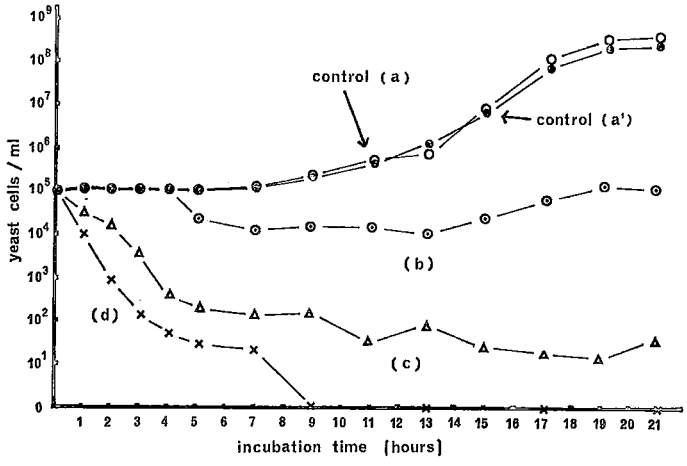
WHEAT INFORMATION SERVICE



No. 28 March, 1969

Wheat Information Service
Biological Laboratory, Kyoto University
Kyoto, Japan

CONTENTS

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I. Research Notes

Necrosis genes in *Triticum macha*, *T. spelta* and *T. vavilovi*[1)]

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Distribution of necrosis and chlorosis genes was investigated using about 120 varieties (or strains) of *Triticum macha*, *T. spelta* and *T. vavilovi*; strains of the former species were obtained from Dr. L. L. DEKAPRELEVICH, while those of the latter two were from Max-Planck Institute. Their helps are greatly appreciated.

All varieties were crossed to three testers, Jones Fife, Prelude and Macha, and their F_1 phenotypes were observed as to necrosis and chlorosis. Based on this observation, their genotype formulae were determined, that are given in Table 1.

As already reported (TSUNEWAKI and HORI 1967), Asian and Western populations of *T. aestivum* are remarkably different from each other as to the frequencies of Ne_1 and Ne_2 genes; the former is prevalent in Asian countries, while the latter is found frequently in Western countries. Both strains of Iranian *spelta* (Nos. 3929 and 3930) carried Ne_1, and on the other hand, 60% of European *spelta* varieties had Ne_2: Differentiation of *T. spelta* into the two population types is evident. *T. vavilovi* can be included into Asian type spelt from its necrosis genotype.

T. macha is distinctly different from other 6x species by having Ch_1 gene at a very high frequency (85%, contrasting to 0.0% in other species). Since all other 6x wheat species contain Ch_2 gene at high frequencies (95% or more), hybrid chlorosis caused by these genes forms a strong isolation barrier between *T. macha* and other 6x species. Hybridization between an Asian type *aestivum* and a Ch_1-carrying spelt emmer, and a consequent introgression of the Ch_1 gene to hexaploid level seem to have resulted in the origin of *T. macha*.

1) Supported by a grant from the Japan Society for the Promotion of Science as part of the Japan-U.S. Cooperative Science Program.

Table 1. Phenotypes with respect to necrosis and chlorosis of F_1 hybrids between three testers and various strains of *Triticum macha*, *T. spelta* and *T. vavilovi*, and their designated genotypes

Species and variety	Country	Strain	Tester			Designated genotype
			Jones Fife $ne_1Ne_2ch_1Ch_2$	Prelude $Ne_1ne_2ch_1Ch_2$	Macha $Ne_1ne_2Ch_1ch_2$	
T. macha colchicum	Gruzia	3566	c, n	c	+	$Ne_1ne_2Ch_1ch_2$
// *eritzianae*	//	3567	n	+	+	$Ne_1ne_2ch_1ch_2$
// *ibericum*	//	3568	c, n	c	+	$Ne_1ne_2Ch_1ch_2$
// *letschchumicum*	//	3569	c, n	c	+	//
// //	//	3570	c	c	+	$ne_1ne_2Ch_1ch_2$
// *megrelicum*	//	3571	c	c	+	//
// *palaeocolchicum*	//	3572	c, n	c	+	$Ne_1ne_2Ch_1ch_2$
// *palaeoimereticum*	//	3573	c, n	c	+	//
// //	//	3574	n	+	+	$Ne_1ne_2ch_1ch_2$
// *rubiginosum*	//	3575	c, n	c	+	$Ne_1ne_2Ch_1ch_2$
// *rubrovelutinum*	//	3576	c, n	c	+	//
// *scharaschidzai*	//	3577	c	c	+	$ne_1ne_2Ch_1ch_2$
// *subletschchumicum*	//	3578	c, n	c	+	$Ne_1ne_2Ch_1ch_2$
T. spelta albispicatum	Bulgaria	4326	+	+	c	$ne_1ne_2ch_1Ch_2$
// //	(unknown)	4327	+	n	*c	$ne_1Ne_2ch_1Ch_2$
// //	Italy	4328	+	+	c	$ne_1ne_2ch_1Ch_2$
// *albovelutinum*	Spain	3551	+	+	c	//
// *album*	Germany	3552	+	n	c, n	$ne_1Ne_2ch_1Ch_2$
// //	//	3553	+	n	*+	$ne_1Ne_2ch_1ch_2$
// //	Switzerland	3554	+	n	c, n	$ne_1Ne_2ch_1Ch_2$
// //	//	3555	+	n	c, n	//
// //	Germany	3901	+	+	c	$ne_1ne_2ch_1Ch_2$
// //	//	3902	+	+	c	//
// //	//	3903	+	+	c	//
// //	//	3904	+	+	c	//
// //	//	3905	+	n	c, n	$ne_1Ne_2ch_1Ch_2$
// //	//	3906	+	n	c, n	//
// //	//	3907	+	+	c	$ne_1ne_2ch_1Ch_2$
// //	//	3908	+	+	c	//
// //	//	3909	+	n	c, n	$ne_1Ne_2ch_1Ch_2$
// //	//	3910	+	+	c	$ne_1ne_2ch_1Ch_2$
// //	//	3911	+	n	c, n	$ne_1Ne_2ch_1Ch_2$
// //	//	3912	+	n	c, n	//
// //	//	3913	+	n	c, n	//
// //	//	3914	+	+	c	$ne_1ne_2ch_1Ch_2$
// //	//	3915	+	n	*c	$ne_1Ne_2ch_1Ch_2$
// //	//	3916	+	n	c, n	//
// //	//	3917	+	n	c, n	//

Table 1 (Continued)

T. spelta	*album*	Germany	3918	+	+	c	$ne_1ne_2ch_1Ch_2$
〃	〃	〃	3919	+	n	c, n	$ne_1Ne_2ch_1Ch_2$
〃	〃	〃	3920	+	n	c, n	〃
〃	〃	〃	3921	+	n	c, n	〃
〃	〃	〃	3922	+	+	c	$ne_1ne_2ch_1Ch_2$
〃	〃	〃	3963	+	n	c, n	$ne_1Ne_2ch_1Ch_2$
〃	〃	〃	4330	+	+	c	$ne_1ne_2ch_1Ch_2$
〃	*alefeldii*	〃	3556	+	n	*c	$ne_1Ne_2ch_1Ch_2$
〃	〃	〃	3923	+	n	c, n	〃
〃	〃	〃	3924	+	n	*c	〃
〃	〃	〃	3925	+	+	*c	$ne_1ne_2ch_1Ch_2$
〃	〃	〃	3926	+	n	c, n	$ne_1Ne_2ch_1Ch_2$
〃	*arduini*	〃	3557	+	n	c, n	〃
〃	〃	〃	3927	+	n	c, n	〃
〃	〃	Switzerland	3928	+	n	*c	〃
〃	〃	Iran	3929	n	+	c	$Ne_1ne_2ch_1Ch_2$
〃	〃	〃	3930	n	+	c	〃
〃	〃	Germany	3931	+	n	*c	$ne_1Ne_2ch_1Ch_2$
〃	〃	〃	3932	+	n	*c	〃
〃	〃	〃	3933	+	n	*c	〃
〃	〃	〃	3934	+	n	*c	〃
〃	〃	〃	3935	+	n	c, n	〃
〃	〃	Bulgaria	4331	+	n	*c	〃
〃	〃	Italy	4332	+	n	*c	〃
〃	〃	〃	4333	+	n	*c	〃
〃	〃	Hungary	4334	+	n	c, n	〃
〃	〃	〃	4335	+	n	*c	〃
〃	*coeruleum*	Germany	3558	+	+	+	$ne_1ne_2ch_1ch_2$
〃	〃	〃	3936	+	+	c	$ne_1ne_2ch_1Ch_2$
〃	〃	〃	3937	+	+	c	〃
〃	〃	〃	3938	+	+	*c	〃
〃	〃	〃	3939	+	+	c	〃
〃	〃	Rumania	3940	+	+	c	〃
〃	〃	Germany	3941	+	n	c, n	$ne_1Ne_2ch_1Ch_2$
〃	〃	Bulgaria	4338	+	+	+	$ne_1ne_2ch_1ch_2$
〃	*dasyanthum*	Hungary	4339	+	+	c	$ne_1ne_2ch_1Ch_2$
〃	*duhamelianum*	Switzerland	3559	+	n	c, n	$ne_1Ne_2ch_1Ch_2$
〃	〃	Austria	3560	+	n	c, n	〃
〃	〃	Germany	3561	+	n	*c	〃
〃	〃	〃	3942	+	n	c, n	〃
〃	〃	〃	3943	+	n	c, n	〃
〃	〃	〃	3944	+	n	c, n	〃
〃	〃	〃	3945	+	n	c, n	〃

Table 1 (Continued)

T. spelta	*duhamelianum*	Germany	3946	+	n	c, n	$ne_1Ne_2ch_1Ch_2$
〃	〃	〃	3947	+	+	c	$ne_1ne_2ch_1Ch_2$
〃	〃	〃	3948	+	n	c, n	$ne_1Ne_2ch_1Ch_2$
〃	〃	〃	3949	+	n	c, n	〃
〃	〃	〃	3950	+	n	*c	〃
〃	〃	〃	3951	+	+	c	$ne_1ne_2ch_1Ch_2$
〃	〃	Rumania	3952	+	+	c	〃
〃	〃	Germany	3953	+	+	c	〃
〃	〃	〃	3954	+	n	c, n	$ne_1Ne_2ch_1Ch_2$
〃	〃	〃	3955	+	+	c	$ne_1ne_2ch_1Ch_2$
〃	〃	〃	3956	+	n	c, n	$ne_1Ne_2ch_1Ch_2$
〃	〃	〃	3957	+	+	*c	$ne_1ne_2ch_1Ch_2$
〃	〃	Portugal	3958	+	+	*c	〃
〃	〃	Germany	3959	+	+	*c	〃
〃	〃	〃	3960	+	n	*c	$ne_1Ne_2ch_1Ch_2$
〃	〃	〃	3961	+	+	c	$ne_1ne_2ch_1Ch_2$
〃	〃	〃	3962	+	n	*c	$ne_1Ne_2ch_1Ch_2$
〃	〃	〃	3964	+	n	c, n	〃
〃	〃	〃	3965	+	n	c, n	〃
〃	〃	〃	3966	+	n	c, n	〃
〃	〃	〃	3967	+	n	*c	〃
〃	〃	〃	3968	+	n	*c	〃
〃	〃	〃	3970	+	n	*c	〃
〃	〃	〃	3972	+	n	*c	〃
〃	〃	(unknown)	1672	+	+	c	$ne_1ne_2ch_1Ch_2$
〃	〃	Bulgaria	4336	+	n	c, n	$ne_1Ne_2ch_1Ch_2$
〃	〃	〃	4337	+	n	c, n	〃
〃	*recens*	Germany	3562	+	+	c	$ne_1ne_2ch_1Ch_2$
〃	*rubrovelutinum*	〃	3563	+	+	c	〃
〃	*vulpinum*	Spain	3564	+	+	*c	〃
〃	〃	Germany	3973	+	+	c	〃
〃	〃	〃	3974	+	+	c	〃
〃	〃	〃	3975	+	+	c	〃
〃	〃	Bulgaria	4341	+	+	c	〃
〃	(unknown)	(unknown)	3565	+	+	c	〃
T. vavilovi	*vaneum*	Armenia	1674	n	+	c	$Ne_1ne_2ch_1Ch_2$

+ : normal, n : necrotic, c : chlorotic.

* : Instead of Macha, NIG-7 (genotype $ne_1ne_2Ch_1ch_2$) was used as a tester.

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Monosomic analysis of a fertility-restoring gene in *Triticum spelta* var. *dahamelianum*[1)]

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KIHARA and TSUNEWAKI (1967) reported *T. spelta* var. *duhamelianum* as an effective fertility-restorer, which restored in F_1 the fertility of a male-sterile wheat with *timopheevi* cytoplasm completely. This particular variety of *T. spelta* was studied in the present investigation by monosomic analysis to clarify the fertility-restoration mechanism.

For this analysis, a modified method of monosomic analysis was employed as follows: *T. spelta* var. *duhamelianum* was crossed as male parent to the 21 monosomic lines of Chinese Spring. At least two monosomic F_1 plants were cytologically selected in each line. At the same time some disomic F_1 plants were also isolated as the control material. Those monosomic and disomic F_1 plants were crossed as the pollen parent to male-sterile line of *T. aestivum* cultivar Bison with *timopheevi* cytoplasm (hereafter expressed by (*timopheevi*)-Bison); at least eight spikes were pollinated in each line. The seeds of all the 21 monosomic as well as disomic families of the crosses were sown in flats, and seedlings produced were transplanted to field. At the time of head emergence three spikes in each plant were covered with paraffin paper bags before anthesis to prevent cross-pollination. All the bagged spikes were harvested separately at the time of maturity, and their selfed seed fertility was estimated from the number of fully developed first and second florets and that of seeds set in them.

Although about 5% of all plants from the test-cross were semi-sterile (seed setting rate was 1~20%), a great majority of plants could be classified into two classes, completely sterile (seed set 0%) and fertile (21~100%). Including the semi-steriles in the fertile class, segregation of the sterile and fertile plants in each di- and monosomic family was tested to fit 1 : 1 ratio, the result being given in Table 1. Since the disomic family gave the 1 : 1 ratio, and both Bison and Chinese Spring with the *timopheevi* cytoplasm were completely sterile under our experimental condition, it is concluded that a single dominant gene of *T. spelta* var. *duhamelianum* is responsible for the fertility-restoration.

Of the 21 monosomic families tested, 19 satisfied the 1 : 1 ratio; this fact indicates that neither of the 19 chromosomes monosomic in these families carries the fertility-restoring gene. A significant deviation from the 1 : 1 ratio, with much less sterile and excessive fertile plants, was observed in mono-1B. Their ratio was close to 96 fertile vs. 4 sterile, that is expected in a critical monosomic family, whose monosomic chromosome carries the fertility-

1) This work has been supported by a Grant-in-Aid from the Ministry of Agriculture and Forestry.

Table 1. Segregation of fertile and sterile plants in the di- and monosomic families of the cross, (*timopheevi*)-Bison × (Chinese Spring monosomics × *T. spelta* var. *duhamelianum*) F_1

Family	No. of plants			% sterile	χ^2-value (1 : 1)
	Total	Fertile	Sterile		
Disomic	201	99	102	50.7	0.0
Mono-1A	117	55	62	53.0	0.4
〃 2A	63	24	39	61.9	3.6
〃 3A	81	47	34	42.0	2.1
〃 4A	48	23	25	52.1	0.1
〃 5A	102	58	44	43.1	1.9
〃 6A	89	46	43	48.3	0.1
〃 7A	102	42	60	58.8	3.2
〃 1B	78	71	7	9.0	52.5**
〃 2B	100	55	45	45.0	1.0
〃 3B	106	48	58	54.7	0.9
〃 4B	118	57	61	51.7	0.1
〃 5B	112	53	59	52.7	0.3
〃 6B	138	74	64	46.4	0.7
〃 7B	88	48	40	45.5	0.6
〃 1D	101	54	47	46.5	0.5
〃 2D	114	54	60	52.6	0.3
〃 3D	76	38	38	50.0	0.0
〃 4D	87	48	39	44.8	0.9
〃 5D	88	52	36	40.9	2.9
〃 6D	114	63	51	44.7	1.3
〃 7D	95	37	58	61.1	4.6*

* Significant at the 5% level.
** Significant at the 1% level.

restoring gene. This indicates that chromosome 1B of *T. spelta* var. *duhamelianum* carries the single dominant fertility-restoring gene. Distortion of the segregation ratio in mono-7D was reverse to that of mono-1B; in this family sterile plants were in excess as compared to fertile ones.

Robertson and Curtis (1967) investigated by the same method a hexaploid strain from the cross, *T. timopheevi* × *T. aestivum* cultivar Marquis[3], that is another fertility-restorer to the *timopheevi* cytoplasm, and reported that it carried one of the duplicated fertility-restoring genes, Rf_1, on chromosome 1A, while the other gene, Rf_2, could not be located, whose location was lately identified in chromosome 7D (Maan, unpublished). We found here that *T. spelta* var. *duhamelianum* carries a single dominant fertility-restoring gene on its chromosome 1B; this gene will be designated as Rf_3. It is noteworthy that Rf_1 and Rf_3

are located on homoeologous chromosomes, 1A and 1B. These findings can be utilized to increase the dosage of restoring genes in a restorer line to get the maximum seed fertility in the F_1 hybrid wheat.

As to the role of chromosome 7D in fertility-restoration, results of two previous works must be mentioned. MAAN and LUCKEN (1968) reported that Chinese Spring mono-7D with the *timopheevi* cytoplasm was somewhat fertile, while disomic Chinese Spring with the same cytoplasm was mostly sterile. Their result suggests that chromosome 7D of Chinese Spring carries a weak fertility suppressor, whose hemizygous condition causes some fertility restoration. As mentioned above, a hexaploid derivative of the cross, *T. timopheevi* × Marquis[8], received two restoring genes from *T. timopheevi*, one of which (Rf_2) was located on chromosome 7D (MAAN, unpublished). His explanation of the result is, however, hard to accept because a gene of *T. timopheevi* can be rarely transferred to a D-genome chromosome. On the contrary, presence of a weak suppressor in chromosome 7D of Marquis, as in Chinese Spring, may explain his result without any complication. From these considerations, we may assume a stronger suppressor in chromosome 7D of *T. spelta* var. *duhamelianum* than that of Chinese Spring or Marquis, in order to explain a distorted ratio of fertile vs. sterile plants in mono-7D family of the present experiment.

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On the substituting ability of individual alien chromosomes in common wheat[1)]

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The possibility of successful substitution of a single pair of alien chromosomes in the wheat genome is now established. Homoeologous relationships have also been demonstrated between the chromosomes of wheat and *Aegilops* by RILEY *et al.* (1966); between wheat and *Agropyron* by KNOTT (1964), JOHNSON (1966), and JOHNSON & KIMBER (1967); between wheat and *Haynaldia* by HALLORAN (1966), and between wheat and *Secale* by RILEY (1964) & GUPTA (1968). Dependence of substitution on the homoeology between the substituted and substituting chromosome has recently been advocated by RILEY (1964), KNOTT (1964) and JOHNSON (1966). This dependence has been described by RILEY *et al.* (1966) in the form of substituting ability of the alien chromosomes. Two kinds of substitut-

1) Adapted from a thesis submitted and approved for the degree of Doctor of Philosophy of the University of Manitoba, Winnipeg, Canada.

Table 1. Transmission of nullisomic (20W) and non-compensating substitution (20W+1R) gametes in the progenies of (21$_{II}$W) ♀ × (20$_{II}$W+1$_{I}$W+1$_{I}$R) ♂ involving three rye chromosomes

Rye chromosome	I			IV			V			Total			
Wheat monosome	Plants analysed	20W	20W + 1R	Plants analysed	20W	20W + 1R	Plants analysed	20W	20W + 1R	Plants analysed	20W	Plants analysed	20W + 1R
1D	41	2	*	23	—	—	31	3	—	95	5	54	—
2D	53	—	—	24	1	—	30	6	—	107	7	107	—
3D	31	—	*	59	3	1	29	—	—	119	3	88	1
4D	60	4	1	49	3	—	43	5	1	152	12	152	2
5D	57	—	—	24	4	—	43	—	—	124	4	124	—
6D	33	1	—	53	1	*	51	2	1	137	4	84	1
7D	—	—	—	29	—	1	31	1	—	60	1	60	1
Total (20W)	275	7		261	12		258	17		794	36 (4.5%)		
Total (20W+1)	203		1	208		2	258		2			669	5 (0.75%)

* Groups where observed frequency of substitution gametes indicated compensation and therefore have not been included in this Table. Therefore while calculating the % of functioning substitution gametes, the plants analysed in these groups(*)have been excluded from the total.

ing abilities were envisaged: (a) specific substituting ability, where substitution was specific for the homoeologous chromosomes, and (b) general substituting ability, where substitutions were possible, irrespective of any homoeologous relationship. While the presence of specific substituting ability has been amply demonstrated, the occurrence of general substituting ability is doubted (Riley *et al.* 1966). Such conclusions were, however, based on the assumption that successful substitution should give rise to healthy, viable and compensating organism. However Jenkins (1966) and Weinhues (1960, 1966) had shown that substitutions can be obtained without any homoeologous relationship between substituted and substituting chromosome. That this may be true was apparent because non-compensating disomic alien substitutions should be possible in the same manner in which 19 non-compensating nullisomic-tetrasomic wheat lines were obtained by Sears (1966). These 19 lines were obtained in only 61 combinations tried. As pointed out by Sears (1966), the possibility of some genetic relationship between non homoeologues could not be ruled out.

In a recent investigation, while studying the transmission of rye chromosome in the plants of 20$_{II}$W+1$_{I}$W+1$_{I}$R (W: wheat chromosome, R: rye chromosome) constitution, it was found that nullisomic gametes (20W) and rye substitution gametes (20W+1R), though largely eliminated, were equally efficient in the male gametophyte. Four types of gametes were expected to be formed in 19(20W): 3(20W+1R): 6(21W): 1(21W+1R) ratio (Gupta 1967, 1968). As shown in Table 1, while the nullisomic gametes were

transmitted in 4.5% cases, the substitution gametes were transmitted in 0.75% cases. Since they were formed in 19: 3 ratio, their transmission indicated that rye chromosome did not put any extra burden on the already deficient nulli gametes. If the percentage of substitution gametes was increased by using the plants of 20IIW+1IIR+1IW constitution, disomic rye substitutions could be obtained in good number. This method was practiced by JENKINS (1966) and RAY (1962) for systematic substitution of rye chromosomes in common wheat. The non-compensating rye substitutions obtained thus, would be at least as good as, if not better than, the 19 non-compensating nullisomic-tetrasomic lines obtained by SEARS (1966) in wheat. The availability of such non-compensating alien substitutions would lend further support to the concept of homoeology between specific wheat chromosomes and those of alien species. How many of the total possible 147 wheat rye substitutions can be obtained, is to be seen. Work in this direction is in progress at the Department of Plant Science, the University of Manitoba, Winnipeg, Canada.

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An induced dominant semi-dwarf plant height mutation in spring wheat*

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The analysis of an F_2 progeny from the cross of an ethyl methanesulfonate-induced mutant to its "mother" variety Marfed has clearly demonstrated the complete dominant nature of the mutation. Of 60 F_2 plants examined, only 12 were as tall (90 cm) as the male parent Marfed. The remaining plants were about the same height (60 cm) as the mutant.

The dominant mutant appears to have vigorous growth characteristics and coleoptile and first leaf growth like Marfed. In the field it appears to tiller somewhat more than Marfed, but the "raw" mutant has so far yielded significantly less. Selections will be made from the backcross progeny in an effort to improve the stock in case the lower yield is due to accessory mutations.

Seed should be available for distribution following the 1969 harvest.

Studies on toxic substance in wheat and barley against brewing yeast

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It has been reported by many authors that certain strains of beer yeast of bottom fermentation which was often used for making dough was not suitable because of its poor quality of CO_2 gas formation as summarized by LECOURT.[1,2,3] Since ever, however, this phenomenon has not been extensively studied. In the present studies, the amounts of the toxic substance against yeast in the grains of different species of cereals, especially wheat and barley, were measured.

1. Material and Method

Grain was ground to 100 mesh powder with a roller mill. The powder was suspended in five fold volume of 0.05N H_2SO_4 which was agitated for 3 hours at 30°C. After the above procedure, insoluble material was precipitated by centrifugation (8,000 rpm. 10 min.) and the supernatant was used for further experiment.

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Various amounts (0.1～1.0 ml) of the supernatant were added to a series of tubes containing 9 ml of beer wort, and total volume in each tube was made to 10 ml with distilled water.* Then, beer yeast (5×10^6 cells of strains BH 10 belonging to *Saccharomyces cerevisiae* subcultured in beer wort) was inoculated. After incubating at 30°C for 24 hours, the propagation response of the yeast cells was measured by the turbidity and gas volume.

In every experiment, the lowest amount to inhibit the propagation of yeast in the medium was defined as one unit (1 u) of the toxic activity.

In the case of using bread wheat, for example, 0.2 ml of supernatant corresponded to 1 u.

2. Results and considerations

Fig. 1 (see on the Cover) shows survival curves of yeast in control medium and in media with various toxin concentrations of 1 u, 2 u and 4 u, respectively (b～d). The number of yeast cells in wort medium was estimated as follows; 1.0～10^{-6}ml of each cort culture was transplanted on to agar medium, and after incubation at 30°C for 24～48 hours, the number of the colonies of yeast was counted. It is demonstrated in the figure that 1 unit is the static concentrations for yeast growth, while 2 or more units bring the death of almost all cells. But certain strains of staub yeast, for instance strain BH 12, were not killed by the toxin.

a. Toxic effect of various cereals:

The toxic effect of various cereals used as raw material for alcoholic beverages were examined by the above mentioned methods. The results are given in Table 1.

Table 1. The toxic effect of various cereals

Cereal	Toxic effect
Zea Mays L. (corn)	−
Holcus Sorghum var. *japonicus* (sorghum)	−
Setaria italica BEAUV. (Italian millet)	−
Panicum Crusgalli L. (deccan grass)	−
Oryza sativa L. (rice)	−
Panicum miliaceum L. (millet)	−
Hordeum vulgare L. (barley)	++
Triticum aestivum L. (wheat)	++
Secale cereale L. (rye)	−
Agropyrum seicostatum NEES (oat)	−
Barley malt	+

− : toxic effect nonexistent, + : toxic effect existent
++ : toxic effect highly existent.

* It is estimated that about 0.005N H_2SO_4 is contained in the wort medium, but it was assured that such concentration of H_2SO_4 does not affect the propagation of the yeast.

It is interesting to note that wheat and barley showed strong effect (+++) and barley malt showed about one third effect (+) while other grains showed no effect (−).

b. Toxin content of wheat species:

It is well known that wheat species are classified into three groups, namely einkorn wheat (genome constitution AA), emmer wheat (genome constitution AABB) and dinkel or bread wheat (genome constitution AABBDD). It has been established by KIHARA and others that *Aegilops squarrosa* is one of the ancestors which donated D genome to bread wheat. Consequently, a hexaploid wheat has been synthesized from the cross of emmer wheat with *Ae. squarrosa*. The toxin content of these materials were measured for the purpose of detecting the differences in toxin content among wheat species with different genome constitutions.

The results are shown in Table 2, in which nitrogen contents of these materials are also given.

Table 2. Toxin content of *Triticum* species

Wheat species	Toxin content		Nitrogen content
Triticum monococcum	20 u/g	0.25 ml*	2.45%
Triticum durum 1	10	0.50	2.53
〃 2	10	0.50	2.43
〃 3	10	0.50	2.38
T. persicum × *Ae. squarrosa*	25	0.20	2.93
Triticum vulgare	25	0.20	1.82

* indicates the lowest volume of the supernatant to inhibit the propagation of yeast in the 10 ml of wort medium (1 u). In the case of *T. monococcum*, it was calculated that one gram grain contains 20 u of toxic activity, since one gram of grain powder was suspended with 5ml of 0.05 N H_2SO_4.

As shown in the Table, emmer wheat gives a lower content of toxin, while bread wheat and synthesized hexaploid wheat give the higher content, but the further studies are now under way.

c. Toxin content of barley species:

From the studies by ÅBERG, WIEKE and TAKAHASHI[4], H. *spontaneum* and *H. agriocrithon* were estimated as the primitive forms of the cultivated type. So the toxin content of above two species and four varieties were measured for the purpose of examining if there are any differences in toxin content among barley species.

The results are shown in Table 3, in which nitrogen contents of these materials are also given. The results indicate that the content of cultivated varieties was higher than that of wild types.

Table 3. Toxin content of *Hordeum* species

Barley	Toxin content		Nitrogen content
Hordeum spontaneum	15 u/g	0.35 ml*	3.26%
〃 *agriocrithon*	20	0.25	1.36
Balder	25	0.20	1.37
Haisa	25	0.20	1.25
Kantobanshei gold	25	0.20	0.96
Tochigi gold	25	0.20	1.30

* indicates the lowest volume of the supernatant to inhibit the propagation of yeast in the 10 ml of wort medium (1u).

With the methods of fractional precipitation with ethanol and pyridine, ion exchange chromatogram and electrophoresis, the substance was purified and isolated and was found to be composed of only amino acids, as was published in Ann. Meet. Agr. Chem. Soc. Japan[5] (1967). By further studies, it has been found that moleculer weight of the toxic substance was estimated to be 9,800, and its isoelectric point was higher than pH 10.0. The details are now in press.

Acknowlegement

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Comparison of radiosensitivities of seven different genomes of *Aegilops*, *Triticum* and *Hordeum* in terms of growth inhibition

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Great numbers of radiobiological studies have been carried out in the genus *Triticum* and some of its relative genera mostly to investigate the relationship between polyploidy and radiosensitivity. However, not many workers have examined the radiosensitivity of each of the various genomes found in these genera.

Radiosensitivities of seven different genomes of diploid *Aegilops*, *Triticum* and *Hordeum* species were compared in terms of X-ray-induced growth inhibition. The seven genomes (all $n=7$) examined were S genome of *Aegilops speltoides* TAUSCH (KU 2–1), C of *Ae. caudata* L. (KU 6), C^u of *Ae. umbellulata* ZHUK. (KU 8–1), M of *Ae. comosa* SIBTH. *et* SM. (KU 17–2), D of *Ae. squarrosa* L. (KU 20–2), A of *Triticum monococcum* L. (KU 104–2), and the genome of *Hordeum distichum* L. (cv. Schwanhals). Seeds of these seven species were soaked for 12 hrs. at 20°C in dark prior to irradiation, and then exposed to 0.5 and 1 kR of 200 kV X rays at an exposure rate of 95 R/min. For each treatment and for each control 100 seeds were employed. The irradiated and control seeds were sown in wooden flats filled with steamed soil about six hrs. after irradiation (or after about 18-hr. soaking for controls) and placed in a greenhouse. The length of the first leaf was measured 10 and 16 days after irradiation on every seedling emerged.

The results obtained are presented in Table 1. At 10 days after irradiation, no very clear differences were found in the responses of the seven species after 0.5 kR treatment. However, obviously different responses to 1 kR of X rays were observed between species. That is, the postirradiation growth of *Triticum monococcum* was most greatly inhibited while that of *Hordeum distichum* least affected. Relative growths of five *Aegilops* species fell between them in the order of *Ae. speltoides*, *Ae. umbellulata*, *Ae. caudata*, *Ae. comosa* and *Ae. squarrosa*. More or less recovery of the postirradiation growth is evident for each species from the data taken 16 days after irradiation.

Based on these results, it is concluded that the seven genomes have specific radiosensitivities different from each other. The most sensitive genome among them is A, and the sensitivity decreases in the order of S, C^u, C, M, and D, with the *Hordeum* genome as the least sensitive (most resistant) one. It seems possible to say that the genomes which are believed to be closer to each other cytogenetically than to others show similar sensitivities.

An evident correlation is found between the sensitivities of some of these genomes and

Table 1. Average length of the first leaves measured 10 and 16 days after irradiation

Species (Genome symbol)	Exposure (kR)	Average length of 1st leaves (mm)	
		10 days	16 days
Aegilops speltoides (S)	0	34.1	70.5
	0.5	30.1 (88)*	65.0 (92)*
	1	15.8 (46)	47.4 (67)
Ae. caudata (C)	0	53.7	90.2
	0.5	48.9 (91)	86.6 (96)
	1	34.2 (64)	68.3 (76)
Ae. umbellulata (C^u)	0	45.3	64.3
	0.5	40.7 (90)	62.2 (97)
	1	26.1 (58)	48.2 (75)
Ae. comosa (M)	0	54.0	82.5
	0.5	50.2 (93)	80.6 (98)
	1	38.2 (71)	69.2 (84)
Ae. squarrosa (D)	0	27.4	92.2
	0.5	25.5 (93)	89.1 (97)
	1	20.9 (76)	77.3 (84)
Triticum monococcum (A)	0	107.6	121.0
	0.5	99.1 (92)	114.9 (95)
	1	38.1 (35)	48.3 (40)
Hordeum distichum (—)	0	106.7	112.3
	0.5	103.8 (97)	108.7 (97)
	1	88.0 (82)	95.5 (85)

* Percent of control.

their interphase chromosome volumes reported earlier (ICHIKAWA and SPARROW 1967, WIS **23/24**: 18~20). Namely, the interphase chromosome volumes measured for *Triticum monococcum* (A), *Aegilops speltoides* (S), *Ae. squarrosa* (D) and *Hordeum vulgare* (having the same genome with *H. distichum*) were 17.9, 16.7, 15.8 and 13.4μ^3, respectively. These values are obviously correlated with the order of sensitivity determined in the present study, supporting our earlier demonstration that the plants with larger interphase chromosome volumes are more radiosensitive (SPARROW *et al.* 1965, Radiation Botany **5**, Suppl.: 101~132; ICHIKAWA and SPARROW 1967, Radiation Botany **7**: 429~441).

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Chromosome variations in the progenies of crosses between aneuploids and euploids in hexaploid *Triticale*[2)]

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Chromosome numbers in the progenies of 41- and 43-chromosome plants in several strains of hexaploid *Triticale* were reported in previous paper (TSUCHIYA 1968b). The materials were the same strains as used for the previous study (TSUCHIYA 1968a, b) as shown in Table 1. Reciprocal crosses were made between aneuploid and euploid plants grown in greenhouse. The seed set was generally very low (Table 1); the overall average cross fertility was 26.8 percent. Chromosome numbers in the progenies of these crosses were counted with results shown in Tables 2~4. The number of plants studied was not large enough to get reliable results in each strain, therefore, a total sum was obtained by adding all data.

Table 1. Materials used for crosses and seed set in various cross combinations

Group*	Seed set (%) in crosses				
	41×42	42×41	43×42	42×43	44×42
A	17.3	10.2	17.4	—	—
B	24.5	35.5	12.5	4.5	—
C	46.4	21.2	25.0	10.6	20.8
Average	34.3	25.6	17.3	9.1	20.8

* A : 6A189 (*T. durum* var. "GHIZA"×*S. cereale*)×6A20 (*T. durum* var. "CARLTON"×*S. cereale*). B : 6A20×6A66 (*T. dicoccoides*×*S. cereale*). C : 6A69 (*T. persicum*×*S. cereale*)×6A67 (*T. persicum*×*S. cereale*).

In the cross 41×42 the frequency of 41- and 42-chromosome plants was 46.2% and 49.2%, respectively. Hyperploids were found in 3.1% plants among 65 plants from this cross. The frequency of hypoploids and 41- and 42-chromosome plants was 31.0% and 63.6%, respectively, in the reciprocal cross, 42×41. No hyperploid was observed among 42 plants in this cross. These results suggest lower transmission of 20-chromosome gametes through the male than through female.

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2) This work was supported by Research Grants from Rockefeller Foundation (RF 65019) and National Research Council of Canada.

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Table 2. Chromosome numbers in the progeny of crosses involving 41-chromosome plants

Chromosome number (2n)	41×42				42×41			
	A	B	C	Total	A	B	C	Total
40			1	1			1	1
40+1 telo							1	1
41	6	3	21	30	2	9	2	13
42	1	7	24	32	2	24	1	27
44			2	2				
Total	7	10	48	65	4	33	5	42

Table 3. Chromosome numbers in the progeny of crosses involving 43- and 44-chromosome plants

Chromosome number (2n)	43×42				42×43			44×42
	A	B	C	Total	B	C	Total	C
37			1	1				
41	1		1	2				
41+1 telo					2		2	
42	10	5	6	21	8	6	14	3
42+1 telo		1		1				
43	6	1	4	11	7		7	1
43+1 telo			1	1				
44	1			1				
Total	18	7	13	38	17	6	23	4

Telocentric chromosomes were found in one plant from the 42×41 cross (2.4%) and none in the reciprocal cross.

In the 43×42 cross 14 out of 38 plants studied had 43 or other hyperploid chromosome numbers (36.8%), and 55.3% plants were 2n=42. In the reciprocal cross, 42×43, the frequencies of hyperploids and euploids were 30.5% and 61.0%, respectively. Hypoploids were found in both cross combinations; 7.9% in the former cross and 8.5% in the latter. The frequencies of 43- and 42-chromosome plants were similar to each other in both cross combinations as shown in Tables 3 and 4. This result suggests 22-chromosome gametes might be able to compete well to 21-chromosome normal gametes in fertilization.

Telocentric chromosomes were also found in 5.2% plants in the 43×42 cross and 8.6% in the reciprocal cross. The frequency of plants with telocentric chromosome is much higher in crosses involving 43-chromosome plants (6.6%) than in those involving 41-chromosome plants (0.93%).

Out of four plants from the 44×42 cross in UM 6250 (C group), three plants were

Table 4. Summary of chromosome variations in the progenies of crosses involving monosomics and trisomics of hexaploid *Triticale*

Cross of selfing	Frequency (%) of			Total No. plants
	Hypoploid	2n=42	Hyperploid	
41×42	47.7	49.2	3.1	65
42×41	36.4	63.6	—	42
41 selfing*	79.9	18.7	1.7	118
43×42	7.9	55.3	36.9	38
42×43	8.5	61.0	30.5	23
43 selfing*	13.5	59.0	27.5	185

* TSUCHIYA, 1958b.

2n=42 and one was 2n=43.

In one cross of 43×43 in UM 6408, the numbers of 43-, 42- and 41-chromosome plants were 3, 2 and 1, respectively. Nine plants from a 42×42 cross in UM 6211 were all 2n=42.

Seven plants from a 41×42 cross showed different results from all other cross combinations similar to this; three plants had 2n=40+1 telo, two had 41+1 telo, one had 42+2 telo, and the last one plant had 42 chromosomes. This result could be explained by the assumption that the 42-chromosome plant used as a pollen parent was actually 2n=40+2 telocentric chromosomes. However, the possibility could not be ruled out that the female parent had 2n=40+1 telocentric chromosomes instead of 2n=41.

The authors wish to thank Mrs. F. NICHOL for her technical help in chromosome studies.

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History of the development of some presently promising hexaploid *Triticales*

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The important cereal grain crops such as wheat, rice, corn, oats, barley and rye used as food or feed, originated many thousands of years ago. They have all been improved by man, particularly in recent years, but even with these improvements there is a growing

concern about being able to feed the rapidly increasing populations of the world. Very recently an entirely new cereal grain crop has come into being which appears to have the potential of producing more yield per unit of land area than any of these cereals. The following chronological listing of events gives a personal viewpoint of the significant factors leading to this development:

1. Observation in the late 1800's of a fertile amphiploid from the combination of bread wheat and rye by the German plant breeder, RIMPAU.

2. Independent but simultaneous discovery in 1918 of the correct chromosome numbers in wheat by SAX in the United States and SAKAMURA in Japan followed by extensive studies of genome relationships among wheat and related plants by KIHARA and associates in Japan.

3. Discovery in 1937 that the drug, colchicine, acts as a polyploidizing agent when applied to living plant tissues.

4. Concentration of work beginning in 1938, particularly by MÜNTZING in Sweden, on the octoploid form of *Triticale* (6x wheat×rye).

5. Development and use of embryo culture techniques during the late 1940's.

6. Production, early in the 1950's of hexaploid *Triticales* (4x wheats×rye) by SANCHEZ-MONGE in Spain, O'MARA in the United States, NAKAJIMA in Japan and KISS in Hungary.

7. Observation by B. C. JENKINS in 1953 at Saskatoon, Saskatchewan, Canada, of O'MARA's wheat-rye amphiploid from "Carelton" durum wheat and spring rye initiating the desire to exploit the apparent potential of this new species.

8. Appointment of B. C. JENKINS in 1954 to a privately endowed research chair in the Department of Plant Science, University of Manitoba, Winnipeg, Manitoba, Canada, enabling him to concentrate on a study of wheat and related species, combining basic and applied research.

9. Development, together with the introduction from many countries of a large collection of *Triticales* as a basis for a breeding program with the new crop.

10. Viewing, by participants attending the First International Wheat Genetics Symposium held at the University of Manitoba in August, 1958, of a "living herbarium" including *Triticales*—a first opportunity for some scientists to become acquainted with this crop.

11. Request for material for distilling by SEAGRAM's of Canada in 1959, and later their sponsoring field increases of *Triticale* for commercial evaluation, providing a stimulus for an accelerated program of improvement.

12. Discovery and use, at the University of Manitoba in 1961, of a dwarf mutant in a field plot of Petkus winter rye.

13. Visit to the U.S.S.R. in the fall of 1961, enabling B.C. JENKINS to meet Dr. V. PISSAREV and obtain a highly fertile hexaploid *Triticale* from the cross of *Triticum persicum*×

rye.

14. Unplanned combination in a greenhouse at the University of Manitoba during the winter of 1961~62 of the fertile *Triticale* from the U.S.S.R. with a new amphiploid involving the dwarf Petkus and a winter durum wheat.

15. Period of observing the many dwarf wheats from February 15 to April 15, 1964 while B.C. JENKINS acted as Temporary Scientific Aide in the wheat program at the CIANO Station, Ciudad Obregon, Sonora, Mexico as guest of the Rockefeller Foundation, firmly establishing the idea that they should be included in any future improvement program with *Triticales*.

16. Crosses made at CIANO in April, 1964 between semi-dwarf bread wheats and hexaploid *Triticales*.

17. Appearance in February, 1965 at CIANO of the first semi-dwarf day length insensitive *Triticales*.

18. Appearance in late March, 1965 at CIANO of exceptional plants in progenies of crosses involving semi-dwarf bread wheat and hexaploid *Triticales*.

19. Publication* in 1965 by KISS in Hungary, of evidence indicating the superiority of secondary hexaploid *Triticales* over primary types.

20. Confirmation in Winnipeg, Manitoba, Canada during the summer and fall of 1965 of the superiority of hexaploid *Triticale* derivatives from the cross of octoploid and hexaploid types.

21. Observation in October, 1965 of the outstanding potential of hexaploid *Triticales* in high mountain valleys of Mexico.

22. Winter of 1965~66—the most outstanding nursery of *Triticales* at CIANO ever seen to that date.

23. Confirmation in Salinas, California and Grand Forks, North Dakota during 1967 of the superior potential of secondary hexaploid *Triticales*.

24. Selection in the spring of 1968 and comparative evaluation of lines during the summer to establish a relationship in California of as much as 50% increase in yield of some *Triticales* over wheat, barley and primary types produced at an earlier date.

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Early selection of induced genetic variability in yield components based on M_2-variances of an easily measurable trait

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Like any other breeding method, mutation breeding includes two basic procedures: (1) the production of variability and (2) the selection according to the final objective. Since FREISLEBEN and LEIN (1944), GUSTAFSSON (1947) and some other authors have shown certain mutants of crop plants to be of practical use, very efficient methods for the induction of mutations have been elaborated. Today there is no problem to produce any amount of genetic variability by ionizing radiation as well as by chemical mutagens. Certainly, the detection of recessive mutants in wheat is impeded by polyploidy. On the other hand, simple inactivation or deletion of genes, the dose of which exceeds the functional optimum may be beneficial in polyploid species. Moreover, RAO and SEARS (1964) pointed towards the interesting possibility, that the "unemployed" homologues of the duplicated genes can be altered in a way to create new functional activity, even within metabolic processes very different from the original one. In this case recessive mutations are manifested phenotypically, not only when homozygous for all four or six alleles, but already in the duplex condition. Such mutants, which arise from the transformation of accessory alleles, my be expected more likely to preserve the fitness of the initial genotype. Therefore, hexaploid wheat appears to be specially suited for mutation experiments which aim at a high percentage of mutants with positive and practically useful potentials.

Selection, the second procedure of mutation breeding, includes few problems as long as drastic mutants are desired. But there is at present no conclusive method of how to select for "small mutations", which probably are the main component of quantitative variation. The question is certainly almost the same for the selection in populations produced by crossing. After mutagenic treatment, the situation may even be less complicated, since the mutant is theoretically expected to differ from the original line only in single loci. However, the frequency of mutations leading to a positive shift in the particular characteristic may be low. Thus the progeny size of the mutagen treated population is generally the factor most seriously limiting the success of any selection.

In order to facilitate the handling of the maximum number of progenies of treated plants several methods of early selection have been proposed. For kernel yield in cereals the pos-

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sibility of a *direct early selection* was tested by RAWLINGS, HANWAY and GARDNER (1958) and BOROJEVIĆ (1965, 1966a) by screening for a high kernel number and by GAUL and MITTELSTENSCHEID (1961) by selecting for superior 1000-grain weight. To avoid a simultaneous negative shift of other yield components, e.g., a decrease of kernel number by the selection for 1000-grain weight, an *indirect early selection via indicator characters* was tried; for example, GAUL and MITTELSTENSCHEID (1961) selected for early types, and BHATIA and SWAMINATHAN (1962) or BOROJEVIĆ (1966b) for awned mutants, of which the yield was determined after the necessary multiplication of the original variants. But so far little is known about the correlations between such indicator traits and the desired yield components. By these kinds of early selection, one therefore runs the risk to lose rather than gain the desired variability.

In the following investigation on mutation breeding for kernel yield in spring wheat we abandoned any selection towards definite characteristics. For the reduction of the population size in M_2 and M_3 we used an *early selection on the basis of variability as such,* to keep the chances high for the following direct selection on yield in M_4. The variability was measured with the aid of the characteristic "ear length", which is easily accessible, sufficiently indifferent to yield, and having relatively high heritability.

Experimental results

Seeds of a line of spring wheat (3880/48, OTTO BREUSTEDT, Schladen, Germany) were soaked in different concentrations of EMS (for details see TRUJILLO, 1968). The M_1 was raised under glass and the M_2 planted ear to row. The progeny of an M_1-ear was called "family", that of an M_2-plant "line". 1888 families were grown in the M_2-generation. The efficiency of the mutagenic treatment was measured phenotypically by means of the frequency of viable drastic mutations in M_2 which ranged from 6.3% to 8.5%. But for

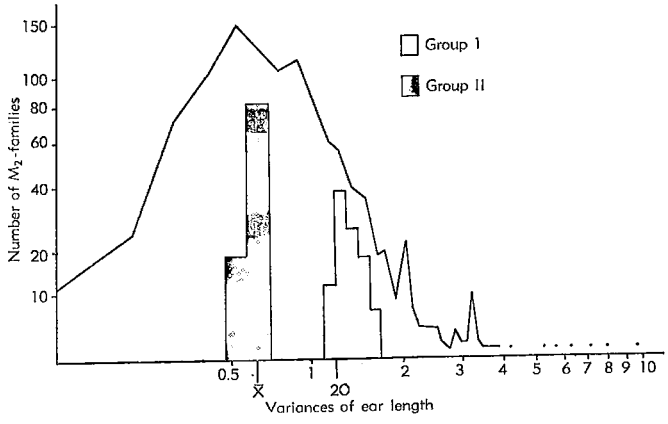

Fig. 1. Variances of the ear length within the M_2-families. The continuous line indicates the total M_2-population ; the columns represent the M_2-families with high (Group I) and normal (Group II) variances selected for the M_3-generation.

the present purpose only those 14.650 families were maintained which did not show drastic mutants, but were phenotypically normal. However, even these were far too many to be included into a yield test, which needs conventional field plots in replicate.

Of the M_2-families two groups were selected consisting of 100 families each with 10 plants (lines): Group I was characterized by a high variance of ear length and Group II by a variance equal to the untreated control (see Fig. 1). In the following M_3 the progenies of these two groups of 1000 lines each differed visibly, as well as in the various measurements performed on the mature plants after harvesting. The variability of Group I was always significantly higher. Moreover, 7.9% of the 1000 lines segregated for new drastic mutants in Group I, but only 3.8% in Group II.

In Table 1 the influence of this selection for ear length variance is shown on other characteristics of the selected M_2-plants. For the three main components of yield, the variances were also higher in Group I. Accordingly, many other characteristics as well as ear length, could have been chosen to determine the induced variability. In addition, it can be seen from Table 1 that the means are generally lower in Group I, indicating the well-known tendency of any induced variability towards the negative side.

In the M_3-generation, the high general variability of Group I was recovered and the selection, therefore, was successful. However, the difference between the two selection groups in respect to the variance of the ear length was lost in the M_3. As another reduction of the total size of the experiment was necessary, it appeared inopportune to select again for ear length variance. Instead, from both groups as well as from the untreated control, a random sample of 16 families with 10 lines each was taken for the M_4-field trial (split plot with 3 replicates in 1×2 lots). This procedure was considered satisfactory as the results of this trial indicated that the families giving lines with superior yield were scattered over the whole range of the M_3-population.

In the M_4-generation, the overall means for kernel yield within the two selection groups

Table 1. Means ($\bar{x}$) and variances (s^2) between lines within families of the M_2-generation, selected for high (Group I) and normal (Group II) variance of the ear length. The difference of all the means and variances is statistically significant ($P \leqq 0.05$)

Character	Selection group	$\bar{x}$	s^2
Number of ears per plant	I	4.37	5.16
	II	4.61	4.44
Number of spikelets per main ear	I	17.47	3.46
	II	17.62	1.98
Kernel weight per plant	I	5.57	11.90
	II	6.09	11.02

Table 2. Relative values for the components of yield and the ear length of those M_4-lines yielding more than 120 per cent of the control mean

Line number	Kernel yield	Density	1000-grain weight	Number of spikelets per ear	Ear length
Group I					
144	147**	110	123**	98	102
2553	142*	122*	98	101	104*
141	136	122*	106	102	102
2552	135	115	105	101	96
142	131	118	102	102	99
2555	122	112	108	98	101
143	121	111	101	98	100
145	121	94	103	99	94
Group II					
3202	130*	116	102	99	100
3279	128*	109	110	99	101
3207	128	118	108	105**	102
3131	127	115	100	107**	99
3204	123	116	108	101	101
Untreated control					
3047	130	101	104	100	99
48	129	102	108	102	100
1099	124	108	104	102	103
$\bar{x}$ control	1860 kg/ha	356.46 ears/m²	31.98 g	18.25 florets/ear	10.24 cm
Confidence interval					
* t=0.05 :	5.23	75.19	3.92	0.549	0.353
** t=0.01 :	6.88	98.81	5.15	0.720	0.464

were still below the corresponding mean of the untreated control, though not significantly. The yield tests in M_4, however, revealed several lines in each group with a significantly higher yield than the control mean. Table 2 shows that not only the number of such superior lines was higher in Group I, but also the best lines were found in this group. This demonstrates the success of our procedure of early selection on the basis of M_2-variances.

The superiority of the lines, detected by the yield tests in M_4, was accomplished by different means. The high yield of the line No. 144, for example, was achieved by a drastic increase of its 1000-grain weight, while in line No. 2553 a significantly higher density (number of ears per m²) was established. Not one of the lines in Group I showed a significant increase in the number of spikelets per ear, although the primary character in M_2 used to select this group was based on the ear length. This again indicates that the selection was not made for this characteristic but for its variance. Some high yielding lines were also

isolated in the untreated control population. But their improvement was based on an equal increase in all of the three components (see Table 2). The shift of the yield structure in most of the superior lines of the Group I and II indicates the mutative nature of the changes; it also offers new opportunities for a combination breeding by crossing.

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(Received October 2, 1968)

EMS treatments of inbred lines of rye

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Institute of Genetics, Lund, Sweden and Bose Research Institute, Calcutta-9, India

In September 1964 dry seeds of three different inbred lines and population plants of the rye variety Steelrye were treated with EMS solutions, the concentrations of which ranged from 0.5 to 2.5 per cent. After treatment for three hours at 18°C there was an interval of about 20 hours before the seeds could be sown. Only seeds treated with 0.5 and

1.0% EMS germinated and of the resulting seedlings most of those from the stronger treatment did not survive the winter.

The treatments, including two more inbred lines, were repeated in the following year. This time the seeds were sown immediately after treatment and in this way germination, seedling vigour and survival were sufficiently good to result in a larger number of M_1 plants and M_2 progenies.

The following *general effects* of the treatments were observed:

(a) Strong concentrations of EMS reduce germination significantly, whereas weaker doses have little or no effect.

(b) Seedling height after treatment and seedling survival vary in proportion to the concentration of the EMS solution.

(c) In M_1 seed set was reduced, the degree of sterility again varying as the strength of the EMS treatment.

(d) The stronger concentrations of EMS resulted in obvious decreases of plant weight in M_1. On the contrary, there was an indication that plant weight was stimulated by weak concentrations.

(e) M_2 seeds derived from the strongest EMS treatments germinated less well than those from weaker concentrations.

The following *differential effects* of the treatments were observed:

(a) The population material of Steelrye was clearly more resistant to EMS treatments than the inbred lines. This was found to be true of the germination of the treated seeds as well as seedling height and seedling survival.

(b) The inbred lines, which may be considered to be perfectly homozygous after a long period of inbreeding, were found to differ in their frequencies of spontaneous chlorophyll mutations. They also reacted differently to the EMS treatments with regard to primary effects as well as to the frequencies of induced mutations. Most probably, each inbred line has its specific norm of reaction to treatments with EMS.

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Interspecific hybrid between the two species of the genus *Taeniatherum* of the tribe Triticeae

Sadao SAKAMOTO
National Institute of Genetics, Misima, Japan

The genus *Taeniatherum* comprises two diploid annual species (2n=14), *Tn. asperum* (SIMONK.) NEVSKI and *Tn. crinitum* (SCHREB.) NEVSKI, distributing widely from Central Europe to Central Asia. In 1965 a strain of *Tn. asperum* (strain no. 7065) collected at

Pul-i-Khumri, Afghanistan, was crossed reciprocally with a strain of *Tn. crinitum* (no. 7064) found at Karaji, Iran. Those two strains were collected by the members of the Kyoto University Scientific Expedition to the Karakoram and Hindukush in 1955 (SAKAMOTO and MURAMATSU 1965). Only three F_1 plants, one from *Tn. asperum* × *Tn. crinitum* and two from the reciprocal combination, were obtained in 1966. F_1 plants showed vigorous growth and marked heterosis was observed in the number of tillers, plant height, and length of top internode, flag leaf and spike. However, the number of spikelets per spike was intermediate between the parents.

Chromosome pairing observed from temporary slides only in 18 MI cells of PMC's of the F_1 varied between 7_{II}, $6_{II}+2_I$, $5_{II}+4_I$, $1_{III}+2_{II}+7_I$, $1_{IV}+5_{II}$ and $1_{IV}+4_{II}+2_I$ at the frequency of 9, 1, 3, 1, 2 and 2 respectively. Average chromosome pairing per cell was $0.2_{IV}+0.1_{III}+5.8_{II}+1.9_I$. Pollen fertility of non-dehiscent anthers of the F_1 was very low (0.2~0.5%) and no seeds were obtained at maturity.

From these observations it is concluded that the two diploid species of *Taeniatherum* contain very similar but structurally differentiated genomes.

Literature

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(Received January 27, 1969)

II. A preliminary report of the Botanical Team of the Kyoto University Scientific Expedition to the Sahara and the Surrounding Areas December 1967~March 1968

K. YAMASHITA, S. SAKAMOTO and K. FUKUI
Kyoto University, Kyoto and National Institute of Genetics, Misima, Japan

The Abyssinian Highland (Ethiopia) is considered to be one of the most important world centers for the origin and differentiation of cultivated plants according to N. I. VAVILOV's theory (1926). The characteristics of this area are summarized as follows:

(1) Concentration of endemic variations of cultivated emmer wheats and barley.

(2) The birth place of teff, sorghum, finger millet, niger seed, safflower, coffee, abyssinian banana (ensete banana), castor bean and khat.

(3) Abundance of variations in chick pea, lentil, field pea, grass pea, common beans, fenugreek, sesame, flax and various spice plants.

The activity of the Botanical Team in the Abyssinian Highland was, therefore, focussed on investigating the variation patterns found in those important cultivated plants and collecting their local strains.

Members

Dr. Kosuke YAMASHITA, Professor of Biological Laboratory, Kyoto University (Leader)
Dr. Sadao SAKAMOTO, Researcher of the National Institute of Genetics
Mr. Katsuyoshi FUKUI, Graduate Student of Fac. of Agriculture, Kyoto University

Itinerary

(S. SAKAMOTO and K. FUKUI)

1967: Dec. 12	Tokyo (Japan) – Karachi (West Pakistan)
13	Stayed in Karachi
14	Karachi – Addis Ababa (Ethiopia)
15~16	Stayed in Addis Ababa; visited Ministry of Agriculture and Institute of Agricultural Research
17	Botanical excursion to Mt. Entoto, North of Addis Ababa
18~19	Stayed in Addis Ababa; visited National Museum
20	Addis Ababa – Debre Zeit – Addis Ababa; visited Agricultural Experiment Station, Haile Sellassie I University
21~23	Stayed in Addis Ababa; visited Institute of Agricultural Research
24	Botanical excursion to Mt. Entoto, North of Addis Ababa
25	Visited Horeta Branch, Institute of Agricultural Research, North-west of Addis Ababa
26~27	Stayed in Addis Ababa; visited Botany Department, Haile Sellassie I University, and Mapping & Geographic Institute
28	Visited Botany Department, Haile Sellassie I University; Addis Ababa – Debre Zeit; visited Agricultural Experiment Station, Haile Sellassie I University
29	Botanical excursion to the South of Debre Zeit
30	Botanical excursion to the East of Debre Zeit
31	Botanical excursion to the South-east and West of Debre Zeit
1968: Jan. 1	Debre Zeit – Addis Ababa – Debre Zeit
2~3	Stayed in Debre Zeit
4	Debre Zeit – Addis Ababa – Debre Zeit
5	Botanical excursion to Mt. Erer, East of Debre Zeit
6~7	Stayed in Debre Zeit

Jan.	8	Debre Zeit – Addis Ababa – Mt. Entoto – Sululta – Debre Zeit
	9	Debre Zeit – Addis Ababa – Debre Zeit
	10	Debre Zeit – Mojo – Nazareth – Awash
	11	Awash – Mieso – Kurubi – Alemaya; visited College of Agriculture, Haile Sellassie I University
	12	Stayed at College of Agriculture, Haile Sellassie I University
	13	Alemaya – Harrar – Jijiga – Alemaya
	14	Alemaya – Dire Dawa – Alemaya – Kurubi – Alemaya
	15	Alemaya – Harrar – Alemaya
	16	Alemaya – Kurubi – Deder – Alemaya
	17	Alemaya – Dire Dawa – Erer Gota – Mieso – Awash
	18	Awash – Nazareth – Mojo – Addis Ababa
	19～22	Stayed in Addis Ababa; visited Institute of Agricultural Research
	23	Addis Ababa – Fiche – Dejen
	24	Dejen – Debre Marcos – Bahar Dar
	25	Bahar Dar – Addis Zemen – Gondar
	26	Visited Provincial Department of Agriculture, Gondar – Gorgora – Gondar
	27	Gondar – Adi Arkai – Enda Sellasie – Axum
	28	Axum – Adi Ugri – Asmara
	29～31	Stayed in Asmara; visited Department of Agriculture
Feb.	1	Asmara – Nafasit – Asmara
	2	Asmara – Senafe – Adigrat – Makale
	3	Makale – Quiha – Maichew – Alamata
	4	Alamata – Kobbo – Weldiya – Dessie
	5	Stayed in Dessie; visited Provincial Ministry of Agriculture
	6	Dessie – Kembolcha – Bati – Dessie; visited Headquarters of Chinese Veterinary Team, Kembolcha
	7	Dessie – Karakore – Debre Sina – Debre Berhan
	8	Debre Berhan – Molale – Debre Berhan
	9	Debre Berhan – South of Jihur – Debre Berhan – Addis Ababa
	10	Addis Ababa – Debre Berhan – Addis Ababa
	11～14	Stayed in Addis Ababa

(K. YAMASHITA)

Feb.	8	Tokyo – Anchorage
	9～10	Amsterdam; IUBS Meeting
	11～13	Amsterdam – Cairo – Addis Ababa
	14	Stayed in Addis Ababa

(K. YAMASHITA, S. SAKAMOTO and K. FUKUI)

	15	Addis Ababa – Debre Zeit – Addis Ababa; visited Agricultural Experiment

Station, Haile Sellassie I University

Feb. 16～18 Stayed in Addis Ababa; visited Ministry of Agriculture and Institute of Agricultural Research

19 Addis Ababa – Ghion – Jimma

20 Jimma – Agaro – Dembi – Jimma

21 Visited Jimma Agricultural Technical School; Botanical excursion to the South of Jimma

22 Jimma – Ghion

23 Ghion – Addis Ababa

24～25 Stayed in Addis Ababa

26 Addis Ababa – Mojo – Maki – Lake Langano

27 Lake Langano – Shashamane – West of Kolito – Shashamane

28 Shashamane – Yirgalem – South of Wendo – Lake Langano

29 Lake Langano – Maki – Mojo

March 1 Mojo – Addis Ababa

2～3 Stayed in Addis Ababa

4 Addis Ababa – Debre Zeit; visited Agricultural Experiment Station, Haile Sellassie I University

5 Debre Zeit – Addis Ababa

6 Stayed in Addis Ababa

(K. YAMASHITA)

7 Addis Ababa – Khartoum (Sudan)

8～9 Stayed in Khartoum

10 Khartoum – Addis Ababa

11～12 Stayed in Addis Ababa

13 Addis Ababa – Karachi –

14 Tokyo

(S. SAKAMOTO)

7～12 Stayed in Addis Ababa

13 Addis Ababa – Karachi

14 Stayed in Karachi

15～16 Karachi – Tokyo

(K. FUKUI)

7 Addis Ababa-Khartoum

8～April 3 Stayed in Khartoum

4 Khartoum – Addis Ababa

5～May 15 Stayed in Ethiopia

16 Addis Ababa – Karachi – Tokyo

Collections

Along the expedition routes various cultivated plants were observed and collected. Field collections are summarized in Table 1. About 1,500 herbarium specimens of wild plants were also made during the expedition. At the same time market collections of cultivated plants and agricultural utensils were made at 21 different local places along the routes as listed in Table 2.

Table 1. Field collections in the Abyssinian Highland (KUSES 1967~68)

Species name	No. of samples	Species name	No. of samples	Species name	No. of samples
Triticum dicoccum	32	*Pisum sativum*	8	*Linum usitatissimum*	8
Tr. polonicum	1	*Cicer arietinum*	5	*Guizotia abyssinica*	4
Tr. durum+turgidum	388	*Lens esculenta*	1	*Carthamus tinctoria*	2
Tr. aestivum	79	*Vicia faba*	4	*Sesamum indicum*	—
Hordeum vulgare	208	*Lathyrus sativus*	1	*Ricinus communis* (wild)	2
Zea mays	19	*Phaseolus* spp.	2	*Lepidium sativum*	3
Sorghum bicolor	58	*Trigonella foenum*	1	*Brassica carinata*	10
wild *Sorghum*	5	*Crotalaria* spp.	2	wild *Brassica*	7
Eragrostis abyssinica	36	wild Leguminosae	22	*Rhaphanus* sp.	2
Avena sp.	9	*Helianthus annuus*	1	*Capsicum frutescens*	2
Lolium temulentum	22	wild Compositae	4	others	59
Eleusine coracana	11				
wild Gramineae	38			Total 1,056 samples	

Table 2. Market collections in the Abyssinian Highland (KUSES 1967~68)

Name	No. of samples	Name	No. of samples	Name	No. of samples	Name	No. of samples
wheat	45	grass pea	7	red pepper	20	*Hagenia abyssinica* (koso)	20
barley	41	common beans	21	squash	10	*Rhamnus prinoides* (gesho)	6
corn	32	peanut	1	onion	13	*Nigella sativa* (tikur azumud)	20
sorghum	45	fenugreek	19	garlic	11	*Carum copticum* (nechi azumud)	20
teff	26	niger seed	10	tomato	2	*Embelia schimperi* (unkoko)	10
finger millet	8	safflower	5	potato	5	*Aframomum korarima* (kororima)	10
field pea	31	sesame	11	ginger	11	other spices and drug plants	131
chick pea	23	castor bean	12	garden cress	15	incense (etan)	9
lentil	19	mustard	23	coffee	7	others	42
horse bean	24	cotton	4			Total 759 samples	

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III. Editorial Remarks

Announcement for future issues

WIS Nos. 29~30 will be published during the fiscal year from April, 1969 to March, 1970. Manuscripts for these issues are accepted any time, and go to press in sequence as soon as they cover planned pages of each issue.

WIS is open to all contributions regarding methods, materials and stocks, ideas and research results related to genetics and cytology of *Triticum, Aegilops, Agropyron, Secale, Haynaldia* and related genera. Contributions should be typewritten in English. The manuscripts should not exceed five printed pages. Lists of stocks are exempted from this page limit. One text-figure (smaller than 7×7 cm^2) will be accepted for each article, if indispensable. Fifty copies of reprint are free of charge, but additional copies are supplied by request at cost price. Communications regarding editorial matters should be addressed to:

K. YAMASHITA
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Kyoto, Japan

Membership

The yearly membership fee is 360 yen or the equivalent paid by Demand Draft, payable at the Dai-Ichi Bank Ltd. the Sumitomo Bank Ltd., Kyoto, Japan, or by the Foreign Postal Money Order.

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The Managing Editor

Explanation of the Figure on the Cover

Fig. 1. Survival curves of yeast (strain BH 10) in (a) control medium (toxin free) and in (b~d) media containing various doses of toxin respectively; namely b. 1 u (0.2 ml), c. 2 u (0.4 ml), d. 4 u (0.8 ml). (a'); survival curve of yeast (strain BH 12) in the medium containing 4 u (0.8 ml). (cf. T. OKADA, H. YOSHIZUMI and Y. TERASHIMA, pp. 10~13 in the present issue.)