Climate and Speciation in the Mediterranean biome

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The Mediterranean basin is one of the world's biodiversity hotspots yet patterns of distribution and diversification of species that are key to maintaining this biodiversity are still poorly understood. The steady rise in population and urban development makes the area at particular risk of biodiversity loss. This project aims to develop a model system for the study and understanding of Mediterranean plant species in relation to geological and climatic history through the Cenozoic using *Narcissus* (daffodils) as an exemplar system. Recent meta-analyses (Escudero et al. 2017; Vargas et al. 2018) indicate Mediterranean species diversification may have started in the mid Cenozoic, before the formation of the Mediterranean climate zone. Limited availability of appropriate climate models to biologists has restricted the interpretation of diversification as a function of climate change in the pre-Mediterranean-climate period. The *Narcissus* centre of diversity is the Iberian peninsula but spreads into North Africa and east through Asia as far as China. It is thought that the distribution is a result of the combined interactions of natural diversification over millions of years and later spread by man, possibly as much as six thousand years.

This project will develop ecological niche models for all *Narcissus* species and further develop the *Narcissus* phylogenetic tree through genomic data. Using the techniques of phyloclimatic modelling the project will bring together *Narcissus* phylogeny, niche preferences, and Cenozoic palaeoclimate models offering the opportunity to understand more general patterns of distribution in Mediterranean species. Previous work by Yesson & Culham on *Cyclamen*, in the Eastern Mediterranean suggested a range of physical factors including orogeny and climate influenced speciation that will be explored further in this project. The genetic patterns we are currently finding in *Narcissus* suggest there has been disruption to the distribution of the genus over varying geological timescales (unpublished) resulting in previously unreported genetic disjunctions between Morocco and northern Spain, a novel story in diversification of Mediterranean species.

The University of Reading in partnership with the Royal Horticultural Society (the international registration authority for *Narcissus* cultivars) have developed molecular tools for both population biology and deep molecular phylogenetics in *Narcissus* using a combination of microsatellite libraries and Illumina HiSeq PE150 genomic data. The team recently published the first complete *Narcissus* plastome (Könyves et al. 2018) and this SCENARIO project will develop the most comprehensive phylogeny yet built, including all sections of the genus.   The collection of well-documented living plant material held by the team provides the basis for sampling.

The project will provide fundamental insights into:
1. Understanding of evolutionary patterns in a global biodiversity hotspot
2. Understanding of the influence of climate change as an evolutionary driver
3. The historic and palaeohistoric influence of man on speciation
4. The risks posed by climate change and habit loss on plant lineages
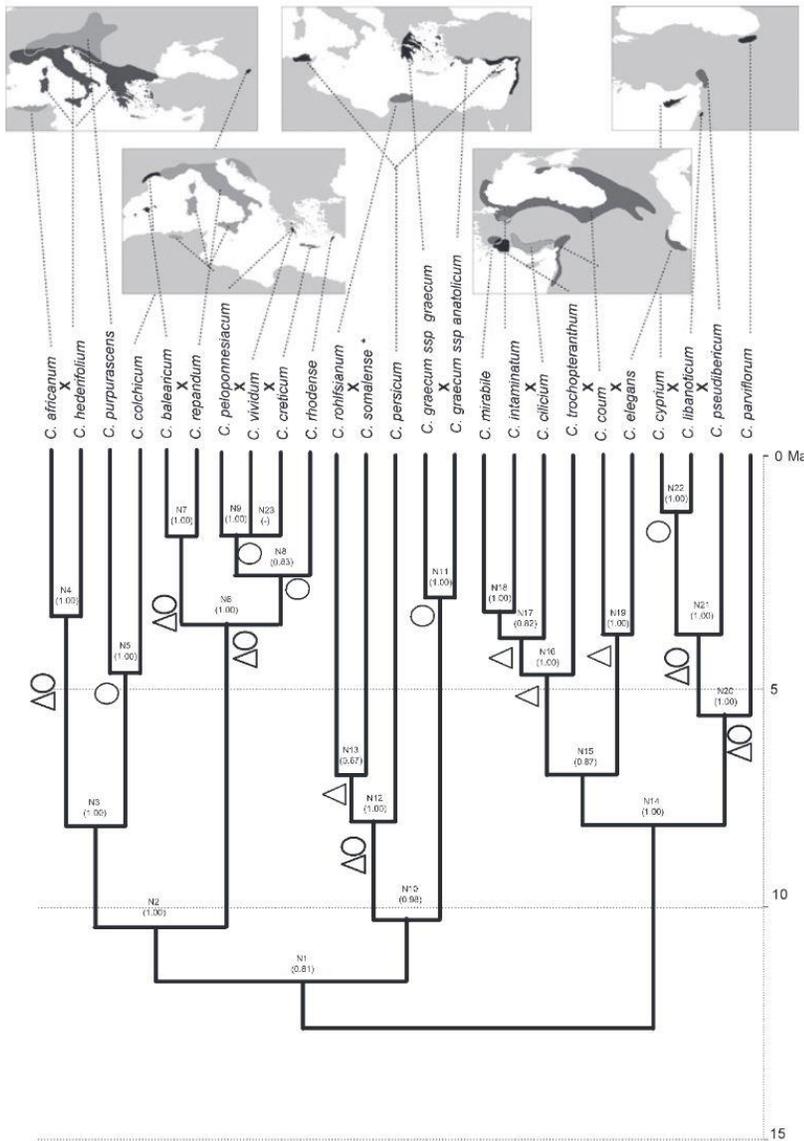
Phyloclimatic modelling of *Cyclamen* in Yesson, Toomey & Culham 2009 Journal of Biogeography

Training opportunities:
The student will have the opportunity to work in all three institutions and take advantage of the training offered in each one (e.g. phylogenetics and interpretation of climate models at Reading, GIS at IoZ) The RHS publishing and RHS shows are known internationally in horticulture and offer a globally recognized platform for communication of all science linked to horticulture. The RHS science team is a unique multidisciplinary group dealing with the science of horticulture who communicate with

ca.500000 members and through their website to a global public. It is expected the student will spend some of their CASE placement time with RHS outreach staff to develop skills in science journalism. There will be opportunities to visit field sites during the PhD through our extensive network of collaborators and through funding via the RHS bursary scheme.

Student profile:
An IT skilled, numerically and statistically literate biologist ideally with experience of data processing and computer modelling. Previous experience with phylogenetics and/or species distribution modelling is valuable.

Funding particulars:
This project is CASE funded.

References:
Könyves, K., Bilsborrow, J., David, J. and Culham, A. (2018) The complete chloroplast genome of Narcissus poeticus L. (Amaryllidaceae: Amaryllidoideae). Mitochondrial DNA Part B, 3 (2). pp. 1137-1138. ISSN 2380-2359 doi: https://doi.org/10.1080/23802359.2018.1521311

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