Karyotype Analysis in *Tulipa* IX

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チューリップ属植物の核型分析 IX

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INTRODUCTION

Since 1955 the present author and his collaborators has carried out observations on the karyotypes of 148 races of *T. gesneriana* and a race of *T. edulis* was reported (Takusagawa et al. 1955, '56, '57, '58, '59, '60, '62a, '62b). Moreover, the author made the karyotype analysis in seven reces of *T. gesneriana*. The present paper deals with the resulte of this investigation.

MATERIALS AND METHODS

The materials used are listed in Table 1. All the specimens were treated by same method as described in Part VII of this series.

Table 1. Races used as the material

Plant name	2 n	Karyotype	Figs.
I Early Flawering Tulips			
* Single Early Tulips			
1. *Violet Beauty*	24	B	(3)
* Double Early Tulips			
2. *Boule de Neige*	24	A−2	(1)
* Mendel Tulips			
3. *White Sail*	24	B	(4,8)
* Triumph Tulips			
4. *Violetta*	24	B	(5,9)
II Late Flowering Tulips			
* Cottage Tulips			
5. *White Rock*	24	B	(6)
* Darwin Tulips			
6. *Allard Pierson*	24	B	(7)
7. *Professor Rauwenhof*	24	A−2	(2)

RESULTS OF OBSERVATION

1. *Tulipa gesneriana* race *Violet Beauty* 2n=24 (B) (Fig. 3 Table 2)

This race has twelve pairs of somatic chromosomes. They may be classified into eight

groups. The first group includes one pair of chromosomes of the largest size (1 and 2). They have each a subterminal constriction. The second group includes two pairs of chromosomes with subterminal constrictions (3, 4, 5 and 6). The third group includes two pairs of chromosomes with subterminal constrictions (7, 8, 9 and 10). The fourth group includes two pairs of chromosomes with subterminal constrictions (11, 12, 13 and 14). The fifth group includes two pairs of chromosomes with subterminal constrictions (15, 16, 17 and 18). The sixth group includes one pair of chromosomes with subterminal constrictions (19 and 20). The seventh group includes one pair of chromosomes with subterminal constrictions (21 and 22). The eighth group includes one pair of chromosomes with submedian constrictions (23 and 24).

Table 2. Measurements of length of somatic chromosomes in *Tulipa gesneriana* race *Violet Beauty*

Chromosomes	Long arm(μ)	Short arm(μ)	Whole length(μ)	Relative length	F%	TF%
1,2	11.8	3.1	14.9	6.1	21	
3,4	10.7	2.1	12.8	5.3	16	
5,6	9.7	2.6	12.3	5.1	21	
7,8	8.8	2.8	11.6	4.8	24	
9,10	8.3	2.8	11.1	4.6	25	
11,12	8.1	2.1	10.2	4.3	21	
13,14	7.8	1.9	9.7	4.0	20	
15,16	7.0	2.1	9.1	3.8	23	
17,18	6.5	2.6	9.1	3.8	29	
19,20	5.9	2.4	8.3	3.4	29	
21,22	5.2	2.1	7.3	3.0	29	
23,24	3.6	2.6	6.2	2.6	42	25

2. *Tulipa gesneriana* race *Boule de Neige* 2n=24 (A—2) (Fig. 1 Table 3)

This race has twelve pairs of chromosomes which are classified into eleven groups by their shape, size and position of constrictions. The first group includes one pair of chromosomes with subterminal constrictions (1 and 2). The second group includes one pair of chromosomes with submedian constrictions (3 and 4). The third group includes one pair of chromosomes with subterminal constrictions (5 and 6). The fourth group includes one pair of chromosomes with subterminal constrictions (7 and 8). The fifth group includes one pair of chromosomes with subterminal constrictions (9 and 10). The sixth group includes one pair of chromosomes with submedian constrictions (11 and 12). The seventh group includes one pair of chromosomes with subterminal constrictions (13 and 14). The eighth group includes one pair of chromosomes with subterminal constrictions (15 and 16). The ninth group includes two pairs of chromosomos with submedian constrictions (17, 18, 19 and

20). The tenth group includes one pair of chromosomes with submedian constrictions (21 and 22). The eleventh group includes one pair of chromosomes with submedian constrictions (23 and 24).

Table 3. Measurements of length of somatic chromosomes in *Tulipa gesneriana* race *Boule de Neige*

Chromosomes	Long arm(μ)	Short arm(μ)	Whole length(μ)	Relative length	F%	TF%
1	6.2	2.5	8.7	5.6	29	
2	6.0	2.7	8.7	5.6	31	
3,4	5.3	3.3	8.6	5.6	38	
5,6	4.9	2.3	7.2	4.7	32	
7,8	4.9	2.2	7.1	4.6	31	
9,10	4.9	2.0	6.9	4.5	29	
11,12	4.2	2.2	6.4	4.2	34	
13,14	4.0	2.0	6.0	3.9	33	
15,16	3.7	1.8	5.5	3.6	33	
17,18	3.3	2.0	5.3	3.4	38	
19,20	3.3	2.0	5.3	3.4	38	
21,22	3.1	2.0	5.1	3.3	39	
23,24	3.1	1.8	4.9	3.2	37	34

3. *Tulipa gesneriana* race *White Sail* 2n=24 (B) (Fig. 4 and 8 Table 4)

There are twenty four chromosomes in the root-tip cell of this race. As shown in Fig. 4,8 and Table 5 these chromosomes are found to be composed of twelve pairs which are classified into nine groups by their shape, size and position of constrictions. All the chromosomes have subterminal constrictions. The chromosomes vary in length from 9.8 microns to 6.3 microns. The karyotype of this race bears a resemble in general to that of race *General de Wet.*

Table 4. Measurments of length of somatic chromosomes in *Tulipa gesneriana* race *White Sail*

Chromosomes	Long arm(μ)	Short arm(μ)	Whole length(μ)	Relative length	F%	TF%
1,2	7.0	2.8	9.8	5.2	29	
3,4	7.0	2.3	9.3	5.0	25	
5,6	7.0	2.3	9.3	5.0	25	
7,8	6.5	1 9	8.4	4.5	23	
9,10	6.5	1.9	8.4	4.5	23	
11,12	5.8	2.3	8.1	4.3	28	
13,14	4.9	2.3	7.2	3.8	32	
15,16	4.9	2.1	7.0	3.7	30	

17,18	4.9	1.9	6.8	3.6	28	
19,20	4.9	1.9	6.8	3.6	28	
21,22	4.9	1.6	6.5	3.5	25	
23,24	4.2	2.1	6.3	3.4	33	27

4. *Tulipa gesneriana* race *Violetta* 2n=24 (B) (Fig. 5 and 9 Table 5)

This race has twelve pairs of somatic chromosomes. They may be classified into ten groups. The first group includes one pair of the chromosomes of the largest size (1 and 2). They have each a subterminal constriction. The second group includes one pair of chromosomes with subterminal constrictions (3 and 4). The third group includes with subterminal constrictions (5 and 6). The fourth group includes one pair of chromosomes with subterminal constrictions (7 and 8). The fifth group includes two pairs of chromosomes with subterminal constrictions (9, 10, 11 and 12). The sixth group includes one pair of chromosomes with subterminal constrictions (13 and 14). The seventh group includes two pairs of chromosomes with subterminal constrictions (15, 16, 17 and 18). The eighth group includes two pairs of chromosomes with subterminal constrictions (19, 20, 21 and 22). The ninth group includes one chromosome with subterminal constriction (23). The tenth group includes one chromosome with submedian constriction (24).

Table. 5. Measurements of length of somatic chromosomes in *Tulipa gesneriana* race *Violetta*

Chromosomes	Long arm(μ)	Short arm(μ)	Whole length(μ)	Relative length	F%	TF%
1,2	9.0	3.3	12.3	3.4	27	
3	9.0	3.1	12.1	5.3	26	
4	8.6	3.1	11.7	5.1	26	
5,6	9.0	2.3	11.3	5.0	20	
7	8.4	2.7	11.1	4.9	24	
8	8.2	2.3	10.5	4.6	22	
9,10	7.8	2.3	10.1	4.4	23	
11,12	7.4	2.5	9.9	4.3	25	
13	7.0	2.0	9.0	3.9	22	
14	5.8	2.9	8.7	3.8	33	
15,16	6.2	2.0	8.2	3.6	24	
17,18	6.2	2.0	8.2	3.6	24	
19,20	5.8	2.3	8.1	3.5	28	
21,22	5.1	2.5	7.6	3.3	33	
23	5.3	2.0	7.3	3.2	27	
24	4.5	2.5	7.0	3.1	36	26

5. *Tulipa gesneriana* race *White Rock* 2n=24 (B) (Fig. 6 Table 6)

Chromosome measurements for this species are given in Table 6. The chromosomes vary in length from 18.1 microns to 8.6 microns. The twenty four chromosomes may be classified into ten groups by their shape, size and position of constrictions. The karyotype of this race bears a resemble in general to that of race *General de Wet*. But there are some difference between them. The seventh pair of chromosomes of this race have submedian constrictions, but those of *General de Wet* have subterminal ones.

Table 6. Measurements of length of somatic chromosomes in *Tulipa gesneriana* race *White Rock*

Chromosomes	Long arm(μ)	Short arm(μ)	Whole length(μ)	Relative length	F%	TF%
1,2	14.3	3.8	18.1	5.7	21	
3,4	11.3	4.9	16.2	5.1	30	
5,6	12.4	3.0	15.4	4.8	19	
7,8	12.4	3.0	15.4	4.8	19	
9,10	11.3	3.0	14.3	4.5	21	
11	9.8	2.6	12.4	3.9	21	
12	8.6	3.8	12.4	3.9	31	
13,14	7.5	4.5	12.0	3.8	38	
15,16	8.6	3.4	12.0	3.8	28	
17,18	8.6	3.0	11.6	3.6	26	
19,20	8.6	3.0	11.6	3.6	26	
21,22	8.6	3.0	11.6	3.6	26	
23,24	6.0	2.6	8.6	2.7	30	26

6. *Tulipa gesneriana* race *Allard Piersson* 2n=24 (B) (Fig. 7 Table 7)

This race has twelve pairs of chromosomes which are classified into eleven groups by their shape, size and position of constrictions. The first group includes one pair of chromosomes with subterminal constrictions (1 and 2). The second group includes one pair of chromosomes (3 and 4), which are curved and have subterminal constrictions. The third group includes one chromosome with subterminal constriction (5). The fourth group includes one chromosome with subterminal constriction (6). The fifth group includes one pair of chromosomes (7 and 8), which are curved and have subterminal constrictions. The sixth group includes one pair of chromosomes with subterminal constrictions (9 and 10). The seventh group includes one pair of chromosomes (11 and 12), which are curved and have subterminal constrictions. The eighth group includes one pair of chromosomes with subterminal constrictions (13 and 14). The ninth group includes three pairs of chromosomes with subterminal constrictions (15, 16, 17, 18, 19 and 20). The tenth group includes one pair of

chromosomes with subterminal constrictions (21 and 22). The eleventh group includes one pair of chromosomes with subterminal constrictions (23 and 24).

Table 7. Measurements of length of somatic chromosomes in *Tulipa gesneriana* race *Allard Pierson*

Chromosomes	Long arm (μ)	Short arm (μ)	Whole length (μ)	Relative length	F%	TF%
1,2	11.3	2.5	13.8	5.5	18	
3,4	9.7	3.3	13.0	5.2	25	
5	8.8	3.3	12.1	4.8	27	
6	9.7	2.2	11.9	4.8	18	
7,8	8.8	2.8	11.6	4.6	24	
9,10	7.7	2.8	10.5	4.2	27	
11,12	7.5	2.8	10.3	4.1	27	
13,14	6.9	2.8	9.7	3.9	29	
15,16	7.2	2.2	9.4	3.8	23	
17,18	6.4	3.0	9.4	3.8	32	
19,20	7.2	2.2	9.4	3.8	23	
21,22	6.1	2.5	8.6	3.4	29	
23,24	5.0	2.5	7.5	3.0	33	24

7. *Tulipa gesneriana* race *Professor Rauwenhof* 2n=24 (A—2) (Fig. 2 Table 8)

This race has twelve pairs of chromosomes which are classified into eleven groups by their shape, size and position of constrictions. The first group includes one pair of chromosomes with subterminal constrictions (1 and 2). The second group includes one pair with submedian constrictions (3 and 4). The third group includes one pair with subterminal constrictions (5 and 6). The fourth group includes one pair of chromosomes with subterminal constrictions (7 and 8). The fifth group includes one pair of chromosomes with subterminal constrictions (9 and 10). The sixth group includes two pairs of chromosomes with subterminal constrictions (11, 12, 13 and 14). The seventh group includes one pair of chromosomes with subterminal constrictions (15 and 16), The eighth group includes one pair of chromosomes with subterminal constrictions (17 and 18). The ninth group includes one pair of chromosomes with subterminal constrictions (19 and 20). The tenth group includes one pair of chromosomes with subterminal constrictions (21 and 22). The eleventh group includes one pair of chromosomes with subterminal constrictions (23 and 24).

Table 8. Measrements of length of somatic chromosomes in *Tulipa gesneriana* race *Professor Rauwenhof*

Chromosomes	Long arm (μ)	Short arm (μ)	Whole length (μ)	Relative length	F%	TF%
1,2	14.9	3.3	18.2	6.0	18	
3,4	10.9	5.1	16.0	5.2	32	
5,6	12.5	3.3	15.8	5.2	21	
7,8	11.6	3.0	14.6	4.8	21	
9,10	11.2	2.6	13.8	4.5	19	
11,12	8.9	3.0	11.9	3.9	25	
13,14	9.2	2.6	11.8	3.9	22	
15,16	8.6	2.6	11.2	3.7	23	
17,18	8.3	2.3	10.6	3.5	22	
19,20	7.6	2.6	10.2	3.3	25	
21,22	7.6	2.3	9.9	3.2	23	
23,24	6.7	2.0	8.7	2.8	23	23

CONSIDERATIONS OF THE KARYOTYPE OF THE DIPLOID RACES IN *TULIPA GESNERIANA*

The results of the observations of the present investigation on the chromosomes in seven races of *Tulipa gesneriana* have revealed that the race studied were diploid, having twenty four somatic chromosomes, and that karyotypes of some races were quite or almost similar to each other, while those of other were different.

Of the karyological facts concerned with the karyotypes obtained, those which seem to be noteworthy may be pointed out as follows :

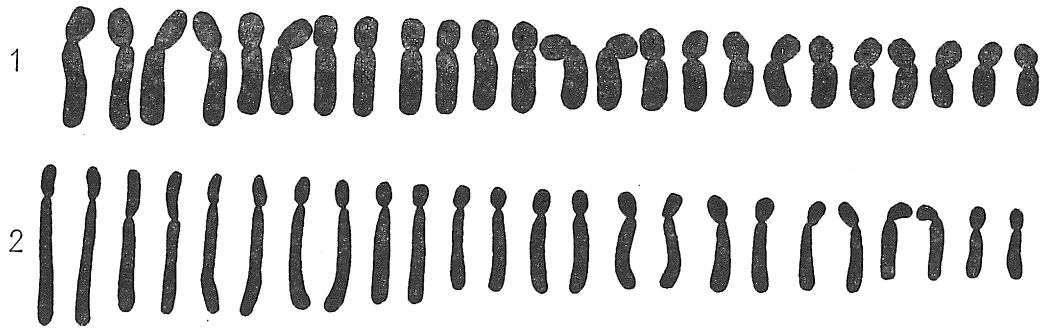
(1) In all the races studied there was the largest chromosome with a subterminal constriction in each chromosome set. (2) In a chromosome set of many races, chromosomes of the large size were found three or four in number. One of them had a median or submedian constriction, while the others had subterminal ones. (3) Most of the chromosomes of middle size each had a subterminal constriction. Some races had one or two chromosomes of middle size with a submedian constriction. (4) Each of the chromosomes of small size had a subterminal constriction. In some races one of the chromosomes of small size was much smaller than the others. (5) In some races all the chromosomes of a chromosome set had subterminal constrictions.

From the view point of the types of karyotypes the races used in this study may be classified as follows :

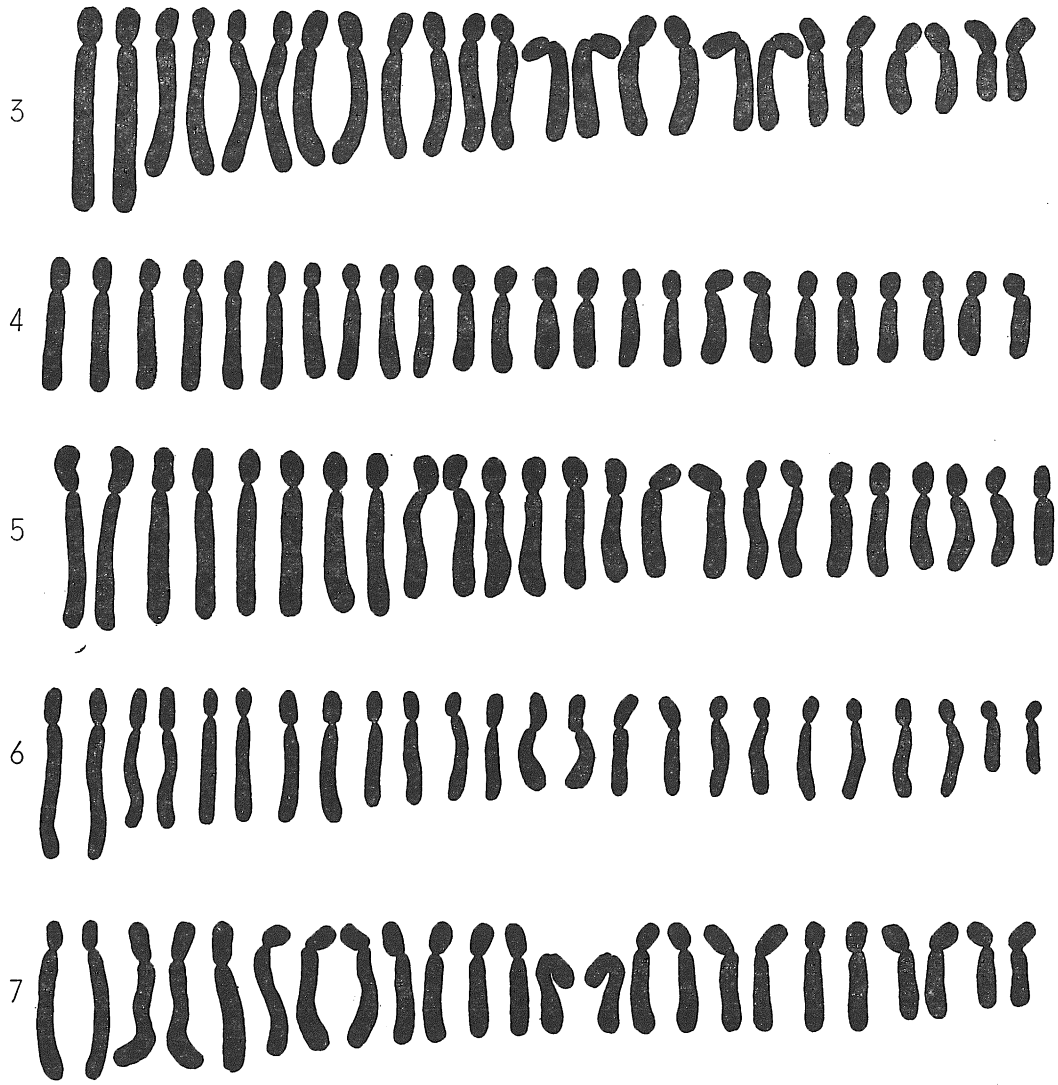
A−2 type : *Boule de Neige* and *Professor Rauwenhof.*

B type : *Violet Beauty, White Sail, Violetta, White Rock* and *Allard Pierson.*

A—2 Type

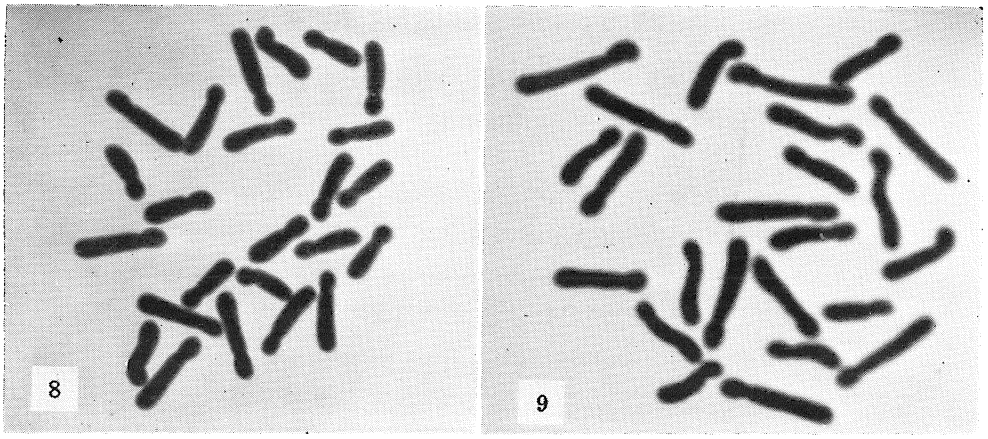


B Type



Figs. 1—7 Somatic chromosomes of seven races in *Tulipa gesneriana*.

1. *Boulede Neige.*　2. *Professor Ravwenhof.*　3. *Violet Beauty.*　4. *White Sail.*
5. *Violetta.*　6. *White Rock.*　7. *Allard Pierson.*　(ca.×2030)



Figs. 8−9 Photomicrographs of somatic chromosomes of two races in *Tulipa gesneriana*.
8. *White Sail*.　9. *Violetta*.　(ca. × 1380)

SUMMARY

1. The karyotype studies were made on seven races in *Tulipa gesneriana*.
2. All the races studied were diploid, having twenty four somatic chromosomes.
3. The karyotypes of all the races used were analyzed. It was found that some of the karyotypes are similar to each other while the others are different from each other.
4. From the standpoint of the karyotype the seven races may by classified into two types. A−2 type . *Boule de Neige* and *Professor Rauwenhof*. B type : *Violet Beauty*, *White Sail*, *Violetta*, *White Rock* and *Allard Pierson*.

摘　　要

今回核型分析を行った種類は *Tulipa gesneriana* に属する7種類である。これらの種類はすべて二倍体であって24個の染色体をもっている。これらのものは同じような核型をもっているものもあり，また或るものは異った核型をもっているものもある。核型の Type からこれを分類すると，A−2 Type に属するものは *Boule de Neige* と *Professor Rauwenhof* の2種類である。そして，B−Type に属するものは *Violet Beauty*, *White Sail*, *Violetta*, *White Rock*, *Allard pierson* の5種類である。

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