Cytogenetic Studies in *Avena*, VIII

A Haploid Plant of Sand Oats (*Avena strigosa*)¹⁾

Ichizo NISHIYAMA

Laboratory of Genetics, Kyoto University

Received November 8, 1960

Since the discovery of a haploid Jimson weed by Blakeslee, Belling, Farnham and Bergner (1922), haploid plants have been found in many plant genera. The cytology of haploids gives some important evidences on the critique of cytogenetic structure in their chromosome complements.

In *Avena*, including wild and cultivated species or varieties, no haploid plant has been found so far as the author is aware. According to Kappert (1933), Ramiah, Parthasarathi and Ramanujam (1933) and others, two sibs from seedlings of twins were often found to have unexpected numbers of chromosome sets such as a ratio of $2n:n$, $4n:2n$, $3n:2n$, etc. instead of normal $2n:2n$. During the period 1935-1960 in the course of the cytogenetical study in *Avena*, the author gave particular, some attention to this problem and picked up twin oats among approximately ten thousand seedlings each year. All of the twins showed no chromosome aberration except two, one being $3n:2n$ in sand oats (hybrid progeny) and the other $2n:2n-3$ in *A. fatua*.

In the study of inheritance of some mutant characters in 1960, however, one F_2 segregate was found to be dwarf and to have the haploid number (7) of chromosomes. The following is a report of cytogenetical observations on this haploid plant.

Results

In the progeny of triploid hybrids between *Avena barbata* ($n=14$) and *A. strigosa* ($n=7$), there was obtained a mutant which segregated sterile and fertile plants in a ratio of 1:3 (Nishiyama 1956). Male and female organs of the former were completely abortive.

Another strain (Td-10), also a progeny of the same triploid hybrids as given above, had pubescent and light brown outer glume of its florets. These two characters were introduced from *A. barbata*, and they are probably controlled by genes on the

1) Contribution from the Laboratory of Genetics, Faculty of Agriculture, Kyoto University No. 286.

The present investigation was supported partly by a grant from the Science Research Fund of the Ministry of Education.

a', chromosomes from the B' genome of *A. barbata* (see Nishiyama 1936, 1956).

One hybrid plant was obtained in the cross between the fertile segregate of sterile strain (58-717-2) and Td-10. The F_1 hybrid was fertile. In the F_2 generation (60-306) 200 seeds were sown and 187 plants grew to maturity. No sterile plant segregated at all. From this result it can be assumed that the F_1 hybrid had received no gene for sterility from the sterile strain. Most of F_2 plants grew normally, with a height of more than 120 cm. One plant 45 cm in height, however, attracted the author's attention by its dwarfness (Fig. 1). All of the plant organs also showed a decrease in size, e. g., narrow culms, slender leaves, etc., although the number of culms was as many as 21. This dwarf plant set no seed in free pollination in the field. The anthers showed very poor development and did not dehisce at flowering time. Female organs did not show any abnormality in their appearance. These characteristics are very suggestive of the haploidization of chromosomes in the dwarf plant.

The chromosome number was determined at the end of the season from microsporocytes stained with aceto-carmin. Seven univalent chromosomes were easily observed instead of seven bivalents. This number quite agrees with the haploid number of diploid sand oats (*A. strigosa*). At metaphase I seven univalents were usually scattered in the whole cell (Fig. 5) but sometimes two of them were loosely paired. That is, out of 109 metaphase I cells, 102 showed 7_I and seven showed a chromosome configuration of $1_{II}+5_I$ (Figs. 2-4). The paired chromosomes indicated a loose end

to end configuration. In one case two chromosomes paired side by side in somewhat early metaphase I. But it can be easily recognized from its appearance that it is only a connection between non-homologous chromosomes. From this fact it can be assumed that the loosely paired chromosomes have homology only in a short segment of the chromosomes which are able to pair in rare cases. These univalents usually did not form a nuclear plate but were assorted to the poles at random.

Chromosome assortments to the poles were observed at anaphase I or early telophase I in some PMC-s (Figs. 5-6). As was expected from the random assortment, 3~4 assortment is most frequently found and 2~5 as well as 1~6 follow in order

Fig. 1. A haploid plant of sand oats, $\times 1/5$

(Table 1). Daughter nuclei were often of different size as a result of the unequal distribution. In some cases the formation of a restitution nucleus or one big nucleus

Figs. 2-9. Meiotic figures of PMC-s of haploid sand oats. 2-4, metaphase I, $1_{II}+5_I$. 5, late metaphase I, 7_I . 6, anaphase I, 3~4 assortment of chromosomes. 7, anaphase I, 1~5 assortment, one lagging univalent is splitting longitudinally. 8, 2~4 assortment, longitudinal halves of a univalent are going to the poles. 9, telophase I with one big nucleus.

Table 1. Frequency of chromosome assortments at anaphase I in PMC-s

Chrom. assort.	0~7	1~6	2~5	3~4	Total
Observed	3	6	13	19	41
Theoretical	0.6	4.5	13.5	22.4	41

was observed at the interphase (Fig. 9). A few univalents sometimes lagged on the equator, and bridges, micronuclei, and cells with more than two nuclei were formed. Lagging chromosomes divided longitudinally and their halves usually moved to either pole but occasionally some of them failed to separate from each other (Figs. 6-7). At the end of the first division cytokinesis occurred, often imperfectly or abnormally.

The second meiotic division proceeded more irregularly than tetrad nuclei, lagging chromosomes and micro-nuclei of different sizes were usually observed. Some tetrad cells proceeded to a further development of pollen grains. That is, two or three nuclei (generative and vegetative) were sometimes observed in pollen grains. Most of

them did not appear to be viable owing to the deformed shape of nuclei or to a deficiency of cytoplasmic contents. The majority of pollen grains were abortive at flowering time. Thus, the haploid sand oats can be said to be highly or completely pollen sterile and also probably female sterile.

Literature

- Kappert, H. 1933 Erbliche polyembryonie bei *Linum usitatissimum*. Biol. Zentralb. **53**: 276-307.
- Nishiyama, I. 1934 The genetics and cytology of certain cereals, VI. Chromosome behavior and its bearing on inheritance in triploid *Avena* hybrids. Memoirs Coll. Agric., Kyoto Imp. Univ. **32**: 1-157.
- 1957 Genetic studies in *Avena* VII. Mutations in the progeny of triploid *Avena* hybrids. Proc. Internat. Genet. Symp. (1956): 318-320.
- Ramiah, K., N. Parthasarathi and S. Ramanujam 1933 Haploid plant in rice (*Oryza sativa*). Current Sci. Mysore **1**: 277-278,