CHROMOSOME STUDIES OF SEVERAL *ALLIUM*-PLANTS

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In the previous papers, the writer (1952, '53) gave full accounts of the karyotypes of pretty many species in *Allium*. The results of further studies on the same genus will be noted in this paper. The materials used and their localities are shown in Table 1. The same method as described in the previous paper was also employed in this work.

Table 1

Plants examined	Localities
<i>Allium Bouddhae</i> form. <i>giganteum</i>	Kyoto
<i>A. Togashii</i>	Shōdoshima, Kagawa Pref.
<i>A. Schoenoprasum</i> var. <i>foliosum</i>	Takada
<i>A. monanthum</i>	Takada
<i>A. Porrum</i>	Matsuyama
<i>A. pseudo-japonicum</i>	Tsushima, Nagasaki Pref.

Observation

Allium Bouddhae Debeaux form. *giganteum* (Makino) Araki

This form has 8 pairs of chromosomes in its root-tip cell (Fig. 1). Of those pairs, 7 are of V-shape, showing a slight difference in length successively, and the remaining one is of J-shape, being characterized by the presence of a large satellite on the short arm of each member. The satellite is slightly smaller than the short arm.

Figs. 1-3. Somatic chromosomes 1, *Allium Bouddhae* form. *giganteum* 2, *A. Togashii*
3, *A. Schoenoprasum* var. *foliosum* $\times 1200$.

The karyotype of this form just described shows no difference from that of *A. Bouddhae* reported in the previous paper (Kurita 1953).

The karyotype formula of this form is as follows:

$$K_{(2n)} = 16 = 14V + 2J^r$$

A. Togashii Hara

The chromosome number of this species is determined to be $2n = 16$ (Fig. 2). These chromosomes are classified into two haploid sets which are quite similar to each other. Of the 8 chromosomes belonging to each set, 5 are V-shaped, showing a slight difference in length successively, and the remaining 3 are J-shaped. Of these J's, the longest one has the short arm somewhat shorter than $1/2$ of the length of the long arm, the shortest one bearing a small satellite on its short arm.

The karyotype of this species is denoted by the following formula :

$$K_{(2n)} = 16 = 10V + 4J_1 + 2J_2^t$$

The writer (1952) reported that the karyotype formula of *A. splendens* Willd. was $K_{(2n)} = 32 = 20V + 8J + 4J^t$ and these 32 chromosomes were sorted into 4 sets which are approximately similar to one another. When the 8 chromosomes in each haploid set of *A. Togashii* are compared with the 8 chromosomes in each set of *A. splendens*, we cannot find any difference between both the complements.

A. Schoenoprasum L. var. *foliosum* Regel

The chromosome number of this variety was determined to be $n = 8$ by Hirata and Akihama (1927) and $2n = 16$ by Ono (1935), while these investigators did not make reference to its karyotype.

The present writer recognizes also 16 chromosomes in the root-tip cell of this variety (Fig. 3). These chromosomes are grouped into two haploid sets which are quite similar to each other. Of the 8 chromosomes belonging to each set, 7 are of V-shape showing a slight difference in length successively, and the remaining one of J-shape bearing a small satellite on its short arm.

The karyotype formula of this variety is as follows :

$$K_{(2n)} = 16 = 14V + 2J^t.$$

The chromosomes of this variety as well as those of *A. Schoenoprasum* var. *orientale* (Kurita 1953) seem, so far as the writer observes, to be fairly smaller than those of the other diploid species having 8 as the basic number. The chromosome length of *A. Schoenoprasum* var. *foliosum* will here be compared with that of *A. Bouddhae* ($2n = 16$) which is included in the section *Schoenoprasum* together with the former. The longest chromosome of *A. Bouddhae* and that of *A. Schoenoprasum* var. *foliosum* are in the ratio 100:71, the shortest chromosome of the former and that of the latter being in the ratio 100:72, according to the result obtained after the measurement of the foresaid chromosomes at 5 metaphases of the root-tip cell and 10 metaphases of the pollen grain in each plant.

A secondary constriction was observed by Levan (1936) on a certain chromosome at the metaphases of the first division in the pollen grain of *A. Schoenoprasum*, while the present writer recognizes no such constrictions on the somatic chromosomes of its variety *foliosum*.

A. monanthum Maxim.

In this species, 32 chromosomes are counted at its root-tip cell (Fig. 4). Those chromosomes are sorted into two groups. One includes 27 chromosomes, the constrictions of which vary in position from median to subterminal, and the other includes the remaining

5 having each a short arm which is extremely small and distinguishable from that of each chromosome in the preceding group. Of the 27 chromosomes in the first group,

Fig. 4. Somatic chromosomes of *A. monanthum*. $\times 1200$.

some have each a short arm which is, in length, equal to or somewhat shorter than half of the long arm. These vary slightly in number according to the difference of nuclear plates. Consequently it is almost impossible to classify the

27 chromosomes into two clearcut types, V-shaped and J-shaped types, though at least 5 of them seem to be J-shaped. Of the 5 chromosomes in the second group, 3 bear a very small satellite on the respective short arm, while the remaining 2 seem to have no satellite.

The karyotype of this species is as follows :

$$K_{(2n)} = 32 = 22V + 5J_1 + 2J_2 + 3J_2^t$$

A. Porrum L.

It was reported by Levan in 1931 that the somatic, the meiotic [and the pollen chromosome numbers of *A. Porrum* were 32, 32/2 and 16 respectively and the quadri-valents in the first metaphase of this species were less common.

The present writer also counts 32 chromosomes in the root-tip cell of this species. These chromosomes are, from the standpoint of morphology, sorted into 3 groups. The first group includes 24 chromosomes (Fig. 5, a-f) which are classified into 4 sets quite similar to one another. The 6 chromosomes belonging to each set have each a median or an almost median constriction, showing a slight difference in length successively. The second group includes 4 J-shaped chromosomes (Fig. 5, g) having each the short arm somewhat shorter than 1/2 of the length of the long arm. Of the 4 J's, 3 have each a secondary constriction almost in the middle of the short arm, and as the short arm of the remaining J takes sometimes an appearance of a dumb-bell, it may also have a secondary constriction, though the writer has not yet confirmed the presence of the constriction. The third group includes the last 4 chromosomes (Fig. 5, h) having each a submedian constriction. Of them 3 have each a secondary constriction which exists, at the short arm, approximately near the primary constriction, and the remaining one may also have such a constriction, while its presence has not yet been confirmed by the writer.

The karyotype of this species is denoted by the following formula :

$$K_{(2n)} = 32 = 24V_1 + V_2 + 3V_2^{cs} + J + 3J^{cs}.$$

A. pseudo-japonicum Makino

The chromosome number of this species is determined

Fig. 5. Somatic chromosomes of *A. Porrum*. $\times 1200$.

to be $2n = 32$. Although the chromosome configuration at the first metaphase of meiosis is not yet observed, those chromosomes seem, as shown in Fig. 6, to be grouped into two haploid chromosome sets which are quite similar to each other from the standpoint of chromosome morphology. Of the 16 chromosomes belonging to each set, 15 are of V-shape showing a slight length-difference successively, the remaining one being of J-shape with a small satellite on its short arm.

Fig. 6. Somatic chromosomes of *A. pseudo-japonicum*.
× 1200.

The karyotype formula is as follows :

$$K_{(2n)} = 32 = 30V + 2J^s.$$

Discussion

It was reported by the writer (1952, '53) that the satellites of *A. Bouddhae* and its two varieties were all large in size. *A. Bouddhae* var. *giganteum* here studied has also such a large satellite. The large size of a satellite seems, therefore, to be one of the chromosomal characteristics of *A. Bouddhae* and its varieties.

Hara (1953), who proposed *A. Togashii* as a new species, reported that the species presented some similarities to *A. splendens*. It has been found by this study that both the species have the same basic karyotype $5V + 2J_1 + J_2^s$.

The chromosomes of the two varieties of *A. Schoenoprasum* studied by the present writer (1953, in this paper) are considered to be fairly smaller than those of the other diploid forms belonging to the race having 8 as the basic number. From the standpoint of the chromosome size, the race seems to be classified into two groups.

Judged from the chromosome number, *A. monanthum* is a tetraploid in the race with the basic number 8. The species seems to show allopolyploidy, since it has 5, in place of 4, similar chromosomes, the short arms of which are extremely small. The chromosomes with such short arms, so far as the writer is concerned, have never been found in other species of *Allium*.

The karyotype of *A. Porrum* was reported to be $2n=32=24V_1+V_2+3V_2^{cs}+J+3J^{cs}$. While, it may be inferred that though there are secondary constrictions on the V_2 - and the J-chromosome in the formula, the constrictions, having no close connection with nucleolus condensation, seldom appear. At any rate, it seems to be sure that the basic complement $6V_1 + V_2^{cs} + J^{cs}$ is included in this species.

A chromosome like the V^{cs} of *A. Porrum* has already been observed in *A. Scorodoprasum* var. *viviparum* by the writer (1953), while the region between both the constrictions of the V^{cs} -chromosome of *A. Porrum* is much shorter than the same region of the V^{cs} found in *A. Scorodoprasum* var. *viviparum*. Further, the writer (1952) has observed such a chromosome as the J^{cs} of *A. Porrum* in *A. victoralis* subsp. *platyphyllum*.

The karyotype of *A. pseudo-japonicum* is quite similar to that of *A. Thunbergii*

studied by the writer (1953), no difference being found between both the karyotypes. Each of the two plants seems to be an amphidiploid between a diploid plant with $n = 8V$ and the other one with $n = 7V + J^t$.

The writer wishes to express his cordial thanks to Prof. N. Shimotomai for his kind direction throughout this work.

Summary

1. The karyotypes of the *Allium*-plants used in this study are as follows :

<i>Allium Bouddhae</i> Deb. form. <i>giganteum</i> (Makino) Araki	$K_{(2n)} = 16 = 14V + 2J^T$
<i>A. Togashii</i> Hara	$K_{(2n)} = 16 = 10V + 4J_1 + 2J_2^t$
<i>A. Schoenoprasum</i> L. var. <i>foliosum</i> Regel	$K_{(2n)} = 16 = 14V + 2J^t$
<i>A. monanthum</i> Maxim.	$K_{(2n)} = 32 = 22V + 5J_1 + 2J_2 + 3J_2^t$
<i>A. Porrum</i> L.	$K_{(2n)} = 32 = 24V_1 + V_2 + 3V_2^{cs} + J + 3J^{cs}$
<i>A. pseudo-japonicum</i> Makino	$K_{(2n)} = 32 = 30V + 2J^t$

2. The chromosomes of the two varieties of *A. Schoenoprasum* (Kurita 1952, in this paper) seem to be fairly smaller than those of the other diploid form belonging to the race with the basic chromosome number 8. Thus, it seems possible to classify the race into two groups from the chromosome size.

3. There is no difference between the karyotype of *A. pseudo-japonicum* and that of *A. Thunbergii*.

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