



Population genomics and historical demography of a montane Atlantic Forest bird community: a refuge hypothesis test

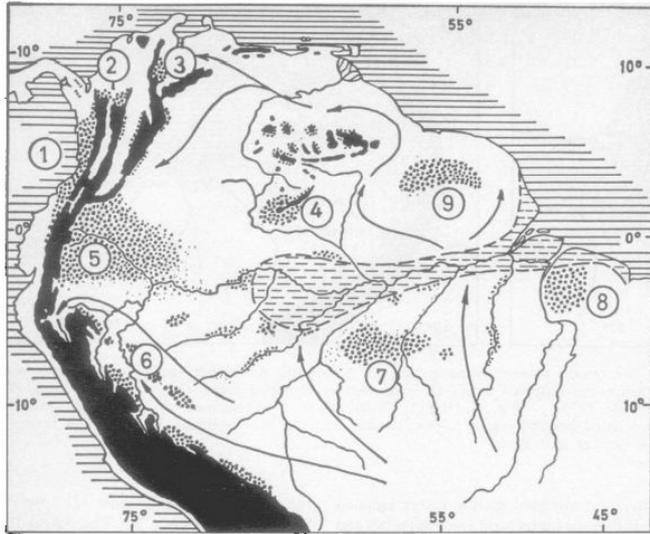


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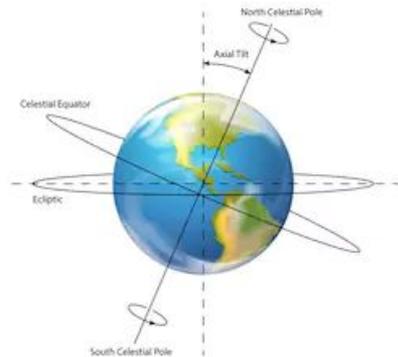
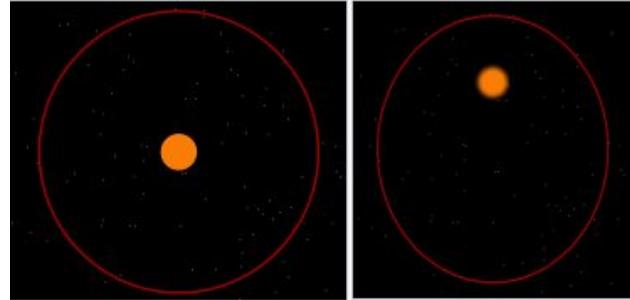
Introduction

Which processes are involved in Neotropical diversity?

- Refuge hypothesis



- Haffer (1969)



- Earth's orbital eccentricity
- Changes in the inclination of Earth's axis

Introduction

What are the underlying causes of studies' controversies in sympatric populations?

- Different ecological attributes of species

- Lack of statistical power and stochastic error

Single locus data vs. NGS data

Introduction

What are the underlying causes of studies' controversies in sympatric populations?

- Different ecological attributes of species

Lowland vs. Highland

- Lack of statistical power and stochastic error

Introduction

1st Question: Has population size affected by past Pleistocene climatic change?

2nd Question: Are those changes related to altitude?

Introduction

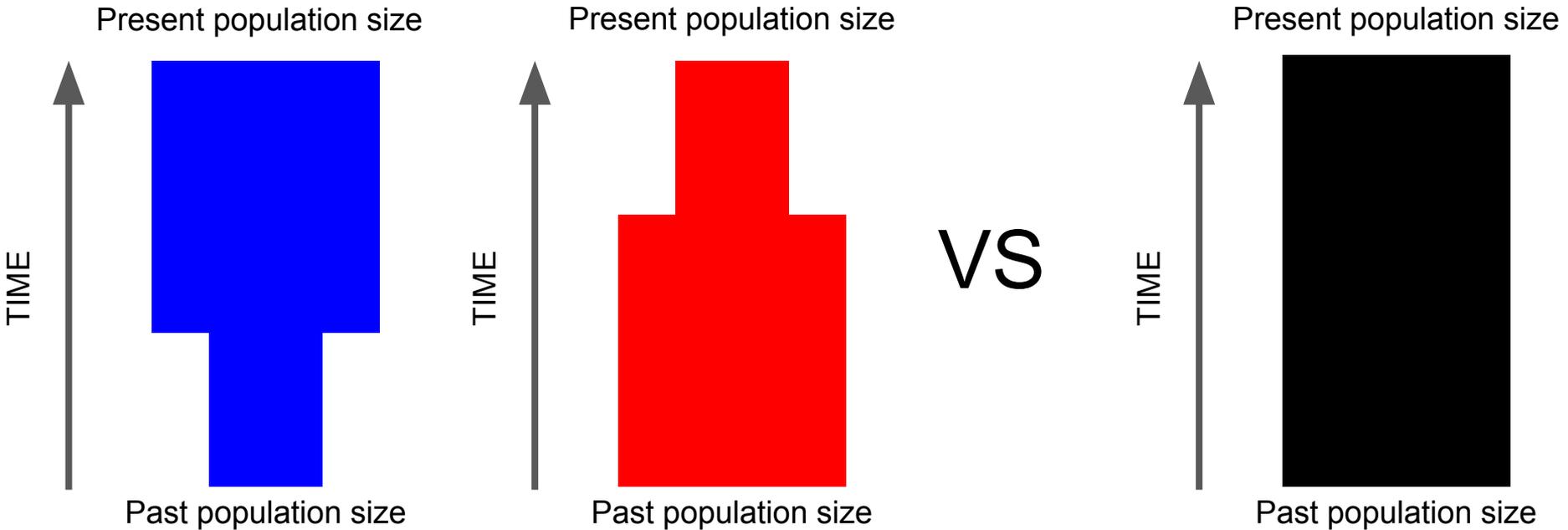
Brazilian Atlantic Forest



- High biodiversity/endemism
- High latitudinal variation
- Complex topography
- Altitudinal gradient

1st Question: Has population size affected by past Pleistocene climatic change? (~800kya)

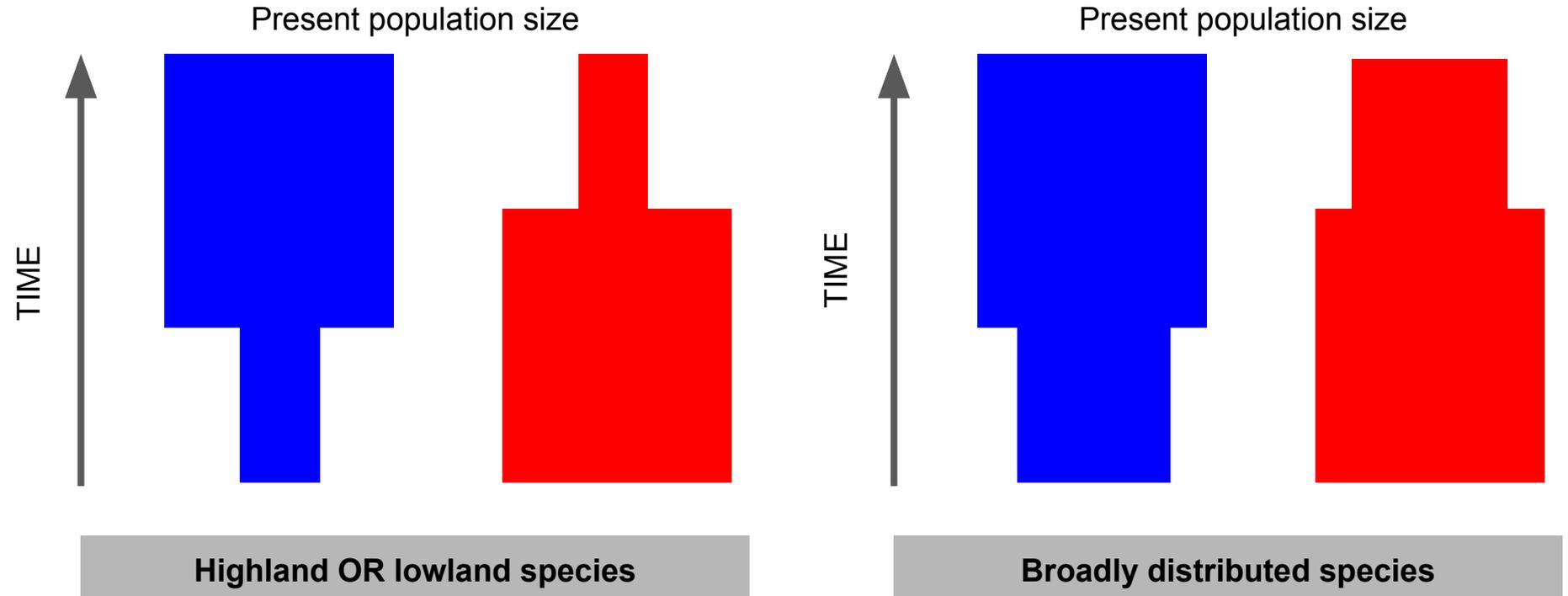
Hypothesis 1: Forest species were affected by glacial cycles as predicted by the refuge hypothesis



2nd Question: Are those changes related to altitude?

Hypothesis 2: The responses depend on the distribution of species in the altitudinal gradient

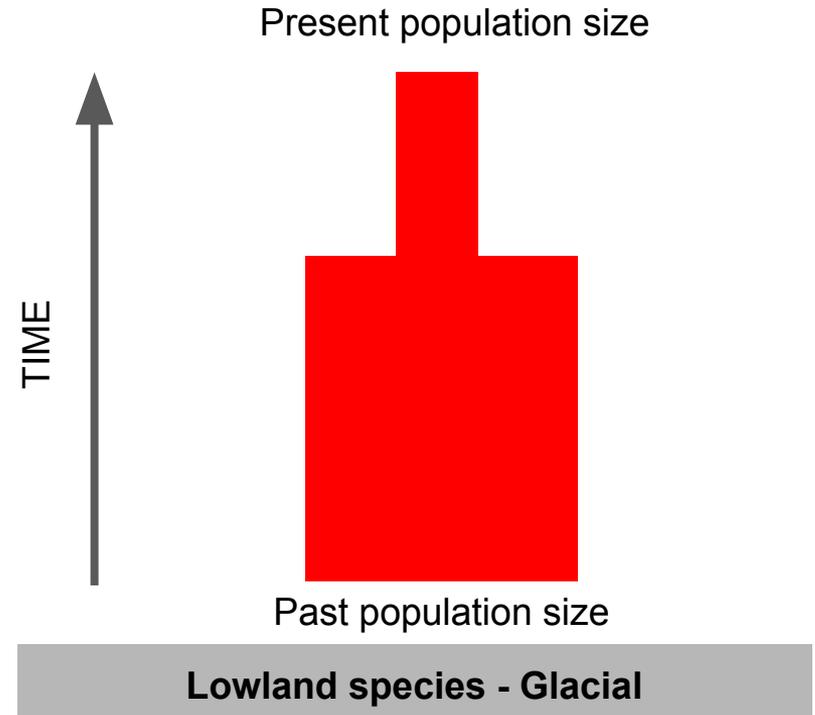
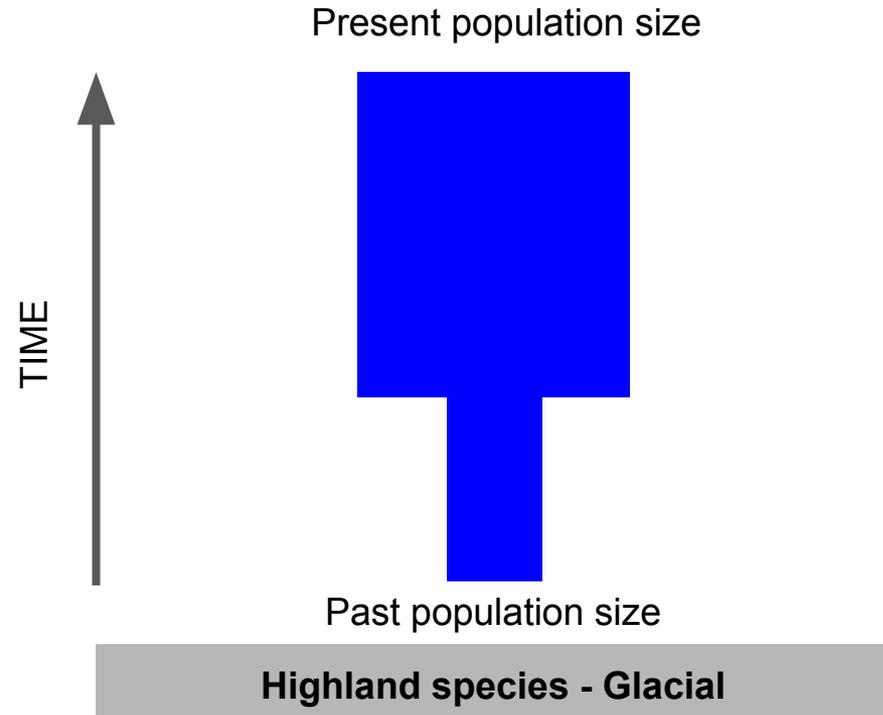
Prediction a)



2nd Question: Are those changes related to altitude?

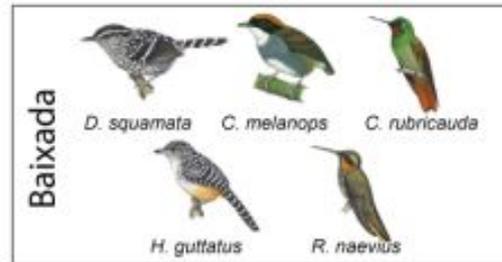
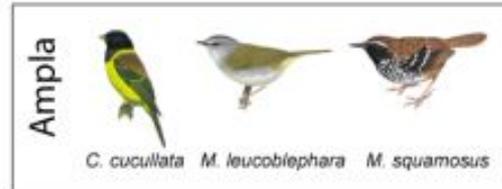
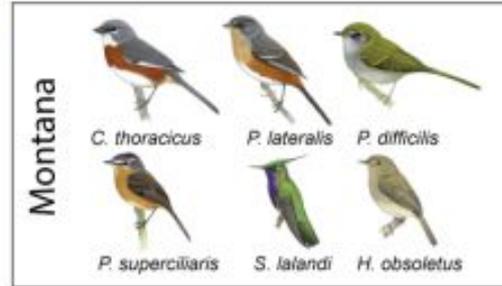
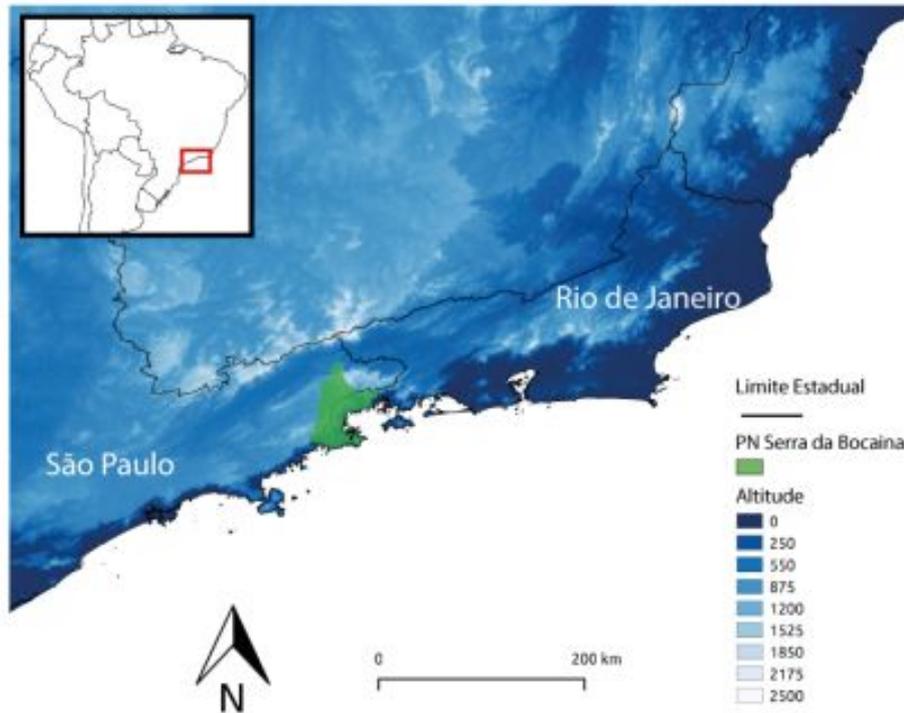
Hypothesis 2: The responses depend on the distribution of species in the altitudinal gradient

Prediction b)



Methods

- Study site and species used



Methods

- Next Generation sequencing of Ultraconserved Elements
- 5 Individuals per species
- DNA extraction using standard protocol
- DNA purification
- Library preparation and sequencing of 2500 Ultraconserved loci

Methods

- Demographic inferences and model selection
 - Site Frequency Spectrum
 - Simulations in Fsc2
 - Model selection using ABC



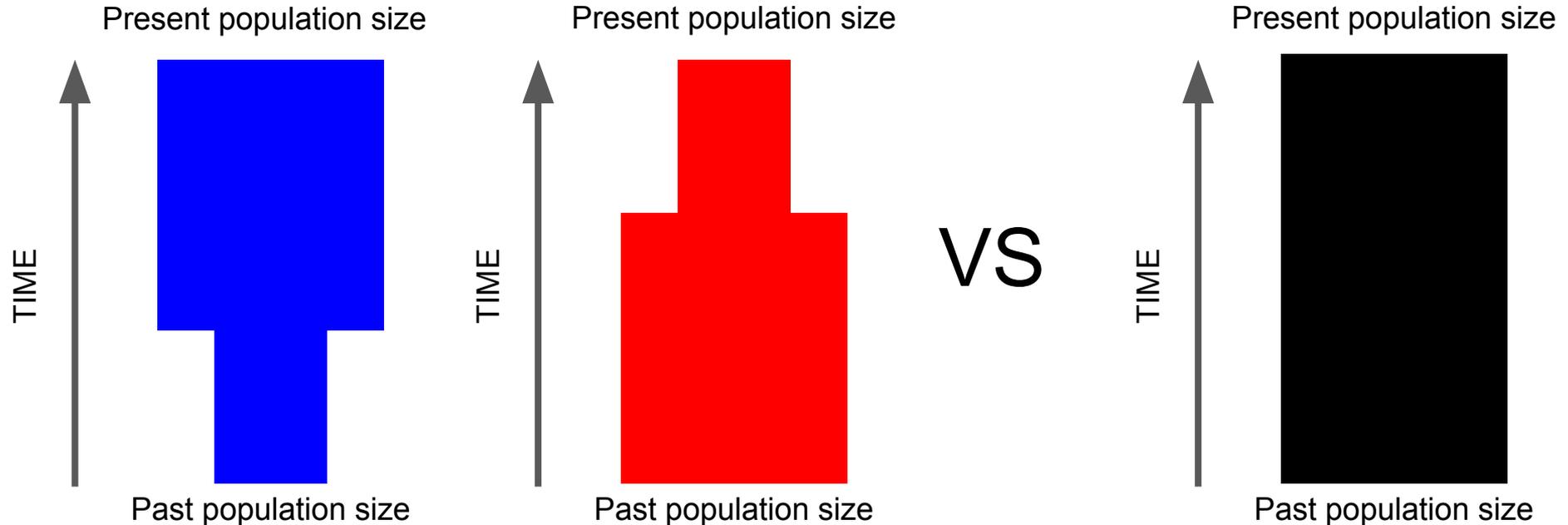
fastsimcoal2



Expected Results

1st Question: Has population size affected by past Pleistocene climatic change? (~800kya)

Hypothesis 1: Forest species were affected by glacial cycles as predicted by the **refuge hypothesis**

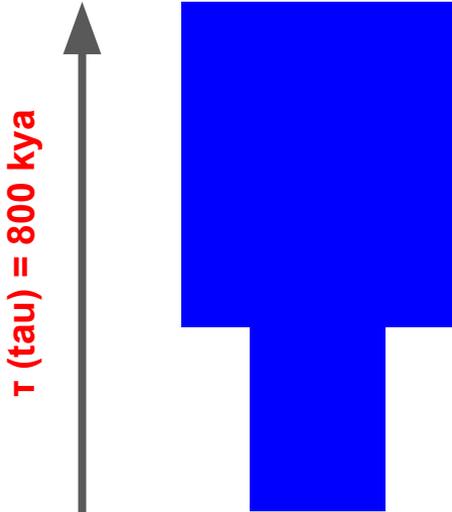


When have the changes occurred?

τ (tau) = 800 thousand years

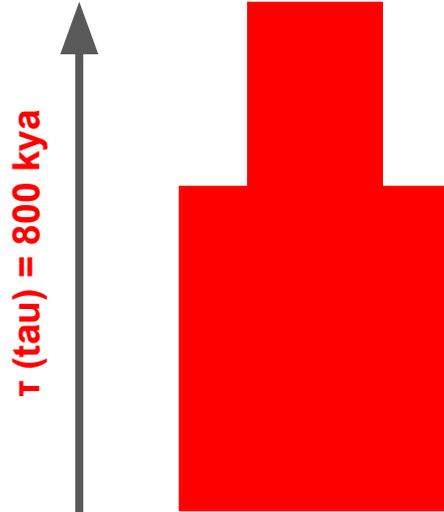
Expansion

Present population size



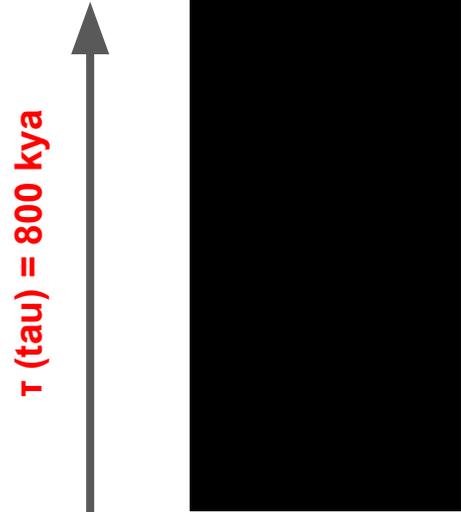
Past population size

Contraction



VS

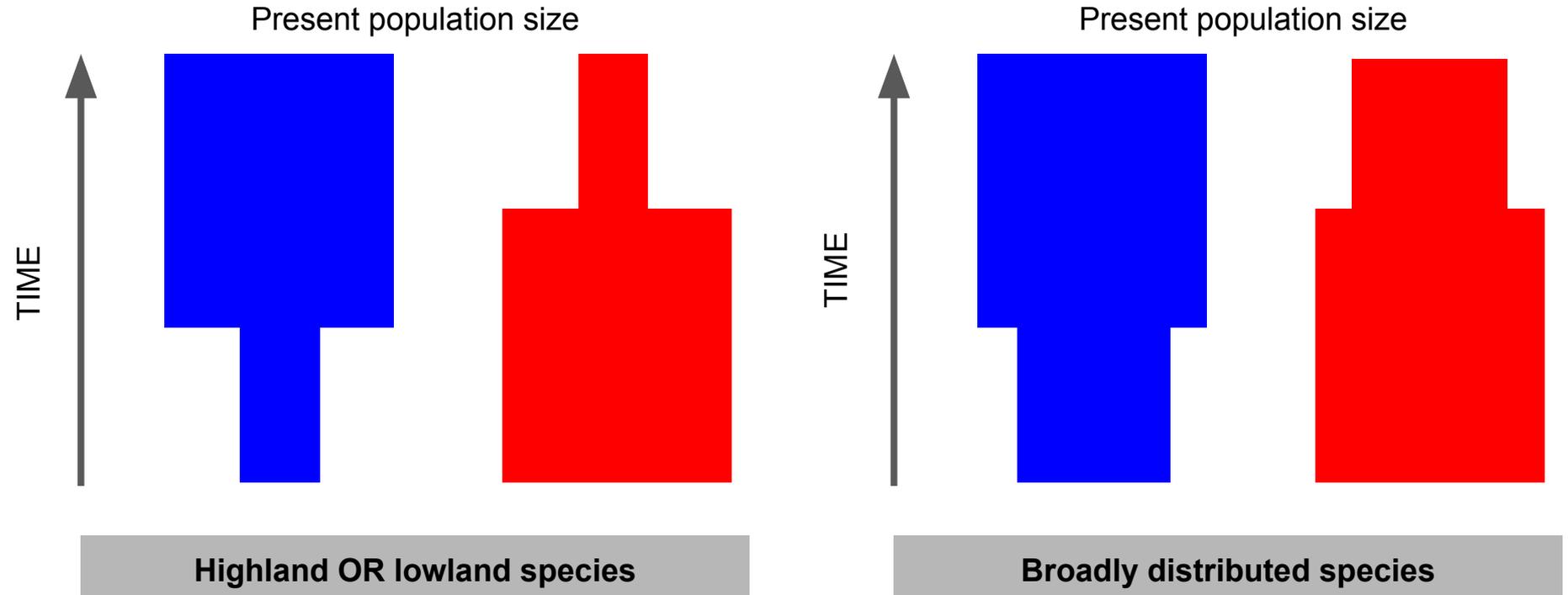
Stability



2nd Question: Are those changes related to altitude?

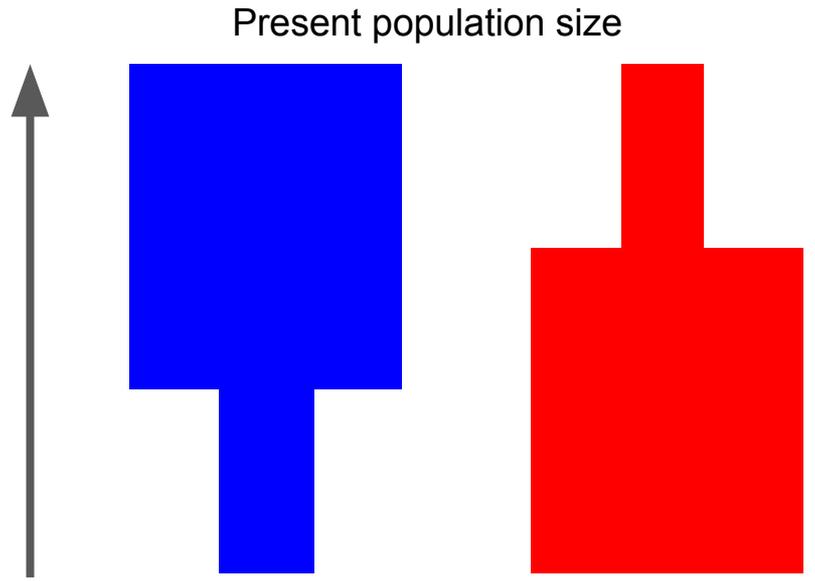
Hypothesis 2: The responses depend on the distribution of species in the altitudinal gradient

Prediction a)

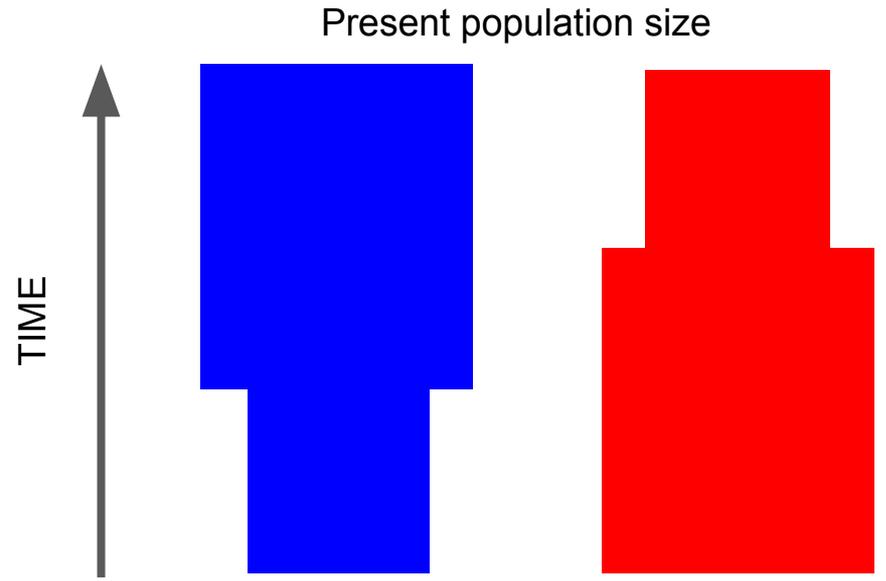


How intense were those changes?

ϵ (epsilon) = size change magnitude index



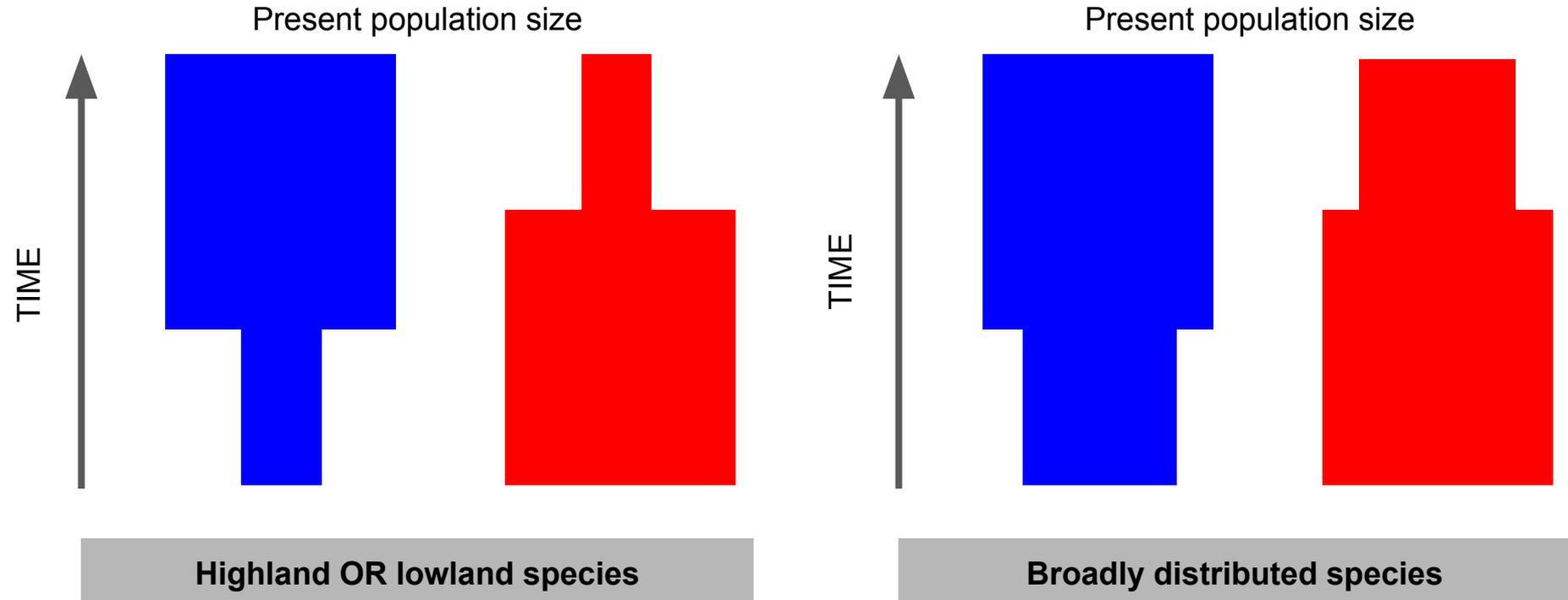
Highland OR lowland species



Broadly distributed species

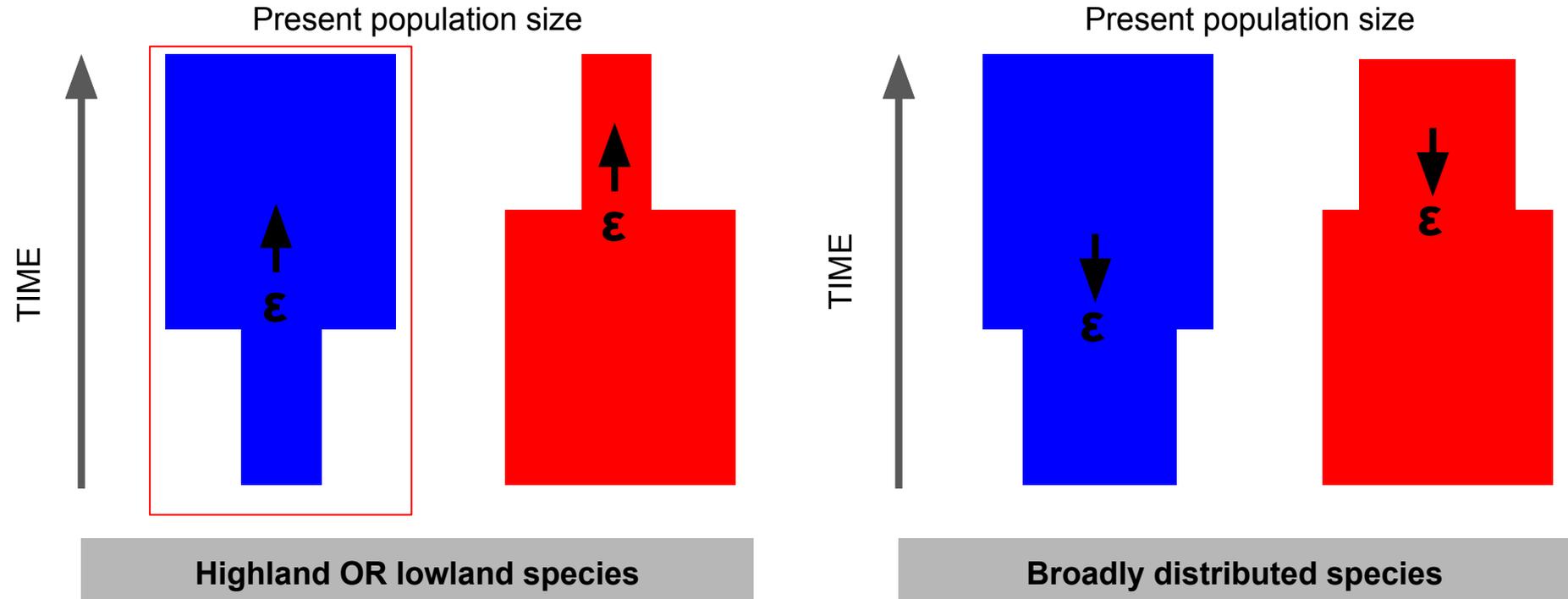
How intense were those changes?

ϵ (epsilon) = size change magnitude index
1 = Population stability



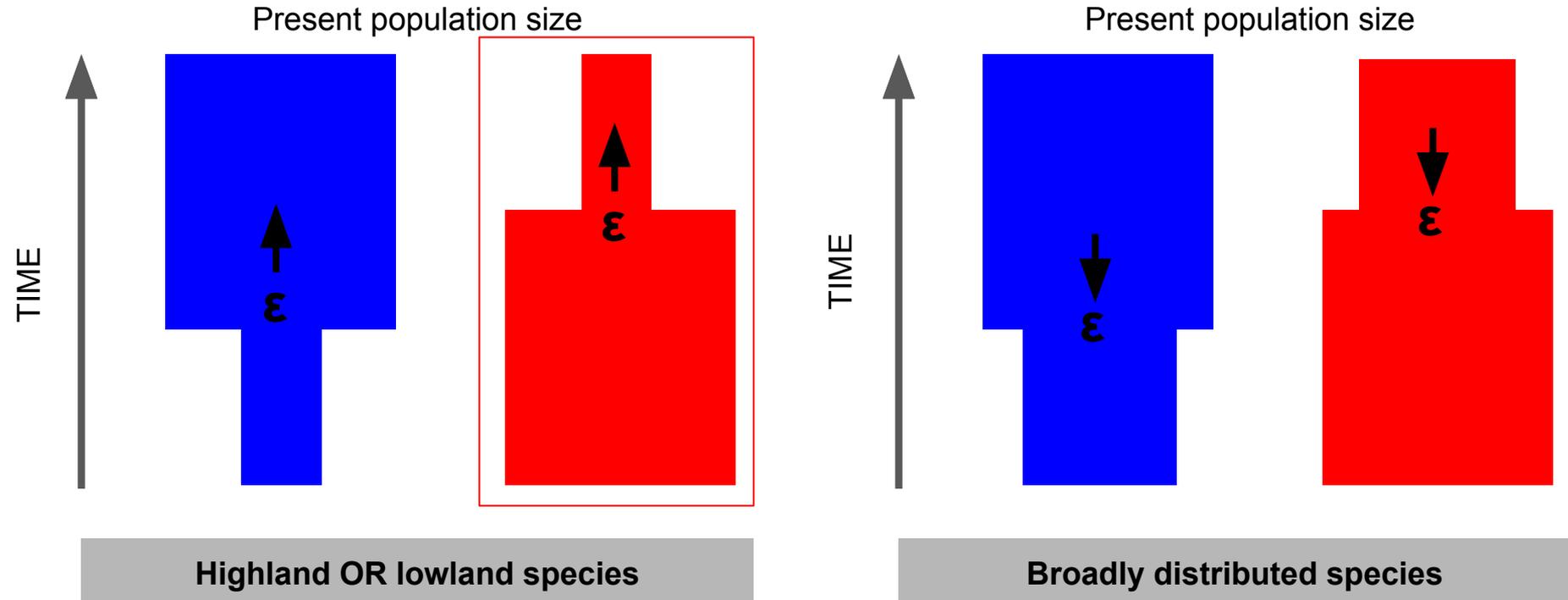
How intense were those changes?

ϵ (epsilon) = size change magnitude index
 $0.2 - 0.02 =$ Population expansion



How intense were those changes?

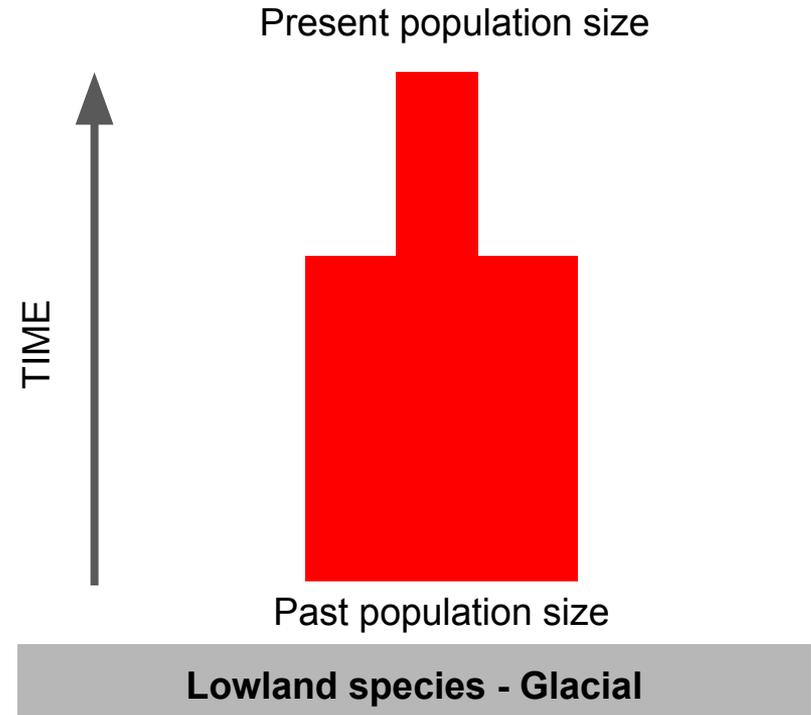
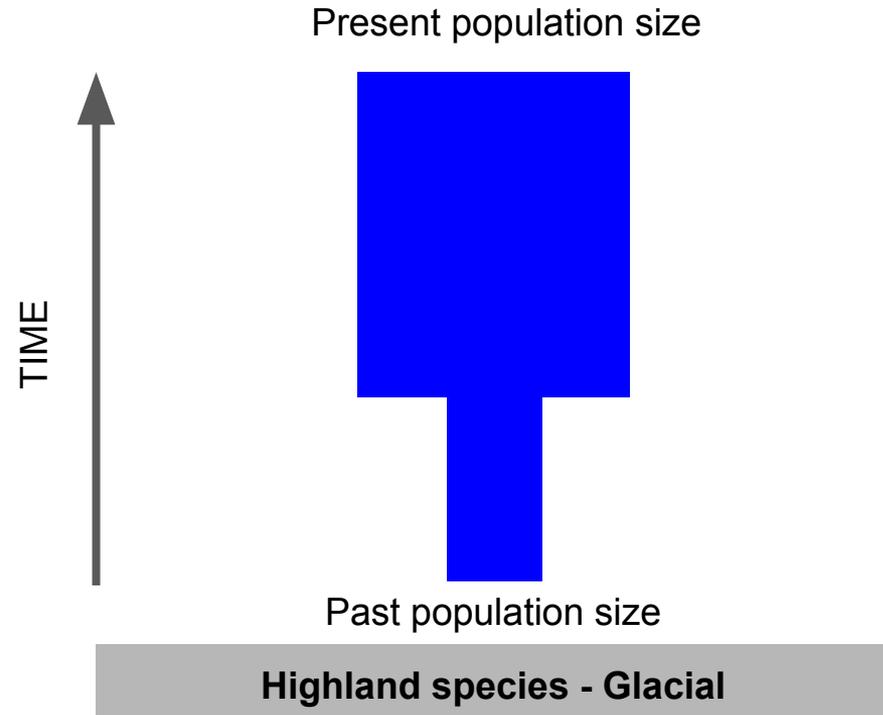
ϵ (epsilon) = size change magnitude index
5 - 100 = Population contraction



2nd Question: Are those changes related to altitude?

Hypothesis 2: The responses depend on the distribution of species in the altitudinal gradient

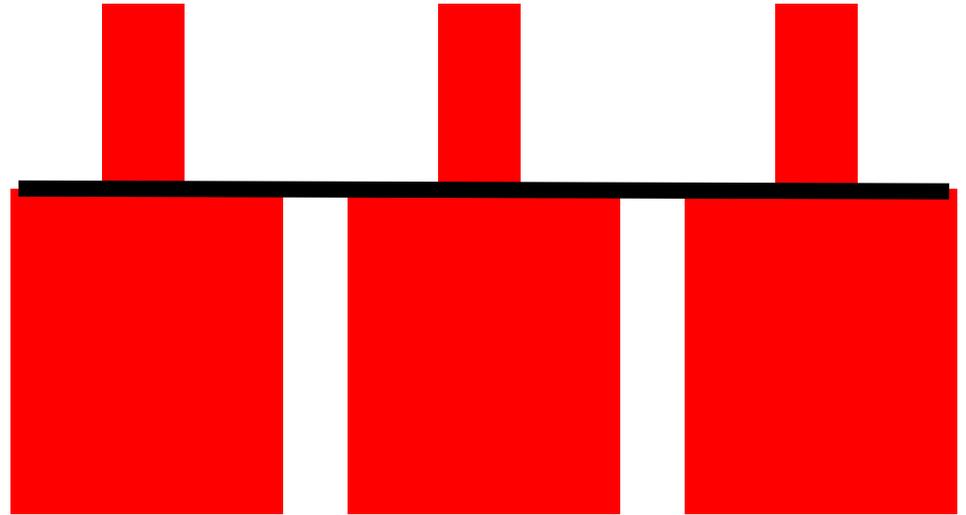
Prediction b)



Measuring synchronic demographic responses

ζ (zeta) - time synchronicity coefficient (0-1)

$\zeta = 1$ (all lowland species in synchronic contraction)

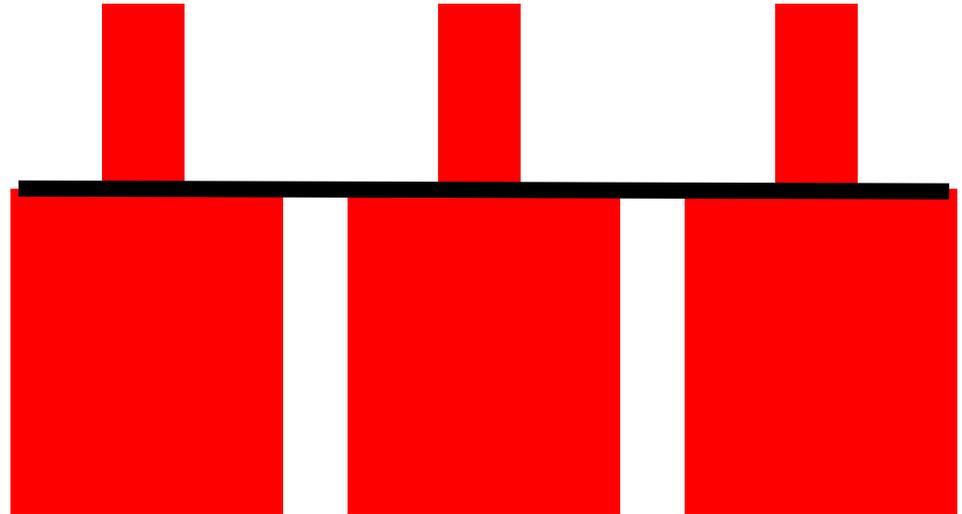


lowland species - glacial

Measuring synchronic demographic responses

$T\zeta$ - Time of synchronic demographic change

$T\zeta$ = instantaneous
demographic change
occurred at x
generations ago



lowland species - glacial

Methods- Demographic inferences

In brief...

- Táxon-specific simulations (Fastsimcoal2)

1.000.000 SFS simulations for each demographic model
(Expansion, contraction, stability)

Estimate the demographic syndrome

Estimate time of instantaneous demographic change

Estimate magnitude of demographic changes

Methods- Demographic inferences

In brief...

- Co-demographic simulations

Estimate the degree of synchronicity of demographic changes for:

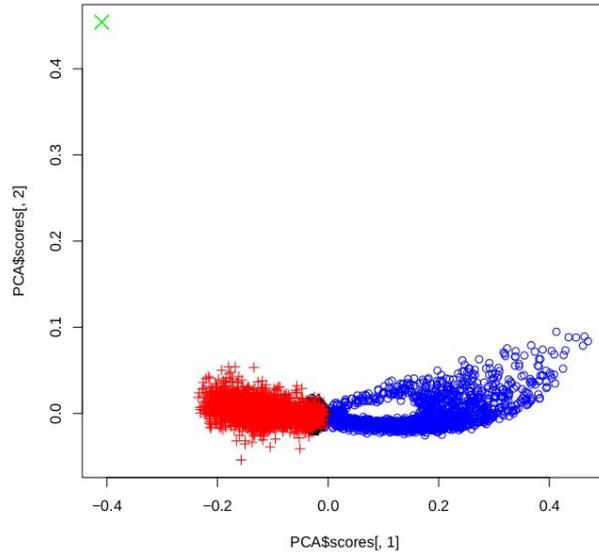
- All species
- Only highland species
- Only lowland species

Estimate **time** of synchronous demographic change

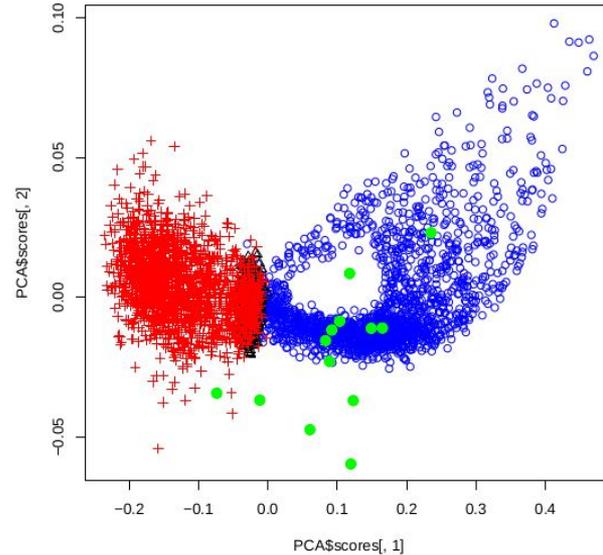
Results

Taxon-specific simulations

- Demographic syndromes: expansion for 11 out of 14 species



M. leucoblephara



Other species

Results

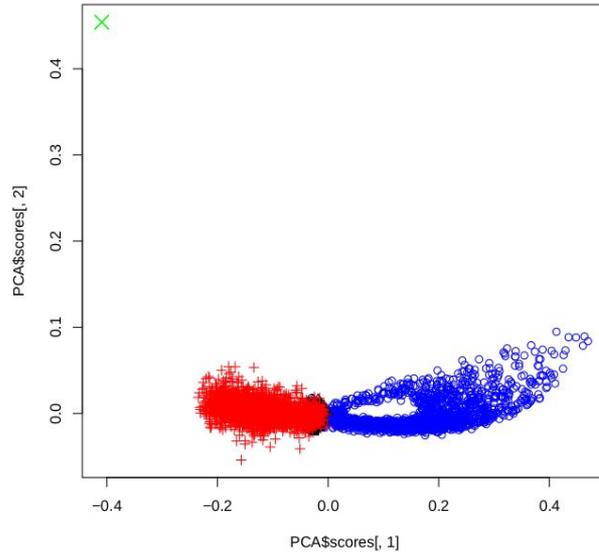
Taxon-specific simulations

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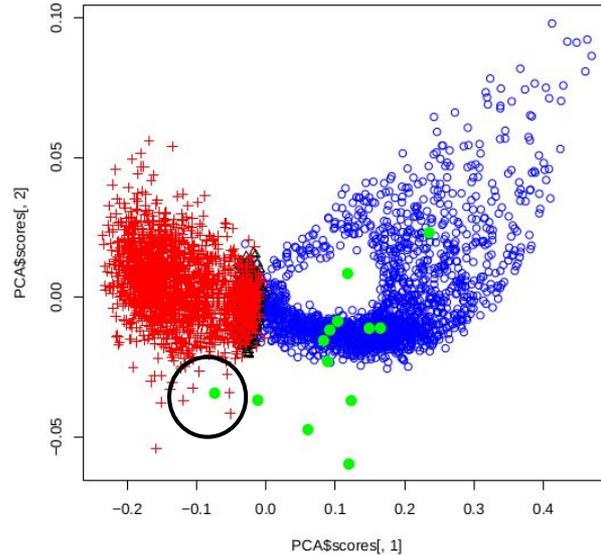
Contraction



Drymophila squamata



M. leucoblephara



Other species

Results

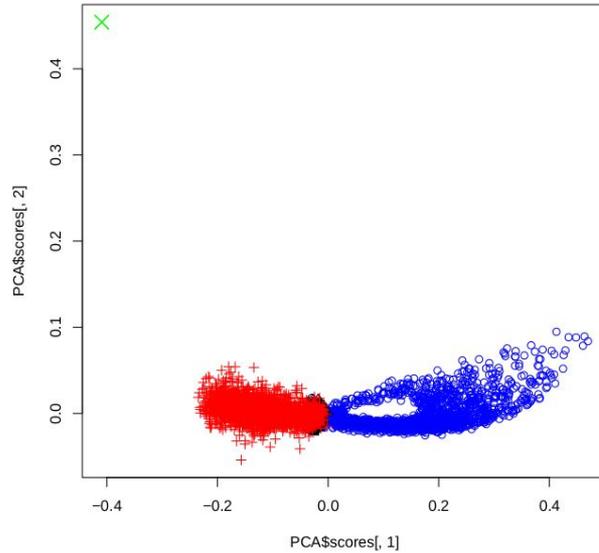
Taxon-specific simulations

- Demographic syndromes: expansion for 11 out of 14 species

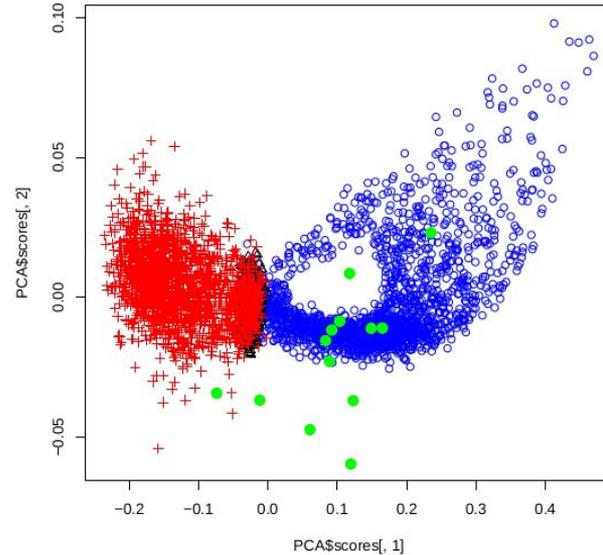
Stability
(pp = 0.677)



Hemitriccus obsoletus



M. leucoblephara



Other species

Results

Taxon-specific simulations

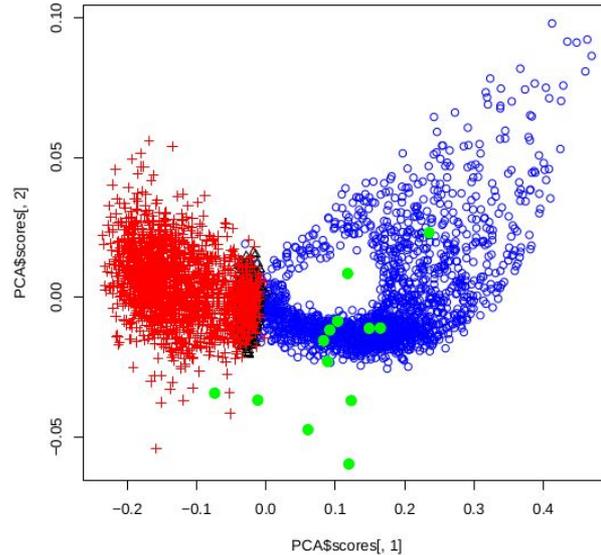
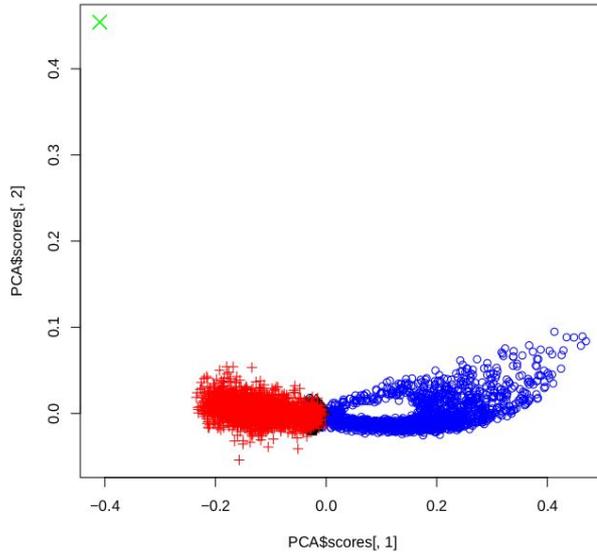
- Demographic syndromes: expansion for 11 out of 14 species

Stability
(pp = 0.708)



*Myrmoderus
squamosus*

M. leucoblephara

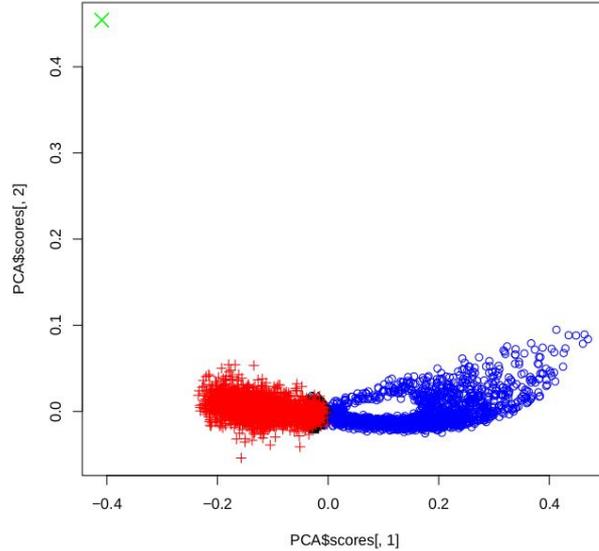


Other species

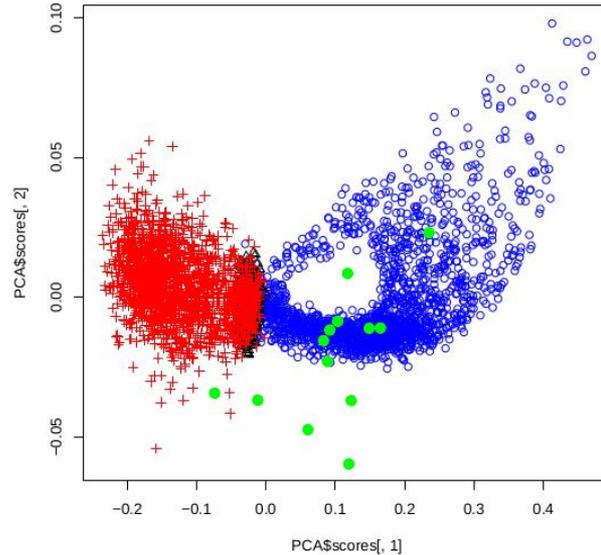
Results

Taxon-specific simulations

- Demographic syndromes: expansion for 11 out of 14 species



M. leucoblephara



Other species

Results

Taxon-specific simulations

- Parameter estimation

1. Time: median ~436 a 566 thousand years

With exceptions: *D. squamata* (contraction ~ 378kya)

C. rubricauda (~ 140kya)

M. leucoblephara (~ 18kya)

Results

Taxon-specific simulations

- Parameter estimation

2. Size change magnitude: varied from ~8 to ~10-fold

ϵ (median) = 0.0862 - 0.1905 for expansions

ϵ (median) = 10.36 for *D. squamata*'s contraction

Mostly near the demographic change limit that can be detected by the method (~8-fold)

Results

3. Synchronicity (co-demographic simulations)

**All 10 species
(5 highland, 4
lowland e 1 broad)**

median $\zeta = 0.6$, ζ mode
= 0.6

Time **~358 kya**

5 highland species

median $\zeta = 0.6$, ζ mode
= 0.9

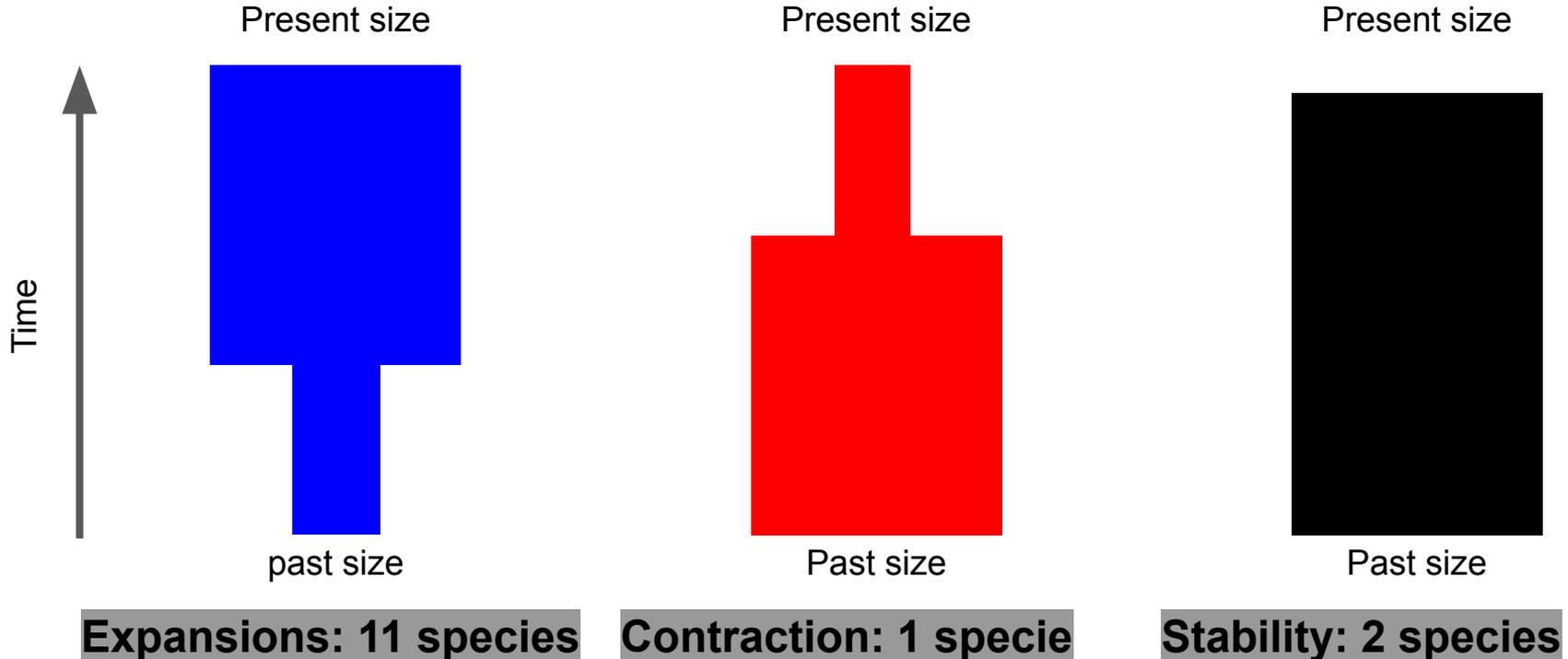
Time **~390 kya**

4 lowland species

median $\zeta = 0.4$, ζ mode
= 0.2

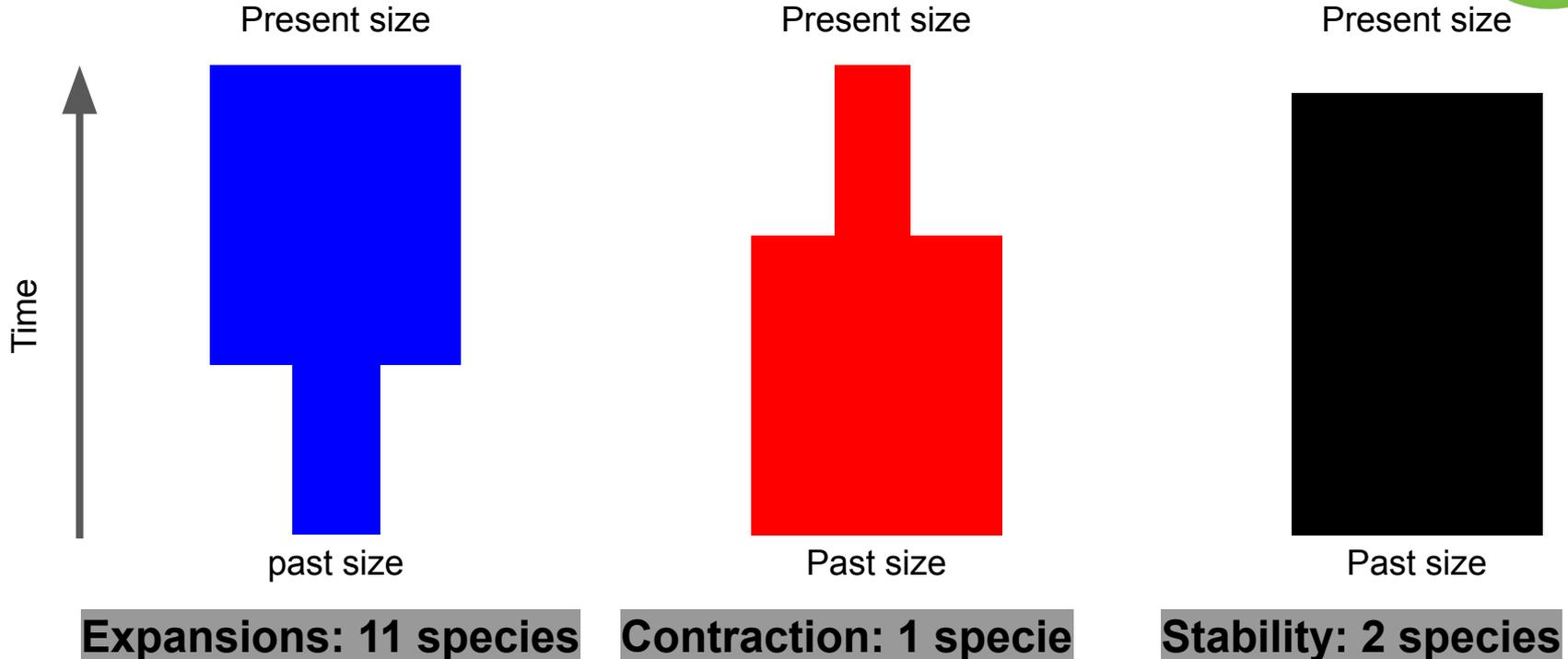
Discussion

- Was population size affected by past climatic changes during the Pleistocene?



Discussion

- Was population size affected by past climatic changes during the Pleistocene?



Discussion

- Are those changes related to altitude?

Hypothesis 2: The responses depend on the distribution of species in the altitudinal gradient

Prediction a) range-restricted species would have more intense demographic changes than wide-ranged species

Discussion

- Are those changes related to altitude?

Hypothesis 2: The responses depend on the distribution of species in the altitudinal gradient

Prediction a) range-restricted species would have more intense demographic changes than wide-ranged species

Intensity: ~8 a ~10 fold

ϵ (median) = 0.0425 - 0.1905 for the 11 expansions

ϵ (median) = 10.36 for *D. squamata*

- Most species' change magnitude was near the limit of demographic change that can be detected by our method (~8x)
- Not related to altitude

Discussion

- Are those changes related to altitude

Hypothesis 2: The responses depend on the distribution of species in the altitudinal gradient

Prediction a) range-restricted species would have more demographic changes than wide-ranged species

Intensity: ~8 a ~10 fold

ϵ (median) = 0.0425 - 0.1905 for the 11 expansions

ϵ (median) = 10.36 for *D. squamata*

- Most species' change magnitude was near the limit of demographic change that can be detected by our method (~8x)
- Not related to altitude

Discussion

- Are those changes related to altitude?

Hypothesis 2: The responses depend on the distribution of species in the altitudinal gradient

Prediction b) Montane and lowland species would have similar responses at the same time

Discussion

- Are those changes related to altitude?

**All 10 species
(5 highland, 4
lowland e 1 broad)**

median $\zeta = 0.6$, ζ mode
= 0.6

Time **~358 kya**

5 highland species

median $\zeta = 0.6$, ζ mode
= 0.9

Time **~390 kya**

4 lowland species

median $\zeta = 0.4$, ζ mode
= 0.2

Discussion

- Are those changes related to altitude

**All 10 species
(5 highland, 4
lowland e 1 broad)**

median $\zeta = 0.6$, ζ mode
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Time ~**358 kya**

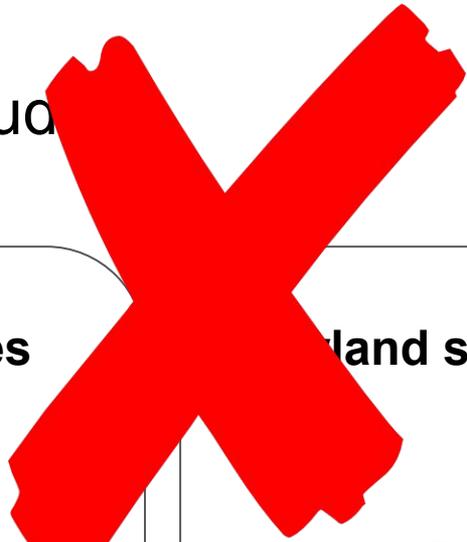
5 highland species

median $\zeta = 0.6$, ζ mode
= 0.9

Time ~**390 kya**

lowland species

median $\zeta = 0.4$, ζ mode
= 0.2



Discussion

What do our results say about the history of Atlantic Forest?

1. Past demographic changes occurred, but were modest
2. Patterns of demographic changes are not related to species' altitudinal range

1. Past demographic changes occurred, but were modest

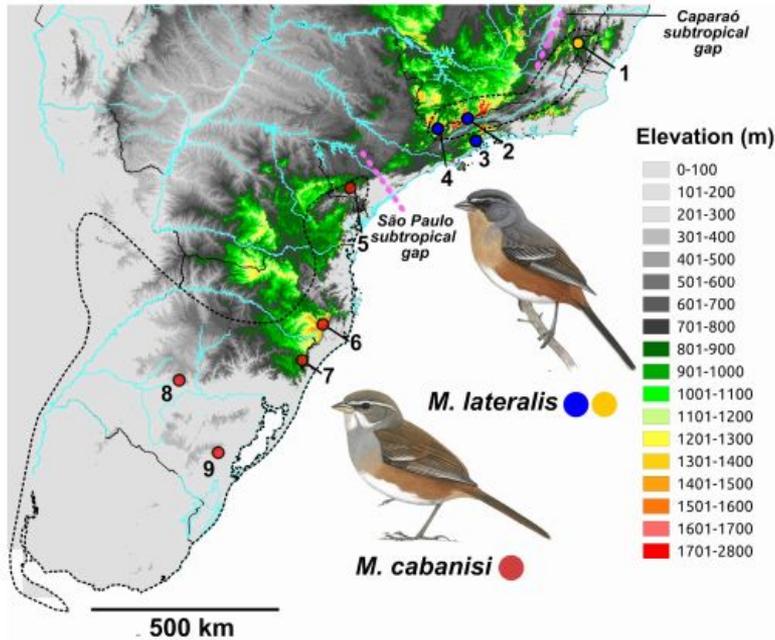
In situ climatic stability?

- Historical climatic stability due to close proximity to warm oceans



1. Past demographic changes occurred, but were modest

- Changes in population distribution without strong demographic change



Climate explains recent population divergence, introgression and persistence in tropical mountains: phylogenomic evidence from Atlantic Forest warbling finches

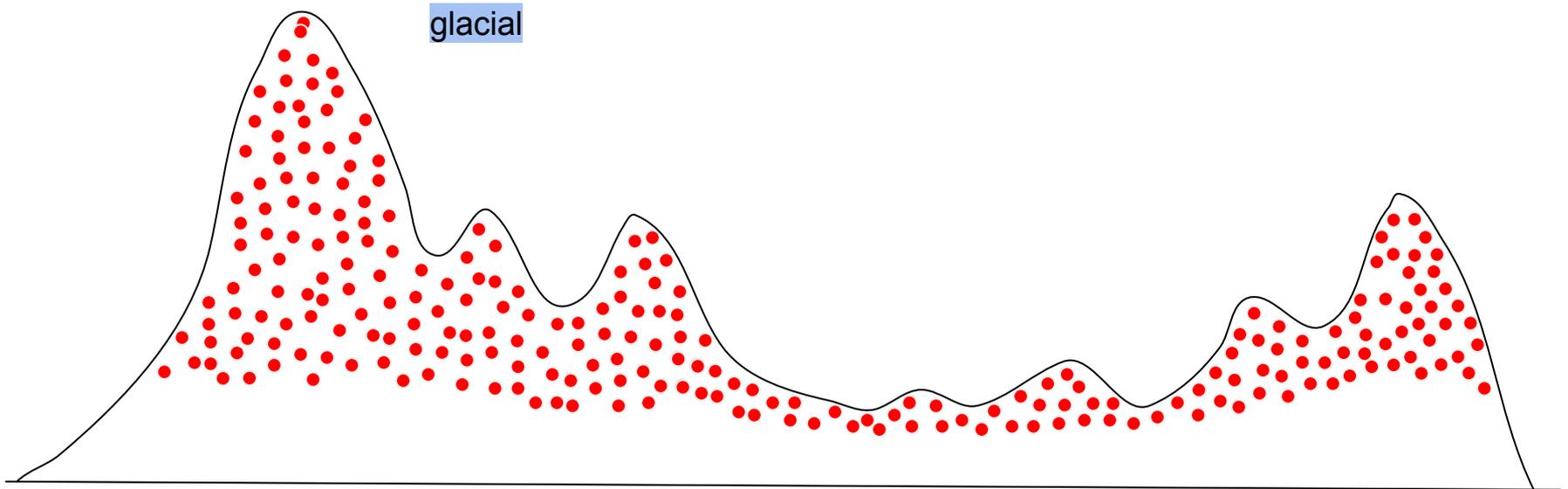
Fabio Raposo do Amaral, Diego Alvarado-Serrano, Marcos Maldonado-Coelho, Katia C. M. Pellegrino, Cristina Y. Miyaki, Julia A. C. Montesanti, Matheus S. Lima-Ribeiro, Michael J. Hickerson, Gregory Thom

- Chosen model: politomy followed by gene flow -> secondary contacts during colder periods but no demographic change

Discussion

Proposed mechanism for changes in altitudinal distribution with no strong demographic change

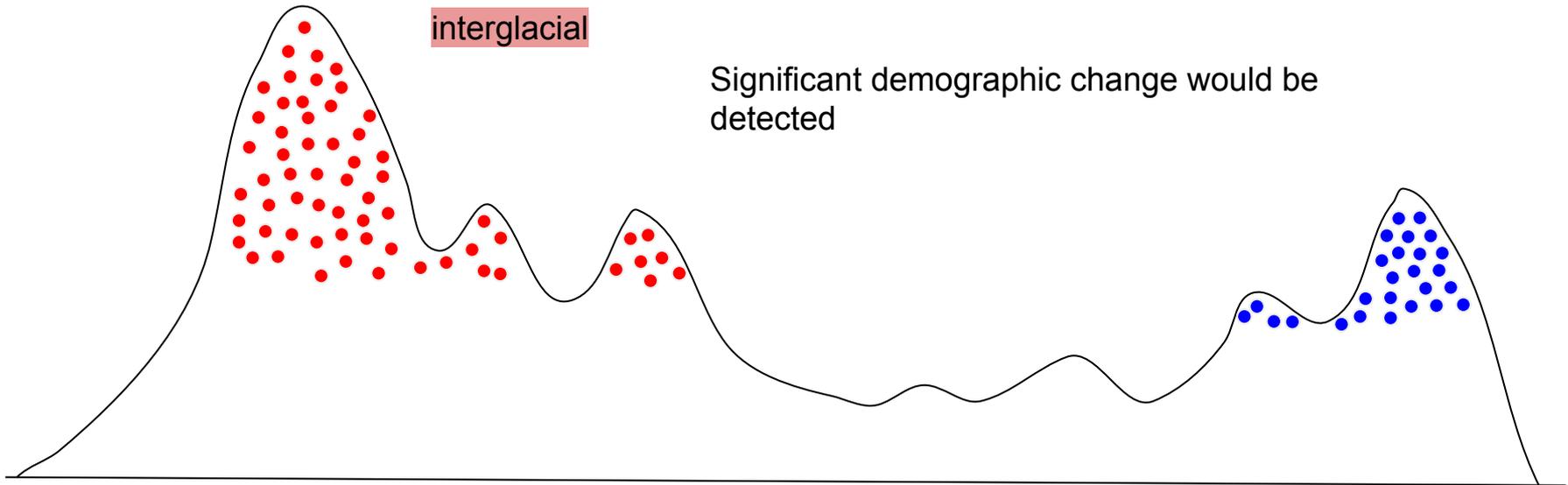
- secondary contacts could not necessarily involve great fluctuations in populations' effective size



Discussion

Proposed mechanism for changes in altitudinal distribution with no demographic change

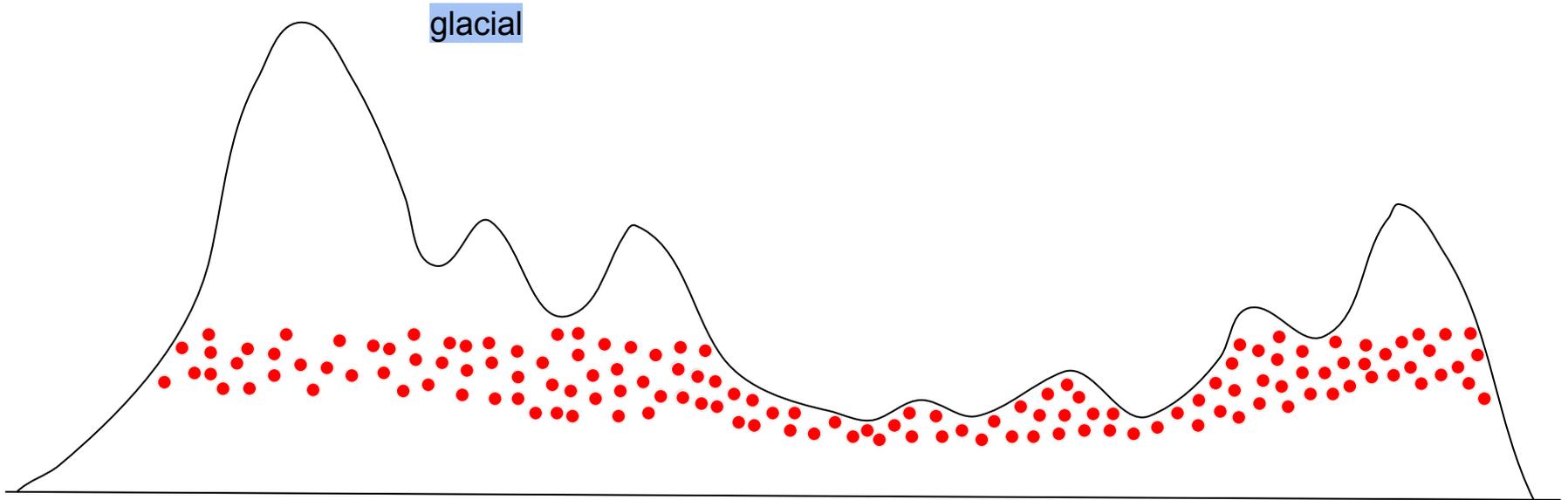
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Discussion

Proposed mechanism for changes in altitudinal distribution with no demographic change

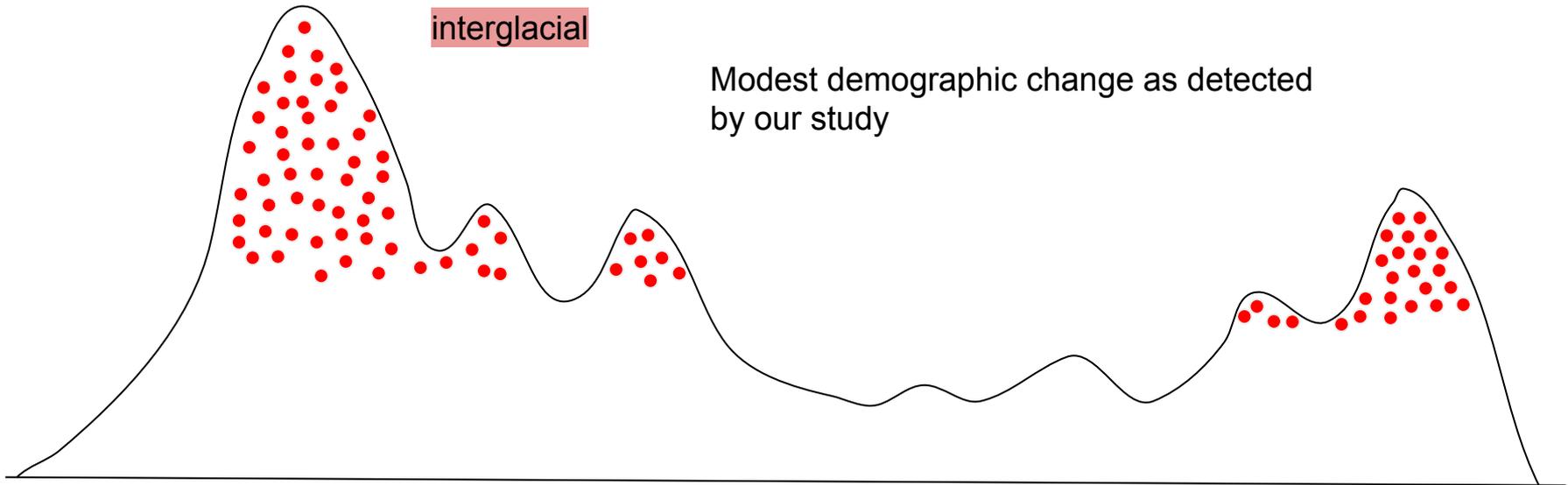
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Discussion

Proposed mechanism for changes in altitudinal distribution with no demographic change

- secondary contacts could not necessarily involve great fluctuations in populations' effective size



Discussion

Gene flow

- Gene flow between populations was not considered
- Rapid responses to climatic change = high gene flow
- High gene flow could be hiding signs of demographic change
- A study between populations could be done to assess this matter

Discussion

2. Patterns of demographic changes are not related to species' altitudinal distribution

- Other ecological attributes could play a bigger role in predicting species' responses



Competition



Vegetation



Feeding

Take home messages

- Demographic changes occurred in the past but were modest for most species
 - Climatic stability
 - Changes in altitudinal distribution without strong demographic change
 - Gene flow
- Patterns of demographic change are not related to species' altitudinal restrictions
 - Other ecological attributes are more important
 - Responses could be idiosyncratic

Acknowledgments





Thank you

Take home messages

- Demographic changes occurred in the past but were modest for most species
 - Climatic stability
 - Changes in altitudinal distribution without strong demographic change
 - Gene flow
- Size change intensity is not related to species' altitudinal restrictions
 - Other ecological attributes are more important
 - Responses could be idiosyncratic