The Transmission of Rye B Chromosomes in Natural Pollination

M. J. PUERTA$ and J. R. LACADENA

Departamento de Genética, Facultad de Biología, Universidad Complutense, Madrid (Spain)

Summary. This paper examines the transmission of B chromosomes in natural (but controlled) pollination, in order to obtain results which can be applied to natural populations of rye. The frequencies of the female gametes in both $2n = 14 + 1$ and $2n = 14 + 2$ rye plants have been estimated with reference to their chromatid constitution. From the results obtained on the offspring, it seems that preferential distribution takes place during female meiosis of $2n = 14 + 2$ plants. It has been demonstrated that pollen carrying B chromosomes formed in plants of $2n = 14 + 2$ was more competitive than normal pollen. On the contrary, when it was formed from plants $2n = 14 + 1$, B chromosome elimination by pollen was total. This process may be considered as sporophytic determination. The genetic significance of the presence of B chromosomes in natural populations is discussed. It is proposed that B chromosomes may be the cytological expression of a complex evolutionary system which results in conservation of population genetic variability.

Introduction

The cytological behaviour of rye B chromosomes during somatic mitosis, meiosis and pollen mitosis has been extensively studied (Kishikawa, 1965; Müntzing, 1966, 1967). However, in the experiments investigating the transmission of B chromosomes the crosses have been manually made. In this paper the transmission of B chromosomes in natural (but controlled) pollination is examined, in order to obtain results which could be applied to natural populations of rye.

Material and Methods

Secale cereale L. var. Caribou was used. Chromosome counts were made on root-tips pretreated in cold water ($0 - 2^\circ$C) for 24 hours and fixed in Farmer's solution (1:3). The root-tips were then hydrolyzed in 1N HCl at 60 $^\circ$C for 12 minutes and stained with fuchsin.

Fertilization was carried out under natural conditions. Groups of plants with determined chromosome constitutions were isolated, so that open pollination between plants of the same group was allowed but the participation of alien pollen excluded. In these crosses almost complete allogamy can be assumed, as rye is characterized by a strong system of incompatibility (Lundqvist, 1956, 1958). Therefore seeds harvested from each plant are formed by their own egg-cells and pollen from other plants of the same pollination group.

Chromosome counts of the offspring were made. Using previous descriptions of meiosis and pollen mitosis, it was possible to deduce the competitive ability of the pollen carrying different numbers of B chromosomes in natural pollination. In addition, the behaviour on the female side was deduced from the offspring obtained.

Results

Table 1 shows the pollination groups under study. In every case, B chromosomes were of the standard type.

In Table 2 the chromosome controls of the offspring obtained from the crosses involving normal and 1 B chromosome rye plants are reported.
with each other (certation), it was not possible to deduce, as in the previous case, the cytological behaviour of the B chromosome present in the male side. A greater tendency for B chromosome conservation on the male side than on the female side was observed.

c) Combinations \( \varphi 14 \times \delta \left\{ \begin{array}{l} 14 \\
                    14 + 1 \\
\end{array} \right\} \) and \( \varphi 14 + 1 \times \delta \left\{ \begin{array}{l} 14 \\
                    14 + 1 \\
\end{array} \right\} \) (Table 3).

In the combination \( \varphi 14 \times \delta \) only plants lacking B chromosomes were harvested from the \( 2n = 14 \) parent. So B chromosome elimination by pollen was total. Therefore, it might be assumed that when pollen from \( 2n = 14 \) and \( 2n = 14 + 1 \) plants is in competition, only normal pollen is fertile; thus, B chromosomes are being transmitted exclusively by the female side. This is further confirmed as the offspring obtained from the combination \( \varphi 14 + 1 \times \delta 14 \) (see first row in Table 3) was similar to that from the combination \( \varphi 14 + 1 \times \delta 14 + 1 \) (3rd row, Table 3). On the other hand, when the plant \( 2n = 14 + 1 \) was not in competition, the pollen carrying B chromosomes was fertile, as shown in the combinations \( \varphi 14 \times \delta 14 + 1 \) 2nd row Table 3) and \( \varphi 14 + 1 \times \delta 14 + 1 \) (5th row Table 3).

In Table 4 the chromosome controls of the offspring obtained from the crosses involving normal and 1 B-chromosome rye plants are reported. The same type of combination could be found several times in the same or different pollination groups (see asterisks in Table 4). Therefore, the percentages of every chromosome constitution of the offspring can be recorded as weighted percentages of the same combination (Table 5).

d) Combination \( \varphi 14 + 2 \times \delta 14 \) (Table 5). The frequencies obtained in the offspring could be attributed to the cytological behaviour of B chromosomes during female gametogenesis. This assumption agrees with that indicated in the combination \( \varphi 14 + 1 \times \delta 14 \). Since no plants \( 2n = 14 + 1 \) were obtained, it can be deduced that gametes carrying 1 B chromosome are not formed in the megasporogenesis.