Individual-level causes and population-level consequences of variation in fitness in an Alpine rodent

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- Lukas Keller
- Barbara Tschirren
- Arpat Ozgul
- Marc Kéry
- Jarrod Hadfield

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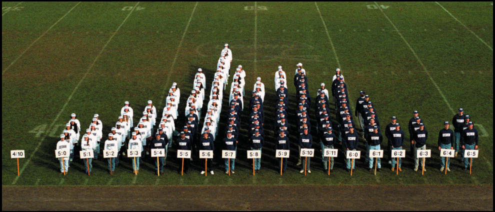
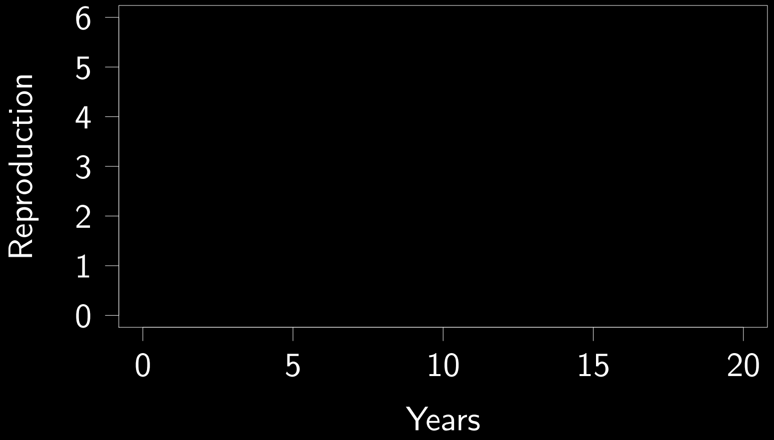
- Eelke Jongejans
- Pirmin Nietlisbach
- Philipp Becker
- Judith Bachmann

Phenotypic variation within population



Phenotypic variation within population

Chance or fate? Why does fitness vary?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4
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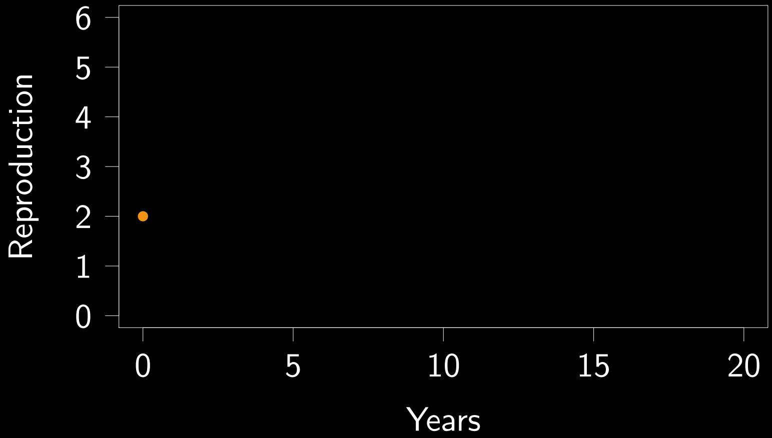
Years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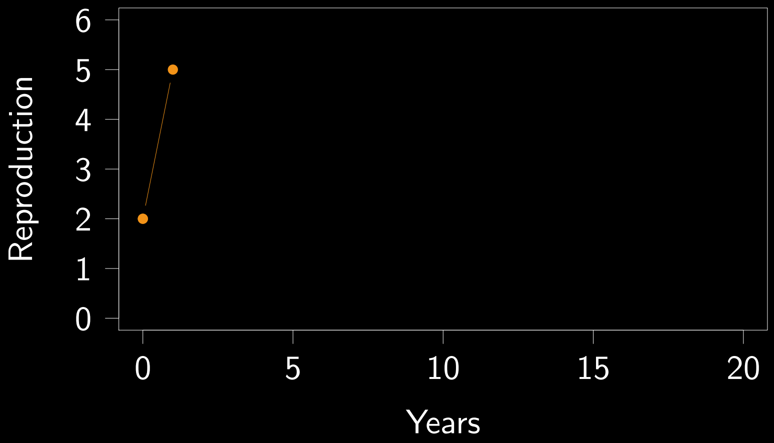
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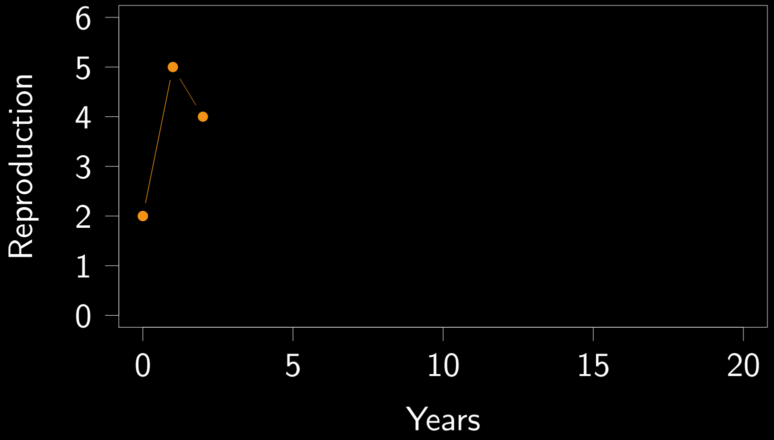
Years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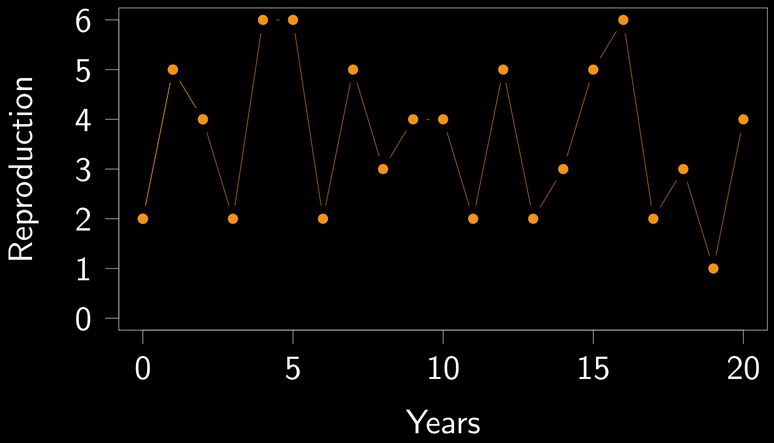
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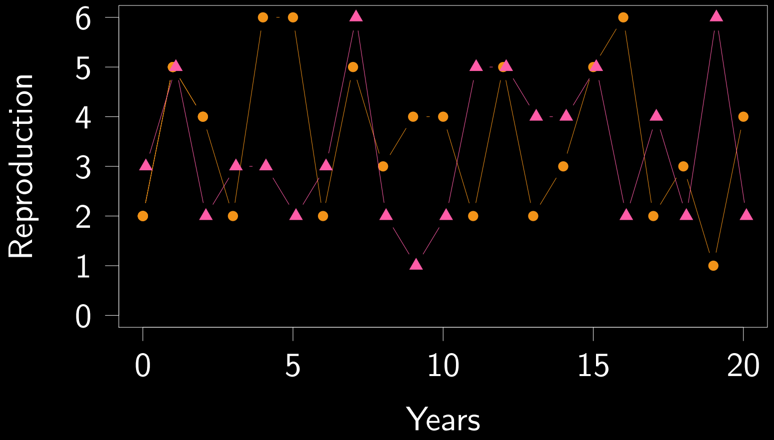
Years



Reproduction
Years
0
1
2
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4
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6
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15
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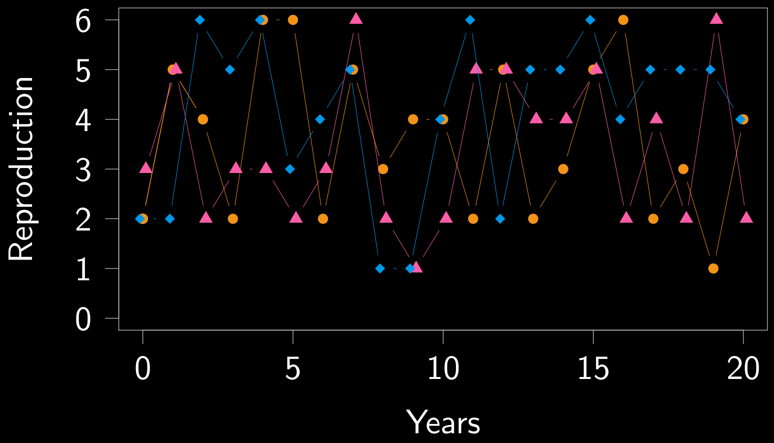

Reproduction
0
1
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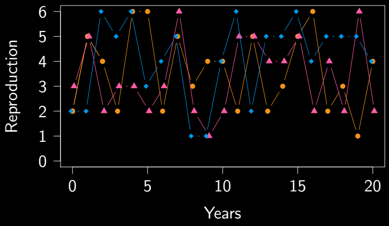
Years

One dice theory



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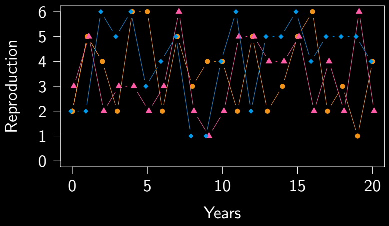
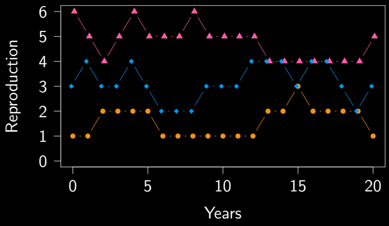


Real pattern



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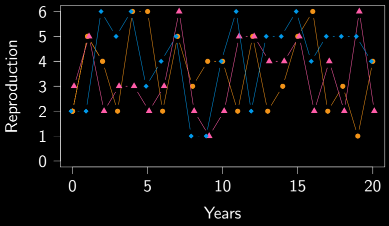

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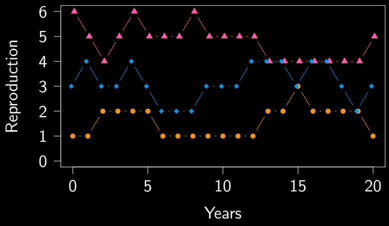
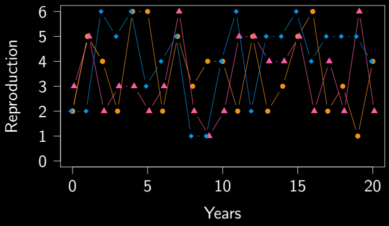


?

Individuals
are different

One dice theory



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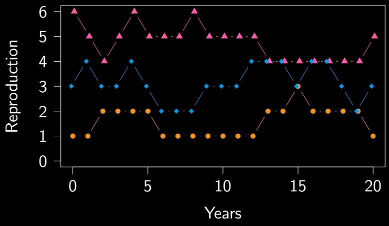
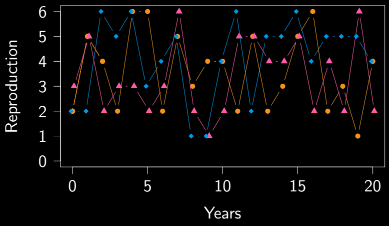


?

Individuals are different

Stages are different

One dice theory



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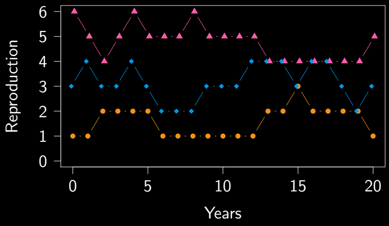

?

Individuals are different ↓ Selection/Evolution

Stages are different ↓ Neutrality

The neutral theory

Neutral theory for life histories and individual variability in fitness components

Ulrich Karl Steiner[a,b,1] and Shripad Tuljapurkar[a]

[a]Department of Biology, Stanford University, Stanford, CA 94305; and [b]Institut National de la Santé et de la Recherche Médicale U1001, Université Paris Descartes, 75014 Paris, France

Edited* by Burton H. Singer, University of Florida, Gainesville, FL, and approved February 3, 2012 (received for review December 3, 2010)

Individuals within populations can differ substantially in their life yes and that this stochastic variation has significant implications

Neutral matrix method

	next year 1	2	3
1	0.9	0.08	0.02
2	0	0.7	0.3
3	0	0.2	0.8

No variation in fitness among individuals

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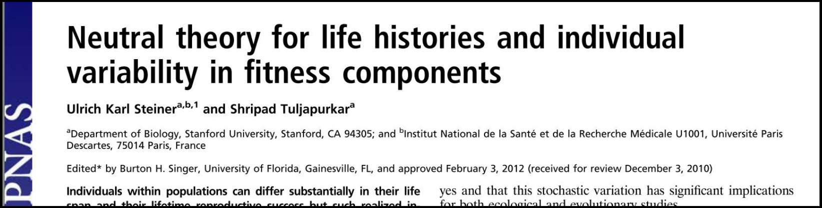
PNAS

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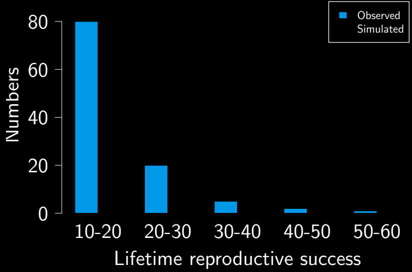
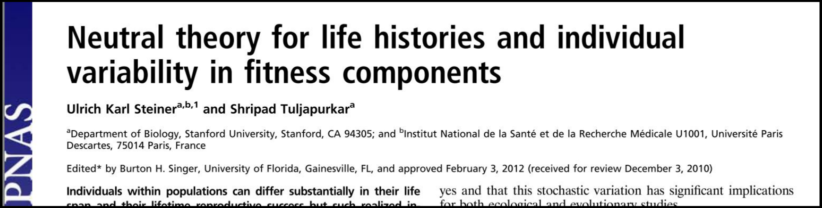


No variation in fitness among individuals



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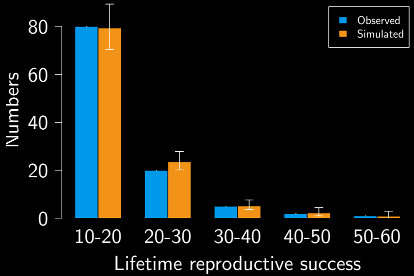
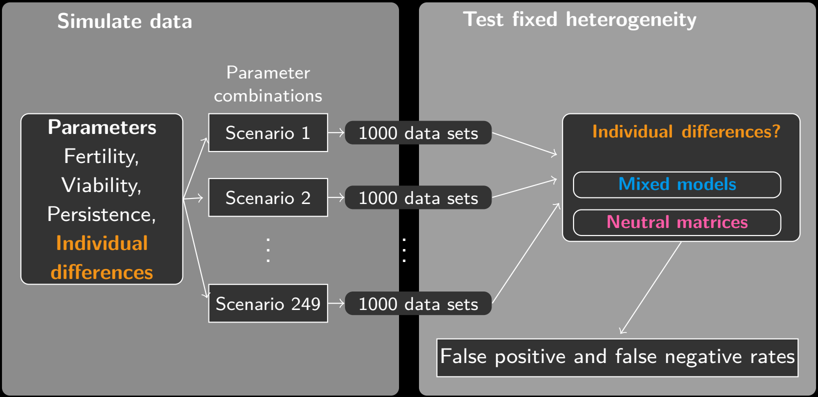


No variation in fitness among individuals

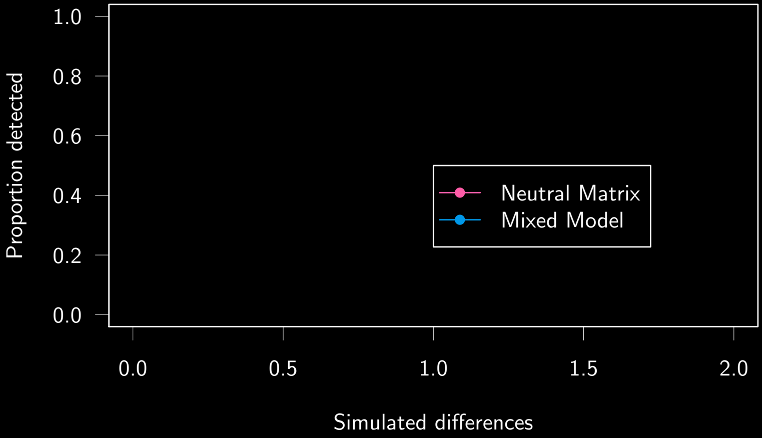
Conflicting results

Method



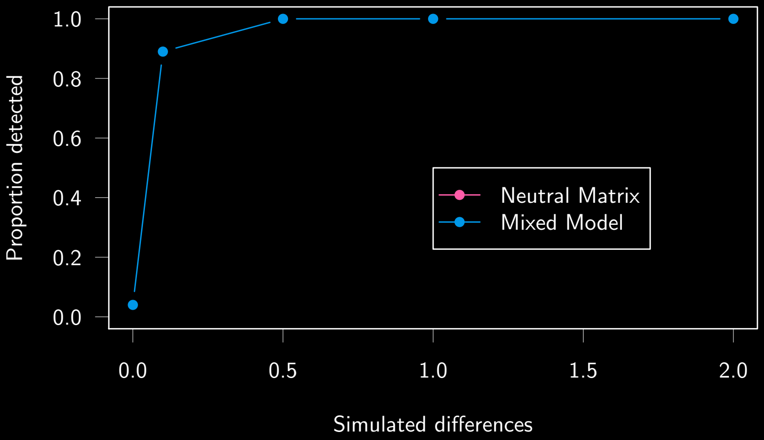
Simulate data
Parameter combinations
Parameters
Fertility,
Viability,
Persistence,
Individual differences
Scenario 1
Scenario 2
Scenario 249
1000 data sets
1000 data sets
1000 data sets
Test fixed heterogeneity
Individual differences?
Mixed models
Neutral matrices
False positive and false negative rates

Results



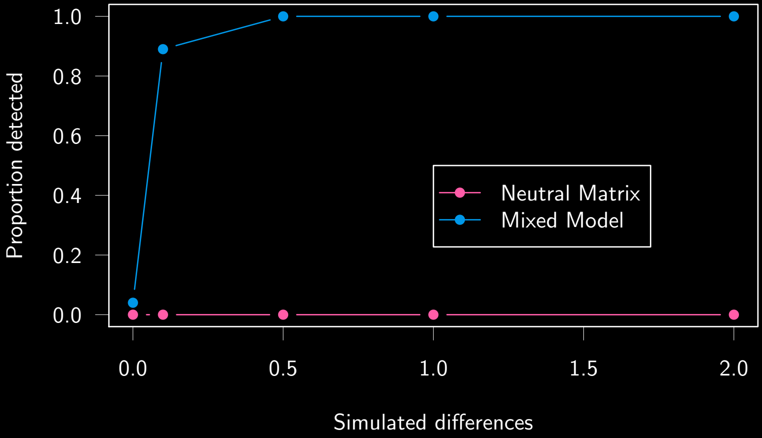
1.0
0.8
0.6
0.4
0.2
0.0
Proportion detected
Neutral Matrix
Mixed Model
0.0
0.5
1.0
1.5
2.0
Simulated differences

Results



Proportion detected
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.5
1.0
1.5
2.0
Simulated differences
Neutral Matrix
Mixed Model

Results



1.0
0.8
0.6
0.4
0.2
0.0
Proportion detected
Neutral Matrix
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0.0
0.5
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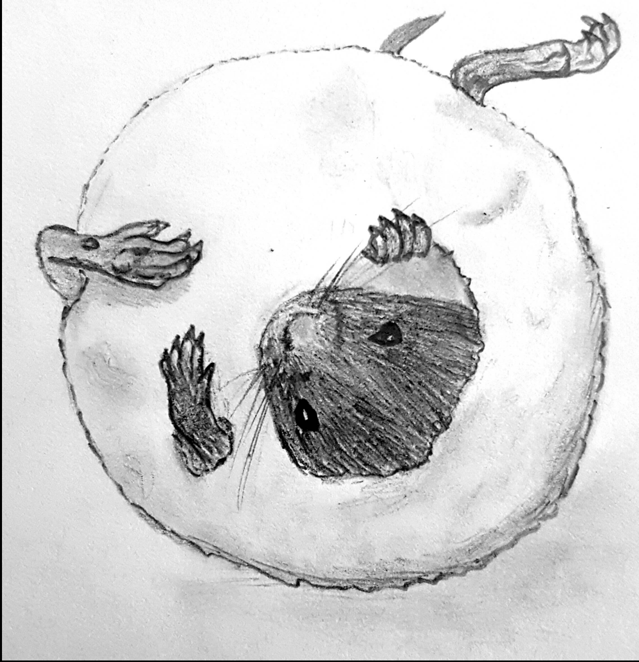
1.5
2.0
Simulated differences

Conclusion

Implications

-

What drives phenotypic change?



Snow vole (*Chionomys nivalis*, Martins 1842)

- NOT white

Snow vole (*Chionomys nivalis*, Martins 1842)

- NOT white
- Rock-dweller

Snow vole (*Chionomys nivalis*, Martins 1842)

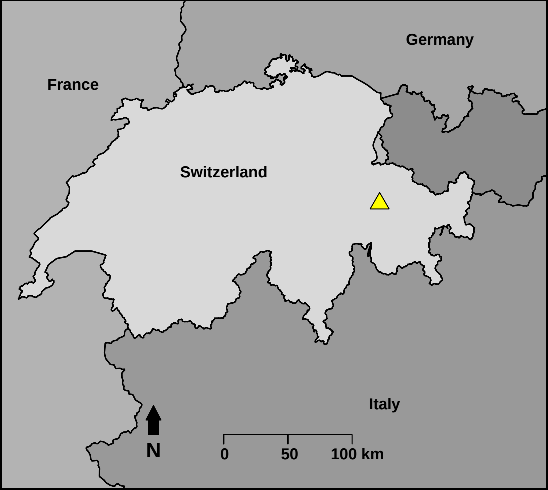
- NOT white
- Rock-dweller
- 30-45g

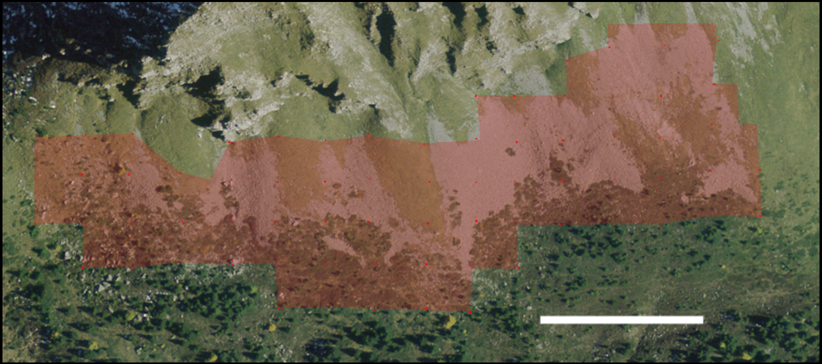
Snow vole (*Chionomys nivalis*, Martins 1842)

- NOT white
- Rock-dweller
- 30-45g
- 10-14cm long + 5-8cm tail

Snow vole (*Chionomys nivalis*, Martins 1842)

- NOT white
- Rock-dweller
- 30-45g
- 10-14cm long + 5-8cm tail
- Slow life pace


Germany
France
Switzerland
Italy
N
0
50
100 km



What we measure

What we measure

- Morphology
  - Body mass
  - Body length
  - Tail length

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  - Tail length
- Capture/Recaptures
  - Death/emigration
  - Location

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  - 20 “neutral” markers
  - Sex identification
  - Any genotyping

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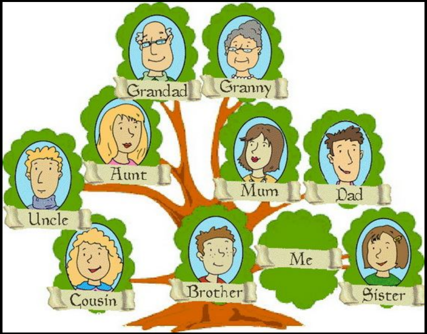
  - **Pedigree**



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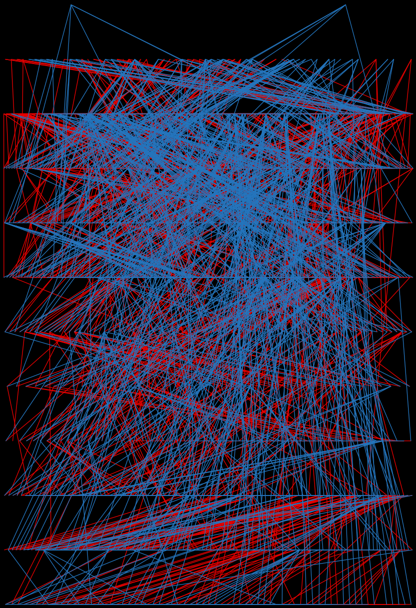

Are snow vole evolving? Why?

Do selection and evolution fluctuate?

What is left?