スイバのY-染色体と異質染色質

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Y-CHROMOSOME AND HETEROCHROMATIN IN *RUMEX ACETOSA*

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Recent papers dealing with heterochromatin of plant sex-chromosome were published by Motegi (1965) and Żuk (1969a, b). A localization of heterochromatin, a relation of sex-chromosomes to chromocenters, a difference in condensation between euchromatic autosomes and heterochromatic sex-chromosomes, were discussed in their papers.

Cytological studies have been carried out by the present authors on sex-chromosomes and chromocenters in somatic cells of *Rumex acetosa* L. In the present paper, certain results obtained heretofore will be given in detail as to Y-chromosomes at mid-prophase and the relationship of the Y's to the chromocenters.

MATERIAL AND METHOD

The materials used were a male clone collected from Kumamoto city and a female clone from Matsuyama city. A few clones from other localities were also used for comparison. Their autosomes (Kuroki and Kurita 1969a) are readily distinguished from the sex-chromosomes, especially from the Y-chromosomes. This is favorable for analysis of morphological changes of the sex-chromosomes in contrast with those of autosomes throughout the prophase.

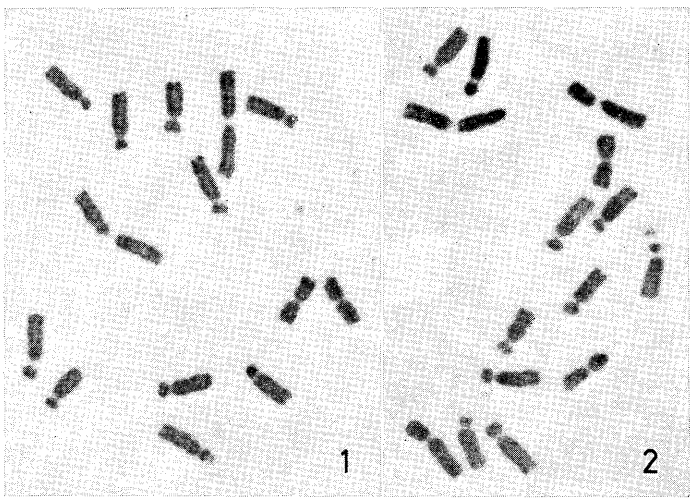
Cytological preparations were made from root tips following the method employed in our early study (Kuroki and Kurita 1969a).

OBSERVATION

Some chromocenters can be observed at interphase of the female cell (Fig. 3). The number of chromocenters per nucleus varies. It is difficult to decide their number per nucleus as stated formerly (Kuroki and Kurita 1969b). However, there are usually three or four per nucleus. Their sizes are also variable even in a single nucleus. Mean diameter of the largest chromocenter in each nucleus was measured, and the results are shown in Table 1. Some of chromocenters are found splitting into two halves or appears empty at the core.

No chromocenter takes part in the condensation of X-chromosomes (Fig. 6) which are completely euchromatic. The condensation gradually advances from a proximal to a distal end in each chromosome arm as found in an euchromatic autosome.

An interphase nucleus (Fig. 4) in the male also shows the chromocenters which are difficult to estimate their number per nucleus and which vary in size, as found in the

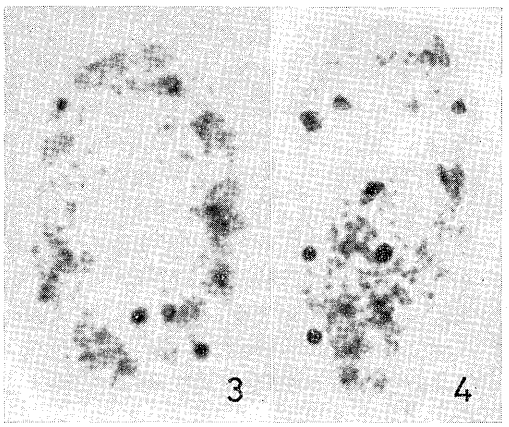


Figs. 1 and 2. Photomicrographs of somatic metaphase chromosomes. 1, female. 2, male. ×ca. 1800.

Table 1. Measurement of chromocenter and Y-chromosome (μ)

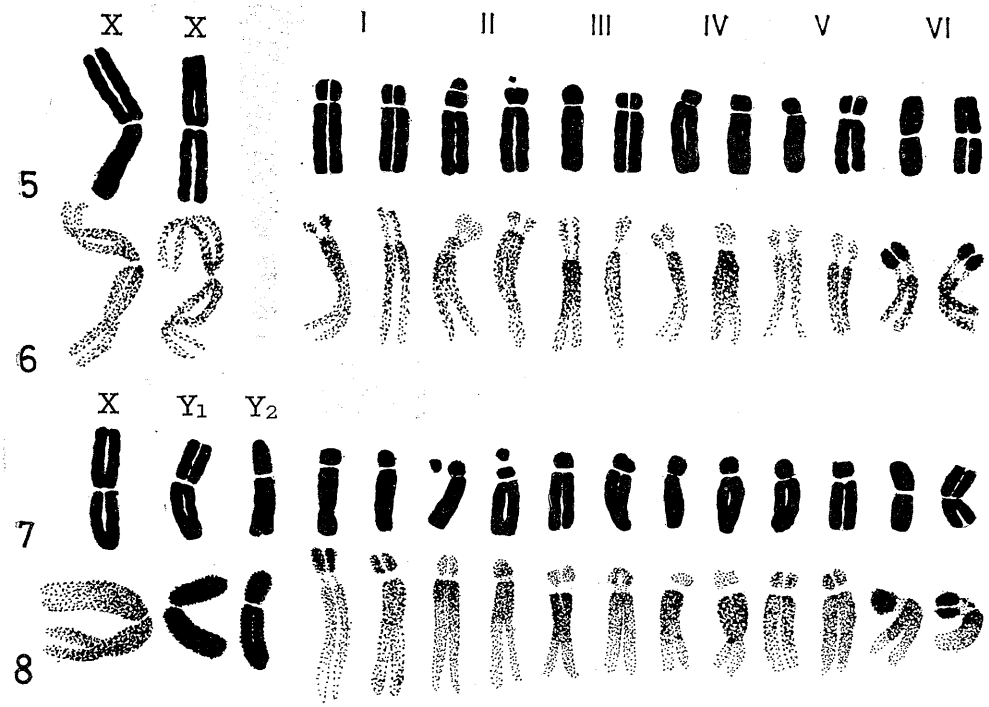
	Largest chromocenter (Range)		Chromosome			
	♀	♂	Y_1		Y_2	
	(1.9–0.8)	(2.9–0.9)	L	S	L	S
M±m	1.2±0.02	1.6±0.03	4.5±0.06	3.0±0.04	4.5±0.06	2.4±0.04

L, long arm. S, short arm.



Figs. 3 and 4. Photomicrographs of somatic interphase nuclei representing chromocenters. 3, female. 4, male. ×ca. 1800.

female nuclei. However, they are generally four to seven in number. The length of the largest chromocenter in each nucleus was measured. It varies from 2.9 μ to 0.9 μ with an average of $1.6 \pm 0.03\,\mu$. Comparing this with that in the female (Table 1), a clear difference is observed in chromocenter length between the female and the male.



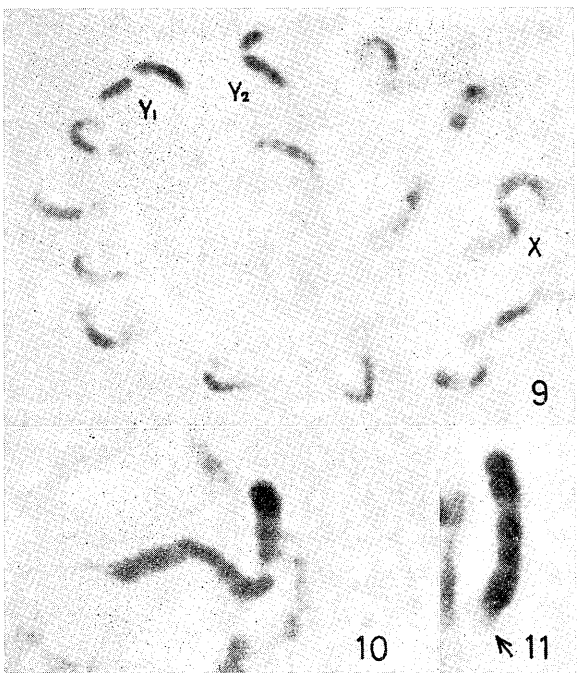
Figs. 5-8. Alignment of somatic chromosomes. 5, metaphase chromosome of female. 6, mid-prophase chromosome of female. 7, metaphase chromosomes of male. 8, mid-prophase chromosomes of male. ×2300.

At early prophase, where the Y_1-chromosome can not be distinguished from the Y_2, Y-chromosome consists of two different segments besides the centromere (Fig. 10; Fig. 12. II, III): one is densely stained, being thick, and the other is lightly stained, being thin. The former is certain to have been derived from the chromocenter and to have been a distal part of the short arm. The latter forms the remaining whole arm other than the just mentioned part. The segments derived from chromocenters differ in length between the Y_1- and the Y_2-chromosomes. The chromocenter seems not to form the whole short arm, because there exists a lightly stained part between the centromere and the segment from the chromocenter as shown in Figs. 10 and 12, and also because even the largest chromocenter usually is shorter than any of the short arms of Y-chromosomes (Table 1). At early prophose advanced slightly (Fig. 12. III), the whole arm of Y-chromosome besides the segment from the chromocenter is as thick as an euchromatic arm of the other chromosomes, while it is a little more densely stained. Even the distal end without the segment from a chromocenter shows a somewhat bold outline.

At mid-prophase, where the Y_1- and the Y_2-chromosome are first distinguishable, both Y's are more densely stained than any other chromosome, their outline being bold throughout the whole length as shown in Figs. 8 and 9. There is sometimes a dim or hyaline small segment attached to the distal end of the long arm in the Y_2-chromosome (Fig. 11, Fig. 12. IV). The transference from the arm end into the segment is not gradual and takes a sudden turn of staining. The difference in condensation between Y-chromosomes and the other chromosomes is much more easily recognized at the mid-prophase than at any other period in prophase. There are, however, found a few cells in which Y-chromosomes are fairly similar in condensation to the other chromosomes.

At late prophase, both Y-chromosomes are not different in the condensation figure from the other chromosomes.

The X-chromosome in male has no relation to the chromocenter and its condensation does not differ from that of the other euchromatic autosome throughout the prophase (Figs. 8 and 9).



Figs. 9-11. Photomicrographs of prophase chromosomes from male. 9, mid-prophase showing two heteropycnotic Y-chromosomes. 10, early prophase Y-chromosome showing distal segment stained densely in the short arm. 11, mid-prophase Y_2-chromosome representing a dim segment (arrow). Fig. 9. ×ca. 1800, Figs. 10 and 11. ×ca. 3600.

DISCUSSION

The size of the largest chromocenter (Table 1) widely varies by the sex. This seems to show that the chromocenter size is under the control of the internal condition of the

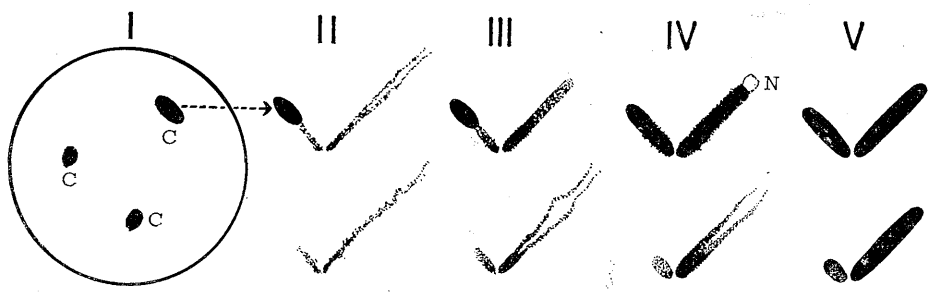


Fig. 12. Diagram representing the condensation of chromosome (upper, Y_2-chromosome; bottom, autosome having no relation to chromocenter). I, interphase. II and III, early prophase. IV, mid-prophase. V, late prophase. C, chromocenter. N, non-staining or dim small segment.

nucleus. The largest chromocenter is longer in the male than in the female. This difference has already been suggested by the presence of the so-called sex-chromatin body (Shimizu 1961) which is found only in the male. The present authors hesitate to say that the sex-chromatin body is very obvious, because there is often observed the male nucleus in which the largest chromocenter is closely similar in size to that in the female.

At early prophase, where the Y_1- and the Y_2-chromosomes are indistinguishable from each other, each Y has been observed to consist of two different segments besides the centromere (Fig. 10; Fig. 12. II, III). One segment is sure to have been derived from the chromocenter, making a distal part of the short arm. This shows that the Y-chromosomes are partially heteropycnotic. As known from Table 1, there is found a case where the largest chromocenter of the male is longer than the shortest arm of Y-chromosomes. Such long chromocenter is considered to have a mere gathering of euchromatic granules which is adjacent to the chromocenter and is mismeasured as a part of the chromocenter. The other segment was lightly stained and was thin as found in euchromatic part of the other chromosome (Fig. 10, Fig. 12. II). At early prophase advanced slightly (Fig. 12. III), this segment is, however, more densely stained and shows an outline bolder than that of the euchromatic part of the other chromosome. This fact is considered to show that each arm of Y-chromosomes except the segment derived from the chromocenter is not heterochromatic but euchromatic, whereas it differs slightly from the euchromatic part of the other chromosome. Then, such part of the arm of the Y-chromosome is intermediate in character between the eu- and the heterochromatin.

At mid-prophase (Figs. 8, 9), the Y_1- and the Y_2-chromosome are, on the whole, more densely stained than any other chromosome, their outlines being bold. Then, both Y's at mid-prophase must be said to be entirely heteropycnotic contrary to those at early prophase. The present authors would like to withhold to mention that the difference in condensation between the Y's and the other chromosomes is very remarkable, because there are sometimes found the cells in which the Y's are fairly similar in the condensation to the other chromosomes. The Y_2-chromosome shows sometimes a dim

or hyaline small segment at the distal end of its long arm (Fig. 11, Fig. 12. IV). This indicates that the above segment is different in condensation from the adjacent euchromatic part of the arm. Therefore, it is concluded that the arms of the Y_2-chromosome at mid-prophase consist of three different segments of which two can be observed at early prophase.

SUMMARY

A cytological study was made mainly on the Y-chromosomes in connection with chromocenters in *Rumex acetosa* L. At mid-prophase in somatic cells, the Y_1-chromosome was found to consist of two different segments besides the centromere: one is derived from the chromocenter, another is euchromatic, but different in condensation from the euchromatic part of the X-chromosome and also of the autosomes. The Y_2 has sometimes a dim or hyaline small segment at the distal end of the long arm besides those two segments as found in the Y_1. Furthermore, at mid-prophase the Y-chromosomes are, on the whole, more darkly stained than any other chromosome. Then, the Y's can be said to be entirely heteropycnotic at this stage, in spite of showing a partial heteropycnosis at early prophase and interphase where the distal part of the short arm revealed itself as a chromocenter.

LITERATURE CITED

Kuroki, Y., and M. Kurita, 1969a Karyotypes of *Rumex acetosa* L. Mem. Ehime Univ., Sci. Ser. B, **6**: 41-49.

Kuroki, Y., and M. Kurita, 1969b Certain autosomes in *Rumex acetosa*. Mem. Ehime Univ., Sci. Ser. B, **6**: 51-56.

Motegi, T., 1965 Some observations on sex chromosomes and sex expression in *Humulus japonicus*. Sci. Rep. Tohoku Univ., Ser. IV, (Biol.) **31**: 7-16.

Shimizu, Y., 1961 Sex chromatin in *Rumex acetosa*. La Kromosomo **49**: 1521-1523.

Żuk, J., 1969a Analysis of Y chromosome heterochromatin in *Rumex thyrsiflorus*. Chromosoma (Berl.) **27**: 338-353.

Żuk, J., 1969b The additional heterochromatic chromosome and its infiuence on sex chromosome pairing in *Rumex*. Heredity **24**: 69-74.