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Self- and cross-incompatibility systems
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13.1 INTRODUCTION

Sexual incompatibility is a widespread phenomenon in flowering plants which restricts inbreeding within populations (self-incompatibility: SI) and also seems to contribute, through the establishment of unilateral barriers between self-incompatible and self-compatible populations, to the reinforcement of speciation (unilateral incompatibility: UI). Darwin and Mather (1949) estimated that half the species in angiosperms display SI; the generalization of the rule proposed by Lewis and Crowe (1958) that SI \times SC species are cross-incompatible would imply that UI operates, on average, in more than one interspecific pollination out of four.

The occurrence of self-incompatibility in many genera which contribute to agriculture and its influence upon plant breeding strategies explain why so much is known to date on its classification and inheritance (Fig. 13.1) and on its distribution (Table 13.1). ‘Sporophytic incompatibility’, in which the incompatibility phenotype in the pollen is determined by the genotype of the pollen producing plant, occurs abundantly in the Cruciferae and the Compositae and has been particularly well studied in the genus Brassica. In certain species, sporophytic incompatibility is associated with floral polymorphism which reinforces the outbreeding potential of the self-incompatible plant. ‘Gametophytic incompatibility’, where the genotype of the individual microspore determines the phenotype of the pollen, is typical of the Leguminosae and the Solanaceae (monofactorial control), the Graminae (bifactorial) and the Chenopodiaceae and Ranunculaceae (polyfactorial). Gametophytic incompatibility is characterized by very large polyallelic series at the locus which govern the pollen-pistil relationship. On the other hand, the difficulty in elucidating the molecular biology of the complex, interrelating, cellular and subcellular structures operating in anthers, pollen, stigmata and styles accounts for our relative lack of knowledge on the products of incompatibility genes, the nature of the recognition and rejection mechanisms and a possible relationship between the biochemical control of SI and that of UI.

It is the purpose of the present Chapter to describe the modifications of sexual incompatibility systems, which are possible in the current state of knowledge, and to discuss briefly the plant breeding achievements and innovations which could result from further progress in our understanding of sexual incompatibility.

13.2 ELIMINATION OF THE SELF-INCOMPATIBILITY BARRIERS

Different types of manipulations can be exerted by man on sexual incompatibility. Some of
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Fig. 13.1. Classification and inheritance of self-incompatibility in the angiosperms. *Complemented in certain species by genes which are gametophytic in action (Lewis et al., 1988). Major exception, the grasses where pollen is trinucleate and SI is stigmatic and gametophytic.

13.2.1 Physiological inhibition

The breakdown of self-incompatibility can be obtained, in several families of plants, through the pollination of buds which do not express the incompatibility phenotype of the mature flower or by means of inhibitors (high temperature, radiations or chemicals preventing RNA or protein syntheses) applied before pollination to the site of the reaction (stigma or style). Such effects are remarkable, from a theoretical point of view, because they contribute to the evidence suggesting that SI does not result from the absence of a stimulation of pollen growth between unlike gene products in pollen and style but from a rejection reaction between like gene products which can be prevented by inhibitors of metabolic activity (for a discussion see Lewis, 1979).

The physiological inhibition of SI is also important for plant breeding because it can be extensively exploited for the creation of the S-homozygous lines needed for F₁-hybrid seed production. Lewis (1949) has provided a summary-outline of the method and of its current applications for the exploitation of hybrid vigour through the production of double-