

## 5A染色体の長腕の部分欠失に基づくTriticum aestivum L. のスペルトイド抑制遺伝子の染色体マッピング

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## Chromosome mapping of a speltoid suppression gene of *Triticum aestivum* L. based on partial deletions in the long arm of chromosome 5A

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### ABSTRACT

Speltoid mutants, which have slender spikes, were found in the offspring of a cross, euploid common wheat, *Triticum aestivum* cv. 'Chinese Spring' (♀) × an alien addition line of Chinese Spring having the long arm of an *Aegilops longissima* chromosome. With the offspring of three of these speltoid mutants, chromosome mapping was conducted for a speltoid suppression gene *Q* of common wheat. The C-banding study demonstrated that the speltoid character was always associated with partial deletions in the long arm of chromosome 5A. The abnormal 5A with the least deletion retained the intercalary C-band which was located at about 54 per cent of the long arm from the centromere. Therefore, it was properly decided that the *Q* gene was situated somewhere in the distal 46 per cent region of the 5A long arm.

### 1. INTRODUCTION

Aneuploid stocks, monosomics, nullisomics, nullitetrasomics, and telosomics of common wheat (*Triticum aestivum*) enable us to allocate many genes cytogenetically to specific chromosomes and, in most cases, to specific arms (Sears, 1954, 1978). Although genetic distances of the genes from the centromere can be worked out by the use of the telocentrics to make chromosome maps, it is not an easy task, requiring a large amount of cytological work. If partial chromosome deletions between the centromere and telomere become available, some genes could directly be mapped to the deleted regions by cytological means. Using a spontaneous deletion, Kota and Dvořák (1986) mapped a chromosome pairing gene and 5S rRNA genes to the short arm of chromosome 5B. Recently some alien chromosomes in common wheat were found to induce high frequencies of chromosome mutations, such as deletion and translocation (Endo, 1985, 1988a, 1988b; Tsujimoto and Tsunewaki, 1985).

They are chromosomes derived from *Aegilops* species that have been known as gametocidal chromosomes: When one of them is present in common wheat, gametes lacking the alien chromosome become nonfunctional, and the *Aegilops*

chromosome is transmitted selectively to the offspring (Maan, 1975; Endo, 1979; Endo and Tsunewaki, 1975). The gametocidal chromosome of *Ae. longissima*, or of *Ae. sharonensis*, causes chromosome mutations at a high frequency in the early embryogenesis of zygotes of common wheat, when it is transmitted through pollen to the zygotes. The gametocidal chromosome of *Ae. cylindrica*, or of *Ae. triuncialis*, loses its gametocidal action in a specific common wheat cultivar ('Chinese Spring' for the *Ae. cylindrica* chromosome, and 'Norin 26' for the *Ae. triuncialis* chromosome), and instead induces chromosome mutations in the gametes that lack the alien chromosome.

This study was planned to present an instance of the chromosome mapping based on genetically induced partial chromosome deletions. As an exemplar gene, the gene *Q* of common wheat was chosen. This gene is responsible for speltoid suppression and the squarehead of spikes, namely, preventing spikes from becoming slender like those of *T. spelta* (MacKey, 1954). The *Q* gene is only partially dominant in the common wheat cultivar 'Chinese Spring' and therefore the spikes become speltoid under the hemizygous condition (Sears, 1954). Speltoid mutants used in this study were those found in the offspring of an alien addition line of common wheat with a chromosome of *Aegilops longissima*, one of the chromosomes known to induce chromosome mutations in common wheat (Endo, 1985).

## 2. MATERIALS AND METHODS

The original alien addition line had the intact chromosome of *Aegilops longissima* S. & M. ( $2n=14$ , genome formula  $S^1S^1$ ) (Maan, 1975). However, during being backcrossed to *Triticum aestivum* L. em. Thell. cv. Chinese Spring ( $2n=42$ , AABBDD) (more than ten times) by the present authors, this line lost the short arm of the alien chromosome (Fig. 1). The telosome was exclusively transmitted



Fig. 1. The intact (left) and the long arm telocentric (right) chromosomes of *Ae. longissima*, both of which cause chromosome mutations in common wheat.

to the offspring through both egg cells and pollen. This alien telosome addition line was crossed as male on to euploid Chinese Spring. Speltoid mutants were occasionally found among the  $F_1$  plants (6 out of 69). On the other hand, no speltoid mutant was found in the offspring of the same alien line, self-pollinated or backcrossed (68 and 42 plants were examined, respectively). Three of these speltoid mutants, one of which was a chimeral plant with speltoid and normal (non-speltoid) spikes (Fig. 2), were selected, together with 5  $F_1$  plants that had normal spikes, for the subsequent cytogenetical study.

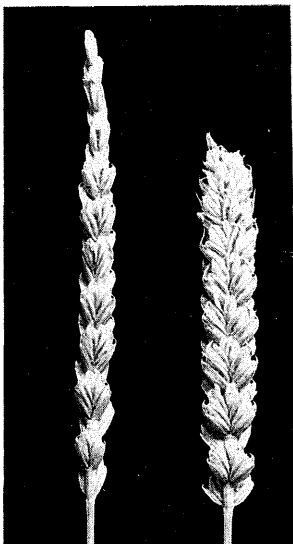


Fig. 2. Spikes of the chimeral plant. Left, speltoid; right, normal or non-speltoid.

Somatic chromosomes of the offspring, self-pollinated or backcrossed with euploid Chinese Spring, of the speltoid, chimeral (both types of spikes were used), and normal-spike-bearing plants were examined by C-banding, with special attention to chromosome 5A, and then the spike type of the offspring was studied. The C-banding was conducted following the procedure reported by Endo (1986).

### 3. RESULTS AND DISCUSSION

For each of the offspring derived from the 5 plants bearing normal spikes and from a normal spike of the chimera, 6 to 11 plants were cytologically examined. No abnormality was found in their chromosome 5A. This suggests that the normal spikes of the parental plants had a normal pair of 5A.

The offspring from the speltoid mutants and a speltoid spike of the chimera segregated into the plants having a normal pair of 5A and those having a structural change in the long arm of 5A. This indicated the presence of the abnormal 5A in the original speltoid spike. The chromosome structural changes

were two types of deletion and one translocation in the long arm (Fig. 3), and the offspring from the same spike had the same abnormal 5A. Out of a total of 75 plants examined, 15 had one abnormal 5A and bore speltoid spikes without exception; all the rest carrying a normal pair of 5A had normal spikes. This indicates a strong correlation between the speltoid character and the deficiency in the 5A long arm. Miller and Reader (1982) also reported that 'Chinese Spring' plants with a major deletion of the long arm of chromosome 5A always exhibited the speltoid phenotype.

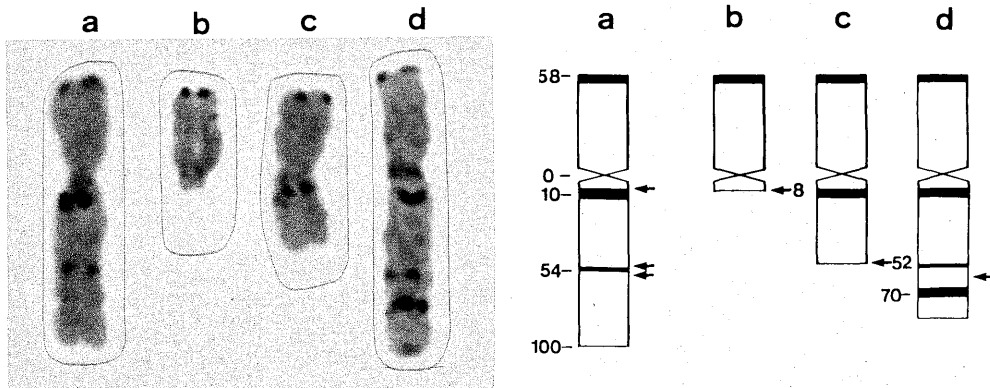


Fig. 3. Photographs and diagrams of the C-banded normal chromosome 5A (a), two deleted 5As (b, c), and a translocated 5A (d). The diagrams were drawn on the basis of the measurements of ten C-banded chromosomes for each chromosome. Arrows indicate the breakpoints. The figures stand for the relative distances from the centromere; they were calculated on the basis of the proportion to the length of the short arm.

The normal chromosome 5A has a faint intercalary C-band in the long arm 54 per cent of its length from the centromere. The translocated 5A (Fig. 3d) also had a faint intercalary band in a very similar position to that of the normal 5A's intercalary band. Besides, a gap, where a chromosome break had possibly been occurred, was sometimes observed just below the intercalary band of the translocated 5A. Therefore, it is safely concluded that the *Q* gene should be situated somewhere in the distal 46 per cent region of the long arm. This gene locus will be further narrowed down when smaller deletions in the 5A long arm become available.

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