

MEIOTIC CHROMOSOME CONFIGURATIONS IN *RHOEO SPATHACEA* (SWARTZ) STEARN.

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Abstract

Rhoeo spathacea exhibits uncommon and unique chromosomal configurations at diakinesis and metaphase I in the form of rings or chains. Chain configurations range from a chain of two to twelve chromosomes with every intermediate size in one, two or three groups. A chain of twelve chromosomes was the common configuration than ring. In the case of two chains per cell highest frequency (10.71%) was observed with 7+5 chromosomes and lowest (4.28%) with 10+2 configuration. Different configurations of three chains per cell were found in 0.7-4.28% cells. However by comparisons of chromosome configurations in *R. spathacea* studied by different workers significant variations were observed. These variations could be due to the use of different clones of *Rhoeo* or to different horticultural environments.

Introduction

Rhoeo spathacea (Swartz) Stearn. (Syn. *Rhoeo discolor* Hance) is characterized by chromosome structural hybridity to such an extent that any two chromosomes in the diploid plant are not genetically identical. It is one of the best known examples as complex interchange heterozygotes are capable of forming a complete ring of all chromosomes during meiosis rather than bivalents (Lin & Paddock, 1973b). The characteristic ring of twelve chromosomes in *Rhoeo* has been interpreted (Belling, 1927) as having resulted from extensive reciprocal translocation. The two arms of each chromosome synapse respectively, with an arm of each of two other chromosomes. The morphological position of each chromosome in the ring is always the same. Lin & Paddock (1973a) have confirmed Sax's (1931) map of the morphological sequence of chromosomes around the ring. Darlington (1929a & b) interpreted the ring in *Rhoeo* on his segmental interchange hypothesis which was confirmed by Desai (1965) who suggested that the pairing between different chromosomes was dependent upon the establishment of chiasmata in homologous parts of different chromosomes which establish a chain. According to Lin & Paddock (1973b) the failure of synapsis is the cause of chain formation rather than the loss of terminal chiasmata. The terminal localization of chiasmata could be simply a matter of genetic control of chiasma formation in *Rhoeo*. The present investigation was undertaken with a view to analyze the behavior of chromosome configuration during meiosis in locally available cultivars of *R. spathacea*.

Materials and Methods

Chromosomal associations were studied in PMCs of diploid *R. spathacea*. After removal of bracts and scales buds were fixed in Carnoy's solution (3 Ethanol:1 Acetic acid) for about 24 hours. Slides were prepared by routine squash technique using 1% acetocarmine and then they were made permanent in Canada balsam. Photomicro-

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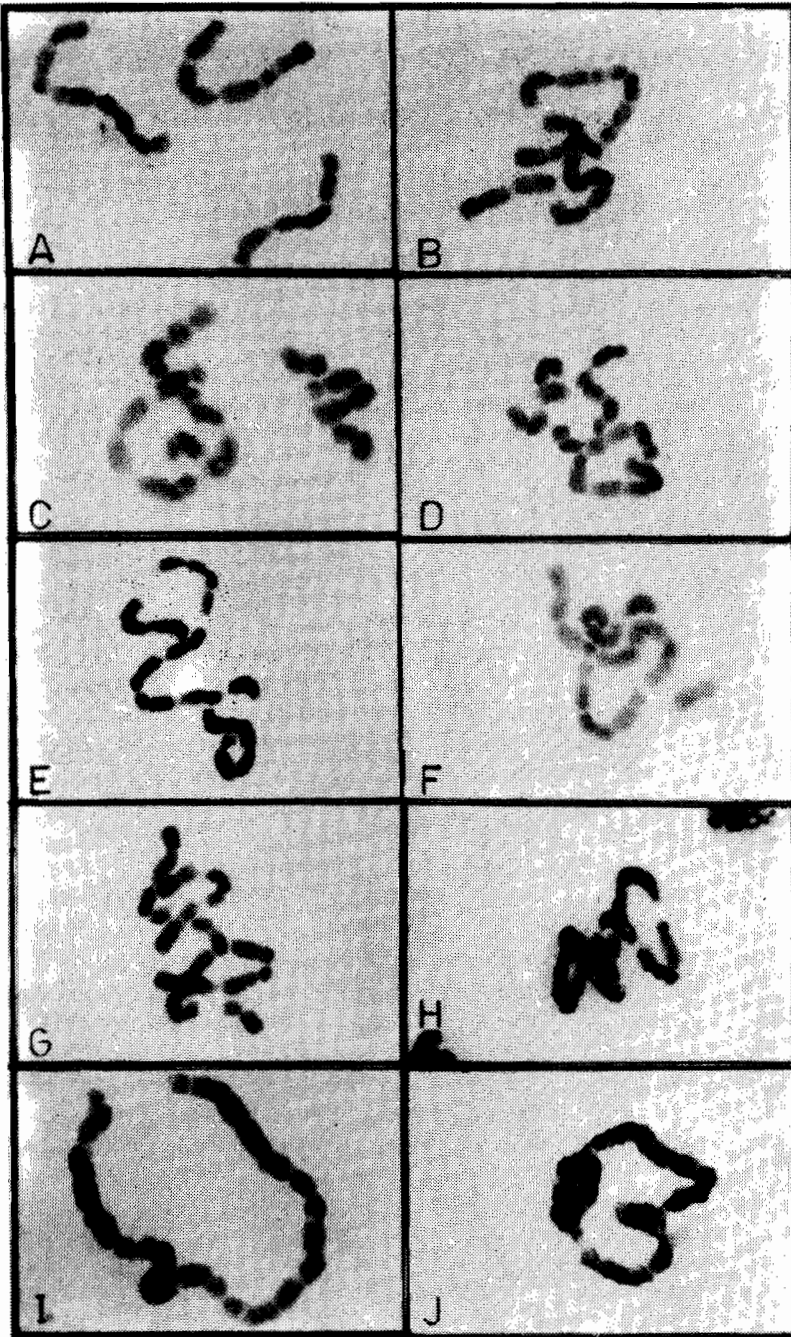


Fig.1. Meiotic chromosomal configurations of *Rhoeo spathacea* showing one to three groups of chain formation: A=5+4+3, B=6+4+2, C=8+4, D=9+3, E=10+2, F=11+1, G-I=12+0, J=Ring of twelve chromosomes.

graphs were taken from permanent preparations. Chromosome configurations were determined from the data collected from 500 well spread PMCs at M-I.

Results and Discussion

Data on chromosome configurations at M-I (Fig.1 A-J, Table 1) was compared with that of Lin & Paddock (1973b). These ranged from a chain of two to twelve chromosomes with almost every intermediate size (Table 1). Chain of twelve was the most common configuration, observed in 42% cells as compared to 4.33% cells by Lin & Paddock (1973b) and 22.5% cells by Simmonds (1945). A configuration of 11+1 was observed in 8.6% cells while it was observed in 4.90% cells by Lin & Paddock (1973b). We observed 4.2% cells with 10+2 configuration, whereas Simmonds (1945) reported 7.5% and Lin & Paddock (1973b) 2.24% cells. In the present study 6.4% cells with 9+3 configuration were found in contrast to 7.5% (Simmonds, 1945) and

Table 1 Frequencies of different chromosomal associations at M-1
in *Rhoeo spathacea* (Swartz) Stearn.

Chromosomal Associations	Present study		Data of Lin & Paddock (1973b)	
	number of cells	percentage of cells	number of cells	percentage of cells
Ring of 12	8	1.60	301	61.50
Chain of 12	210	42.00	119	24.33
Chains in 2 groups:				
11+1	43	8.60	24	4.90
10+2	21	4.20	11	2.24
9+3	32	6.40	8	1.64
8+4	40	8.00	5	1.02
7+5	53	10.60	3	0.61
6+6	28	5.60	2	0.41
Chains in 3 groups:				
10+1+1	-	-	4	0.82
9+2+1	4	0.80	3	0.61
8+3+1	4	0.80	1	0.20
8+2+2	10	2.00	1	0.20
7+4+1	4	0.80	1	0.20
6+5+1	-	-	1	0.20
6+4+2	10	2.00	4	0.82
6+3+3	8	1.60	-	-
5+5+2	4	0.80	1	0.20
5+4+3	21	4.20	-	-
Total	500	100	489	100

1.64% cells (Lin & Paddock, 1973b). Distribution of 8+4 at M-I was found in 8% cells as compared to 2.5% cells observed by Simmonds (1945) and Lin & Paddock (1973a). With the configuration of 7+5, 10.6% cells were observed, whereas Akemine (1937) and Lin & Paddock (1973a&b) have reported 23, 25.8 and 0.61%, respectively. A configuration of 6+6 in 5.6% cells as observed in the present study was lower than all the others. A distribution of 10+1+1 and 6+5+1 as reported by previous workers was not observed. Configurations of 5+4+3 and 6+3+3 reported here have not been reported previously. A ring of twelve chromosomes was found only in 1.6% cells. Simmonds (1945) reported this ring in 15% cells, while it was found in 61.55% cells by Lin & Paddock (1973b).

The percentage of cells with different chromosome configurations showed greater variation in pairing behavior. Chains were found more frequently than ring. Similar observations have been made by Sax (1931), who found that pairing was variable and chains were more common than rings. In earlier studies of *Rhoeo* involving multiple interchanges, high frequency of one, two or three chains have been observed (Darlington, 1929b; Sax, 1931; Simmonds, 1945). The union of the chromosomes at meiosis to form the ring is accomplished by chiasma formation and crossing over in their distal segments (Stebbins, 1971). In *Oenothera* unsynapsed differential segments embrace all centromere region, in such regions synapsis is prevented because of dissimilarity in linear structure (Darlington, 1931). This would lead to the terminal localization of chiasmata. According to Sax (1935) twelve terminal chiasmata form a complete ring, eleven chiasmata form a chain of twelve chromosomes, ten chiasmata form two chains. According to Lin & Paddock (1973b) when chiasmata have failed to form in one or more pairs of arms, the ring becomes one or more chains. Differences in length of homologous segments within arm pairs does seem to favour chiasma failure. Transposable elements in higher organisms have also been found to be responsible for rearrangement of chromosome segments such as deletions, inversions and duplications including translocations (Lima-de-Faria, 1983). Comparing the present data with that of previous workers indicates a considerably higher degree of variations in chromosomal associations. Sax (1931) found varying degrees of asynapsis at low temperatures. Increase in temperature shortened the meiotic cycle in wheat and rye which leads to many meiotic irregularities (Reddy, 1992). The recombination frequency may be affected more by temperature when translocation is involved (Jensen, 1981). There are also indications that environment can influence chromosome pairing and chiasma frequency in wheat and triticale (Naranjo *et al.*, 1989). Temperature effect is unlikely to have a marked influence on conventional breeding programmes, so the environmental influence on chromosome pairing should not be underestimated. Translocations are known to occur frequently in most plant species (Stebbins, 1950). However, they do not produce any recognizable effect on either the external morphology or the physiological adaptive characteristics of the species. The evidence in the present study would suggest that failure of synapsis is the cause of chain formation and variation in the pairing behavior could be due to the different horticultural environments.

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