

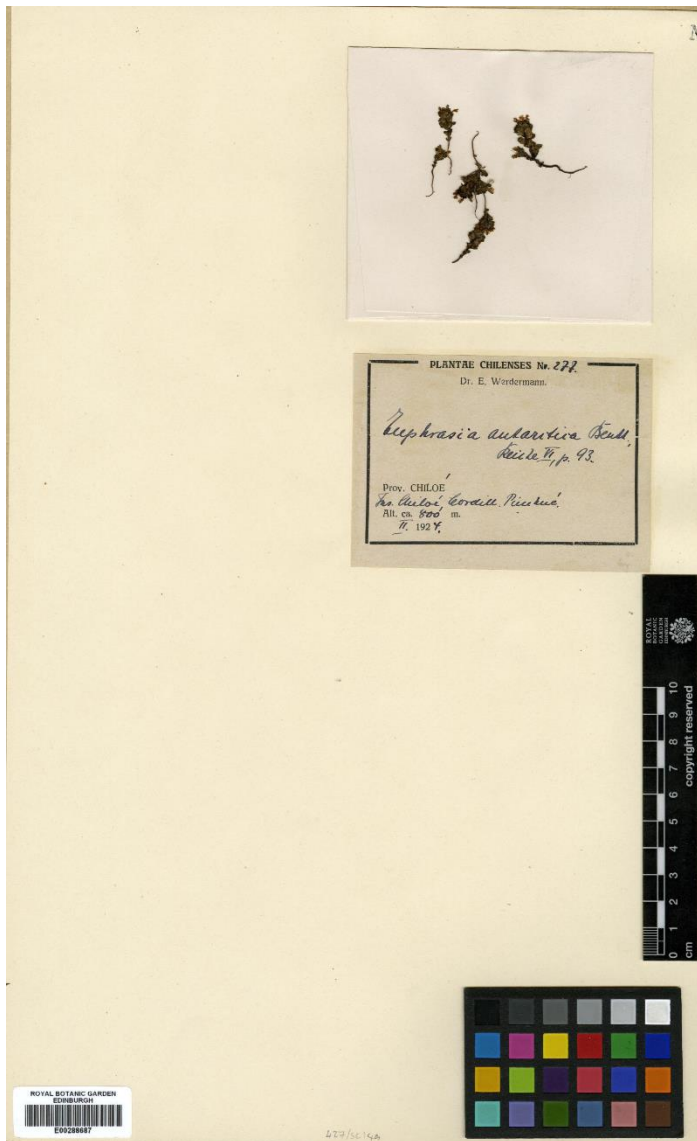
Genomics and the nature of species
differences in taxonomically complex
Euphrasia (Orobanchaceae)



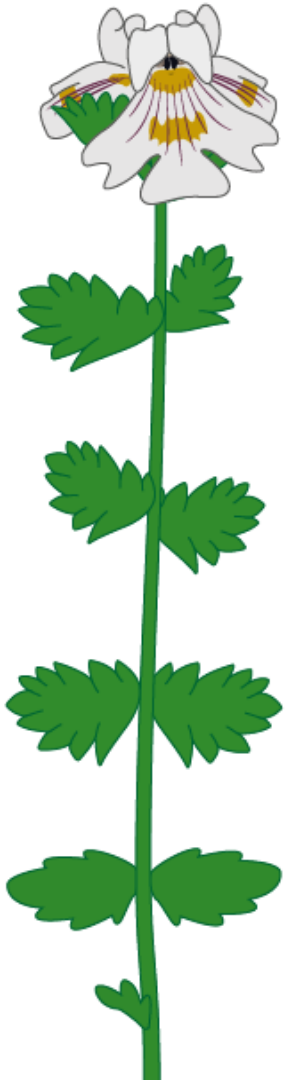
Alex Twyford



Euphrasia taxonomic complexity

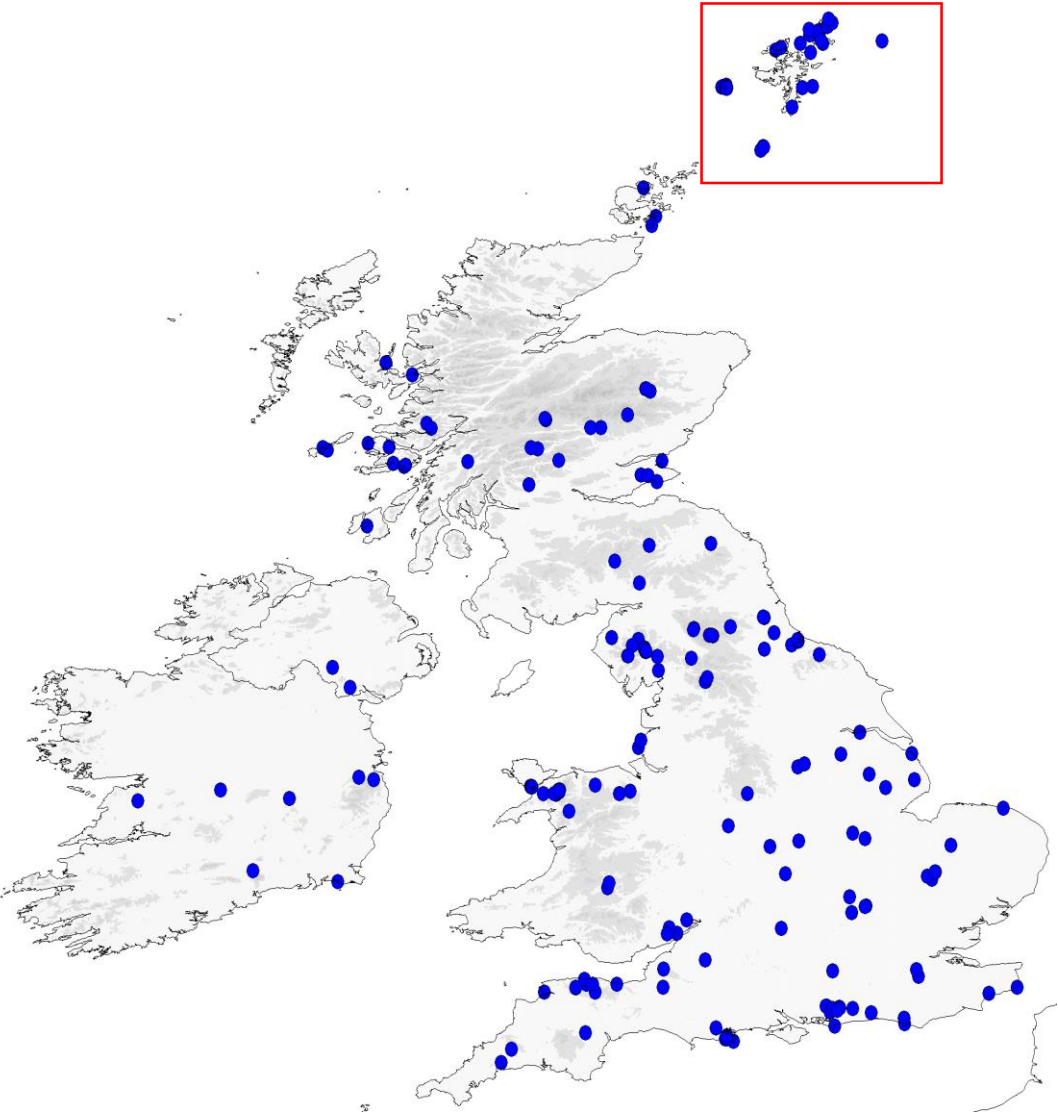


Euphrasia as an evolutionary study system



- Polyploidy
- Postglacial diversity
- Mating system
- Rampant hybridisation
- Parasitism

Britain and Ireland *Euphrasia* sampling





Fair Isle

A floristic survey of Fair Isle

C. V. Quinteros Peñafiel^{1*}, N. J. Riddiford² and A. D. Twyford³

¹Royal Botanic Garden Edinburgh, 20A Inverleith Row, Edinburgh EH3 5LR, UK

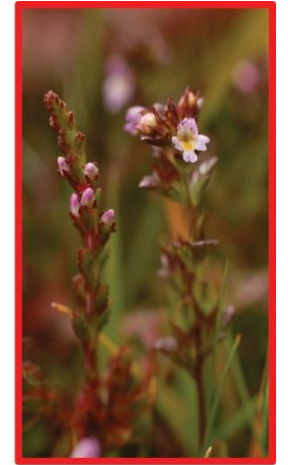
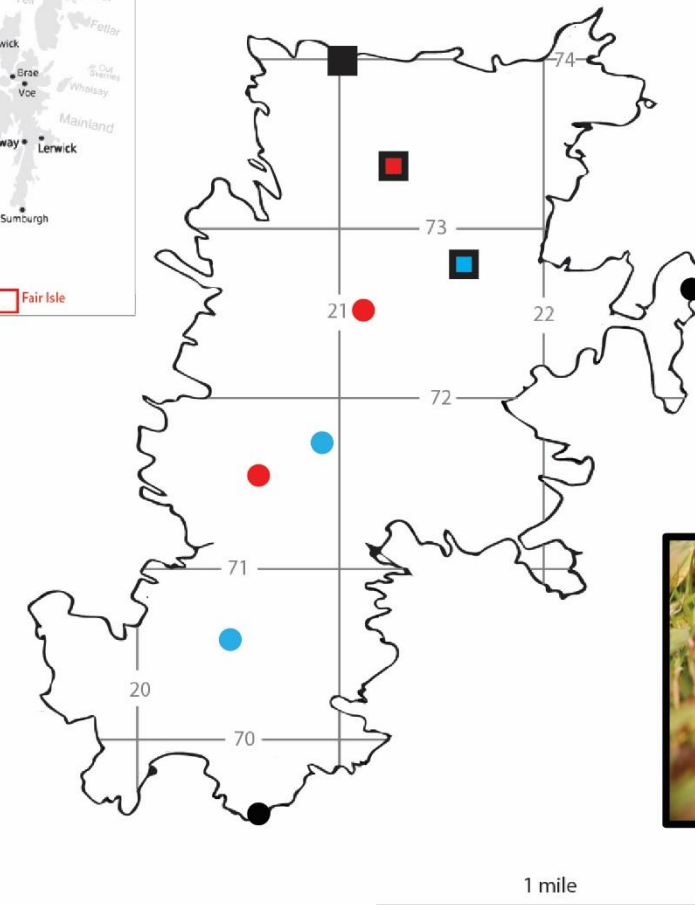
²Schoolton, Fair Isle, Shetland ZE2 9JU, UK

³Institute of Evolutionary Biology, The University of Edinburgh, Ashworth Laboratories, Charlotte Auerbach Road, Edinburgh EH9 3FL, UK

Fair Isle is a small isolated island located off the northern tip of Great Britain. Recognised internationally for rare migratory birds and important seabird colonies, the flora of Fair Isle has received far less attention. To rectify this, we present the first comprehensive floristic study of the island. A botanical survey was performed for each monad, and habitat information was collated following the NCC Phase 1 habitat survey method. These data were compiled to give a comprehensive checklist of 318 species, classified into 31 orders, 68 families and 191 genera according to APG IV. Of the total number of species, 255 are native to Great Britain and the remaining 63 are aliens. The list includes 10 species under threat, seven nationally scarce and one nationally rare species. Our results reveal that even though Fair Isle is about 200 times smaller than the full archipelago of Shetland, it holds over one-third the number of species. The island is also notable for its complex mosaic of habitats, which include a range of communities that are rare or under threat elsewhere in the British Isles. We provide a detailed commentary of island diversity, and recommendations for future monitoring to record changes in land-use and the effects of climate change.



Figure 2 Threatened species present on Fair Isle as classified by the Vascular Plant Red List (Cheffings et al., 2005): (A) *Coeloglossum viride* (VU), (B) *Gentianella campestris* (VU), (C) *Hymenophyllum wilsonii* (NT), (D) *Mertensia maritima* (NT), (E) *Radiola linoides* (NT).





Do narrow geographic collections of *Euphrasia* species show clear and reproducible trait differences?

Are trait differences maintained in a common garden environment?

Are there genetic differences between species?

Trait differences in the wild



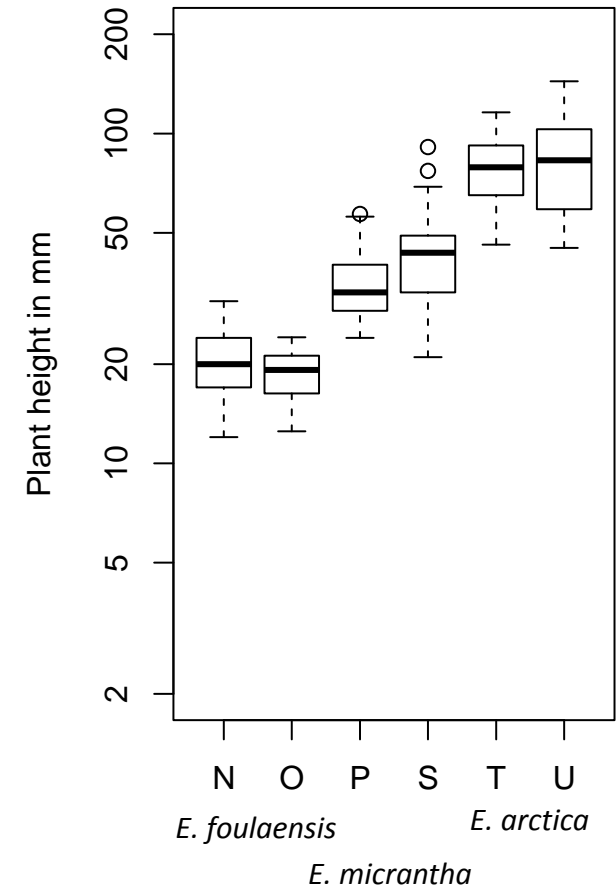
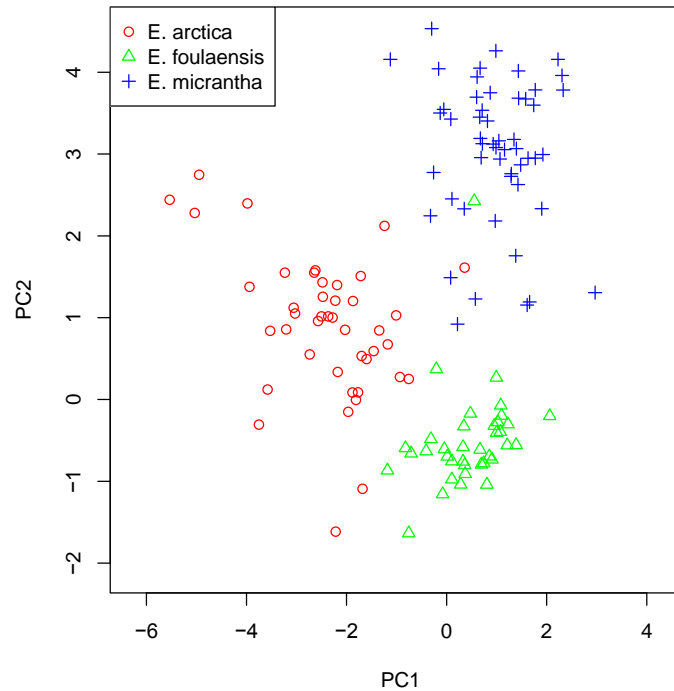
E. arctica



E. foulaensis



E. micrantha



Trait differences in a common garden



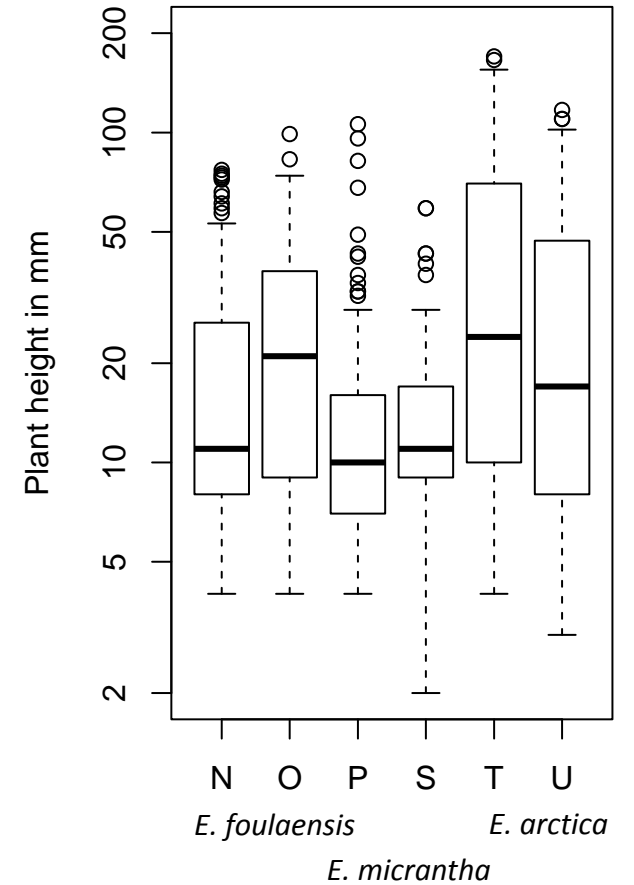
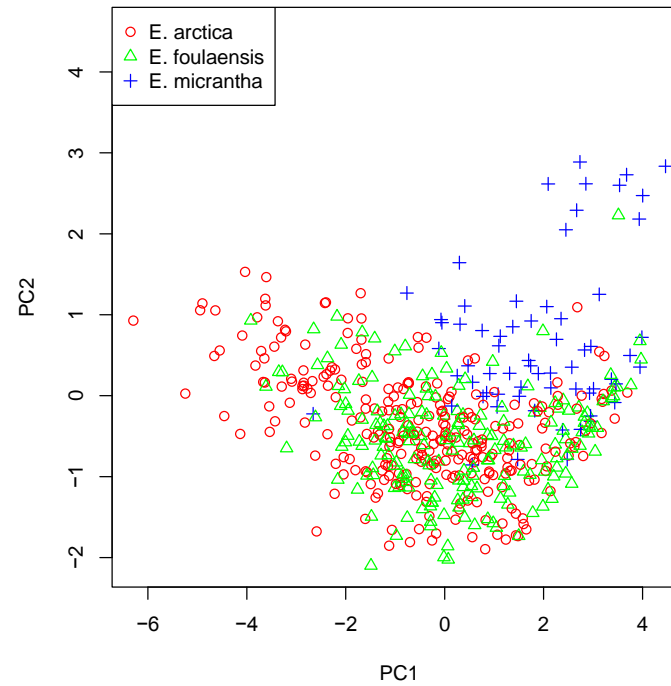
E. arctica



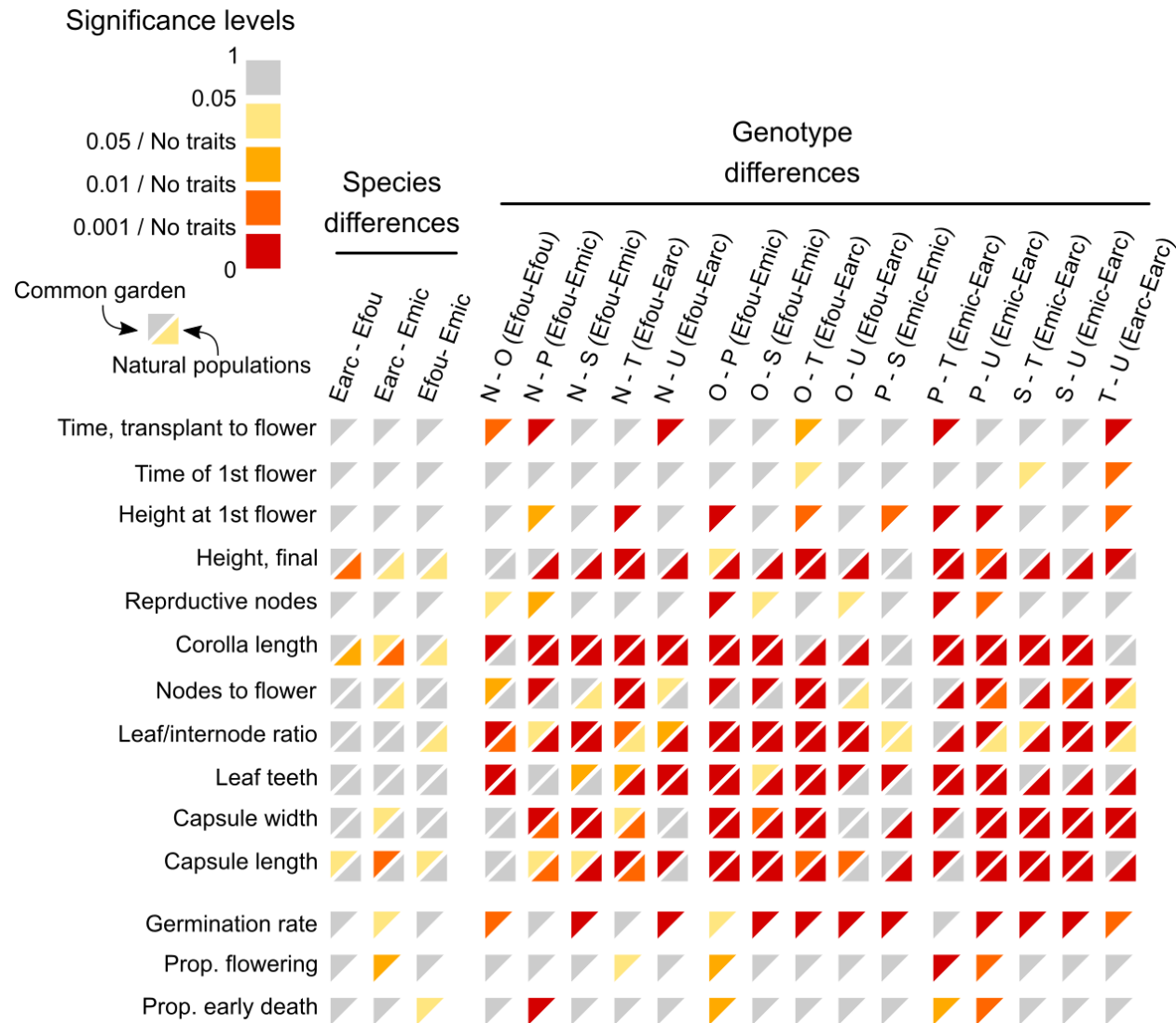
E. foulaensis



E. micrantha

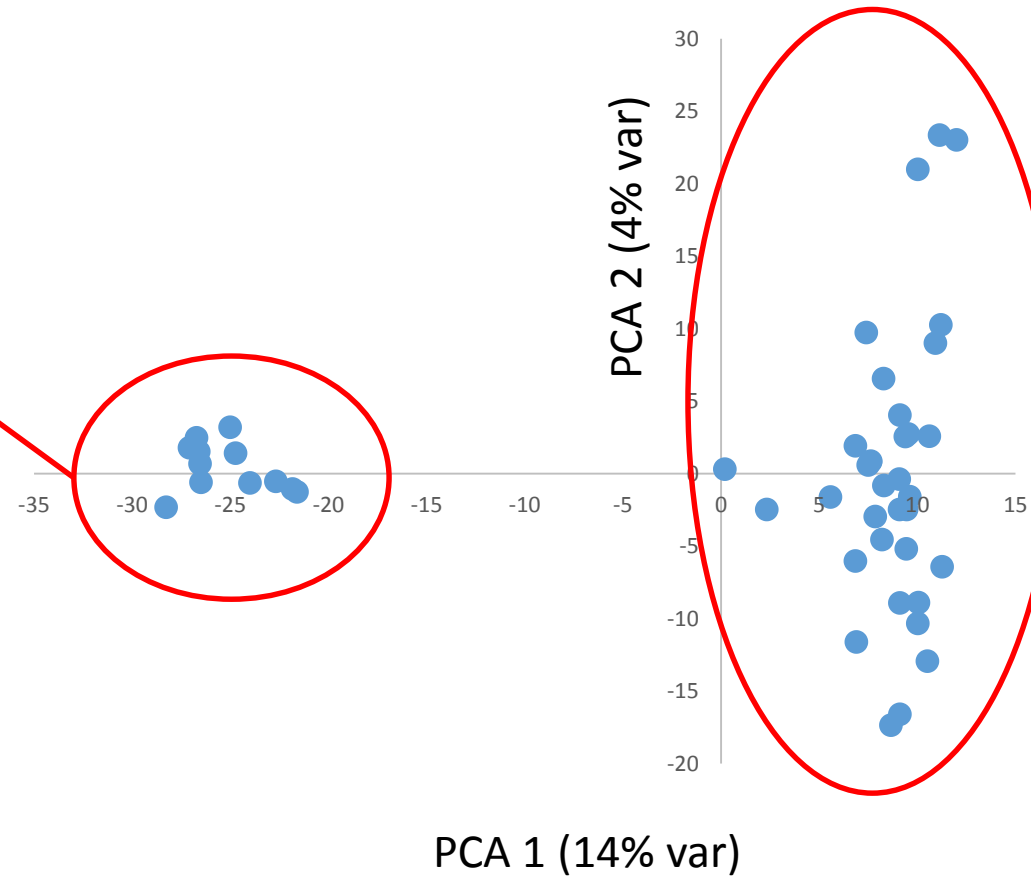


Few traits differ at the species level

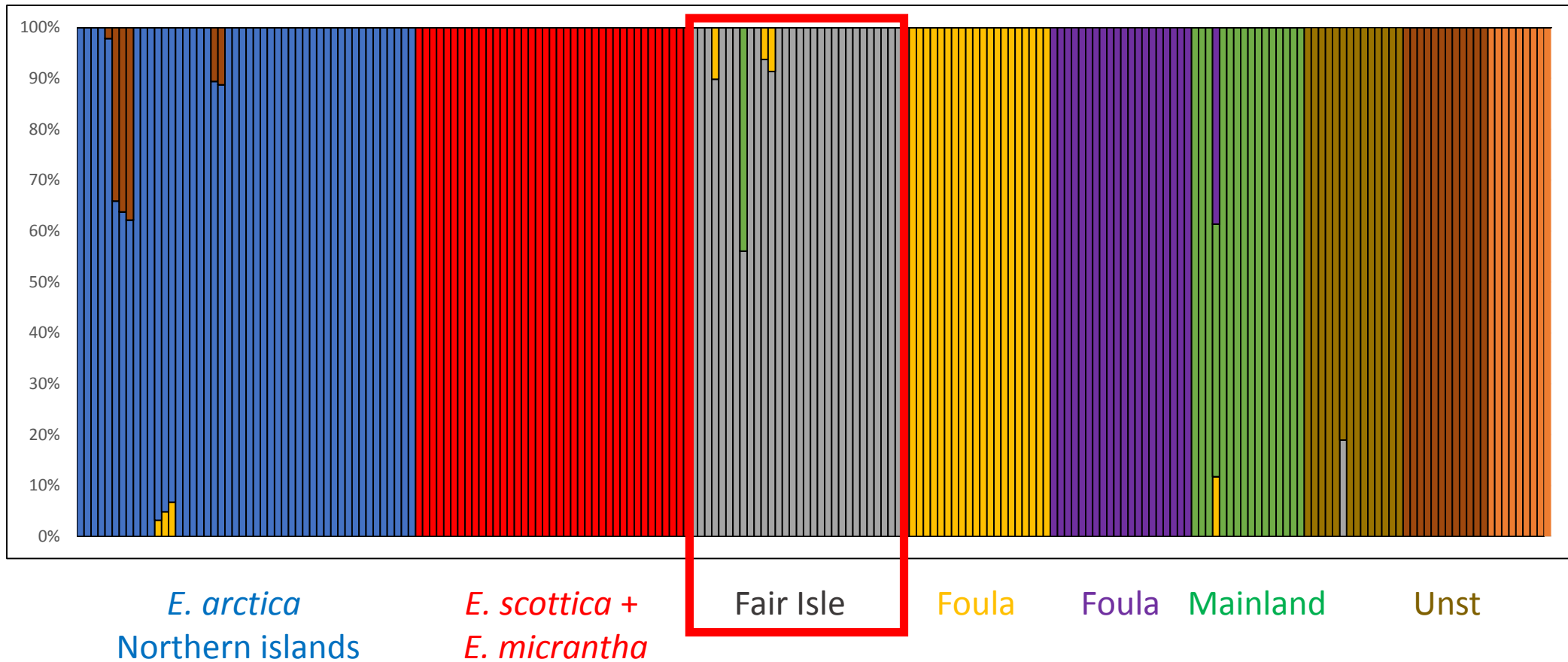


Genomic diversity in Shetland

40,000 SNPs generated with GBS

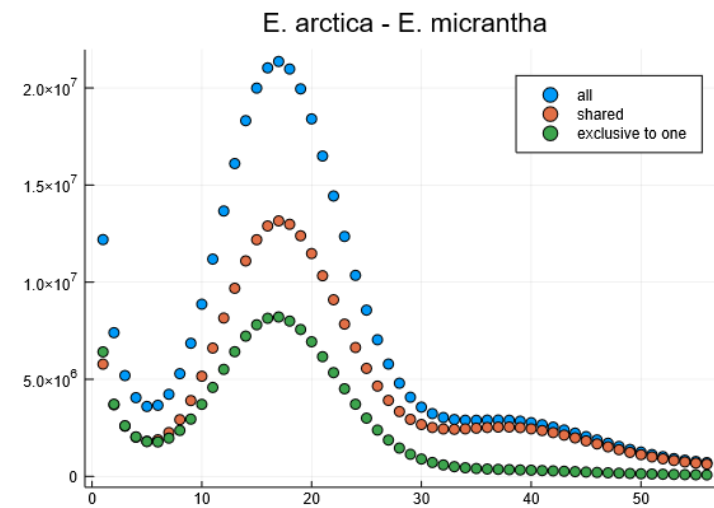
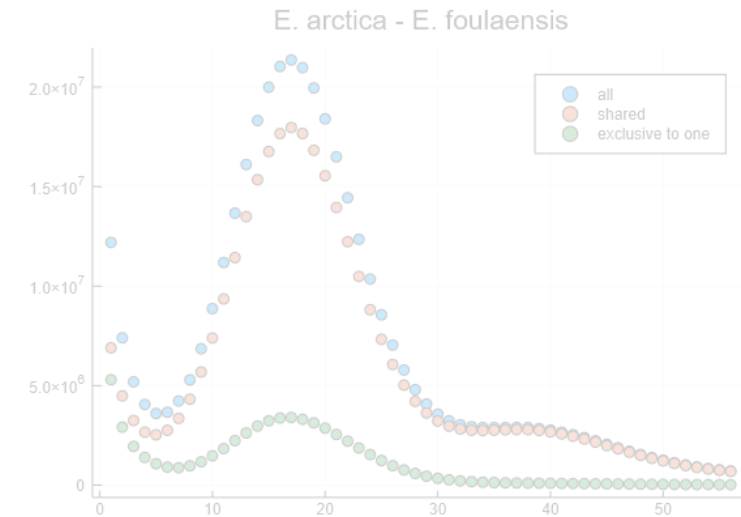
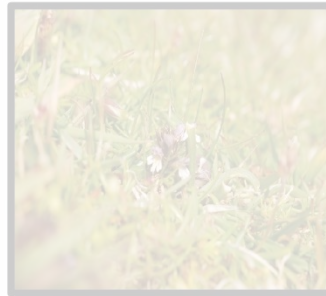
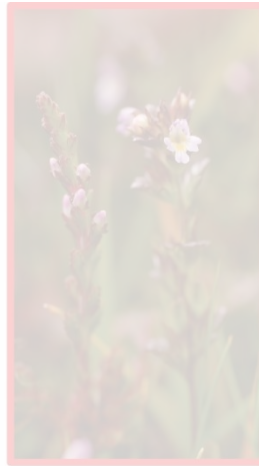


Genomic diversity in Shetland



Genome-wide signal reflects geography not species-level differences.
Near complete genomic homogenization on islands.

Genome sequencing & relatedness

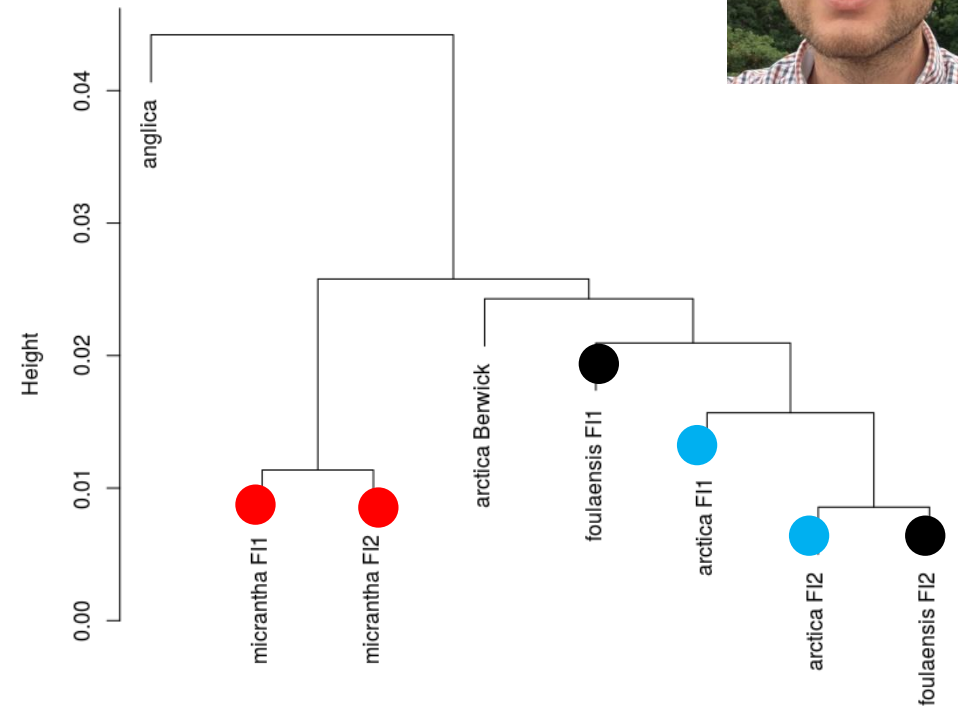


Genome sequencing & relatedness



1 mile

Cluster Dendrogram



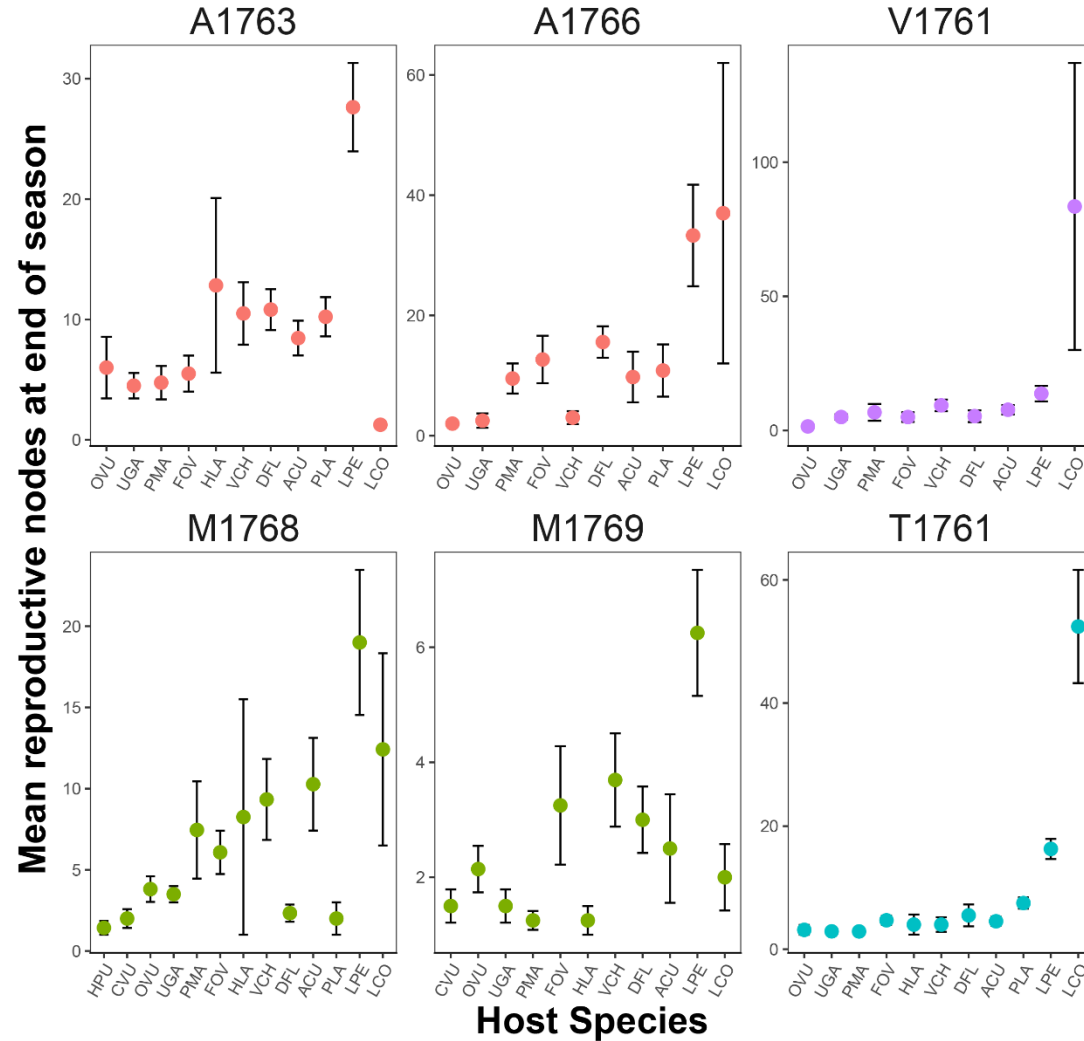
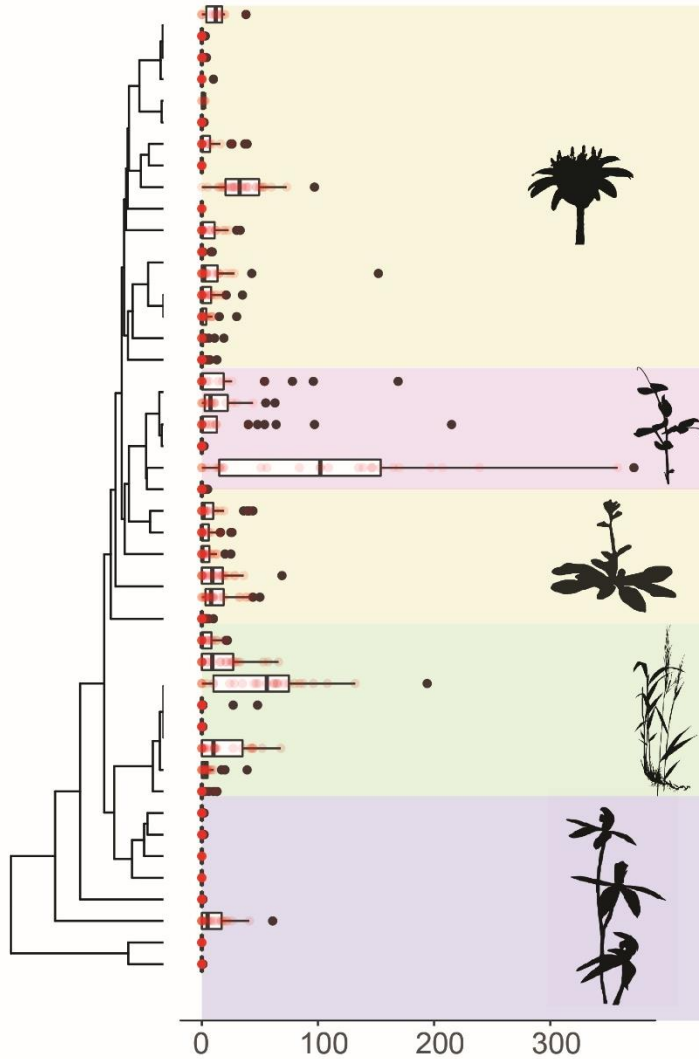
On the evolution of *Euphrasia* diversity

- *Euphrasia* species are characterised by a gradient of morphological and genomic differentiation, from indistinct to clearly different.
- New species from old genes?
- Inbreeding as a driver of population differences
- Parasitism as an evolutionary stimulus

Host-parasite interactions



Host-parasite interactions





Darwin Tree of Life Project: Plants

Initial 2-year project will collect 815 plant species and assemble 100 high quality plant genomes.

Vascular plants: Flowering plants, conifers, ferns (275)

Bryophytes: Mosses, liverworts, clubmosses (450)

Seaweeds (90|33)

PhD and postdoc positions available!



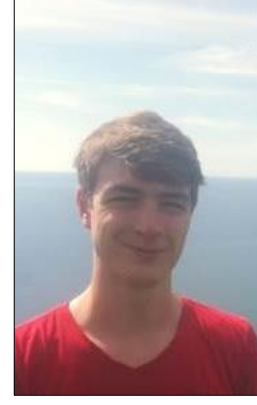
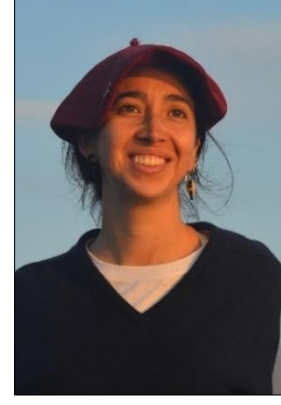
wellcome



Royal Botanic Garden Edinburgh



Thanks!



Some species are hard to tell apart...

