8.1 Natural Polyploidy and Its Adaptive Value in *Festuca*

The fact that a large proportion of the grass species are natural polyploids clearly shows the importance of polyploidy in evolution. Of the different types of polyploids, allopolyploids are preponderant in nature because they enjoy the benefits of polyploidy and hybridity and, hence, are better adapted to diverse climatic conditions. The allopolyploids have enzyme diversity coded by related genes in different parental genomes. This biochemical versatility is believed to contribute to their selective advantage and fitness (see Gottlieb 1973; Adams and Allard 1977). Increased levels of enzyme production, probably stemming from dosage effects of the genes in the homoeologous sets of chromosomes in the allopolyploids, may also result in greater photosynthetic rates of higher polyploids in the same taxon. For example, Randall et al. (1977) found that a decaploid ($2n = 10x = 70$) *Festuca arundinacea* clone had higher net photosynthetic rate than the ten hexaploid ($2n = 6x = 42$) clones tested. The ribulose 1,5-bisphosphate carboxylase activity in the decaploid was 1.3 to 2 times higher than that of a hexaploid selected from the cultivar Kentucky 31, suggesting that an altered genetic expression of this enzyme led to increased CO$_2$ exchange rate in the former. Increases in ploidy level are reported to quantitatively alter photosynthesis-related properties in several other species (e.g., Setter et al. 1978) (however, see also Sect. 8.4.5).

The genus *Festuca* is particularly characterized by the preponderance of polyploid taxa. Intraspecific ploidy is also of frequent occurrence (Levitskii and Kuzmina 1927; Stählin 1929). Most of these are allopolyploids with diploid-like pairing. Examples of taxa constituting a polyploid series are:

- *F. pratensis* Huds. ($2n = 2x = 14$)
- *F. apennina* De Not. [= *F. pratensis* var. *apennina* (De Not.) Hack.] ($2n = 4x = 28$)
- *F. scariosa* Asch. & Graeb. ($2n = 2x = 14$)
- *F. mairei* St. Yves ($2n = 4x = 28$)
- *F. arundinacea* Schreb. ($2n = 6x = 42$)
- *F. arundinacea* var. *atlantigena* forma *pseudo-mairei* Lit. and Maire ($2n = 8x = 56$)
- *F. arundinacea* var. *letourneuxiana* St. Yves ($2n = 10x = 70$)
8.2 Absence of Natural Polyploidy in Lolium

In nature, polyploidy is common in most genera of the grass family. The genus Lolium is, however, an exception in this regard, all its species being diploids with $2n = 14$ chromosomes. Occasionally, a tetraploid may be observed as a spontaneous twin seedling (Sulinsowski et al. 1982).

Although polyploid species are preponderant in the genus Festuca, its ally Lolium is devoid of polyploid members in nature. This is a riddle from the evolutionary standpoint. Most, if not all, species of these genera are sexual. I feel strongly that polyploidy and sexuality cannot coexist in the same taxon without a regulator of chromosome pairing (Jauhar 1975e). The absence of polyploidy in the genus Lolium is probably due to the fact that genetic control of chromosome pairing has not developed in this group. Although some specific genotypes of Lolium species may have pairing suppressor or pairing promoter genes (see Sect. 4.4.2), there is considerable homoeologous pairing in diploid hybrids and their amphidiploids (Sect. 11.9).

Since the species of Lolium are closely related, diploid-like pairing in their amphidiploids will probably not be achieved without a genetic diploidizing mechanism of the type present in hexaploid tall fescue. An alternative means of achieving meiotic stability of the amphidiploids will be to have a genetically controlled, regular disjunction of multivalents, so that balanced gametes are formed. This is, however, hard to achieve (see Sect. 8.7.1). On the other hand, the genetic control of diploid-like chromosome pairing confers on the polyploid species of Festuca stable meiosis and disomic inheritance. Thus, Festuca has the benefits of polyploidy and hybridity, and has become a...