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Diane C. Bouchet, Pierre-Olivier Cheptou, Francois Munoz. Flowering overlap in Mediterranean plant communities along an ecological succession with recurrent mowing - Synchrony predominates at earlier stages and under mowing. *Sféologie-2016*; International Conference of Ecological Sciences, Oct 2016, Marseille, France. 10.13140/RG.2.2.21184.12809 . hal-02911714

HAL Id: hal-02911714

<https://hal.science/hal-02911714>

Submitted on 31 Aug 2020

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Flowering overlap in Mediterranean plant communities along an ecological succession with recurrent mowing

Synchrony predominates at earlier stages and under mowing

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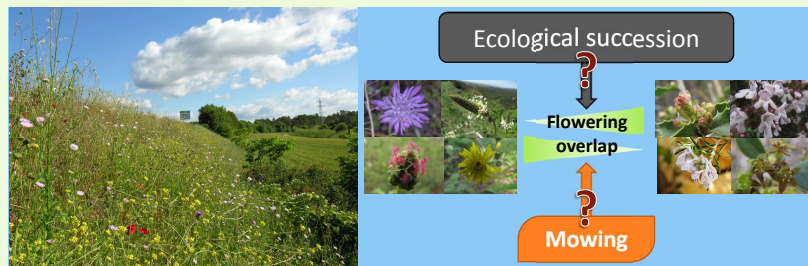
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Introduction

Flowering phenology is critical for the success of plant reproduction and depends both on abiotic constraints and on biotic interactions with other plants and fauna. Flowering synchrony or asynchrony within communities could thereby reflect local assembly processes associated with reproductive strategy. Changes in flowering phenology along the succession has been little studied. Thus, the interplay of a recurrent disturbance on successional changes in reproductive strategy remains unknown. Road slopes that are yearly mown are a good model to study these effects.



Questions

- How do changing community assembly processes along the succession and due to mowing influence flowering overlap (i.e. synchrony or asynchrony) ?
- Does flowering overlap depend on pollination strategies and flower colour diversity in communities?

Methods

Study sites: Chronosequence of 15 Mediterranean road slope plots including both mown and unmown subplots (Fig. 1).

Flowering monitoring: Record of flowering status of all angiosperm species (286 species) at population level within each subplot (Fig. 1C) of each road slope over a whole year.

Statistical analyses:

$$Overlap_k = \frac{\sum_j \left(\sum_r S_{wr} \right) / W / Rt}{R}$$

R: number of species observed flowering during the year,
r: index of weeks during which species *j* flowered,
r: index of other species flowering within subplot *k* along the year,
S_{wr}: flowering status of species *r* flowering during week *w* (with 1 = flowering and 0 = not flowering),
W: number of weeks where species *j* flowered, and
Rt: total species richness in the subplot (i.e., all the species observed during the year, including those that did not flower)

Linear models – testing variation of flowering overlap with age, mowing, flower colour diversity, topological and pedological features and pollination strategies.

Null models – testing deviation of mean flowering overlap from expectations in randomly assembled communities.

Study sites

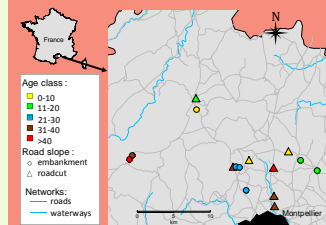


Figure 1A. Localisation and characteristics of road slopes sampled. The study area is located in Hérault, France. All road slopes included both mown and unmown parts.



Figure 1B. Mown (M) and unmown (U) part on embankment and roadcut. Mowing (8 to 10 cm) yearly during late autumn-early winter with a side-arm flail-mower.

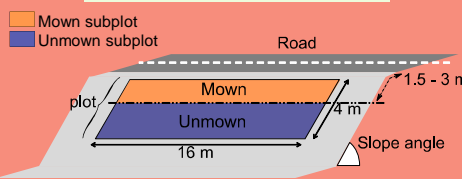


Figure 1C. Flowering monitoring. Each subplot was checked for flowering species 23 times from February 2014 to February 2015.

Results

- Decrease of flowering overlap along the succession (Fig. 2A).
- Slower successional decrease with mowing (Fig. 2A).
- Greater flowering overlap than expected (flowering synchrony) before 30 years without mowing (Fig. 2B).
- Longer flowering synchrony with mowing (until 40 years, Fig. 2B).
- Higher overlap with lower colour diversity.
- Lower overlap on North-oriented than on East-oriented slopes.
- Decrease of overlap with increasing slope angle
- Lower flowering overlap for strictly entomophilous species than for other species (Ent. = 0.23 vs. Other = 0.24, *V* = 335, *P* = 0.03).
- Significant relationship of flowering overlap with SLA and LDMC at community-level (CWM, Fig 3).

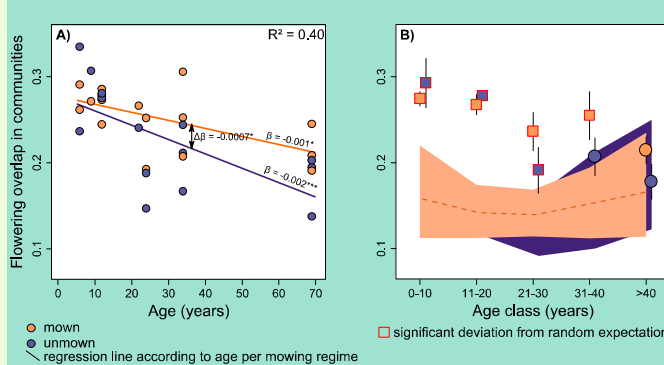


Figure 2.1. Variation of flowering overlap according to age and mowing (A) and related deviation of the overlap from null expectations (B). In A, Regression lines, R-squared value and beta coefficients represent the results of the linear model including the interaction between age and mowing regime. β is the estimated slope per mowing regime and associated stars show significance of slope (i.e. beta differs from zero). $\Delta\beta$ is the estimated difference between these slopes, and the associated stars show the significance of this difference, with * *P* < 0.05, ** *P* < 0.01, *** *P* < 0.001. In B, polygons represent the 95% confidence interval of flowering overlap in randomly assembled communities for each mowing regime (mown and unmown represented by light grey and dark grey respectively) and dashed lines represent mean flowering overlap based on the same 1000 permutations. Squares with blue external colour represent mean flowering overlap value significantly higher than expected by chance (flowering synchrony).

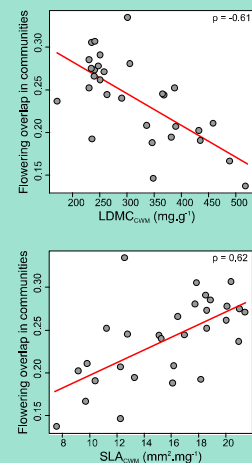


Figure 3. Relationship between flowering overlap and community weighted mean values (CWM) of Specific leaf area (SLA) and Leaf Dry Matter content (LDMC). Rho values in the corners correspond to estimated Spearman correlation coefficients.

Discussion

- In earliest successional stages, acquisitive plants highly depend on favorable meteorological conditions for vegetative growth and following investment in reproduction, thus resulting in higher flowering synchrony.
- Assembly appears neutral in regard to flowering phenology in later stages, probably reflecting a lower influence of constraints impeding flowering synchrony for conservative plants.
- Mowing increases flowering synchrony probably due to a synchronization of vegetative growth and via its influence on resource-use strategy.
- Flowering synchrony seems related to facilitation for pollinators' attraction with enhanced colour signal (lower flower colour diversity), for entomophilous species in particular.

Conclusion

- Reproductive timing is an important driver of community assembly and appears tightly related to resource-use strategy.
- Flower synchrony within communities can reflect both
 - influence of abiotic conditions constraining the optimal period to invest in reproduction in Mediterranean area
 - facilitation processes helping entomophilous species to attract pollinators more efficiently thanks to synchronous homogeneously-coloured flowering signal.