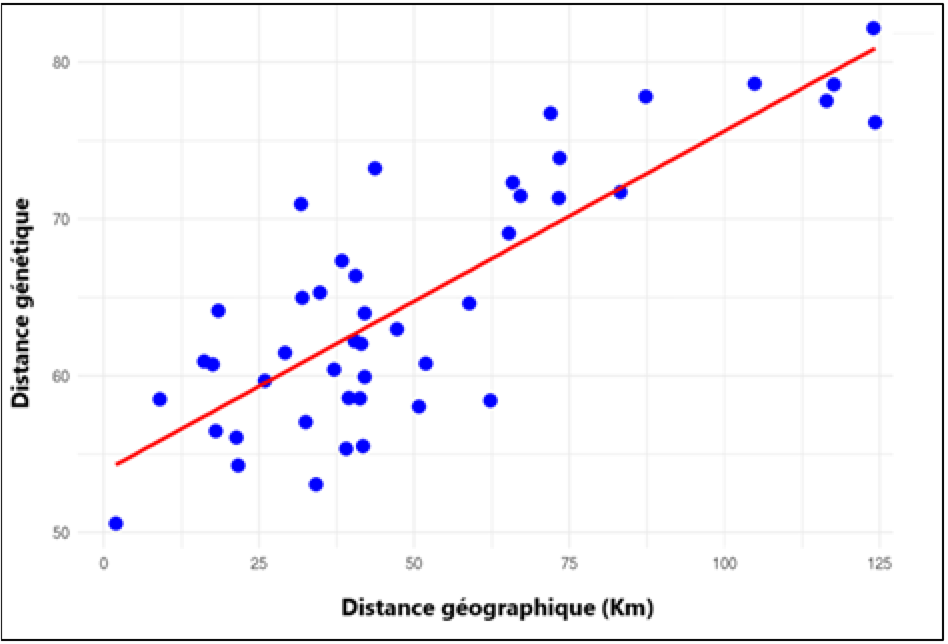


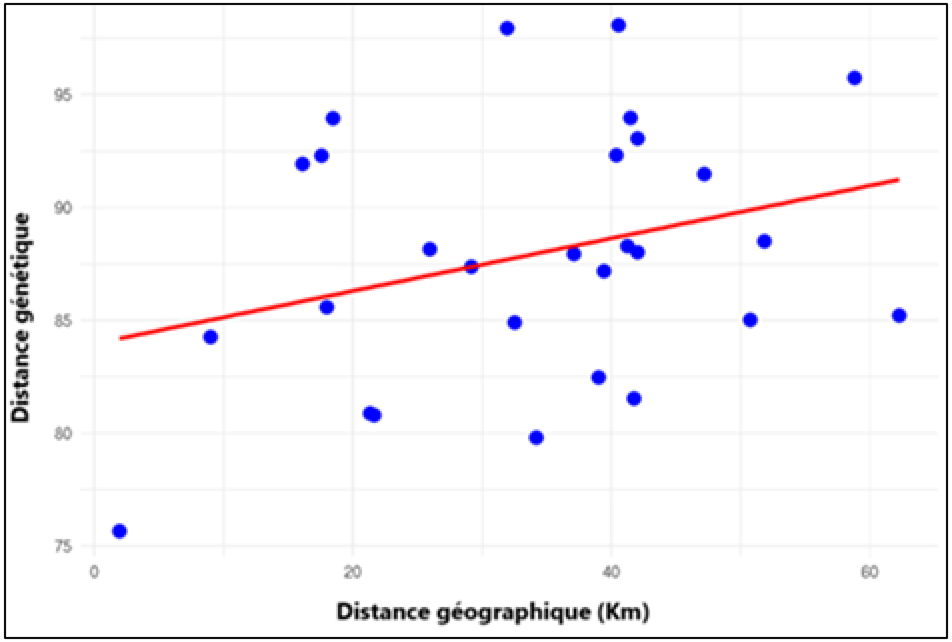
FST values are mostly below 0.05

PUY and TIO stand out with higher FST values

Population structure

Isolation by Distance





r = 0.824 p-value = 0.001

r = 0.3019, p-value = 0.064

Absence of Isolation by Distance when PUY and TIO are removed

Population structure

Conclusion:

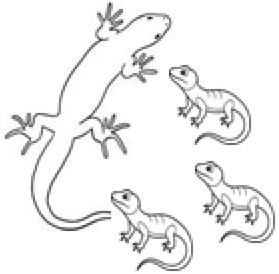
- Weak genetic structuring → ecological paradox
- Hypothesis: high genetic diversity → potential for local adaptation

Thesis Perspectives:

- The ECOFEED common garden experiment
- Analysis of selection regimes

Conclusion

Years of phenotyping and climate measures



Impact of warmer climate on life traits

Pedigree & Quantitative genetics

Heritability of traits

Population genomics

Genomic architecture and deciphering adaptation

- **Interplay of environmental - phenotyping - genotyping datasets**
- **Population genomics is promising for adding new layers to the understanding of the adaptive potential of the lizard model**

Acknowledgments

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Established by the European Commission

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