Abstract submission

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1. Title of manuscript *

Long-term responses of life-history strategies to climatic variability in flowering plants

2. Authors and affiliations *

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4. Article type (for details see here under Article types: https://tinyurl.com/ms5wkd3m and https://tinyurl.com/56w4p4d7) *

Original - Full Paper

5. Which journal (*New Phytologist* or *Plants, People, Planet*) do you prefer for your contribution? *

- (selected) *New Phytologist*
- *Plants, People, Planet*

6. Do you agree to also be considered for the alternative journal if your first preference isn't possible? *

- (selected) Yes
- No

7. Data details – specifically indicate how RBG Kew's World Checklist of Vascular Plants (https://tinyurl.com/33fe6um9) will be used in the study, and indicate which other data will be used. *

We make use of the WCVP in two ways: to place species geographically and to score life history strategies. Hemicryptophytes and therophytes will be scored as annuals, while phanerophytes (including nanophanerophytes and herbaceous phanerophytes) will be scored as perennials. This scoring is fluid as we may have to adjust the life history scoring depending on the specific characteristics of the whole database. We will score life history data (e.g. annual or perennial) for a list of c. 40.000 species of flowering plants for which we have robust phylogenetic data for (based on a dataset of >180 empirical phylogenetic trees that will also be made available with our publication). Based on our hypotheses, WCVP geographic data will be initially used to collect climate data from CHELSA (Climatologies at high resolution for the earth's land surface areas), such as temperature seasonality (bio4) and precipitation seasonality (bio15).

8. Main research questions / hypotheses your contribution will address (max. 100 words) *

Our goal is to model the evolution of life history strategies in flowering plants by explicitly incorporating the impact of climatic niche variation using recent theoretical developments in trait evolution models and on a global scale. We aim to test two hypotheses: (1) annuals tend to evolve in regions of high seasonality more often than perennials because they can rapidly take advantage of short beneficial climatic conditions for reproduction; and (2) annuals tend to have faster rates of climatic niche evolution than perennials because of their higher invasibility and shorter generation times.

9. What is the scientific novelty of this research? (max. 100 words) *

Despite an appreciation that the geographic distribution of annual and perennial strategies are broadly linked to certain climatic characteristics, clade specific studies have found mixed support for these associations. We will provide a global analysis that accounts for the heterogeneity of evolutionary histories in flowering plants and the habitats associated with them. The new hOUwie model (Boyko et al. in prep) is the first to be able to explicitly model the joint evolution of discrete and continuous characters and thus simultaneously accounts for both life history evolution and climatic niche evolution as well as their impact

10. What is the geographical scope of the study? *

Global.

11. What is the taxonomic scope / sampling of the study? *

Flowering plants.

12. Analyses – briefly describe the statistical analyses used to address the main research questions / hypotheses (max. 100 words) *

To test our hypotheses, we will use hOUwie to compare models of dependent evolution, where life history strategy is correlated with seasonality, to models of independent evolution. We will then conduct model averaging and compare several parameter estimates within hOUwie: (1) whether annuals have a higher climatic seasonality optima than perennials, (2) if evolutionary transitions from perennial to annual are higher in seasonally variable climates, and (3) whether evolutionary rates of climatic evolution are higher for annuals than perennials. Besides answering our research questions, this analysis will provide an example of

13. If your proposal is very similar to those of another submitted contribution, would you be willing to discuss with the other author(s) to explore a collaboration or discuss how to minimise overlap (and can we contact you in that case about this)? *

We would be open to discussing collaboration or which of the unique aspects of each study should be explored.

14. Abstract (max. 300 words) *

Understanding the evolution of different types of life history strategies within flowering plants is a long-standing goal in evolutionary biology. Increasingly, biologists have sought to explain the distribution of annuals and perennials based on their association with broad climatic variables such as temperature or precipitation. However, these efforts have focused on specific clades or geographic areas and, due to methodological limitations, have not allowed the joint modelling of the evolution of both climatic niches and life history strategies. Here, we combine data on life form and geographic distribution from the WCVP with a recently developed modelling framework which accounts for rate heterogeneity and joint evolution of continuous and discrete traits to evaluate two hypotheses: (1) annuals tend to evolve in regions of high seasonality more often than perennials because they can rapidly take advantage of short beneficial climatic conditions for reproduction; and (2) annuals tend to have faster rates of climatic niche evolution than perennials because of their higher invasibility and shorter generation times. We will compare models of dependent and independent evolution to evaluate whether seasonal climatic variability is correlated with life history strategy. Additionally, we conduct model averaging to evaluate several key parameter estimates in the context of our hypotheses. This study will provide the first global analysis of life history strategy evolution in flowering plants and the habitats associated with them. We expect mixed support for our hypotheses due to clade specific evolutionary patterns. Some clades will undoubtedly have more heterogeneity in transition rates between life history strategies, whereas other clades may have exclusively unidirectional transitions, and yet others may have no heterogeneity at all. However, due to our large dataset and the ability to account for rate heterogeneity in our model, we expect that we can illuminate the