

# Which evolutionary mechanisms allow *Senecio inaequidens* DC. to face a changing climate?

## A synthesis

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### Plant populations facing gradual climatic variation

Plant populations are expected to face gradual climatic variation in the next decades. Understanding and quantifying evolutionary and non-evolutionary mechanisms allowing populations response to climate is therefore crucial to anticipate the actual consequences of climate change on plants. However, studying the direct effects of climate change in wild populations is of little anticipating interest... *there invasive plants can help!*

We studied the sources of phenotypic variation in populations that gradually invaded different climatic zones over the last century, and assessed the role of local adaptation, non-adaptive genetic differentiation, phenotypic plasticity and environmental maternal effects in plant population response to climate.

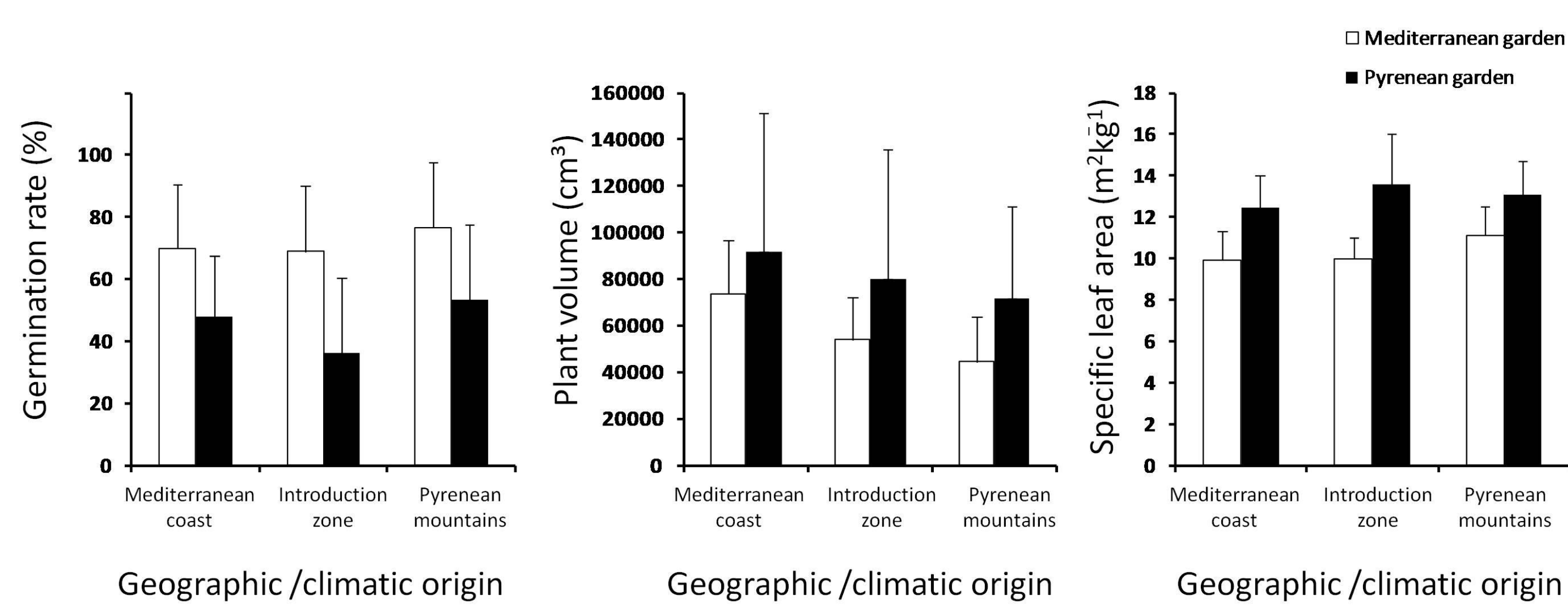
### *Senecio inaequidens*: an ideal model for the “space instead of time” approach

Our approach is based on the idea that spatial colonization of contrasted climates is comparable to the temporal climatic variation plant populations will face due to climate change. For this purpose, we needed a plant model that:

- was introduced in a single, precisely known area
- has spread from this area into contrasted climatic zones, with a documented invasion history.

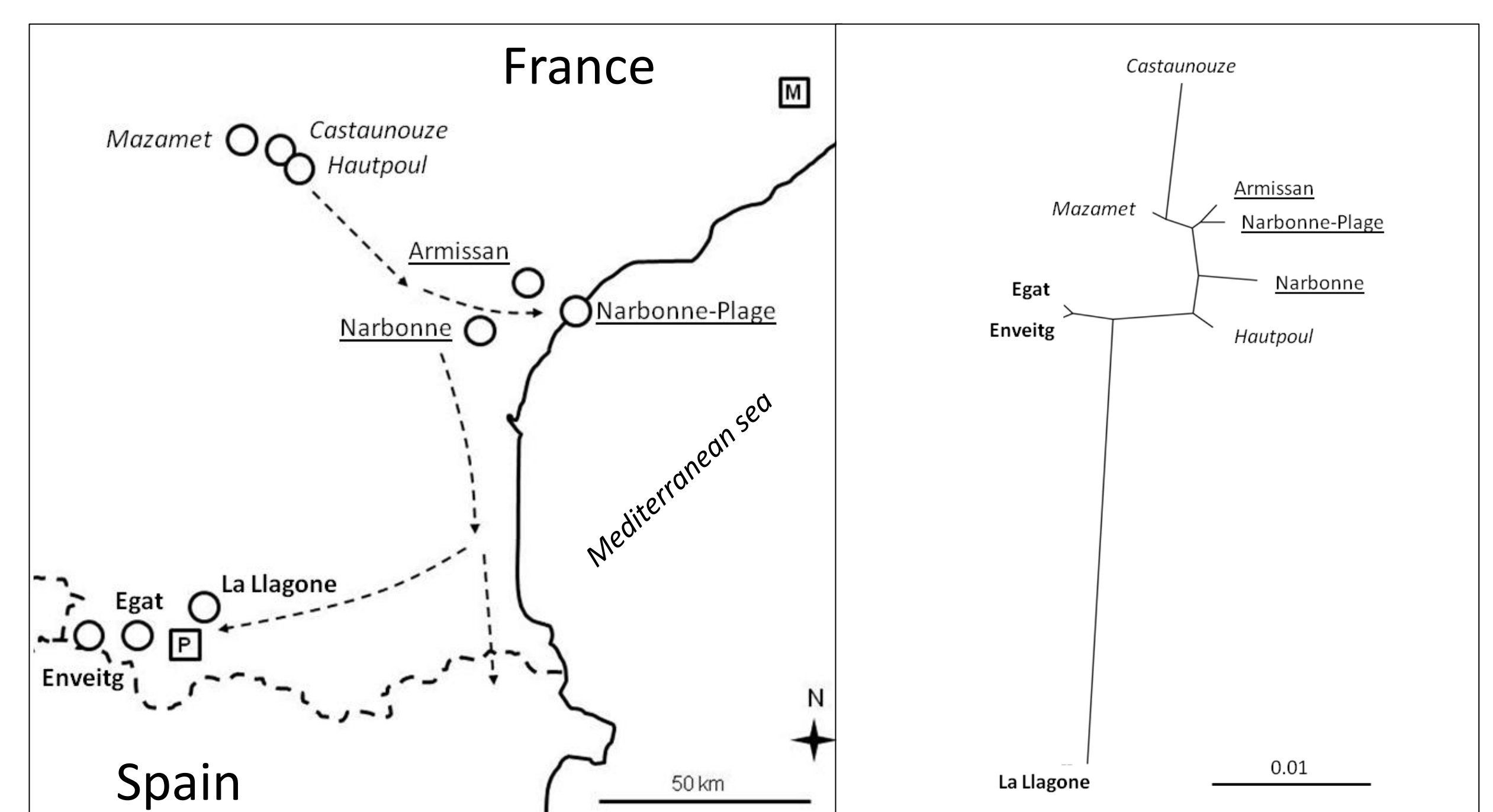
The African ragwort *S. inaequidens* presents these features in Southern France. We used populations sampled along a climatic gradient from the Mediterranean coast to the Pyrenean mountains to perform several common garden experiments, AFLP analysis and a reciprocal sowing experiment.

### Phenotypic plasticity: Direct response of individuals to climate



Life history traits averaged by geographic zone in the two gardens (Mediterranean garden: Montpellier, alt. 100m; Pyrenean garden: La Cabanasse, alt. 1500m). Bars are standard deviation.

### Genetic differentiation: Colonization and genetic drift



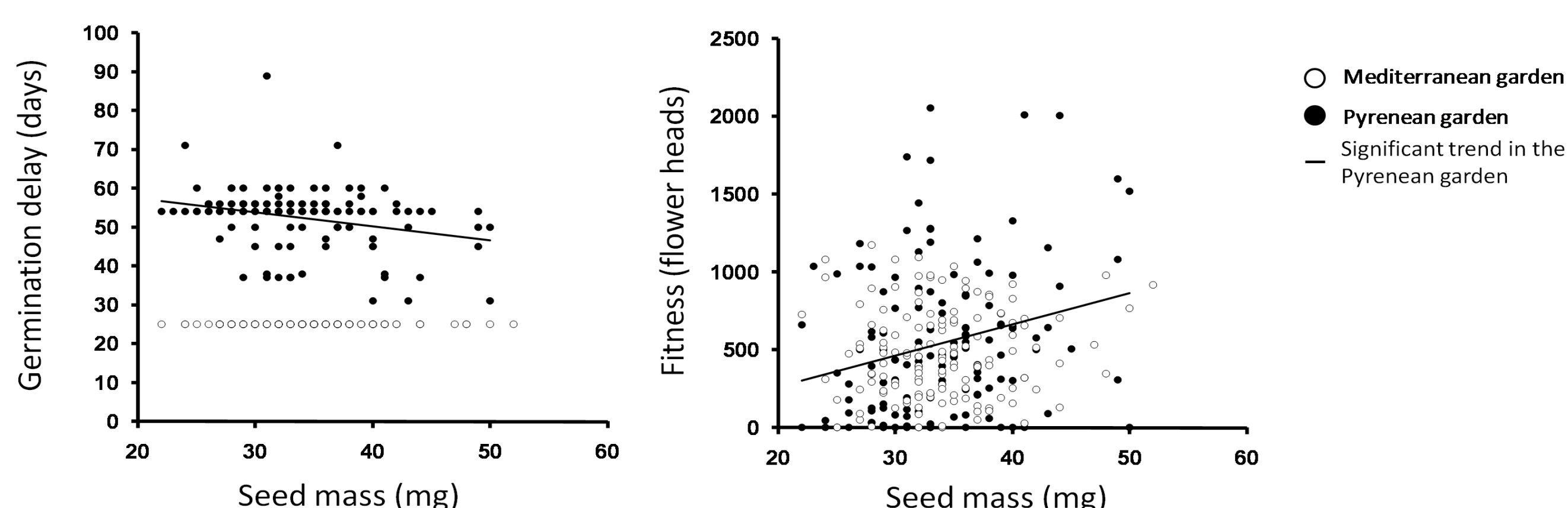
Map of the progressive colonization of *S. inaequidens* from the introduction site of Mazamet, towards the Mediterranean coast and the Pyrenean mountains. Circles represent the populations used in this study. M and P represent the locations of the gardens.

Neighbour-joining unrooted dendrogram showing the genetic distance between all pairs of population ( $F_{ST}$ ), based on the AFLP analysis.

- Plastic response to climate for most life-history traits
- Under mediterranean climate, better germination in spring but reduced growth in summer and fall due to drought
- Specific leaf area variation only due to plasticity

- Low but significant level of genetic differentiation among populations ( $F_{ST} = 0.0161$ ,  $P < 0.001$ ).
- Differentiation pattern roughly matching colonization history

### Environmental maternal effects: The complex role of seed mass variation



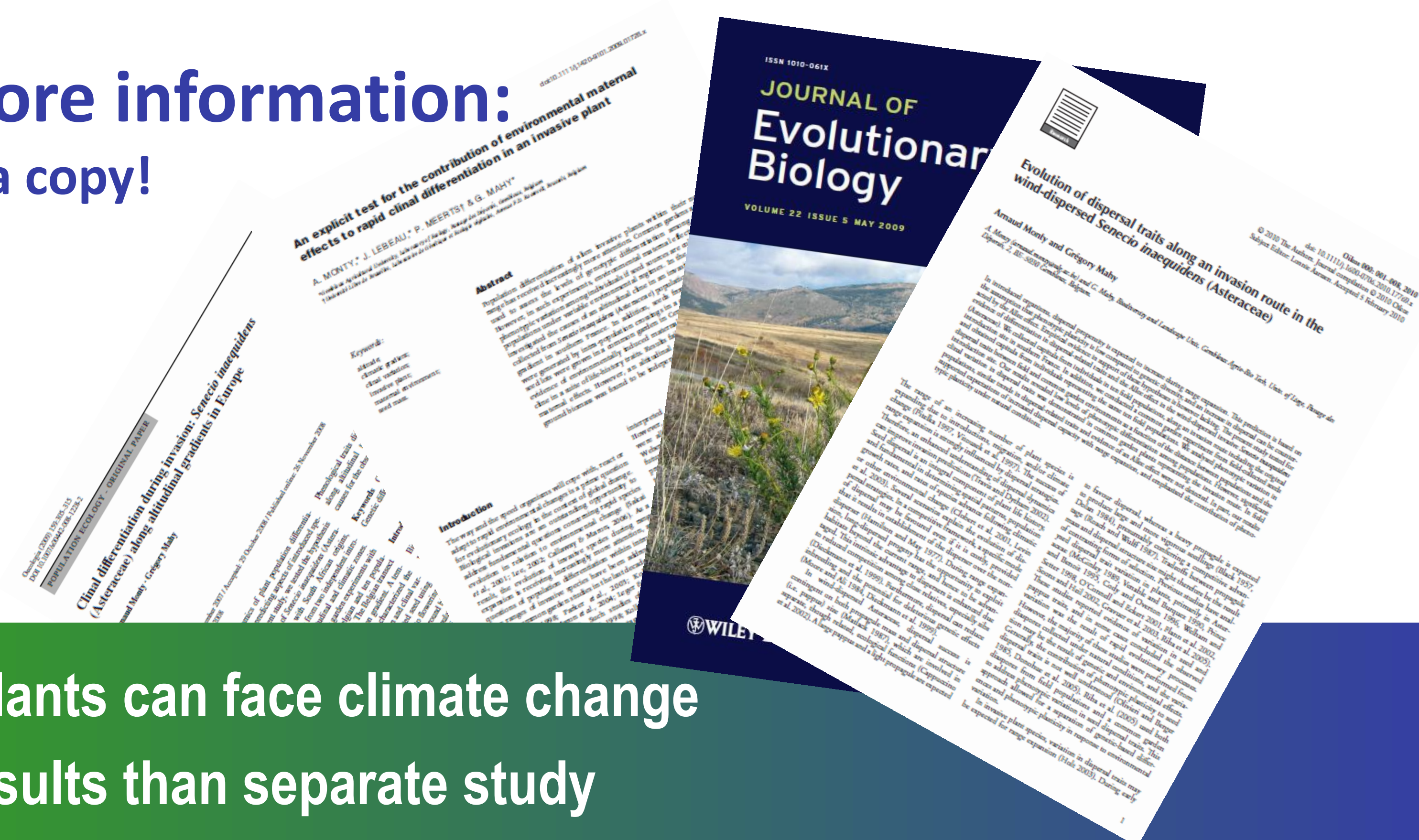
Influence of seed mass on germination timing and flower head production, in the two gardens (Mediterranean garden: Montpellier, alt. 100m; Pyrenean garden: La Cabanasse, alt. 1500m).

### Adaptation ?

- Climate-dependent seed mass influence, indicating a climatic regulation of environmental maternal effects expression
- Rapid evolution of seed mass in relation to dispersal

- No strong pattern of local adaptation to climate
- Importance of adaptive maternal effects under colder climate

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### Take-home message

- ➔ « Space instead of time »: an approach to anticipate the mechanisms by which plants can face climate change
- ➔ Study of the different sources of phenotypic variation altogether → different results than separate study
- ➔ Importance of adaptive environmental maternal effects (trans-generational plasticity) in plant population response to colder climate