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Genetic and epigenetic divergence of duplicate genes in two legume species

*Chunming Xu**, Institute of Plant Breeding, Genetics and Genomics, University of Georgia, Georgia, USA
Kyung Do Kim, Institute of Plant Breeding, Genetics and Genomics, University of Georgia, Georgia, USA
Brian Nadon, Institute of Plant Breeding, Genetics and Genomics, University of Georgia, Georgia, USA
Scott Jackson, Institute of Plant Breeding, Genetics and Genomics, University of Georgia, Georgia, USA

Gene duplication, especially whole genome duplications (WGDs), have played an important role in plant genome evolution. Many questions remain about how duplicated gene copies evolve both genetically and epigenetically. The legume species soybean (*Glycine max*) and common bean (*Phaseolus vulgaris*) shared a polyploidy event ~59 MYA, followed by a *Glycine*-specific WGD event about 8-13 MYA. In both species, we classified genes into five categories: singletons, dispersed, proximal, tandem or WGD. We found strong correlations between gene types and some functional annotations (GO and Pfam). In both species, genes involved in transcriptional regulation were significantly over-retained within the WGD class, while the “photosynthesis” GO term was significantly over-represented in the singleton gene class, which fits predictions of the “gene balance hypothesis” and the “selected single copy gene hypothesis”. We also observed that the divergence of gene expression and DNA methylation between WGD paralog pairs increased with age in both species which may play into the “subfunctionalization hypothesis,” that is WGD genes initially retained via dosage constraints have since undergone subfunctionalization in which other factors (e.g. DNA methylation) may be involved. Genes from different duplication classes differed in breadth, levels and specificity of expression in both species. Singleton and WGD duplicated genes had clearly distinct expression patterns. However, singleton genes contrasted between the two species—singletons in soybean tended to be expressed in fewer organs, at lower levels, and with lower specificity than WGD genes, this contrasted to common bean as well as previous results in Arabidopsis. Gm (soybean)-specific genes represented 78% of singletons which showed distinct expression patterns from non-specific singletons. Tandemly duplicated genes showed contrasting characteristics than WGD genes in both species indicating that the two types of duplicates evolved in different ways.