

Trait variation across multiple biological scales in recalcitrant Fagaceae seeds

*O. Williams**, *N. Pradhan*, *L. Colville*

*Department of Trait Diversity and Function, Royal Botanic Gardens, Kew, Haywards Heath, RH17 6TN, UK,
O.Williams@kew.org

Keywords: temperate forest trees, recalcitrant species, seed traits, Fagaceae

Many temperate forest trees produce recalcitrant seeds that are desiccation-sensitive and pose challenges for long-term ex situ conservation. Traits such as seed structure and the distribution of water among seed tissues may influence how these seeds respond to drying and storage conditions. However, variation in these traits across recalcitrant species, trees, and individual seeds remains poorly documented.

Seed structural traits and moisture content were quantified in two genera of recalcitrant trees, *Quercus* (*Q. robur*, *Q. petraea*, *Q. rubra*, and *Q. ilex*) and *Castanea sativa*. Traits measured included whole seed mass, embryo mass, pericarp proportion, and moisture content of whole seeds and individual tissues (embryo, cotyledon and pericarp). Variation was examined across multiple biological levels, including among species, among trees within species, among individual seeds produced by the same tree, and among tissues within individual seeds. Differences and relationships among seed traits were assessed using non-parametric tests and correlation analyses.

Many seed traits differed across *Quercus* species, including embryo moisture content, embryo dry mass and pericarp proportion. For example, *Q. ilex* seeds had smaller embryos than the other *Quercus* species, while *Q. rubra* showed relatively higher pericarp proportions. Seed traits also varied among trees within species in both *Castanea sativa* and *Quercus robur*, and considerable variation was present among individual seeds produced by the same tree. Across both genera, moisture content differed among seed tissues, with embryos consistently containing more water than cotyledons and pericarps. Whole seed dry mass also increased with embryo dry mass, indicating coordinated scaling between seed and embryo size.

Overall, the results of this study show substantial variation in seed structure and moisture distribution across multiple biological levels in recalcitrant Fagaceae seeds. Characterising this variation provides a basis for exploring how seed traits relate to regeneration processes and broader patterns of seed ecology.