CYTOGENETIC STUDIES IN THE TRIBE TRITICEAE.
VI. INTERGENERIC HYBRID BETWEEN *EREMOPYRUM ORIENTALE*
AND *AEGILOPS SQUARROSA*¹⁾

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In an attempt to clarify genetic relationships of the genus *Eremopyrum* with other genera of the tribe Triticeae, intergeneric hybrids between *Er. buonapartis* and *Er. orientale* and *Aegilops squarrosa* were produced in crosses undertaken in 1964. This report deals mainly with an intergeneric hybrid between *Er. orientale* and *Ae. squarrosa*.

MATERIALS AND METHODS

Two tetraploid species ($2n=28$) of *Eremopyrum* as female parents, *Er. buonapartis* (Spreng.) Nevski²⁾ var. *buonapartis* and *Er. orientale* (Linn.) Jaub. et Spach, and the diploid ($2n=14$) *Aegilops squarrosa* Linn. var. *typica* Zhuk. as male parent, were used.

Er. buonapartis (strain no. 7038) and *Er. orientale* (strain no. 7037) were collected at Tabriz-Ardabil, Iran in 1955 by the members of Kyoto University Scientific Expedition to the Karakoram and Hindukush (Sakamoto and Muramatsu 1965). The origin of *Ae. squarrosa* (strain no. 2) goes back to a sample sent by Dr. H. Kappert, University of Berlin, in 1934.

Two lowest florets in each spikelet of the *Eremopyrum* species were used for hybridization. The crosses were made in 1964 with plants grown in a greenhouse. Cytological studies were made with microsporocytes at meiotic metaphase using the acetocarmine squash method. Microphotographs were made from temporary slides.

Voucher specimens of the parental strains and hybrids will be placed on file with the National Science Museum, Tokyo.

RESULTS

In crosses between *Er. buonapartis* and *Ae. squarrosa* eight seeds (seven good and one shrivelled) were obtained from 85 florets; two seeds germinated and produced one true hybrid and one nonhybrid. The hybrid (culture no. 6526) was not studied in detail due to poor tillering.

From pollination of 112 florets of *Er. orientale* with *Ae. squarrosa* pollen 28 good seeds were obtained. Out of 21 seeds sown, 17 germinated and all gave vigorous F₁

1) Contributions from the National Institute of Genetics, Misima, Japan, No. 666.

2) *Er. bonaepartis* (Spreng.) Nevski (Bowden 1962)

Fig. 1. Spikes of *Er. orientale*, *Ae. squarrosa* and the intergeneric hybrid. ($\times 1.0$).

- a. *Er. orientale*
- b. *Ae. squarrosa*
- c. *Er. orientale* $\times$ *Ae. squarrosa* F_1

Fig. 2. Spikelets, glumes and seeds of *Er. orientale*, *Ae. squarrosa* and their intergeneric hybrid. ($\times 1.5$).

- a. *Er. orientale*
- b. *Ae. squarrosa*
- c. *Er. orientale* $\times$ *Ae. squarrosa* F_1

flowering of *Er. orientale*, *Ae. squarrosa* and their F_1 hybrids observed in 1965 in the greenhouse were May 1st, May 9th and April 30th, respectively. Thus the F_1 plants started to bloom as early as the *Eremopyrum* parent. Number of tillers, plant height and length of flag leaf of the F_1 were the same as those of *Eremopyrum* parent, while the length of top internodes was the same as that of *Aegilops* parent (Table 1). Length of spike of the F_1 was intermediate between the parents (Fig. 1), while the spike shape and spikelet characters were of *Eremopyrum* type as clearly shown in Fig. 2 and Table 1. The pubescent outer glume of *Er. orientale* was dominant over the glabrous glume of *Ae. squarrosa*, although the amount of hair was less in the F_1 than in *Er. orientale* (Fig. 2c). Disarticulation of ripe spikelets of *Er. orientale* is of wedge-type (rachis is brittle at every lower joint), with 2-3 florets, as shown in Fig. 2a. However, that of *Ae. squarrosa* is of barrel-type, i.e. rachis is brittle at every upper joint (Fig. 2b). The

hybrids in 1965 (culture no. 6533).

Quantitative and morphological characteristics of the parents and F_1 hybrids are presented in Table 1 and Figs.

1 and 2. The average dates of first

Table 1. Quantitative characters of *Er. orientale*, *Ae. squarrosa* and their F₁ hybrid

Characters	<i>Er. orientale</i> (7037)	<i>Ae. squarrosa</i> (no. 2)	F ₁ (6533)
Average date of first flowering	May 1st	May 9th	April 30th
No. of tillers	38.0	40.5	37.0
Plant height (cm)	49.0	70.5	42.3
Length of top internode (cm)	21.5	15.9	15.5
Length of flag leaf (cm)	4.5	13.0	5.4
Length of spike (cm)	3.9	16.6	7.4
No. of spikelets per spike	30.4	12.1	19.4
No. of florets per spikelet	2.8	3.9	3.2
Length of rachis (mm)	1.4	9.8	3.1
Length of empty glume (mm)	10.1	7.0	10.9
Length of outer glume with awn (mm)	10.6	19.5	13.9
Length of inner glume (mm)	6.8	7.3	6.9

Table 2. Chromosome pairing at MI of PMCs of *Er. orientale*, *Ae. squarrosa* and their F₁ hybrid

	Chromosome pairing	No. of cells observed	%
<i>Er. orientale</i> (7037)	14 _I	42	100.0
<i>Ae. squarrosa</i> (no. 2)	7 _I	81	100.0
F ₁ hybrid (6533)	21 _I	1,067	89.6
	1 _I +19 _I	123	10.3
	2 _I +17 _I	1	0.1

F₁ was characterized by wedge-type disarticulation as in *Er. orientale*.

Chromosome pairing at MI of the parents and F₁ plants is given in Table 2. Of 1,191 F₁ PMC's examined, 89.6% showed 21_I. The highest chromosome association was 2_I+17_I, observed in one cell only. Average chromosome pairing per cell was 0.1_I+20.8_I. All bivalents observed were associated loosely by a terminal chiasma (Fig. 3). F₁ plants showed complete pollen- and seed-sterility.

DISCUSSION

Crossability of the hybrid was 15.3% calculating from the number of hybrid plants produced/number of flowers crossed. Although the genus *Eremopyrum* is taxonomically rather distinct from other genera of the tribe Triticeae, the value for crossability indicates fairly high genetic affinity between *Eremopyrum* and *Aegilops*. From cytogenetic studies of the genus *Eremopyrum* it was assumed that *Er. orientale* is an allotetraploid derived from amphidiploidization of a hybrid between diploid *Er. distans* and diploid *Er. triticeum* (Sakamoto 1967). *Ae. squarrosa* is a diploid contributor of the D-genome to bread wheat (MacFadden and Sears 1944, Kihara 1944). From the chromosome pairing in the present F₁ hybrids the difference between two genomes of *Er. orientale* and

Fig. 3. Chromosome pairing at MI of PMCs of *Er. orientale*, *Ae. squarrosa* and their intergeneric hybrid. ($\times 750$).

a. *Er. orientale*, 14_I ; b. *Ae. squarrosa*, 7_I ; c-f. *Er. orientale* $\times$ *Ae. squarrosa* F_1
 c. 21_I , d. 21_I , e. $1_I + 19_I$, f. $1_I + 19_I$

the D-genome of *Ae. squarrosa* was clear. Absence of multivalents and occurrence of loosely connected bivalents indicate also lack of segmental genetic homology among the chromosomes of the three genomes of the two distantly related species of the same tribe.

SUMMARY

An intergeneric hybrid between *Er. orientale* and *Ae. squarrosa* was reported. The spike shape of the F_1 was intermediate between the parents but the spikelets showed the characters of *Eremopyrum*. In the majority of cells no chromosome pairing was observed. Average chromosome pairing was $0.1_I + 20.8_I$. This shows that the genomes of *Er. orientale* are quite different from the D-genome of *Ae. squarrosa*.

LITERATURE CITED

- Bowden, W. M., 1962 Cytotaxonomy of the native and adventitive species of *Hordeum*, *Eremopyrum*, *Secale*, *Sitanion*, and *Triticum* in Canada. *Can. J. Botany* **40**: 1675-1711.
- Kihara, H., 1944 Die Entdeckung der DD-Analysatoren beim Weizen. *Agr. Hort.* **19**: 889-890.
- MacFadden, E. S., and E. R. Sears, 1944 The synthesis of *Triticum spelta*. *Rec. Genet. Soc. Amer.* **13**: 26-27.
- Sakamoto, S., 1967 Genome analysis of the genus *Eremopyrum*. *Wheat Information Service* **23-24**: 21-22.
- Sakamoto, S., and M. Muramatsu, 1965 Morphological and cytological studies on various species of Gramineae collected in Pakistan, Afghanistan and Iran. *Results of the Kyoto University Scientific Expedition to the Karakoram and Hindukush, 1955, Vol. I*: 119-140.