



## Phenotypic variability of forest herbaceous species along environmental gradients

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Thematic action concerned : WP2

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### Context —

Changes in environmental conditions can influence the persistence of plant species, some species being expected to strongly decline in their core area in response to current environmental changes. One way species have to adapt or acclimate to new environmental conditions is through their phenotypic variability, i.e. the ability of genotypes to express different phenotypes in response to the environment. Phenotypic variability is particularly important in the current context of climate change for species with low dispersal abilities.

### Objectives —

We studied the phenotypic variability of two understorey plant species which have low colonization abilities (*Anemone nemorosa* (L., 1753) and *Lamium galeobdolon* ((L.), L., 1759)), in response to fine-scale environmental heterogeneity. These species have different development periods: *A. nemorosa* starts developing earlier than *L. galeobdolon*.

### Approaches —

Data collection was part of three research projects carried out between 2018 and 2023 (Bioval project, AAP Labex 2018 ; « Variabilité phénotypique des espèces végétales le long de gradients environnementaux en contexte de changement climatique » project, AAP CS/PS A2F-2022 and PheVar project, AAP Labex 2023). A total of 22 (*L. galeobdolon*) et 23 (*A. nemorosa*) populations were sampled in the plateau, the north/east and the south/west slopes, and in the bottom of 6 steep-sided valleys located in northeastern France. Phenotypic variability was expressed by measuring leaf functional traits: specific area (SLA), dry matter content (LDMC), nitrogen content, C/N ratio, chlorophyll, anthocyanins and flavonols content, nitrogen balance index and isotopes  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ . In addition, plant height, rhizome diameter (for *A. nemorosa*), phenological and reproductive traits were also sampled: the flowering peak week and seed mass. These traits were linked with environmental factors related to soil, topography, temperature and dendrometry, by performing multivariate analyses and models.

### **Key results —**

- *A. nemorosa* was more conservative, had a more water use efficiency and a better protection against UV radiation than *L. galeobdolon*.
- Vegetative traits of the two species responded similarly to environmental gradients.
- The traits the most linked to environmental gradients were: the acquisition/conservation strategy of resources (SLA, LDMC), the protection against UV radiation (flavonols), the nitrogen content of the leaves.
- The topographical position index and the eastness had a major effect on vegetative traits of both species.
- The temperature had an effect on vegetative traits of *Anemone* while soil humidity had an effect on *Lamium*'s traits.
- The phenology and seed mass of the two species were poorly linked to environmental gradients.

### **Main conclusions including key points of discussion —**

*Anemone nemorosa* and *Lamium galeobdolon* have similar ecological niche, they were similarly influenced by environmental gradients at fine scales, however, a few differences were observed. In the current context of climate change, *A. nemorosa* would be the most vulnerable species to the increase in temperature and in drought than *L. galeobdolon*.

### **Perspectives —**

Analyzing the range of trait values will validate or invalidate potential differences in phenotypic variability between the two species and along environmental gradients.

### **Valorization —**

An engineer thesis was written and a scientific article is in preparation for submission in an international journal. C. Hamel, 2023. Study of the response of functional traits of herbaceous species of the understorey along environmental gradients. Engineer thesis, VetAgro Sup Clermont-Ferrand, France. 47 pp.

### **Leveraging effect of the project—**

The response of plant species to environmental changes has commonly been studied along environmental gradients over long distances, while finer scales such as those we considered in the PheVar project, have barely been considered. This project also allowed us to improve our knowledge on the response of a poorly studied species: *Lamium galeobdolon*, to environmental gradients. It could lead to a project proposal on the response of plant species that are in marge of their distribution range, particularly mountainous species adapted to some steep-sided valleys (developing in the north/east slope and in the valley bottom). These species are particularly threatened by climate change and their future in these valleys are compromised. Several public agencies in France are directly interested in the results of this project, such as: ONF, Parc naturel regional de Lorraine, Conservatoire régional des espaces naturels and Réserve naturelle du Val-Suzon.