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The chromosome variation in *Trillium apetalon* MAKINO

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HAGA and KURABAYASHI ('53) carried out the genome analysis of *Trillium* species found in Japan by means of investigation of differential patterns of chromosomes revealed by the cold treatment of plants. They studied a plant of *T. apetalon* MAKINO* obtained from Maruyama in the surburbs of Sapporo City and defined the genomic constitution of the species to be SSUU.

Utilizing the same method, KURABAYASHI and SAHO ('57) studied the chromosome composition of *T. miyabeanum* MIYABE et TATEWAKI, and confirmed that this plant is the interspecific hybrid between *T. apetalon* and *T. tschonoskii* MAXIM. Further, it was found that the chromosome sets of the hybrid plants derived from *T. apetalon* are slightly variable from locality to locality (Table 2).

The purpose of the present study is to clarify the state of chromosome variation in *T. apetalon*.

Material and Method

Material plants were obtained from the localities shown in Fig. 1, and transplanted to the experimental garden of our University. Immediately after flowering, the plants were transferred into a cold chamber and kept at 0°C for 72–96 hours. Then, the cells of ovular tissue were fixed with La Cour-2BE and stained by Feulgen's method.

Result and Discussion

The chromosome types observed in the present study are demonstrated in Fig. 2, and the chromosome composition of plants in each population are listed in Tables 1 and 3. Table 2 shows the types of two chromosome sets of *T. miyabeanum* derived from *T. apetalon*. In these Tables and in

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* *T. smallii* MAXIM., the former name, was used in the preceding papers, HAGA and KURABAYASHI ('53), KURAYASHI and SAHO ('57a, b), etc.

the text, the type of chromosomes will be expressed by the numerals marked to them as shown in Fig. 1. It is obvious from Tables 1 and 2 that the chromosomes of *T. miyabeanum* exactly identical with those found in the plants of *T. apetalon* from the same locality (*Bt*, *Ty* and *Ms***).

In all the plants examined except those of *On* and *Srr* populations, each of the five chromosomes consists of two homologous pairs, and the plants of the same population have the same chromosome composition. One out of thirteen plants of *Hr* population, however, shows a different composition in chromosome C from the others. Though only a few plants were examined from *Bt*, *Ap* and *Sz*, all of them have ten homologous chromosome pairs regularly. As to the *On* and *Srr* populations, which show intrapopulational polymorphism of chromosomes, report will be made separately.

As is clear in Table 1, the chromosome composition varies from locality to locality. Three types of chromosome A, three of B, four of C, three of D and four of E are recorded in the localities listed in Table 1 except *On* and *Srr*. The pair of *A–3* is found in all the localities and the remaining pair of chromosome A is represented by *A–6* or *A–7*. It is interesting that *A–7* is found in the populations at western and southernmost parts of Hidaka Peninsula (*Bt*, *Sz*, *Ap* and *Sy*), while the populations at east side of Peninsula (*Srr*, *Hr*, *Ty* and *Ms*) possess *A–6* instead of *A–7*. Almost all populations have the pair of *B–3* and of *B–5*, and *B–1* is found only in *Sy* population. The *B–5* found in *Bt*, *Ap*, *Sz* and *Hs* is slightly different from that of the other populations, but the distinction among them is sometimes difficult (Fig. 2). A pair of chromosome C of all the populations is represented by *C–6* except one plant of *Hr*, and another pair is represented by *C–4* or *C–2*. The three types of chromosome D are found in all the possible combinations, i. e., *D–1* and *D–5* are included in the plants of *Ma* and *Hs*, *D–1* and *D–4* in *Ty*, *Ms*, etc., and *D–4* and *D–5* in the plants of *Bt* and *Ap*. The chromosome E is less variable than the other chromosomes. The *E–1* and *E–5* are found in all the populations except *Hs* where *E–7* appears instead of *E–5*.

Though the number of plants investigated is rather small and conclusive decision can not be made at present, it appears that the populations of *T. apetalon* are in the state of complete or nearly complete fixation with respect to the chromosome types. However, the process of fixation seems to have differed among the five chromosomes. All the populations of west

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** The name of locality is expressed in abbreviated form. The full name is given in Fig. 1.

and southernmost parts of Hidak Peninsula have been fixed to *A–7*, while the populations of east side of the Peninsula to *A–6*. It is assumed that the process of fixation of chromosome A was not completely random and affected more or less by the pressure of migration or natural selection. In contrast to chromosome A, the fixed types of chromosome C and D are variable among adjacently located populations. This suggests that the random fixation had been more operative for these chromosomes.

The fact that all the possible combinations of three types of chromosome D are found, suggests that, at least in part, the two genomes of *T. apetalon* can substitute each other without any shortcoming in viability.

The *On* population is characterized by the intrapopulational polymorphism of chromosomes (Table 3). In other words, this population has not yet reached the complete fixation of chromosomes. Among thirteen plants examined, four types of chromosome A, two of B, three of C, four of D and three of E are found, and various combinations of these types are realized. There is no plant which has both *A–3* and *A–1*, or both *A–4*, and *A–6*. All the plants have a pair of *B–1* and a pair of *B–5* except two plants having two pairs of *B–5*. As is shown in Fig. 2, there are three indistinctive types in *B–5* (*B–5*, *B–5′* and *B–5″*). All the plants have a pair of *C–6* and the remaining pair is represented by *C–2* or *C–3* except one plant which has the heterozygous pair of *C–3* and *C–2*. This heterozygous pair may be derived from conjugation of a gamete bearing *C–3* and *C–6* with that bearing *C–2* and *C–6*. There is no plant which has both *D–1* and *D–8*, or, both *D–4* and *D–5*. All the plants have a pair of *E–3* except only one plant which has a pair of *E–5*. It is interesting that the remaining pair of chromosome E is represented by a chromosome which has an excess segment on its long arm (*E–t* in Fig. 2). Since all the plants have a pair of *E–t*, it is presumed that this chromosome provides the plants some selective advantage. In this population, in spite of the polymorphism of chromosomes, heterozygous pair is infrequent. This suggests that self-pollination is more or less effective in *T. apetalon*. If predomination of open pollination was assumed, it would result in frequent production of plants with heterozygous chromosome pairs.

HAGA and KURABAYASHI ('53) suggested the allopolyploid origin of *T. apetalon* and gave it the genome symbol SSUU. The present data shows that plants *T. apetalon* possess regularly ten homologous chromosome pairs. This presumes exact pairing of homologous chromosomes at meiosis and clearly indicates the allopolyploid nature of the species. However, in some cases, distinction of two genomes could not be made among the chromosome types. For example, three types of chromosome D appear in all the possible combinations, indicating that the two genomes can substitute each other at least partly. This fact may be a supporting evidence for the tentative conclusion of KURABAYASHI, SAHO, HIRAIZUMI and SAMEJIMA ('58) that the constituent genomes of *T. apetalon*, S and U, have close homological relation with each other.

Summary

1) The chromosome variation of *Trillium apetalon* MAKINO was studied with respect to the differential patterns revealed by the cold treatment.

2) In many populations investigated in the present study, it seems likely that the chromosomes have been fixed to certain types. In some populations, however, the process of fixation has not yet reach the final state.

3) The chromosome types are variable from locality to locality. It is suggested that each of five chromosomes has been affected differently by natural selection, random fluctuation and perhaps migration in the course of fixation.

4) In a population which is characterized by intrapopulational heteromorphism of chromosomes, the heterozygous chromosome pair is less frequent. This suggests that self-fertilization is rather predominant in *T. apetalon*.

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References

HAGA, T. and M. KURABAYASHI 1953 Genome and polyploidy in the genus *Trillium*. IV. Genome analysis by means of differential reaction of chromosomes to low temperature. *Cytologia*: 18 13-38.

KURABAYASHI, M. and T. SAHO 1957 Evolution and Variation in *Trillium*. IX. Chromosome complement in two interspecific hybrids newly found. *Cytologia* 22: 263-272.

KURABAYASHI, M., T. SAHO, Y. HIRAIZUMI and K. SAMEJIMA 1958 Evolution and variation in *Trillium*. X. Homological relationships among different genomes of Japanese *Trillium*. *Cytologia* 23: 349-355.

TABLE 1. Chromosome composition of *Trillium apetalon* MAKINO in each locality

Locality	No. of Plants Investigated	Chromosome Composition				
		A	B	C	D	E
*On**	13	(1, 3, 4, 6′)	(1, 5, 5′, 5′′)	(2′, 3, 6)	(1, 4, 5, 8)	(3, 5, t)
Ma	1**	3 3 6 6	5 3 5′ 5′	4 4 6 6	1 1 5 5	1 1 5 5
Ms	10	3 3 6 6	3 3 5′ 5′	4 4 6 6	1 1 4 4	1 1 5 5
Ty	10	3 3 6 6	3 3 5′ 5′	2 2 6 6	1 1 4 4	1 1 5 5
Hr	12	3 3 6 6	3 3 5′ 5′	4 4 6 6	1 1 4 4	1 1 5 5
	1	3 3 6 6	3 3 5′ 5′	4 4 5 5	1 1 4 4	1 1 5 5
*Srr**	50	3 3 6 6	(1, 2, 3, 5)	(4, 5, 6, 8)	(1, 3, 4, 5)	1 1 5 5
Sy	1	3 3 7 7	1 1 5′ 5′	2 2 6 6	1 1 4 4	1 1 5 5
Ap	1	3 3 7 7	3 3 5 5	4 4 6 6	5 5 4 4	1 1 5 5
Sz	2	3 3 7 7	3 3 5 5	4 4 6 6	1 1 4 4	1 1 5 5
Bt	5	3 3 7 7	3 3 5 5	4 4 6 6	5 5 4 4	1 1 5 5
Hs	6	3 3 7 7	3 3 5 5	4 4 6 6	1 1 5 5	1 1 7 7

* Only chromosome types found there are listed in parenthesis. See Table 3 with respect to *On* population.

** The plant investigated by HAGA and KURABAYASHI ('53).

TABLE 2. Composition of two chromosome sets of *Trillium miyabeanum* derived from *Trillium apetalon*

Locality	No. of Plants Investigated	Chromosome Composition				
		A	B	C	D	E
Bt	8	3 7	3 5	4 6	4 5	1 5
Ty	4	3 6	3 5′	2 6	1 4	1 5
Ms	4	3 6	3 5′	4 6	1 4	1 5

TABLE 3. Chromosome composition in each individual of *Trillium apetalon* MAKINO from Onnebetsu (*On*) population

Plant No.	Chromosome Composition				
	A	B	C	D	E
1	3 3 4 4	1 1 5″ 5″	3 3 6 6	1 1 4 4	3 3 t t
2	3 3 4 4	1 1 5″ 5″	3 3 6 6	1 1 4 4	3 3 t t
3	3 3 4 4	1 1 5″ 5″	3 3 6 6	1 1 4 4	3 3 t t
4	3 3 4 4	1 1 5″ 5″	3 3 6 6	1 1 4 4	3 3 t t
5	3 3 4 4	1 1 5″ 5″	3 2′ 6 6	1 1 4 4	3 3 t t
6	3 3 4 4	1 1 5″ 5″	3 3 6 6	1 1 4 4	3 3 t t
7	1 1 4 4	1 1 5″ 5″	2′ 2′ 6 6	8 8 4 4	3 3 t t
8	1 1 6′ 6′	1 1 5′ 5′	2′ 2′ 6 6	8 8 4 4	3 3 t t
9	1 1 4 4	1 1 5″ 5″	2′ 2′ 6 6	1 1 4 4	3 3 t t
10	3 3 4 4	1 1 5″ 5″	3 3 6 6	8 8 4 4	3 3 t t
11	3 3 6′ 6′	5 5 5′ 5′	3 3 6 6	8 8 5 5	5 5 t t
12	1 1 4 4	1 1 5″ 5″	3 3 6 6	8 8 5 5	3 3 t t
13	3 3 6′ 6′	5 5 5′ 5′	3 3 6 6	8 8 5 5	3 3 t t

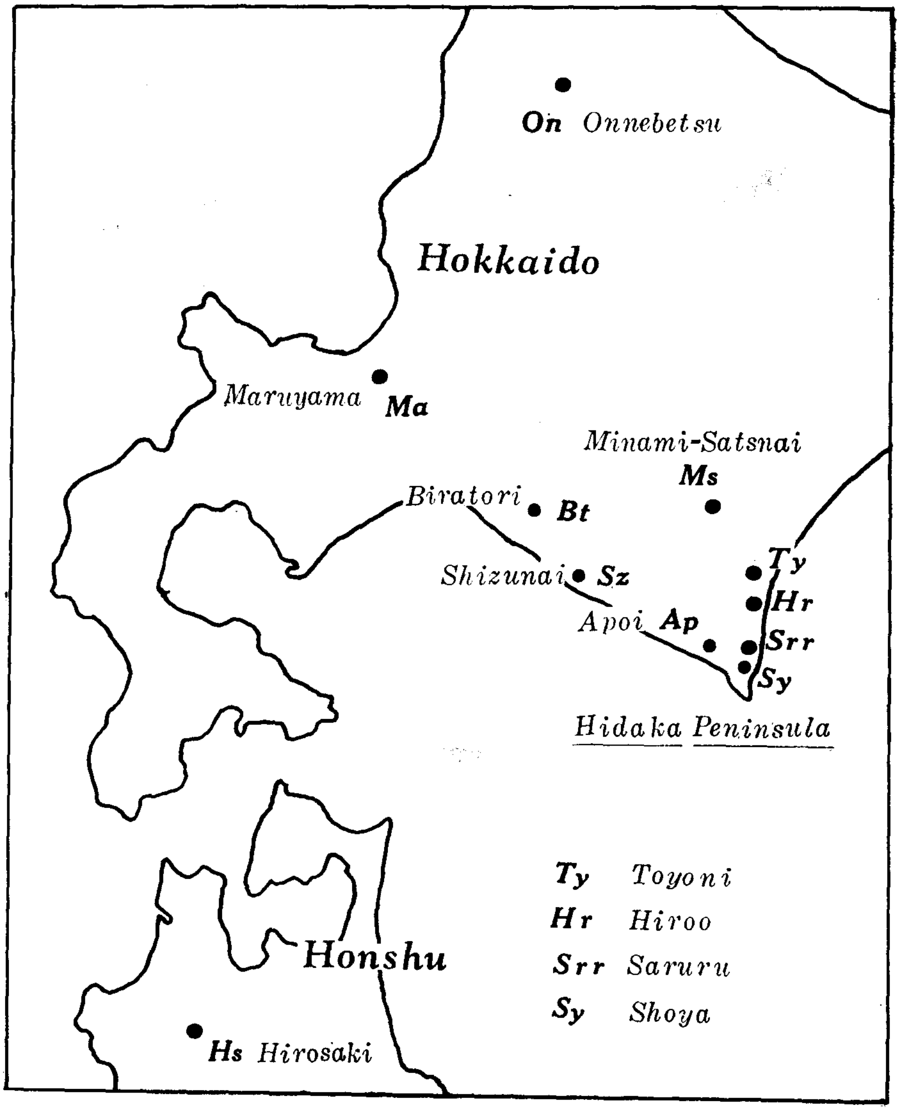

Fig. 1. Localities where the material plants of the present investigation were obtained.

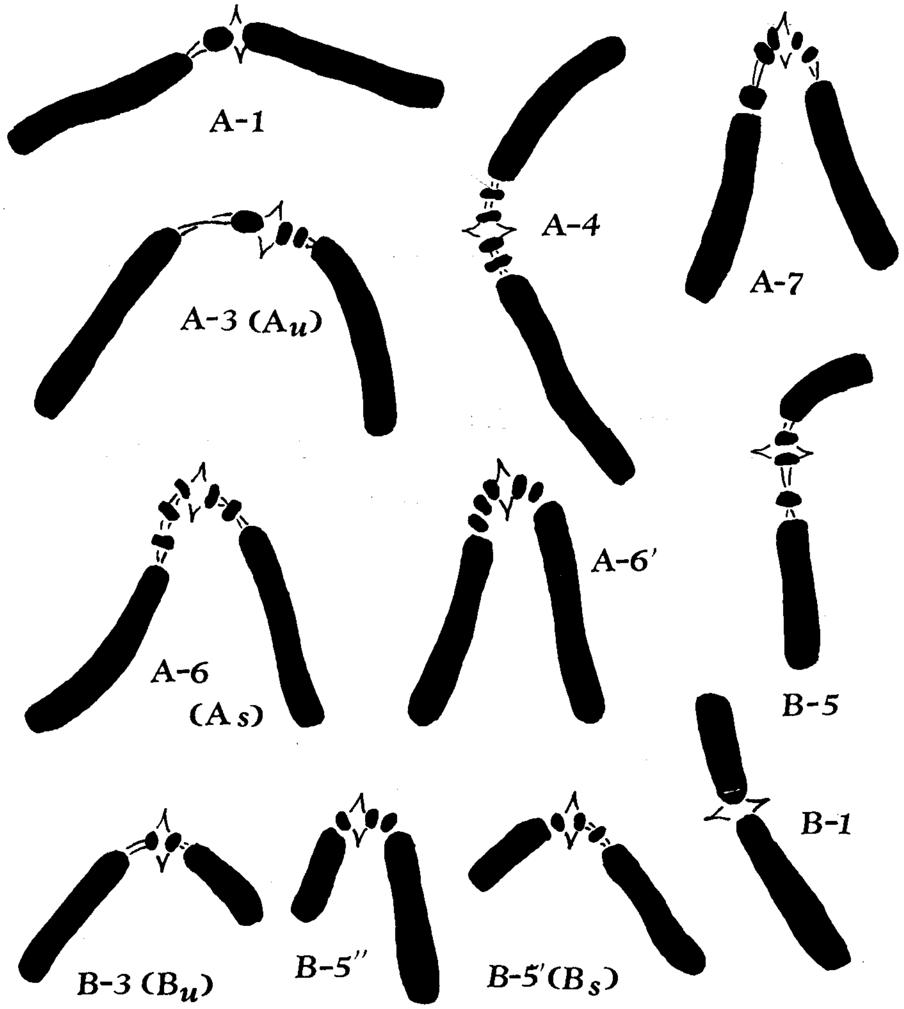

Fig. 2. Chromosome types found in *Trillium apetalon* MAKINO. The types with the same number distinguished by dushes, such as *B-5*, *B-5′* and *B-5″*, are the chromosomes differing slightly from each other but clear distinction is sometimes impossible among them.
The symbols in parenthesis are those given by HAGA and KURABAYASHI ('53).

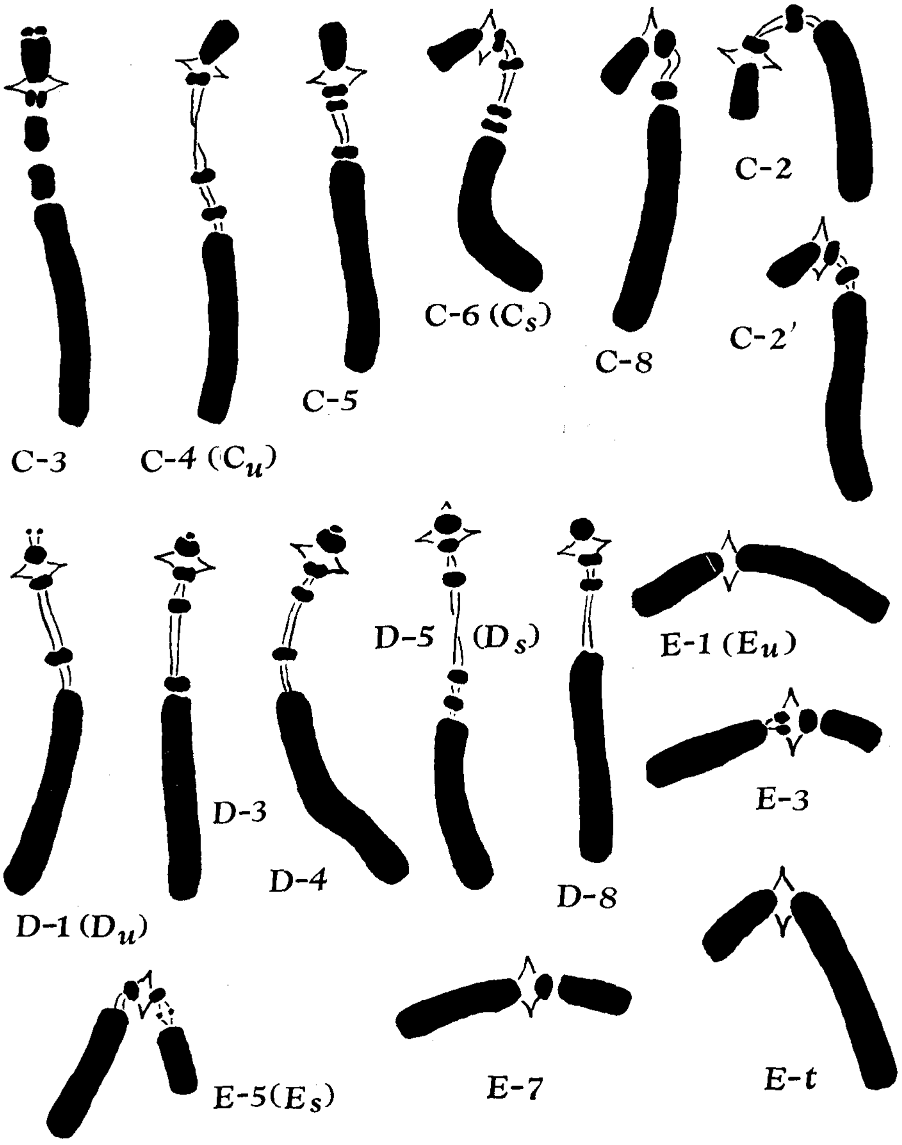

Fig. 2. (Continued)