FRB
FONDATION POUR LA RECHERCHE SUR LA BIODIVERSITÉ

CESAB
CENTRE FOR THE SYNTHESIS AND ANALYSIS OF BIODIVERSITY

Project summary

DIVERS

From reproductive strategies to species diversity: how evolution of breeding systems and associated traits shapes plant species diversity?

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Some flowering plants self-pollinate, but most have evolved a wide range of mechanisms to transfer pollen between flowers: separate sexes, genetic self-incompatibility, brightly colored flowers, etc. The FRB-CESAB DIVERS group aimed to understand how this exceptional diversity in reproduction can explain species richness

Context and objectives

Sexual reproduction involves the combination of two sets of genes, usually originating from two individuals, and the extent to which these individuals differ genetically is crucial for evolution and adaptation. Flowering plants, the most species-rich group of

plants (approximately 350,000 species), have evolved a wide range of strategies promoting outcrossing (cross-pollination), from genetic self-incompatibility to the separation of sexes, and by using different vectors to ensure pollen transfer between plants. However, self-pollination can also be advantageous in some cases, mainly because it guarantees reproduction when mates are rare or absent. Although several plant traits are associated with these reproductive strategies, it remains unclear how these traits interact and how they influence evolutionary success and the diversity of flowering plants.

The objective of the DIVERS group was to **achieve a more comprehensive description of reproductive strategies in flowering plants by combining multiple floral and life-history traits, and to understand how these traits interact to affect speciation and species persistence**. This required integrating approaches from botany, pollination biology, ecology, and modeling in population genetics and phylogenetics.

Methods and approaches used for the project

An inventory of predictions regarding the impact of reproductive systems on plant species diversity was compiled based on a literature review and the expertise of the group members. This work made it possible to identify the main reproductive traits to consider, as well as the key hypotheses to be tested. The results of previous studies examining the effects of traits on plant diversification were also synthesized, with particular attention paid to methodological aspects.
A database of reproductive traits was then assembled through an extensive literature survey. Two sets of species were investigated:

- the first covered **the entire angiosperm phylogeny**, with sampling limited to a few species per family;
- the second focused on **the family *Polemoniaceae***, with the aim of achieving exhaustive coverage.

Multivariate analyses were conducted to identify the main reproductive strategies at both scales. Diversification analyses were subsequently performed to test the effects of these strategies on speciation and extinction rates.

Principal conclusions

Understanding the determinants of biodiversity remains a central challenge in evolutionary biology. However, analyses of theoretical predictions and empirical studies focusing on flowering plants show that it is difficult to explain species diversity based on a few traits considered in isolation—such as lifespan, the capacity for self-fertilization, or flower size. Indeed, most of these characteristics can have contrasting effects on speciation and extinction, and their influence depends strongly on ecological and evolutionary context. These results suggest that **the diversity of flowering plants can only be understood through an integrative approach that considers combinations of traits rather than isolated characteristics**. The database compiled as part of the project made it possible to describe these combinations and to highlight the existence of a continuum of reproductive strategies, structured by complex associations between floral traits and life-history traits. This approach reveals that **reproductive strategies are more nuanced and more interdependent than previously assumed**. Ongoing diversification analyses now aim to determine to what extent these different strategies help explain the variations in species richness observed among flowering plants.

Anticipated (or actual) impact of these results for science, society, and public and private decision making

For the scientific community, the results of this project highlight the complexity of the dynamics that have shaped present-day biodiversity. Research is still too often focused on studying the effects of traits considered in isolation on diversification and evolutionary success. Yet only by taking into account the context in which these traits occur will it be possible to better understand the mechanisms underlying species richness.

This work, which is primarily fundamental, has laid the groundwork for more applied research: which characteristics make species more vulnerable to extinction? How do land-use changes driven by human activities influence the diversity of floral reproductive strategies? **Work is currently underway to translate these findings into tools that can be used in biodiversity inventories, on which decision-makers can rely.**

For society, plants are mainly known through their flowers. **Better understanding how these flowers fulfill their primary function—reproduction—offers a different perspective on the biodiversity crisis.**

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