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Genetic diversity among Plantagos

17. A novel trisomic in *Plantago lagopus*

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Summary. In the progenies of the crosses between disomics and trisomics, two plants were isolated which carried an extra chromosome that was unlike any in the standard complement. The plants were not alike; while one carried a metacentric, the other had a telocentric extra chromosome. Their detailed structure and possible modes of origin are discussed.

Key words: Extra chromosome – Trisomics – *Plantago lagopus* – Telotrisomics

Introduction

Utility of trisomics in mapping chromosomes and determining linkage groups is well documented (Burnham 1962; Khush 1973). The trisomics are of varied types; Khush (1973) has recognized as many as 14 types. Recently, more types have been described (Pantulu and Rao 1981; Sai Kumar et al. 1982; Tsuchiya 1983; Sapre and Barve 1986). The present communication adds one more type to this list.

In *Plantago lagopus* (n = 6) primary trisomics for five chromosomes, out of the six possible, have been raised in this laboratory (Sharma and Koul 1984; Bhan 1986; Bhan et al. 1989). Because of the small size of chromosomes and very little constitutive heterochromatin, banding techniques have not helped in the identification of individual chromosomes. Pachytene analysis helps, but it is time-consuming and laborious (Dhar 1988). For purposes of chromosome identification, detection of structural changes and evaluation of the nature of trisomy, somatic prometaphase was found more useful in this species.

Materials and methods

The plants of *P. lagopus* were raised in the University Botanic Garden, from seed harvested in 1988. Root tips were excised from plants uprooted temporarily. These were pretreated with 0.002 *M* 8-hydroxy quinoline for 5 h and fixed in a mixture of 3 parts ethyl alcohol : 1 part acetic acid. The root tips were stained through the conventional Feulgen staining procedure and squashed in a drop of acetocarmine.

For meiotic studies, young inflorescences were fixed in a mixture of chloroform, ethyl alcohol and acetic acid (4:3:1), supplemented with a pinch of ferric acetate. The spikes were fixed for 24 h, washed and stored in 70% ethanol. Anthers from freshly fixed buds were squashed in 1% acetocarmine.

Results and discussion

From the progenies of various crosses between disomics (2n = 12) and trisomics (2n = 12 + 1), a few individuals were recovered which carried an additional chromosome that did not match any in the standard complement. The additional chromosomes present in different progeny plants are not alike in morphology. Two types exist: one had median and the other terminal centromere. Both have a satellite at one end and are smaller in size than the smallest chromosome of the standard complement. All chromosomes, including the two types of extras, are readily identifiable at somatic prometa- and metaphase (Fig. 1). Table 1 presents the relative size of the extra chromosomes at prometaphase and metaphase stages of root-tip mitosis.

During prophase-I of the PMC meiosis, the meta- as well as telocentric extra chromosomes pair with two of the four nucleolar chromosomes and form trivalents. The trivalent stays attached to the nucleolus in 86.6% PMCs in the metacentric chromosome-bearing plants (Fig. 2a) and in 84.6% cells in the telocentric chromosome-

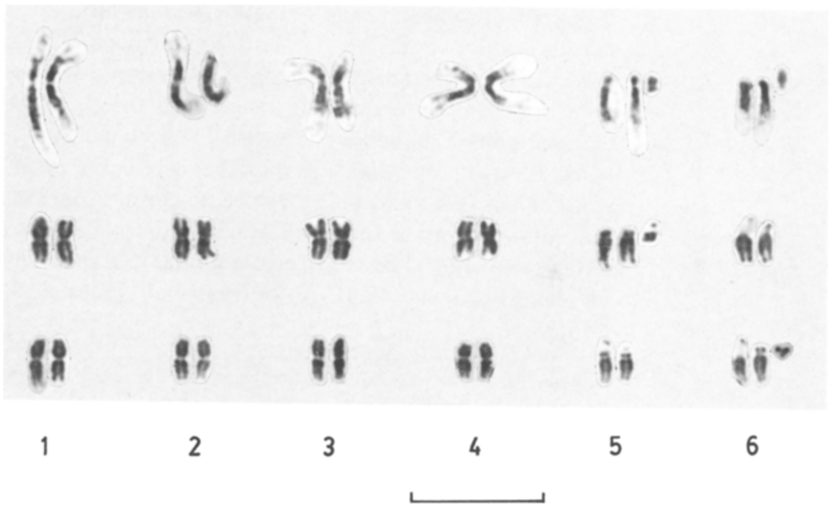

Fig. 1. Prometaphase and metaphase karyotypes of meta- and telotrisomic individuals; scale = 10 μm

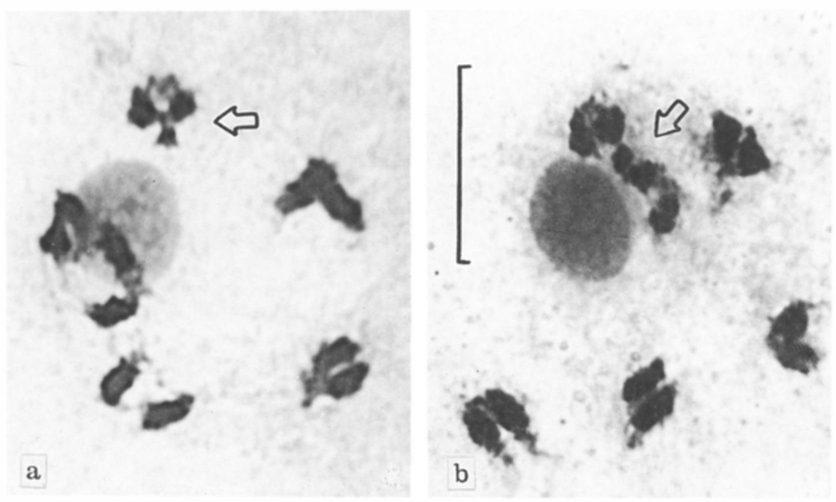

Fig. 2a and b. Meiotic prophase of meta- (**a**) and telotrisomic (**b**) individuals; scale = 10 μm

Table 1. Relative size of extra chromosomes at two stages of mitotic division

Stage of nuclear division	Length of nucleolar (μ) chromosome		Length of metacentric extra chromosome (μ)		Length of telocentric extra chromosome (μ)	
	5th	6th	Total	Relative[a]	Total	Relative[b]
Prometaphase	7.69	6.92	1.15	14.95%	1.53	22.10%
Metaphase	2.50	2.30	0.69	27.60%	0.96	41.73%

[a] Length of the extra chromosome in relation to nucleolar chromosome no. 5

[b] Length of the extra chromosome in relation to nucleolar chromosome no. 6

bearing individuals (Fig. 2b). These chromosomes occur in all cells, tissues and organs of respective individuals, and their number is always one per complement. Addition of either of the two extra chromosomes induces no change in plant phenotype and fertility. In this respect they behave like the primary trisomics of the species.

Taking clues from their morphology and behaviour during meiosis, these plants represent partial trisomics for the NOR-bearing segment of one or both of the nucleolar chromosomes. The metacentric extra chromosome seems to have originated from chromosome number 5 of the standard complement through a break in the

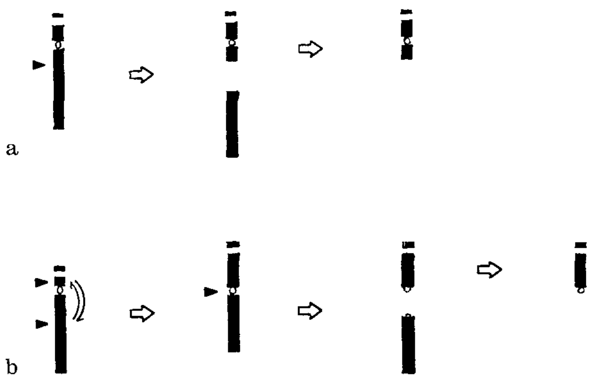

Fig. 3. Line drawing indicating the probable modes of origin of meta- (**a**) and telocentric (**b**) extra chromosome

long arm, close to the centromere (Fig. 3a). In size it represents only 27.6% of the length of nucleolar chromosome (Table 1) at metaphase. Individuals where the extra chromosome is metacentric are termed metatrisomics (Tsuchiya 1983), and the extra chromosome is designated meta $5S^{5L}$.

The origin of an acrocentric extra chromosome in sugar beet (Romagosa et al. 1985) and barley (Shahla and Tsuchiya 1986) has been explained the same way.

The origin of the telocentric extra chromosome cannot be explained on the basis of a single break. This chromosome is longer in size than the short arm of both nucleolar chromosomes, nos. 5 and 6. Its derivation from chromosome 6 has been confirmed by crossing the telocentric extra chromosome-bearing plant (12+t) with triplo-6. In the progeny an individual was recovered which carried the telocentric as well as chromosome 6, in addition to the standard complement ($12+1+t$). During PMC meiosis, the telocentric chromosome paired with the additional chromosome 6, suggesting their homology.

Keeping the present evidence in mind, one feels inclined to suggest a two-step mechanism for the origin of the telocentric chromosome. A pericentric inversion in chromosome 6 causes an increase in the size of the short arm and is followed by misdivision (Fig. 3b). That such a process has really taken place is substantiated by the recovery in a sister disomic plant of a structurally altered nucleolar chromosome having a larger short arm.

Burnham (1962) has defined telotrisomics as "individuals in which the extra chromosome is a telocentric fragment chromosome homologous to one arm of a chromosome pair in the standard complement." Since the extra chromosome recovered in the present case does not fit the above definition, a new term needs to be coined to name the individuals carrying such a chromosome. It is proposed that such individuals be called inversion telotrisomics and that the specific chromosome involved in trisomy be indicated as 6S.6L (inv.). Tsuchiya and his coworkers have recovered a similar case in barley involving telosome 4S.4L (inv.) (personal communication).

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