Disentangling the sources of phenotypic variation in *Ambrosia artemisiifolia* L.: the role of seed traits

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- INTRODUCTION -

Ambrosia artemisiifolia L. invasion success is strongly linked to seed characteristics. For example, little outgrowth on the seed head make it able to stick to piece of mud, and then to be dispersed by human activities. Some seeds are floating, and can be dispersed by water courses. Furthermore, a secondary dormancy allow the seed to be buried more then 30 years and still remain able to germinate.

However, seed characteristics are highly variable (see Fig. 1). In this study we aim a better understanding of how seed variability is structured, what are the main sources of variation, and how the seed traits impact the early stage of seedling growth.

OBJECTIVE ➔ Analyze the variability of seeds from different origins, and quantify the impact of the seed traits on the seedling phenotype.

Fig. 1: Illustration of the variability of *A. artemisiifolia* seeds. Note the differences in color, size, and outgrowth length.

- METHOD -

We sampled three populations in each three geographical areas in Western Europe (Fig. 2). We sampled 10 seeds on 10 plants, in each population.

To assess seed variability, we measured several traits on standardized pictures of seeds (Fig. 3-1). We measured the length, width, area, circularity and pigmentation (translated into a gray scale) of the 900 seeds, using Image J software (Fig. 3-2). The seeds were also weighted before stratification.

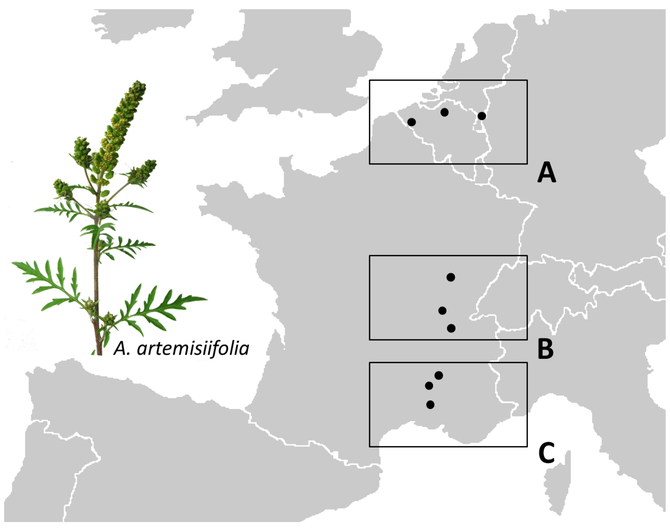

Fig. 2: Localization of the sampled populations among the 3 latitudinal areas.

Variability of seeds from the 3 latitudinal zones was assessed with a nested ANOVA and visualized via a PCA.

Fig. 3 : 1. Equipment used to take standard pictures of each seed; **2.** Measurement we made on seed pictures (Area, color, length, diameter, circularity); **3.** Seedling emergence; **4.** Standard picture of the seedling leaf area.

After characterization, seeds were disposed in two growth chambers (Fig. 3-3), to apply two separate temperature treatments (5 seeds per plant, in each chamber).

The time of emergence of seedlings was recorded. After exactly two weeks of life, a picture of each seedling was taken on a black background, to determine the leaf area (Fig. 3-4). This area is considered as a proxy of the early competitive ability (ECA). We stopped the experiment after 2 months, and we recorded seedlings height and biomass.

We performed an ANCOVA with PCA scores in covariates, to analyze the variation of seedlings traits.

- RESULTS -

Seed traits variability:

The result of the PCA is shown on the Fig. 4. ACP1 axis appeared to correspond to dimension parameters (Diameter, mass, area and length) and ACP2 axis to appearance parameters (Circularity and color).

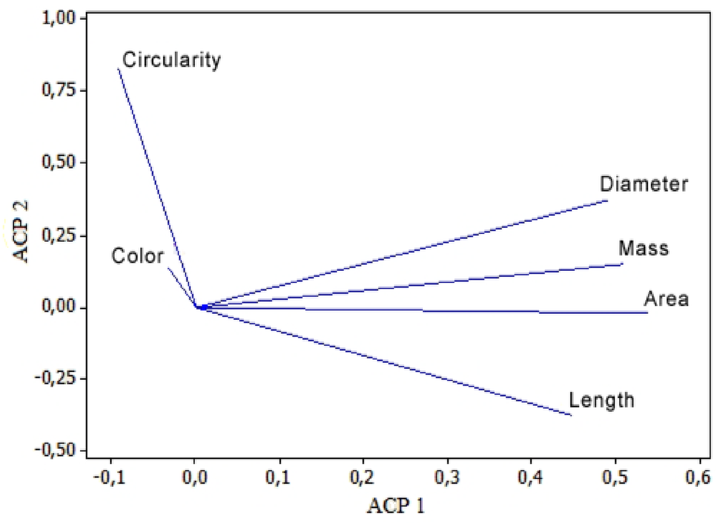

Fig. 4: Graph of the Principal Components Analysis.

The result of the ANOVA performed on seed traits showed that seeds were varying significantly among zones (for mass, length and diameter traits), populations (for length, Area, shade of gray and circularity traits) and parents (all traits), with more than 30% of the variation attributable to the mother plant identity (Fig. 5).

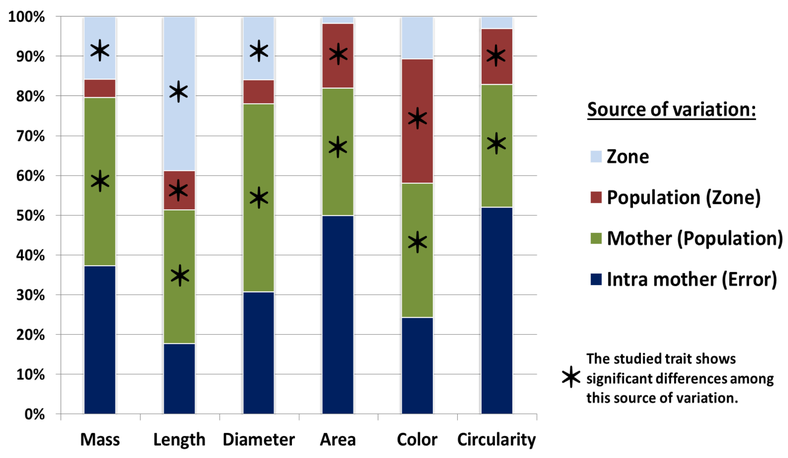

Fig. 5: Decomposition of the variability contribution (%) of measured seed traits, following studied explanatory factors.
The star indicates significant differences among the regarding source of variation

Seedling response:

The results of the ANCOVA performed on the seedling traits showed a significant impact of seed mass when used as covariate. Seed mass had a significant impact on ECA ($F = 15.04$; $P < 0.001$) and on seedling biomass ($F = 7.12$; $P < 0.01$).

Surprisingly, ACP scores did not have as much impact on seedlings as seed mass taken separately. Only the first axis impacted ECA ($F = 5.36$; $P < 0.05$).

Overall, the influence of the population and the zone of origin did not have a significant impact on seedling traits. Phenotypic plasticity in response to temperature treatments appeared to be the main sources of seedlings phenotypic variation ($P < 0.001$ for all measured traits).

TAKE-HOME MESSAGES

- The seed traits were significantly different among areas, populations, and parents;
- Phenotypic plasticity in response to temperature appeared to be the main source of seedlings phenotypic variation;
- No genetic differentiation was detected in seedling traits;
- Seed mass appeared sufficient to assess environmental maternal effects.

SEARCH FOR ME !

I look forward to answer your questions!