On the Spontaneous Hybrids and their Descendants Found among the Cultivations of Different Species of *Tradescantia* Part I[1]

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Introduction

Tradescantia is one of the favorite material among many cytologists (Küster 1933). Especially in this country many important cytological investigations on the behaviours of chromosomes in the mitosis as well as in the meiosis were done using this plant (Kuwada 1927, Sakamura 1927, Shimakura 1934, Wada 1930, 1950 etc.). This is due to the fact that this plant gives us the sufficient material throughout the year, if carefully treated (Yasui 1939) (cf. the explanation of Fig. 8), and that it is very convenient material for treatment under the microscope. From the genetical standpoint this plant is a complicated material to analyse; however, some important data, especially on the natural hybrids, are to be found out concerning it.

We have certain examples which appeared spontaneously in the experiment-field as a result of the hybrid formation between different kinds of this plant, owing to the introduction of certain new elements into an old cultivation of *Tradescantia*. Later several other stocks from different sources were added to our culture, and it is probable that the interminglings will cause more complications in the future, so that I wish to have the records of those material which we had before 1945. On the experiments and the discussions of their results the writer is preparing Part II.

I. Materials

On January 16, 1932, we received six different stocks of *Tradescantia* from the New York Botanical Garden through the courtesy of its staff. They were labeled as follows:

1. *Tradescantia virginiana* (collected in Bardoboo, Wisconsin, U. S. A.)
2. *T. virginiana* (cultivated in the Garden)
3. *T.* sp.

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4. *T.* sp.
5. *T. montana*
6. *T. bracteata*

Figs. 2–7 are the photographs of the flowering branches of those stocks 1–6 respectively, taken in the spring 1932.

At that time our Koishikawa Botanical Garden of the University of Tokyo had a stock of *Tradescantia* known as *T. virginiana* cultivated for years. Later Dr. Makino pointed out that it is to be called *T. reflexa.* This latter is to be replaced with *T. canaliculata* after Anderson and Woodson (1935). It is not known who has brought this stock to the Garden. The propagation of this stock was generally performed by dividings, and not by seeds; really this stock gives rather few seeds, probably due to high selfsterility. However, the writer now considers that the cultivation of this stock has been actually continued by seeds, though uncounsciously, because we found quite healthy seedlings here and there in the Garden, though rather seldom, so that it seems natural to believe that the old weakened cultivations were replaced by such healthy stocks in the garden, where no special care had been taken for the preservation of the original stock. But as a result our *T. canaliculata* in the Koishikawa Botanical Garden was selected through self-pollination for years and was preserved rather pure until we received those stocks from New York Botanical Garden.

Most of those stocks from New York Botanical Garden were cultivated in the experiment-field for cyto-genetic studies in the Koishikawa Botanical Garden, while some parts were transplanted in the garden of the Ochanomizu University (then Tokyo Higher Normal School for Women).

Here the writer wishes to define some of the words used in this report: (1) the *associate* means a group of the associated chromosomes in the meiotic pro-metaphase such as quadrivalent, bivalent etc.; (2) *2n-sets* means the complement of the chromosomes in the nucleus in the cell of the sporophyte; (3) the *chromosome combination* (*CC*) means the combination of those associates in the meiotic pro-metaphase; (4) *S-descendant* means the descendant grown spontaneously from the seed.

II. Observations

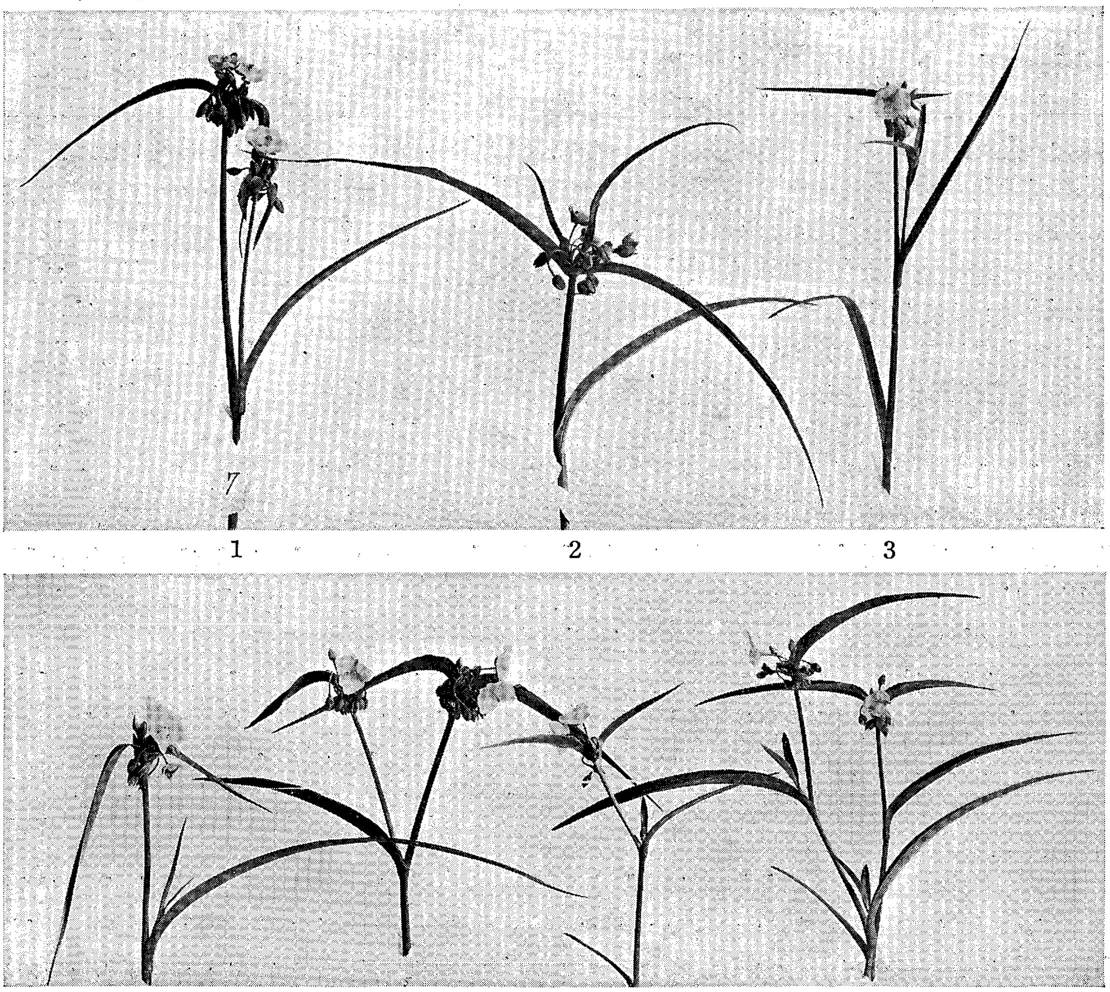
Descriptions of the original stocks.

II, 1. *The stock of Koishikawa Botanical Garden* (*SKBG*). This plant was a typical *T. canaliculata* (Fig.1). The colour of the flower was hortense violet (Ridgway Pl. XI), and not blue as that of the same species from New York. On this point a discussion will be given later.

The chromosome number of this stock was 2n=24. In the meiotic pro-metaphase the various associates, IV, III, II, and I, were found with various combinations.

II, 2. *The stock from the New York Botanical Garden* (*SNYBG*).

SNYBG Nos. 1, 2, 3, and 4 (Figs. 2–5). They were identified as *T. canaliculata.* The general appearance was not widely different from each other and also from SKBG, except for the floral colour. It was an astonishment for the writer to find out the blue flower, spectrum blue (Ridgway Pl. IX), when the new stocks bloomed in the spring, 1932;



Figs. 1–7. Seven original stocks of *Tradescantia.* 1, *T. canaliculata,* the old cultivation in Koishikawa Botanical Garden; 2–7, those from New York Botanical Garden; 2–5, *T. canaliculata*; 6, *T. virginiana*; 7, *T. hirsutiflora* (4X). All photos taken in the spring, 1932.

the colour was much different from that familiar to us as the floral colour of *Tradescantia,* but year by year the colour showed an increasing tinge of red, so that the colour shifted toward violet. These data led the writer to consider that the floral colour of the SKBG may be produced by the same processes, which are probably due to the influence of certain factors in the soil upon the factors in the plant concerning the blue colour formation.

The chromosome number was 2n=24, and in addition 1, 2 or 4 fragments were found. Various associates and the CCs were found in the meiotic phases.

SNYBG No. 5 (Fig. 6). This stock labeled as *T. montana* was the one to be called *T. virginiana* (after Bailey, *T. montana* is one of the second names of the latter). The floral colour was amparo blue (Ridgway Pl. X), and the chromosome number was 2n=24+2 fragments. The records of certain CCs are:

No. 1 $2n=4_{IV}$ (3 rings+1 chain)$+4_{II}$ (2 rings+2 chains)+1 frg.
No. 2 $2n=3_{IV}$ (2 rings+1 chain)$+6_{II}$ (3 rings+3 chains)+2 frgs.
No. 3 $2n=1_{VI}$ (ring)$+2_{IV}$ (1 ring+1 chain)$+5_{II}$ (3 rings+2 chains)+2 frgs.

The dividings from the original stock, including those which were cultivated in the field, gradually dwindled and disappeared after four or five years. While the cultures in the pots survived longer, but at last they faded away in 1949.

The colour of the leaves of this stock was yellowish green, in contrast with deep green with a few nuances of other stocks.

SNYBG No. 6 (Fig. 7). This stock was labeled as *T. bracteata*, but after Anderson and Woodson (1935), it was to be called *T. hirsutiflora* (4 X). The plant grew vigorously with well developed floral shoots which repeat branching. The colour of flower was also amparo blue. The number of the chromosomes was 2n=24+3 fragments, and the records of certain CCs are:

No. 1 $2n=1_{VIII}$ (chain)$+1_{IV}$ (chain)$+2_{III}$ (chains)$+2_{II}$ (1 ring+1 chain)+2 (bars) +3 frgs.
No. 2 $2n=4_{IV}$ (2 rings+2 chains)$+4_{II}$ (2 rings+2 chains)+4 frgs.

The original stock gradually dwindled and the descendants by seeds are taking its place now. The blue colour of the flower was kept rather well in the later generations in this stock, though it became thinner and faintly tinged with red.

The spontaneous descendants.

Two or three years later after the commencement of the cultivation, seedlings began to be found growing spontaneously here and there in the field. When they grew up and bloomed, several morphological characters which had not been found in the parent stocks appeared among them. Certain special ones were picked up for the studies.

III. The Varied Characters Shown in the Descendants

III, 1. *The floral shoot.* The number of the nodes of the floral shoot (aerial shoot) and the number of the adaxial branches having inflorescences on the apexes are specific in each species. In the descendants these characters in the different species appeared often exchanged with each other, showing that there the interspecific hybrid formation had been carried out among the original stocks. While, in some plants the shoot owned quite different characters from those which were found in their supposed parents; e.g. the floral shoot of a plant has no branch at all.

III, 2. *The number of the floral organs. a.* Number increased. In some plants, flowers having more than 4 petals appeared mixed with the normal ones (Figs. 8, *a* and 9). As we see in Fig. 9 this character is accompanied by the increases at an equal rate in other floral elements. Such a manner of the increases must be due to the fasciation of the floral axis, and not to the longitudinal duplications of floral nodes; there was found no such flower as that in which the corolla or other element only was duplicated.

b a

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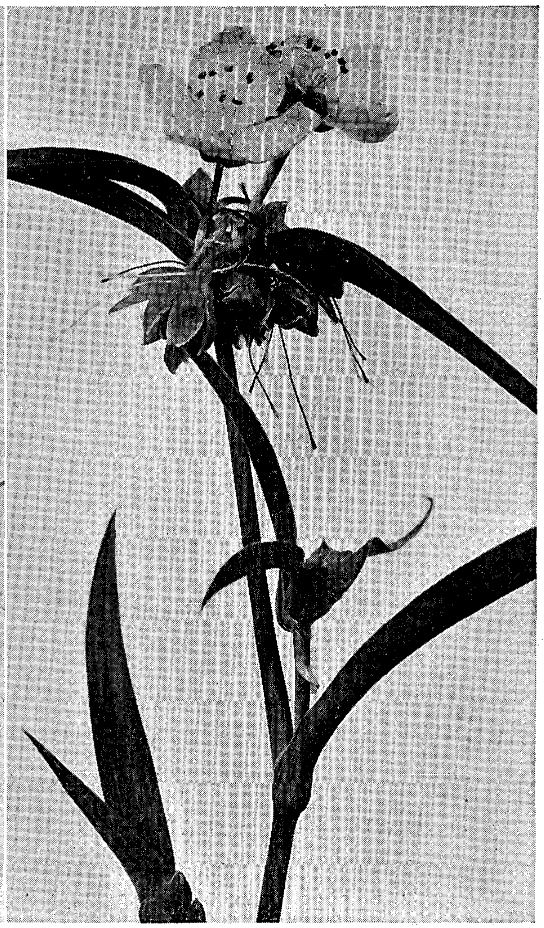

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Fig. 8 A comparison of the results of the long-day treatment in the green house (a) and the plant at the outdoor (b). The blooming stock is a descendant having the fasciated flowers. Photo taken on February 17, 1939. ×ca. 1/9
Fig. 9 The upper part of the floral stem of the plant (Fig. 8, *a*). ×ca. 3/4

b. Number decreased. The extreme case of the decreasing of the floral elements appeared as a deficiency in the carpels, in other words, there appeared unisexual plant having only male flowers instead of the hermaphrodite, though some flowers rarely had very imperfect pistils such as those we found often in other unisexual male plants.

In another example of the male plants the number of the stamens also decreased.

Those decreases are due to the earlier stop of the development or the incomplete development of the floral axis.

III, 3. *Decrease of the number of the flowers in the inflorescences.* One of the examples has only a few flowers, one or two, sometimes only residues of the flowers, which have stopped their development, on the floral stem which developed normally. This phenomenon may be due to the deficiency which causes the suppression of the development of the flowers after certain stages of development have been gone through.

III, 4. *Non-flowering plant* (*the miniature*). A non-flowering miniature plant appeared in a pot in 1937 (Fig. 10). As we see in the photo this miniature plant has many branches having slender leaves. The branching repeats several times in a season in the ground. The spontaneous appearing of this plant in a pot put the writer to make efforts for years to find out the parent stocks. Finally the parent was found and it was confirmed that this character is heritable in the manner of Mendelian inheritance, and that there were two or more recessive genes concering it. A more exact analysis of the physiological roles of those genes is going on.

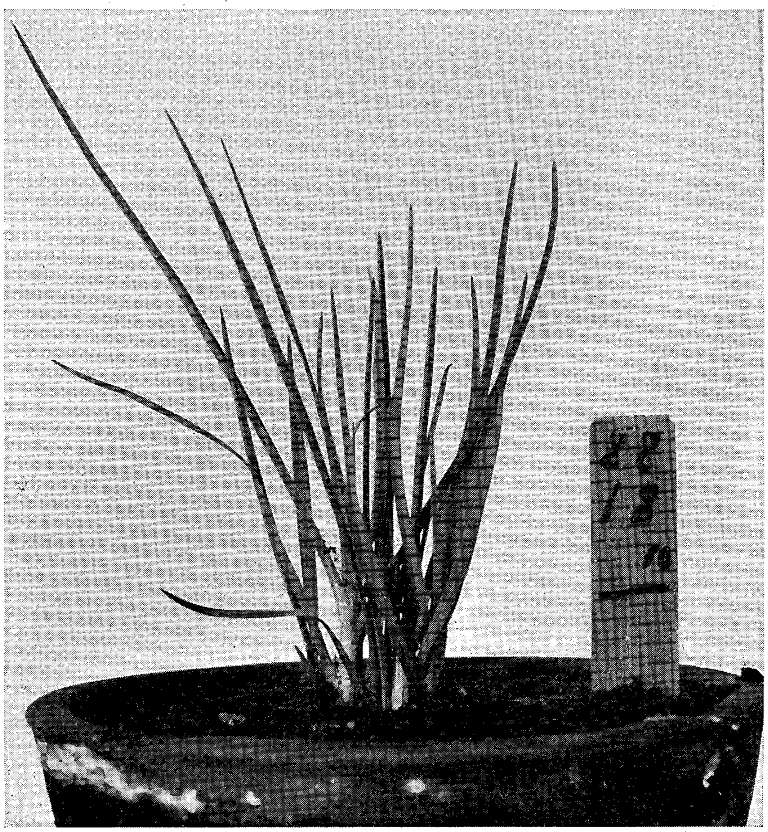

Fig. 10 The non-flowering miniature plant. ×ca. 4/5

III, 5. *The floral colour.* Floral colour in the descendants varied in blue, purple and violet with nuances, in which the rhodamine purple (Ridgway Pl. XII) was prominent. Those colours appear, due to the presence of the anthocyan in the cell sap. The genic analysis of those characters, due to the presence of the anthocyan, shows that there are at least three pairs of the genes, concerning the chromogen, reddening factor and bluing factor, and that those genes are generally carried by different chromosomes (Bateson 1905). Therefore, the purple colour must be caused by the drop-off of the gene concerning the bluing factor, or the suppression of the action of the gene which concerns the absorption of the mineral elements into the cell. Recently Hayashi (1951) discussed the formation of the blue colour in the flower.

III, 6. *The chromosome association and the combination of the associates in the CC.* So far as the examination of the chromosome number in the S-descendants is concerned they all have 24 chromosomes with or without fragments.

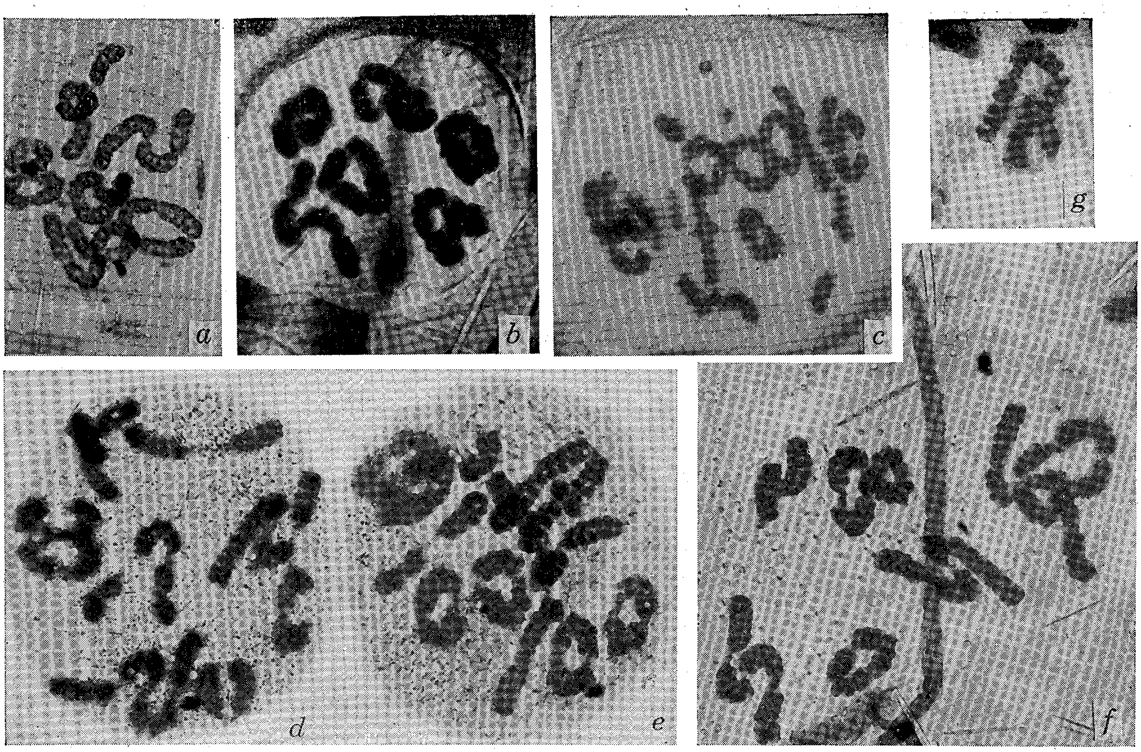

Fig. 11 Photos of six chromosome complements and a quadrivalent. *a* and *b*, different complements from the same flower on No. 88, 66; *c*, a CC having one VI and 4 frgs. in it (No. 88, 67, 3); *d–f*, CCs found in the same anther on No. 88, 75, 5; *g*, a quadrivalent showing a twisting between a set of the chromosomes situated side by side. ×ca. 1000

The number of the chromosomes in one associate varies from one to eight as in the case of the parent stocks. The various combinations of those various associates in a 2n-sets appeared not only in different stocks but also in one and the same anther as the following examples show:

Examp. I. Stock No. 88, 66

1. $2n=6_{IV}$ (5 rings+1 chain)+1 frg. (Fig. 11, *b*);
2. $2n=6_{IV}$ (3 rings+3 chains)+1 frg. (Fig. 11, *a*)

Examp. II. Stock No. 88, 62, 5

1. $2n=5_{IV}$ (2 rings+3 chains)+2_{II} (1 ring+1 chain) (Fig. 11, *f*);
2. $2n=3_{IV}$ (1 ring+2 chains)+1_{III} (chain)+4_{II} (chains)+1_{I} (bar) (Fig. 11, *d*);
3. $2n=2_{IV}$ (1 ring+1 chain)+1_{III} (chain)+6_{II} (3 rings+3 chains)+1_{I} (bar) (Fig 11, *e*)

Examp. III. Stock No. 88, 75, 13

1. $2n=2_{IV}$ (chains)+1_{III} (chain)+6_{II} (4 rings+2 chains)+1_{I} (bar)+2 frgs.

Examp. IV. Stock No. 88, 67, 3

1. $2n = 1_{VI}$ (chain)$+2_{IV}$ (rings)$+4_{II}$ (2 rings+2 chains)$+2_{I}$ (bars)+4 frgs. (Fig. 11, *c*)

We see in those examples that the highest number of the quadrivalents in a complement is six and that of the bivalents is also six, and the appearance of the trivalent in a complement took place on the decrease of the number of quadrivalents.

The component chromosomes in the associate generally join each other with the ends of the chromosomes, and the parallel pairing is quite seldom. In a quadrivalent it was found that the component chromosomes were caught with each other at a point in the spirals (Fig. 11, *g*), a rare example showing the parallel association.

Conclusion and Summary

1. A few years later after the cultivation had begun with different species of *Tradescantia* many spontaneous seedlings appeared in the field. When they grew up most of them showed the inter- or intraspecific hybridization between certain two in the stocks. Among them, those having certain characters of *T. virginiana* including the latter stock gradually disappeared. On the contrary, the descendants which leaned toward *T. canaliculata* or *T. hirsutiflora* increasingly dominated in the field year after year, except that a few vigorous ones having hybrid nature between latter two survived.

These phenomena show us that these species can hybridize; however, the parent species have their own well-harmonized components in their protoplast for the existence, consequently the hybrids having certain discordant complements were selected off gradually from the descendants.

2. We have found a few plants which have the mutant characters such as a non-flowering miniature and unisexual plants in the descendants. It is very interesting that there was found no descendant having the chlorophyll deficiencies among those descendants, though searches have been made. On the contrary, we have plants which give us the seedlings having various deficient characters concerning the chlorophyll formation, since a certain number of the stocks of *Tradescantia* were brought into our green house in 1945 from Hiroshima. There the albino and the virescent appeared with a comparatively high rate among the seedlings mixed with other deficients such as the nonflowering (H. non), unisexual (male) plants (H. males).

3. Among the S-descendants there appeared various floral colours, blue to purple with nuances, in which the purple (rhodamine purple) was prominent It is considered now that the latter may have been produced by the influence of certain yet unknown deficiency concerning bluing gene, which concerns the absorption of the mineral elements into the

cell, kept in SKBG, and brought into the offspring through the hybridization.

4. The various combinations of the various kinds of the associates in the 2n-sets were observed not only in the different stocks, but also in one and the same anther. The highest number of the quadrivalents in a complement was six, and that of the bivalents also six. The increase of trivalents in a complement was caused by the decrease of the quadrivalents. The components in an associate join each other with their ends, and the parallel pairing is seldom.

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