# Karyotype Analysis in *Tulipa* X

by Harushige TAKUSAGAWA and Masaharu YOSHIDA

(Laboratory of Biology)

# チューリップ属植物の核型分析　X

田草川 春 重・吉 田 正 温　(生物学研究室)

## INTRODUCTION

Since 1955 the present auther and his collaborators has carried out observations on the karyotypes of 155 races of *T. gesneriana* and a race of *T. edulis* was reported (Takusagawa et al. 1955, '56, '57, '58, '59, '60, '62a, '62b, '63,) Moreover, the author made the karyotype analysis in five races 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 | 2n | Karyotype | Figs |
|---|---|---|---|
| I Early Flowering Tulips | | | |
| * Double Early Tulips | | | |
| 1. race *William* III | 24 | A—1 | (1,6) |
| II Late Flowering Tulips | | | |
| * Cottage Tulips | | | |
| 2. race *Lemon Queen* | 24 | B | (4,7) |
| 3. race *Madame Mottet* | 24 | B | (5) |
| * Parrot Tutips | | | |
| 4. race *Blue Parrot* | 24 | A—2 | (3) |
| * Double Late Tulips | | | |
| 5. race *Uncle Tom* | 24 | A—1 | (2) |

## RESULTS OF OBSERVATION

1. *Tulipa gesneriana* race *William* III 2n=24 (A—1) (Fig. 1 and 6 Table 2)

This race has twenty four chromosomes in its somatic cell. As shown in Fig. 1 and Table 2 these chromosomes are composed of twelve pairs which may be classified into nine groups. The first group includes one pair of the largest chromosomes of the complement (chromosomes, nos. 1 and 2). They have each a subterminal constriction. The second group consists of one pair of large chromosomes with subterminal constrictions (3 and 4). The third group includes one pair of large chromosomes with subterminal constrictions (5 and 6). The fourth group includes one pair of large

chromosomes with submedian constrictions (7 and 8). The fifth group includes three pairs of chromosomes of middle size with subterminal constrictions (9, 10, 11, 12, 13 and 14). The sixth group includes one pair of chromosomes of middle size with subterminal constrictions (15 and 16). The seventh group includes two pairs of chromosomes of small size with subterminal constrictions (17, 18, 19 and 20). The eighth group includes one pair of chromosomes of small size with subterminal constrictions (21 and 22). The ninth group includes one pair of chromosomes of small size with subterminal constrictions (23 and 24).

Table 2　Measurements of length of somatic chromosomes in *Tulipa gesneriana* race *William* III

| Chromosomes | Long arm ($\mu$) | Short arm ($\mu$) | Whole length ($\mu$) | Relative length | F% | TF% |
|---|---|---|---|---|---|---|
| 1, 2 | 15 | 5 | 20 | 5.6 | 25 | |
| 3, 4 | 15 | 3.8 | 18.8 | 5.3 | 20 | |
| 5, 6 | 15.1 | 2.5 | 17.6 | 4.9 | 14 | |
| 7, 8 | 11.2 | 6.3 | 17.5 | 4.9 | 36 | |
| 9, 10 | 12.5 | 2.5 | 15 | 4.2 | 17 | |
| 11, 12 | 12.5 | 2.5 | 15 | 4.2 | 17 | |
| 13, 14 | 12.5 | 2.5 | 15 | 4.2 | 17 | |
| 15, 16 | 8.0 | 3.8 | 12.6 | 3.5 | 30 | |
| 17, 18 | 10 | 2.5 | 12.5 | 3.5 | 20 | |
| 19, 20 | 10 | 2.5 | 12.5 | 3.5 | 20 | |
| 21, 22 | 8.8 | 2.5 | 11.3 | 3.2 | 22 | |
| 23, 24 | 7.5 | 2.5 | 10 | 2.8 | 25 | 22 |

2. *Tulipa gesneriana* race *Lemon Queen* 2n=24 (B) (Fig. 4 and 7 Table 3)

There were twenty four chromosomes in the root-tip cell of this race. The twenty four somatic chromosomes may be classified into seven groups by their shape, size and position of constrictions (Fig. 3 Table 3). The first group includes three pairs of chromosomes of large size with subterminal constrictions (1, 2, 3, 4, 5 and 6). The second group consists of three pairs of large chromosomes with subterminal constrictions (7, 8, 9, 10, 11 and 12). The third group includes one pair of subterminally constricted chromosomes (13 and 14). The fourth group includes one pair of chromosomes of middle size with subterminal constrictions (15 and 16). The fifth group includes two pairs of chromosomes of small size with subterminal constrictions (17, 18, 19 and 20). The sixth group includes one pair of chromosomes of small size with submedian constrictions (21 and 22). The seventh group includes one pair of chromosomes with subterminal constrictions (23 and 24).

Table 3　Measurements of length of somatic chromosomes in *Tulipa gesneriana* race *Lemon Queen*

| Chromosomes | Long arm ($\mu$) | Short arm ($\mu$) | Whole length ($\mu$) | Relative length | F% | TF% |
|---|---|---|---|---|---|---|
| 1, 2 | 12.5 | 3.8 | 16.3 | 5.0 | 23 | |
| 3, 4 | 12.5 | 3.8 | 16.3 | 5.0 | 23 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 5, 6 | 12.5 | 3.8 | 16.3 | 5.0 | 23 | |
| 7, 8 | 12.5 | 2.5 | 15 | 4.6 | 17 | |
| 9, 10 | 12.5 | 2.5 | 15 | 4.6 | 17 | |
| 11, 12 | 12.5 | 2.5 | 15 | 4.6 | 17 | |
| 13, 14 | 10 | 3.8 | 13.8 | 4.2 | 28 | |
| 15, 16 | 10 | 3.8 | 12.6 | 3.9 | 30 | |
| 17, 18 | 8.8 | 3.5 | 11.3 | 3.5 | 22 | |
| 19, 20 | 8.8 | 2.5 | 11.3 | 3.5 | 22 | |
| 21, 22 | 6.3 | 3.8 | 10.1 | 3.1 | 38 | |
| 23, 24 | 7.5 | 2.5 | 10 | 3.1 | 25 | 24 |

3. *Tulipa gesneriana* race *Madame Mottet* 2n=24 (B) (Fig. 5 Table 4)

Chromosome measurements for this race are given in Table 4. The chromosomes vary in length from 23.8 microns to 8.8 microns. The twenty four chromosomes may be classified into eight groups by their shape, size and position of constrictions. The first group consists of one pair of chromosomes which is the longest in the complement, and has subterminal constrictions (1 and 2). The second group includes two pairs of chromosomes (3, 4, 5 and 6) with subterminal constriction. The third group comprises one pair of chromosomes with subterminal constrictions (7 and 8). The fourth group includes one pair of chromosomes with subterminal constrictions (9 and 10). The fifth group includes one pair of chromosomes with subterminal constrictions (11 and 12). The sixth group includes two pairs of chromosomes with subterminal constrictions (13, 14, 15 and 16). They are of the same size and shape. The seventh group includes three pairs of chromosomes with subterminal constrictions (17, 18, 19, 20, 21 and 22). The eighth group includes one pair of chromosomes with subterminal constrictions (23 and 24).

Table 4 Measurements of length of somatic chromosomes in *Tulipa gesneriana* race *Madame Mottet*

| Chromosomes | Long arm ($\mu$) | Short arm ($\mu$) | Whole length ($\mu$) | Relative length | F% | TF% |
|---|---|---|---|---|---|---|
| 1, 2 | 18.8 | 5 | 23.8 | 6.9 | 21 | |
| 3, 4 | 12.5 | 5 | 17.5 | 5.1 | 29 | |
| 5, 6 | 12.5 | 5 | 17.5 | 5.1 | 29 | |
| 7, 8 | 12.5 | 3.8 | 16.3 | 4.7 | 23 | |
| 9, 10 | 12.5 | 2.5 | 15 | 4.4 | 17 | |
| 11, 12 | 10 | 3.8 | 13.8 | 4 | 28 | |
| 13, 14 | 10 | 2.5 | 12.5 | 3.6 | 20 | |
| 15, 16 | 10 | 2.5 | 12.5 | 3.6 | 20 | |
| 17, 18 | 8.8 | 2.5 | 11.3 | 3.3 | 22 | |
| 19, 20 | 8.8 | 2.5 | 11.3 | 3.3 | 22 | |
| 21, 22 | 8.8 | 2.5 | 11.3 | 3.3 | 22 | |
| 23, 24 | 6.3 | 2.5 | 8.8 | 2.6 | 28 | 23 |

4. *Tulipa gesneriana* race *Blue Parrot* 2n=24 (A—2) (Fig. 3 Table 5)

This race has twenty four chromosomes in its somatic cell. As shown in Fig. 3 and Table 5, these chromosomes are composed of twelve pairs which may be classified into ten groups. The

first group includes one pair of the largest chromosomes of the complement (1 and 2). They have each subterminal constriction. The second group consists of one pair of large chromosomes with submedian constrictions (3 and 4). The third group includes one pair of subterminally constricted chromosomes (5 and 6). The fourth group includes one pair of chromosomes middle size with subterminal constrictions (7 and 8). The fifth group includes two pairs of chromosomes of middle size with subterminal constrictions (9, 10, 11 and 12). The sixth group includes one pair of chromosomes of middle size with subterminal constrictions (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 two pairs of chromosomes with subterminal constrictions (21, 22, 23 and 24).

Table 5　Measurements of length of somatic chromosomes in *Tulipa gesneriana* race *Blue Parrot*

| Chromosomes | Long arm ($\mu$) | Short arm ($\mu$) | Whole length ($\mu$) | Relative length | F% | TF% |
|---|---|---|---|---|---|---|
| 1, 2 | 12.5 | 3.5 | 16 | 5.5 | 22 | |
| 3, 4 | 9 | 6.5 | 15.5 | 5.4 | 42 | |
| 5, 6 | 11 | 4 | 15 | 5.2 | 27 | |
| 7, 8 | 11 | 2.5 | 13.5 | 4.8 | 19 | |
| 9, 10 | 10 | 2.5 | 12.5 | 4.3 | 20 | |
| 11, 12 | 10 | 2.5 | 12.5 | 4.3 | 20 | |
| 13, 14 | 9 | 3 | 12 | 4.2 | 25 | |
| 15, 16 | 9 | 2.5 | 11.5 | 4.0 | 22 | |
| 17, 18 | 7.5 | 2.5 | 10 | 3.5 | 25 | |
| 19, 20 | 6 | 3 | 9 | 3.1 | 33 | |
| 21, 22 | 6 | 2.5 | 8.5 | 2.9 | 29 | |
| 23, 24 | 6 | 2.5 | 8.5 | 2.9 | 29 | 25 |

5. *Tulipa gesneriana* race *Uncle Tom* 2n=24 (A—1) (Fig. 2 Table 6)

Chromosome measurements for this race are given in Table 6. The chromosomes vary in length from 12.5 microns to 7 microns. The twenty four chromosomes may be classified into nine groups by their shape, size and position of constrictions. The first group consists of two pairs of chromosomes which is the longest in the complement, and has subterminal constrictions (1, 2, 3 and 4). The second group includes one pair of chromosomes (5 and 6) with subterminal constrictions. The third group comprises one pair of chromosomes with submedian constrictions (7 and 8). The fourth group includes one pair of chromosomes with subterminal constrictions (9 and 10). The fifth group includes one pair of chromosomes with subterminal constrictions (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). They are of the same size and shape. The ninth group comprises one pair of chromosomes with subterminal constrictions (23 and 24).

Table 6 Measurements of length of somatic chromosomes in *Tulipa gesneriana* race *Uncle Tom*

| Chromosomes | Long arm ($\mu$) | Short arm ($\mu$) | Whole length ($\mu$) | Relative length | F% | TF% |
|---|---|---|---|---|---|---|
| 1, 2 | 10 | 2.5 | 12.5 | 5.1 | 20 | |
| 3, 4 | 10 | 2.5 | 12.5 | 5.1 | 20 | |
| 5, 6 | 9 | 3 | 12 | 4.9 | 25 | |
| 7, 8 | 7.5 | 4 | 11.5 | 4.7 | 35 | |
| 9, 10 | 9 | 2.5 | 11.5 | 4.7 | 22 | |
| 11, 12 | 7.5 | 2.5 | 10 | 4.1 | 25 | |
| 13, 14 | 7 | 2.5 | 9.5 | 3.9 | 26 | |
| 15, 16 | 6.5 | 2.5 | 9 | 3.7 | 28 | |
| 17, 18 | 7 | 2 | 9 | 3.7 | 22 | |
| 19, 20 | 6 | 2.5 | 8.5 | 3.5 | 29 | |
| 21, 22 | 6 | 2.5 | 8.5 | 3.5 | 29 | |
| 23, 24 | 5 | 2 | 7 | 2.9 | 29 | 28 |

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

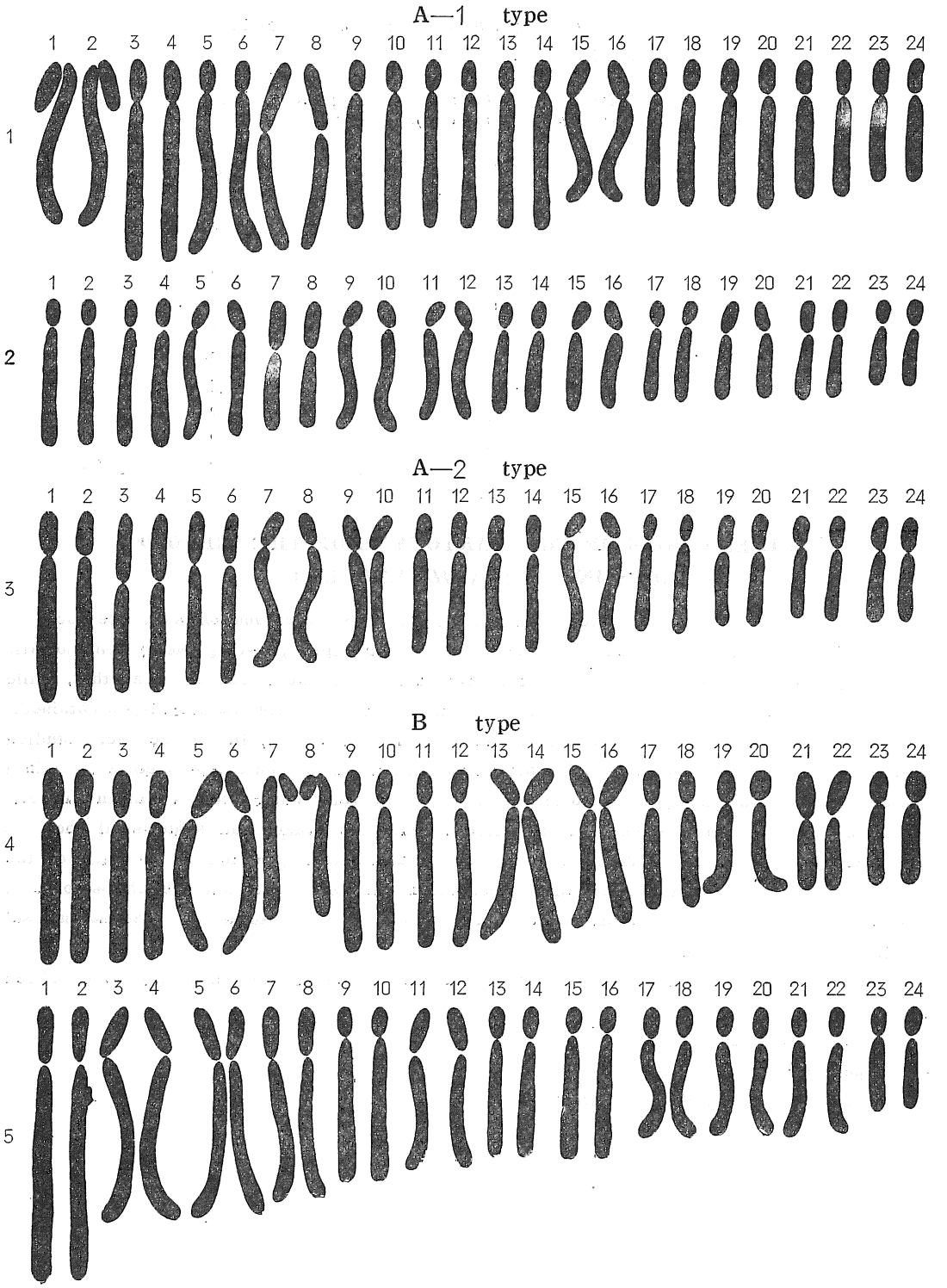
The results of the observations of the present investigation on the chromosomes in five races of *Tulipa gesneriana* have revealed that the races studied were diploid, having twenty four somatic chromosomes, and that karyotypes of some races were quite or almost similar to each other, while those of others 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, chromosome 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 chromosome of middle size each had a subterminal constriction. (4) Each of the chromosomes of smsll size had a subterminal constriction. In some race had one chromosome of small size with submedian constriction. (5) In some race 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:

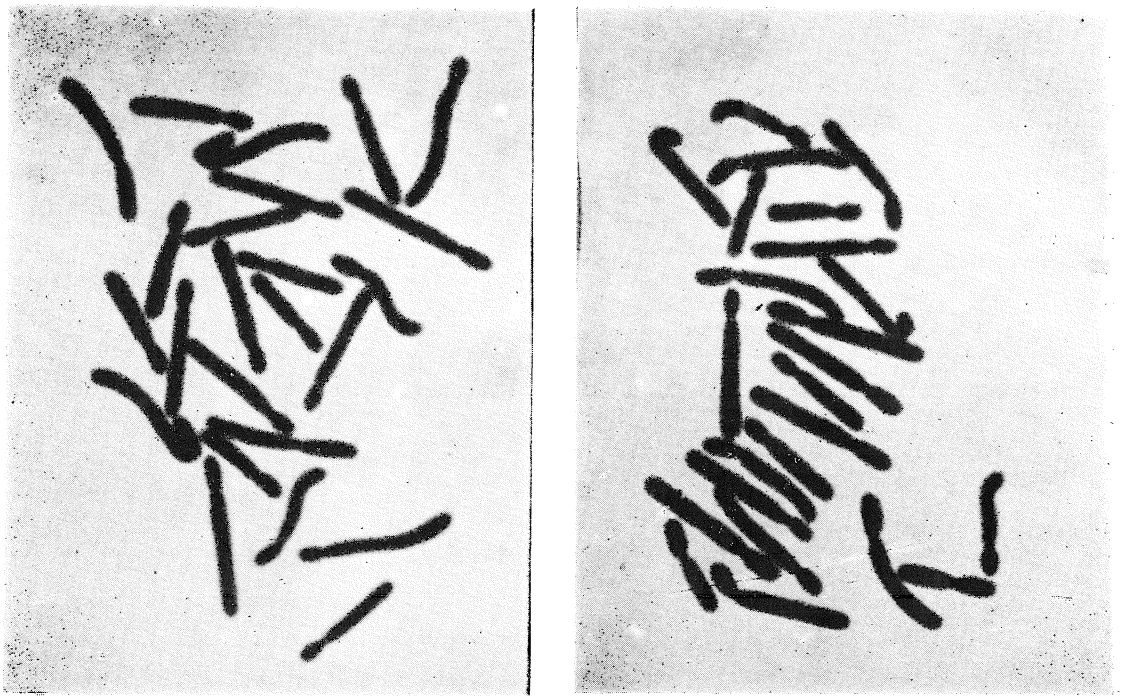
A—1 type : *William* Ⅲ, *Uncle Tom.*

A—2 type : *Blue Parrot.*

B type : *Lemon Queen, Madame Mottet.*




Figs. 1—5. Somatic chromosomes of five races in *Tulipa gesneriana*.
1. *William* Ⅲ. 2. *Uncle Tom*. 3. *Blue Parrot*. 4. *Lemon Queen*. 5. *Madame Mottete*.
(ca × 1800)



Figs. 6—7. Photomicrographs of somatic chromosomes of two races in *Tulipa gesneriana*.
6. *William* Ⅲ. 7. *Lemon Queen*. (ca. × 1320)

## SUMMARY

1. The karyotype studies were made on five races in *Tulipa gesneriana*.
2. All the races studied were diploid, having twenty four somatic chromosomes.
3. The karyotype 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 five races may be classified into three types.
A—1 type : *William* Ⅲ and *Uncle Tom*. A—2 type : *Blue Parrot*
B type : *Lemon Queen* and *Madame Mottet*.

## 摘　　要

今回核型分析を行なった種類は *Tulipa gesneriana* に属する5種類である．これらの種類はすべて二倍体であって，体細胞に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，またあるものは異な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—1の type に属するものは *William* Ⅲ と *Uncle Tom* で A—2 の type に属するものは *Blue Parrot* で B-type に属するものは *Lemon Queen* と *Madame Mottet* である．

## REFERENCES

Sisa, M., Hazu, G., Sakurai, H. & Kimura, K. (1955). The study on the Tulip-breeding. Tokyo.
Takusagawa, H. & Kashiwagi, Y., Bull. of the Shimane Agri. College. No. 3 : 38—43. (1955).
Takusagawa, H. & Yoshida, M., Bull. of the Shimane Agri. College. No. 4 : 31—48. (1956).
……, Bull. of the Shimane Agri. College. No. 5 : 130—137. (1957).
……, Bull. of the Shimane Agri. College. No. 6 A : 45—60. (1958).

……, Bull. of the Shimane Agri. College. No. 7 A : 21—34. (1959).
……, Bull. of the Shimane Agri. College. No. 8 A : 19—26. (1960).
Takusagawa, H., Bull. of the Shimane Agri. College. No. 10 B—2 : 1—32 (1962).
Takusagawa, H., Yoshida, M. & Yasukawa, T., Bull. of the Shimane Agri. College. No. 10 B—2 : 32—38. (1962).
…… , Bull. of the Shimane Agri. College. No. 11 B—2 : 1—9. (1963).
The Royal General Dutch Bulbgrowers Society (1958). A classified list of tulip names. Haarlem.
Tjio, J. H. & Levan, A., Anal. Est. Exp. Aul. Dei. 2 : 21—64. (1950b).
Tjio, J. H. & Hagberg, A., Anal. Est. Exp. Aul. Dei. 2 : 149—167. (1951).