

Preface and Acknowledgments

Crabapple is the umbrella term for plants from the genus *Malus* (Rosaceae) that have a small fruit diameter. These plants have important ornamental value, deep cultural heritage, strong environmental adaptability, and widespread applications. Crabapples, peonies, plum flowers, and orchids have been termed as the four great spring blossoms and have the reputation of national glamour, national flower, national soul, and national scent, respectively. Crabapples not only have colorful and charming blossoms (purple, red, pink, and white), but many crabapple cultivars also have fruits of ornamental value (purple, red, pink, orange, yellow, and green). During autumn and winter, the fruits of these cultivars adorn the trees and do not wither for many months. This presents an aesthetically pleasing sight for people and often attracts various bird species.

China is the center of origin for crabapples, which have a wide geographical distribution and exhibit great morphological variation. China also has a crabapple cultivation and utilization history of more than 2000 years. However, the most commonly cultivated ornamental crabapple germplasm is limited to a few species, such as *M. halliana*, *M. micromalus*, and *M. hupehensis*, and many precious crabapple germplasm resources are not fully exploited and utilized. The species of crabapples originated in Europe and North America are comparatively few. China's crabapples spread to North America before 1780 and into Europe by the eighteenth century, where they were highly valued. Through introduction, selective breeding, hybridization, and other cultivation techniques, multiple crabapple cultivars with ornamental properties relating to the foliage, fruit, flowers, and tree shape have been cultivated. This has resulted in more than 100 cultivars, of which several dozen are widely used in North America and Europe. However, crabapple germplasms exhibit complex diversity, and the amount of varieties and cultivars is increasing. Many cultivars emerged by selective breeding or were accidentally discovered, and thus, their genetic background and phylogenetic relationships are unclear.

Plant pollen carries large amounts of genetic information, and the phenotypic traits exhibit species-specific characteristics. These traits are the product of long-term evolutionary processes and are often used to determine the genetic origin and

evolution and also inform taxonomic studies. Classical palynological research is mainly based on the three main features of pollen, including morphology, exine ornamentation, and the germination organs. Of these three features, pollen exine ornamentation characteristics are the most complex, as the associated research method is mainly descriptive in nature and thus direct quantitation is difficult. The main content of this book originates from the research findings of the Ornamental Crabapple Research Laboratory of Nanjing Forestry University and details the three dimensions of crabapple pollen morphology and its evolution, pollen exine ornamentation and its evolution, and anatomical observations of pollen developmental patterns. The second chapter of this book utilizes the interval distribution function of the pollen characteristic parameters to elucidate the genetic evolutionary trend of crabapple pollen. The third chapter of this book is based on pollen ornamentation arrangement patterns. Three crucial variables were extracted (presence or absence of pollen exine ornamentation arrangement regularity, X_i ; size of the regular arrangement range, Y_i ; quantity of the arrangement patterns, Z_i) to construct a binary trivariate data matrix ($X_i Y_i Z_i$). This was combined with a weight assignment method to convert the matrix data into decimal data, which were then used to evaluate the regularity of pollen ornamentation and coalesce the qualitative and quantitative analyses. It was also used to elucidate the evolutionary trends of the regularity of crabapple germplasm pollen ornamentation. The results of this study provide a reference for future taxonomic investigations in the *Malus*.

Thirty-six natural species of *Malus* have been classified according to the three classical taxonomic systems (Li, Reder, and Yu), which are generally consistent with the grouping. There are 107 crabapple germplasms in this book (including 26 species and 81 cultivars). Even though this is relatively representative, the sample size could still be further expanded. We will fully demonstrate the advantages in the national crabapple germplasm genetic database platform of Nanjing Forestry University continuing the electron micrograph measurements of further crabapple germplasms, which should then facilitate more systematic and comprehensive genetic studies on crabapple pollen. This will provide a theoretical basis for the classification of crabapple germplasms and tests for Distinctness, Uniformity, and Stability (DUS).

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We encourage readers to engage with us if they feel that any aspects of this book are lacking.

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