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REVIEW

From *Avicennia* to *Zizania*: Seed Recalcitrance in Perspective

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• *Background* Considered only in terms of tolerance of, or sensitivity to, desiccation (which is an oversimplification), orthodox seeds are those which tolerate dehydration and are storable in this condition, while highly recalcitrant seeds are damaged by loss of only a small proportion of water and are unstorable for practical purposes. Between these extremes, however, there may be a gradation of the responses to dehydration – and also to other factors – suggesting perhaps that seed behaviour might be best considered as constituting a continuum subtended by extreme orthodoxy and the highest degree of recalcitrance. As the characteristics of seeds of an increasing number of species are elucidated, non-orthodox seed behaviour is emerging as considerably more commonplace – and its basis far more complex – than previously suspected.
• *Scope* Whatever the post-harvest responses of seeds of individual species may be, they are the outcome of the properties of pre-shedding development, and a full understanding of the subtleties of various degrees of non-orthodox behaviour must await the identification of, and interaction among, all the factors conferring extreme orthodoxy. Appreciation of the phenomenon of recalcitrance is confounded by intra- and interseasonal variability across species, as well as within individual species. However, recent evidence suggests that provenance is a pivotal factor in determining the degree of recalcitrant behaviour exhibited by seeds of individual species. Non-orthodox – and, in particular, recalcitrant – seed behaviour is not merely a matter of desiccation sensitivity: the primary basis is that the seeds are actively metabolic when they are shed, in contrast to orthodox types which are quiescent. This affects all aspects of the handling and storage of recalcitrant seeds. In the short to medium term, recalcitrant seeds should be stored in as hydrated a condition as when they are shed, and at the lowest temperature not diminishing vigour or viability. Such hydrated storage has attendant problems of fungal proliferation which, unless minimized, will inevitably and significantly affect seed quality. The life span of seeds in hydrated storage even under the best conditions is variable among species, but is curtailed (days to months), and various approaches attempting to extend non-orthodox seed longevity are discussed. Conservation of the genetic resources by means other than seed storage is then briefly considered, with detail on the potential for, and difficulties with, cryostorage highlighted.
• *Conclusions* There appears to be little taxonomic relationship among species exhibiting the phenomenon of seed recalcitrance, suggesting that it is a derived trait, with tolerance having been lost a number of times. Although recalcitrant seededness is best represented in the mesic tropics, particularly among rainforest climax species, it does occur in cooler, drier and markedly seasonal habitats. The selective advantages of the trait are considered.

Key words: Cryostorage, desiccation sensitivity, ecology, evolution, genetic resources, hydrated storage, metabolic activity, mycoflora, recalcitrant seeds.