

# Impact of recurrent whole genome duplication on transcriptional plasticity under environmental changes in *Biscutella laevigata* (Brassicaceae)

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Whole genome duplication (WGD) events have happened regularly during plant evolution and are followed by the process of genome fractionation, whereby duplicated genes are either retained or lost over millions of years of evolution resulting in a novel diploid (i.e. mesopolyploid) genome. Although WGD events appear to correlate with periods of global environmental change, underpinnings remain elusive. One hypothesis posits that duplicated genetic material promotes survival under changing environments and thus predicts that favourable environment-responsive genes are preferentially retained as duplicates during genome fractionation. This PhD thesis addresses this hypothesis in the mesopolyploid *Biscutella laevigata* (Brassicaceae) as well as its recently duplicated derivatives *B. laevigata* subsp. *laevigata* and investigates how WGD and genome fractionation affect transcriptional plasticity in response to environmental changes.

Mesopolyploid *B. laevigata* were subjected to cold, heat, drought and herbivory treatments and an extensive transcriptomics analysis identified environment-responsive genes and their organisation in the transcriptional network. Using the first diploid genome assembly of *B. laevigata*, genes retained in duplicated pairs after the last *Biscutella* WGD ca. 11.5 MYA, were investigated for the mechanisms of their retention. Around 40% of retained duplicates presented an environmental response, highlighting environmental cues as an important driver of genome evolution. Transcriptional plasticity in response to environmental changes was often observed in one member of a retained duplicated gene pair, while the other presented constitutive expression. Therefore suggesting an indirect benefit of WGD events, whereby evolution of constitutive stress tolerance and transcriptional plasticity under environmental changes are supported by the retention of related duplicated gene pairs.

A field experiment spanning over two years and involving diploid (i.e. mesopolyploid) and tetraploid (i.e. following recent WGD) populations of *B. laevigata* from both lowland and alpine environments that were transplanted to common gardens in low (585 m), medium (1236 m) and high elevation (1967 m) to assess their transcriptional plasticity, phenotypic plasticity and fitness. Leaf transcriptomes collected after the first year evaluated to what extent transcription reflects past growth environments and suggested no difference in transcriptional plasticity between ploidy levels. Furthermore, no consistent differences of plasticity for phenotypic traits were observed between ploidy levels. A fitness advantage of tetraploid *B. laevigata* was observed at low elevation, but fitness between ploidy levels was similar in higher elevation sites.

Together the results of this work support a polyploid fitness advantage over diploids in some environments, which was not obviously related to differences in plasticity of the phenome and transcriptome. However, genome fractionation following WGD events induces re-organization of transcriptional plasticity and retains environment-responsive genes in duplicates, indicating cycles of WGD and subsequent fractionation provide adaptive fine-tuning of gene expression dosage.

## **Jury**

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