Homoeologous recombination in 2*n*-gametes producing interspecific hybrids of *Lilium* (Liliaceae) studied by genomic in situ hybridization (GISH)

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Abstract: Interspecific hybridization of *Lilium longiflorum* (L) with Asiatic (A) lily hybrids results in so-called LA-hybrids. Some of these hybrids produce 2*n*-pollen, which were used to perform crosses on Asiatic and Oriental (O) hybrids, resulting in ALA- and OLA-hybrids. Recombination between homoeologous chromosomes (introgression) and the mechanism of 2*n*-pollen formation in these hybrids were studied using genomic in situ hybridization (GISH). A clear differentiation between the chromosomes of *L. longiflorum,* Asiatic, and Oriental hybrids was observed in four ALA- and one OLA-hybrid using GISH. Two ALA-hybrids showed 3 and 5 recombinant chromosomes with a total of 5 and 10 crossover sites per hybrid, respectively. These occurred at random positions on the chromosomes. The number and the location of the rDNA-sites were determined using in situ hybridization and provided a tool, the FISH-marker, for identifying the NOR-bearing chromosomes in the lily hybrids. Evidence for the occurrence of the FDR-mechanism (first division restitution) of 2*n*-pollen formation in the LA-hybrids was obtained on the basis of absence of homologous chromosomes of *L. longiflorum* in the ALA- and OLA-hybrids.

Key words: *Lilium longiflorum*, introgression, FDR, interspecific hybridization, FISH.

Résumé : Des hybridations interspécifiques entre le *Lilium longiflorum* (L) et des lys hybrides asiatiques (A) produisent des hybrides LA. Certains de ces hybrides produisent du pollen 2*n* et ceux-ci ont été croisés à des hybrides asiatiques ou orientaux (O) pour produire des hybrides ALA et OLA. L'hybridation génomique in situ (GISH) a été utilisée pour étudier la recombinaison entre chromosomes homéologues (introgression) et le mécanisme de production de pollen 2*n* chez ces hybrides. Une nette différenciation des chromosomes du *L. longiflorum* ainsi que des hybrides asiatiques et orientaux a pu être faite chez les hybrides ALA et OLA grâce à la technique GISH. Deux hybrides ALA ont montré trois et cinq chromosomes recombinants avec un total de cinq et dix sites d'enjambement par hybride, respectivement. Ceux-ci sont survenus à des positions aléatoires sur les chromosomes. Le nombre et l'emplacement des sites d'ADNr ont été déterminés par hybridation in situ et constituent un marqueur FISH permettant d'identifier les chromosomes portant les organisateurs nucléolaires chez les lys hybrides. Des évidences d'un mécanisme de type FDR (restitution à la première division) à l'origine de la formation du pollen 2*n* ont été obtenues sur la base de l'absence de chromosomes homologues du *L. longiflorum* chez les hybrides ALA et OLA.

Mots clés : *Lillium longiflorum*, introgression, FDR, hybridation interspécifique, FISH.

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Introduction

Lilium longiflorum Thunb. ($2n = 2x = 24$) is an important species for flower production and acts as a parent in interspecific hybridization programs (Asano 1980; Beattie and White 1993; Van Creij et al. 1993). For successful interspecific hybridization in *Lilium,* pre- and post-fertilisation barriers can be overcome by the use of various in vitro pollination and embryo rescue techniques (Van Tuyl et al. 1991). Wide interspecific crosses between *L. longiflorum* and the Asiatic hybrid group of *Lilium,* result mainly in F1-hybrids which are sterile due to a lack of chromosome pairing during meiosis. Somatic chromosome doubling can induce homologous pairing and restore fertility, and is one way to overcome the F1-sterility problem (Van Tuyl and De Jeu 1997). Another way is through the use of 2*n*-gametes (Hermsen 1984; Veilleux 1985). Although rarely formed in interspecific *Lilium* hybrids they are found in some cross combinations (Van Tuyl et al. 1989*a*). However, little is known about the mode of 2*n*-gametes formation in lily hybrids. The use of 2*n*-gametes for the lily breeding would be useful for designing efficient breeding strategies. The value of 2*n*-gametes is the effect on introgression of characters from dip-

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