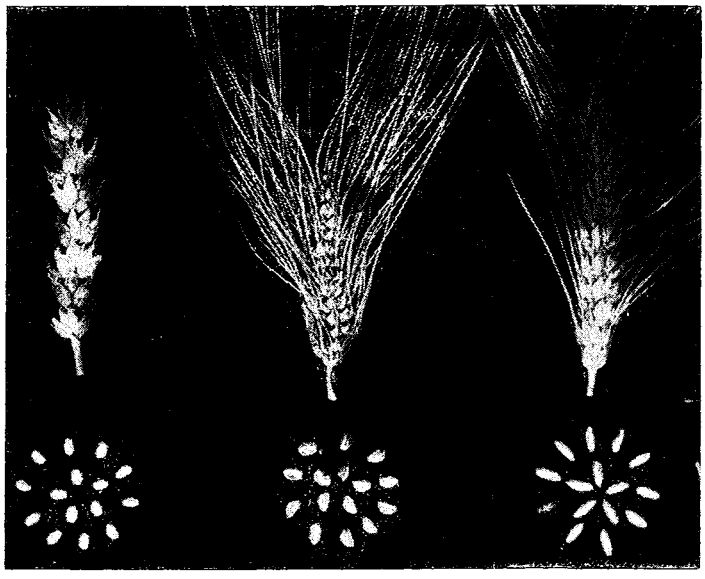
WHEAT INFORMATION SERVICE



a b c

No. 39 October, 1974

Wheat Information Service
Kihara Institute for Biological Research
Misima, Japan

CONTENTS

No. 39 October, 1974

I. Research Notes

Aegilops speltoides promotion of homoeologous pairing in one *Triticum aestivum* × *Agropyron intermedium* derivative

Yvonne CAUDERON and G. RYAN
Station de Génétique et d'Amélioration des Plantes I.N.R.A.-78000-Versailles, France

It will be reported here some preliminary data from a wider program designed to exploit the disease resistance of *A. intermedium* by transferring it into common wheat. In this part of the work, one ditelosomic addition line, TAF 2d (21_{II} ABD+t_{II} 7 Agi α) previously obtained (GAUDERON *et al.* 1969), was used as female in crosses with a strain of *Ae. speltoides* (collected near ASHQUELON, Israel, and kindly provided by M. FELDMAN), with the aim of inducing homoeologous pairing between the *Agropyron* telosome, carrying a gene (s) for resistance to stem rust (*Puccinia graminis tritici* ERICKS. and HENN.) and its wheat homoeologous (7D). In successive backcrosses, several common wheat cvs (Vilmorin 27, Champlein, Capitole) and another ditelosomic addition line, TAF_1 d, were used as male parents. Different features for successive generations are summarized in Table 1. Both the F_1 and BC_1 plants showed almost complete self sterility but gave some seeds when backcrossed to wheat. Seed setting was better on BC_1 (4.28%) than in F_1 (2.36%). The pollen sterility decreased from 95 to about 50%. However anthers were

Table 1. Pollen sterility and seed setting for different generations of (TAF 2d × *Ae. speltoides*) hybrid

Generation/year	Pollen sterility (%)	No. of pollinated florets	Seeds per pollinated florets (%)	No. seeds obtained	No. plants obtained	Germination time (days)
Previous similar crosses	–	1866	0.37	7	0	–
Original cross-1971 (field)	–	175	4.57	8	1	35
F_1 1972 (field)	>95	806	2.36	19	8	7 to 13
BC_1 Greenhouse-1973	≧50	959	5.11 } mean 4.28	49	not tested	–
BC_1 Field-1973	≧50	1539	3.77 }	58		–

indehiscent in both cases. Germination time showed a considerable decrease, and viability was increased in BC_1 seeds; chromosome numbers of the 8 BC_1 plants were respectively: 2n=35 (4 plants), 36 (2 plants), 37 (1 plant), 37 t (1 plant from a backcross to TAF_1 d). These results are in agreement with those obtained by RILEY and KIMBER (1966) in one "standard" cross, *T. aestivum* cv Holdfast mono 5B × *Aegilops bicornis* (FORSK.) JAUB. So if pattern is the same for the next generations of this cross it may be assumed that the chances to recover, many meiotically regular 42-chromosome derivatives would be high.

Chromosome pairing at M_1 was studied for both the F_1 and TAF_2 d, and compared to other relevant data, (Table 2): a mean number of 24.23 associated chromosomes per cell was found. The level of pairing is high: 83.5% of the chromosomes are involved

Table 2. Comparative meiotic pairing of some *Triticum* × *Aegilops* hybrids

Material	Chrom. number	No. of cells	Meiotic pairing : mean + (range)						Number of Xta/cell	Associated chromosomes	
			univ.	biv.		triv.	quadriv.	pentav.		mean no.	%
				ring	total						
TAF 2d	42+2t	100	0.10 (0~2)	19.82 (17~22)	21.95 (21~22)	—	—	—	41.77 (39~44)	43.90	99.77
F_1 (TAF 2d × *Ae. speltoides*)	28+t	100	4.77 (0~11)	3.51 (0~9)	6.77 (2~12)	1.29 (0~5)	1.34 (0~4)	0.12*** (0~2)	18.49 (12~25)	24.23	83.55
F_1 (Agrus Tc^7 × *Ae. speltoides*) III*	28+t	114	7.00	—	7.85	1.60	0.32	0.01	14.96	22.00	75.86
F_1 (Agrus Tc^7 × *Ae. speltoides*) I*	28+t	—	15.55	—	5.79	0.59	0.03	—	6.70	13.45	46.38
F_1 (*T. aestivum* × *Ae. speltoides*)**	28	50	6.04	—	6.64	1.88	0.76	—		21.96	78.42
F_1 (*T. aestivum* × *Ae. longissima*)**	28	100	24.04		1.96	0.01		—		3.96	14.14

Data adapted from (*) DVORAK (1972) and (**) RILEY and KIMBER (1966) ;
(***) hexavalent : 0.12 (0~2), heptavalent : 0.02 (0~1)

Table 3. Number of PMC with each type of chromosome configuration (100 PMC's)

Chromosome configurations	Number of chromosome configurations per cell												
	0	1	2	3	4	5	6	7	8	9	10	11	12
Univalents	1	4	9	14	19	18	15	6	11	1	1	1	—
Bivalents	—	—	3	3	10	13	16	19	13	9	10	3	1
Trivalents	27	39	20	8	4	2	—	—	—	—	—	—	—
Quadrivalents	24	33	31	9	3	—	—	—	—	—	—	—	—
Pentavalents	89	10	1	—	—	—	—	—	—	—	—	—	—
Hexavalents	89	10	1	—	—	—	—	—	—	—	—	—	—
Heptavalents	98	2	—	—	—	—	—	—	—	—	—	—	—

in associations against 99.8% in TAF_2 d. More than 50% of the bivalents are closed and the mean number of xta/cell is 18.49 (0.64/chromosome). In Table 3 frequencies of different chromosome configurations per cell are recorded. An unique feature of this hybrid is the presence of the *Agropyron* telosome acting as a cytological marker and thus allowing to measure accurately specific pairing between *Agropyron* and *Triticum* homoeologous chromosomes. In this case, heteromorphic configurations were clearly identified in 15 cells and *Agropyron* telosome was included in 12_{II}, 2_{III}, and 1_{IV} (CAUDERON *et al.* 1973).

Results of two F_1 from RILEY and KIMBER (1966) (Table 2) allow to compare parallel hybrids including *T. aestivum* and, alternatively, *Ae. speltoides* or *Aegilops longissima* SCHWEINF. and MUSCH. (2n=14). The mean number of bivalents of the F_1 (*T. aestivum* × *Ae. speltoides*) is practically the same as in the present hybrid. Taking into account the different chromosome number, and substracting from the total frequency (6.77%) the heteromorphic associations implying the *Agropyron* telosome, the corresponding figure is 6.65. Higher associations give an overall frequency of pairing about 5% higher in this case. It can be stated that the presence of the alien chromosome has no disturbed free homoeologous pairing involving *Triticum* and *Aegilops* genomes. DVORAK data (1972) belong to two F_1 between a ditelosomic addition line (Agrus T_c^7) and *Ae. speltoides* with a "low" (I) and a "high" (III) levels of activity. Even in spite of a higher bivalent frequency, the mean number and the % of associated chromosomes are lower than those of RILEY and KIMBER and present data. DVORAK and KNOTT (1972) also reported that with *Ae. speltoides* (level III), the % of heteromorphic associations involving the *Agropyron* telosome (7 Ag) was 12.3 against respectively 45.0 and 77.0 for the wheat telosomes 7B or 7A. DVORAK (1971) reported pairing of three other *A. elongatum* telosomes with wheat chromosomes but frequencies are not indicated. It is interesting to note that for another *A. elongatum* telosome (homoeologous with group 6) JOHNSON and KIMBER (1967) found that it was involved in heteromorphic associations in an overall frequency of 4.8% (0.0 to 10.8) of PMC, whilst, 18 wheat telosomes tested exhibited a mean pairing of 51.1% (34.0 to 71.3). In this work, it must be emphasized that the pairing frequency of 15% observed for the *Agropyron* telosome was recorded in a higher overall pairing frequency background (Table 2), as compared with the other mentioned cases, but there is no wheat telosomes behaviour for comparison. In turn, JOHNSON and KIMBER (1967) made no estimation of overall frequency.

It is evident that *Agropyron* telosomes pair much less frequently than any of the wheat telosomes observed. Some explanation of this contradiction observed between the pairing behaviour of the *Agropyron* telosomes and their ability to substitute very efficiently for wheat chromosomes, was advanced by RILEY and CHAPMAN (1966). These authors think that the pairing affinities have diverged further than the factors controlling gene-

tic equivalence, possibly because these changes in limited and specific chromosome regions are evolutionary more tolerated than changes with more radical effects in vital physiological processes. Inversely, according to ATHWAL and KIMBER (1972), two homoeologous chromosomes may have equivalence in pairing segments while showing different alleles on them. Pairing affinities would be determined by the interaction of two factors: the homology in nucleotide sequences in the sites of recognition and its activation by a balanced system of genes (DVORAK 1972). It could be reminded that, besides these factors, situation in the particular case of telosomes might be complicated because of the absence of one entire arm which could carry some important sites responsible for pairing ability for the whole chromosome; this fact would be also illustrated by the variation found in pairing frequency of the wheat telosomes.

Besides some obvious differences in experimental conditions, general differences in pairing frequencies, as those shown in Table 2, may well be caused by some other factors. In one complex interspecific hybrid (each one is a unique individual recombination product) there must be, within the limits of its homoeology, a competition in pairing ability between participating chromosomes, in this case: *Triticum, Aegilops* and the *Agropyron* telosome. Three are few quadrivalents and higher associations in 5B-deficient haploids of *T. aestivum* but these associations are more frequent when *Aegilops sp.* are included in 5B-deficient hybrids (RILEY and KIMBER 1966); pairing between wheat and *Aegilops* chromosomes is shown when *Ae. speltoides* or *Aegilops mutica* BOISS. (2n=14) are used to suppress the effect of 5B (RILEY and CHAPMAN 1964). Indeed, overall pairing frequency obtained here (24.23%) correspond to 16.71 if only 20 chromosomes were present and is substantially higher than the reported 12.07 in nulli-5B haploids of *T. aestivum* (KIMBER and RILEY 1963). According to previous work in this field and to present data it is possible to state that it would not be easy to employ this method as a simple additional tool in conventional plant breeding. There are two main handicaps: difficult interspecific hybridization and subsequent hybrid sterility. This difficulty to get any seeds from this type of cross, is shown by present data and unpublished results obtained in this laboratory both under greenhouse and field conditions. Even if this problem could be presumably surmounted by means of embryo culture, it would still remain another major obstacle in the weak viability of resulting seeds and in the high sterility of the first generations. It is possible, however, to get new recombinations through this method; they will give, after the first sterile generations, enough individuals to allow further selection.

It could be useful to remark the importance of genotypic variability of the different species employed. In the case of *Aegilops*, this was pointed out by FELDMAN and MELLO-SAMPAYO (1967). Because *Ae. speltoides* is a cross-pollinated species a high heterozygosity is expected for many characters, including homoeologous pairing promotion in hybrids;

this is still complicated by its spontaneous interspecific crossability within the genus. It is not surprising then to find such differences, as reported for promoting levels (DVORAK 1972), for *Ae. mutica* pairing induction (RILEY *et al.* 1971) and for both *Ae. speltoides* and *Ae. mutica* homoeologous pairing promotion (DOVER and RILEY 1971). Moreover, intraspecific variability present in the *Agropyron* source employed may determine some differences in pairing behaviour and it must also considered the genetic back-ground of *T. aestivum* which has been crossed: *e g,* TAF 2d has been derived from a "V. 27" background and structural chromosome differences between this cultivar and *Chinese Spring* are known (THE and BAKER 1970, CAUDERON 1974). Finally, differential interactions between other identified genetic factors responsible for normal meiotic pairing and genetic systems involved in *Ae. speltoides* (or *mutica*) (FELDMAN 1968) may also be responsible of differences in homoeologous pairing in interspecific hybrids.

(Received June 1, 1974)

Meiotic studies of 3 generations of backcrosses to the amphidiploid hybrid *Triticum durum* DESF. × *Agropyron intermedium* (HOST) BEAUV.[1)]

B. A. YOUNG and J. SCHULZ-SCHAEFFER
Department of Plant and Soil Science and Genetics Institute, Montana State University, Bozeman, Montana 59715, U.S.A.

Progress has been made towards the development of a meiotically stable male sterile derivative from the cross *Triticum durum* DESF. × *Agropyron intermedium* (HOST) BEAUV. (SCHULZ-SCHAEFFER *et al.* 1971, 1973).

Material and methods

Perennial amphidiploids (AD) in the F_7 and F_8 generations were used as parent material in these investigations. *T. durum* served as the female parent. *A. intermedium* was used as the recurrent backcross parent in all 3 backcross generations (SB_1, SB_2 and SB_3).

Spikes were collected in the field, fixed in a 3:1 mixture of absolute ethanol and acetic acid (Farmer's formula), and stored in 70% ethanol. Staining was done in aceto-carmine according to the smear technique (SMITH 1947). Part of the study of univalents in th SB_3 was done in metaphase I (MI) of meiosis. Since MI is a relatively long stage, it enables a favorable chance for observing a high number of cells. We analyzed 2915

1) Contribution of the Montana Agricultural Experiment Station, Bozeman Montana, U.S.A. Paper No. 530, Journal Series, Montana Agr. Exp. Sta., published with approval of the Director.

cells of 52 plants in MI. Only 234 cells could be analyzed where bivalents and univalents could be identified in the same cell. These observations were done in stages of shorter duration such as diakinesis and anaphase I.

Results and discussion

In Table 1 the observed chromosome pairing and total chromosome numbers of all 3 backcross generations (SB_1, SB_2 and SB_3) are compared with the pairing in *A. intermedium* and with the expected values. The observed average number of bivalents increased from 11.7 in the SB_1 to 19.1 in the SB_2 and to 20.2 in the SB_3. Stabilization towards the expected number of 21 bivalents has proceeded rapidly, yet has still not been completed as reflected in the range (14~21 bivalents) and the pooled variance of the mean (Table 3, $s_p^2/n=0.14$) of the SB_3. The observed average number of univalents decreased from 21.0 in the SB_1 to 7.9 in the SB_2 to 2.4 in the SB_3. This is rapidly approaching the zero value for univalents in *A. intermedium*. The observed average total chromosome number decreased from 47.0 in the SB_1 to 45.0 in the SB_2 to 43.0 in the SB_3. This is very close to 2n=42 of *A. intermedium*.

Table 1. Comparison of chromosome pairing and total chromosome number in the SB_1, SB_2, and SB_3 generations

Materials	No. plants investig.	No. of Bivalents			No. of Univalents			Total chromosome no.			PMC's investig.
		expect.	calculated		expect.	calculated		expect.	calculated		
			avg.	range		avg.	range		avg.	range	
SB_1	25	21.0	11.7	0~26	14.0	21.0	2~47	56.0	47.0	16~62	311
SB_2	25	21.0	19.1	4~29	7.0	7.9	0~39	49.0	45.0	32~68	816
SB_3	35	21.0	20.2	14~21	3.5	2.4	0~25	45.5	43.0	34~52	234
A. intermedium	—	21.0	—	—	0.0	—	—	42.0	—	—	—

Table 2. Comparison of observed and expected numbers of bivalents and univalents in 3 backcross generations (SB_1, SB_2, and SB_3)

Materials	χ^2			d.f.
	bivalent no.	univalent no.	total chrom. no.	
SB_1	106.51**	221.93**	18.82†	23 (17)°
SB_2	11.32+	120.71**	10.63+	25
SB_3	2.71+	56.45**	8.15+	35

**=p<0.005, +=p>0.95, †=p>0.25, °=d.f. for total chromosome number in parenthesis.

Observed and expected values were compared by a heterogeneity chi-square test (Table 2). In the SB_1, heterogeneity was high among both the bivalents ($\chi^2=106.51$)

and the univalents (χ^2=221.93), and the goodness of fit to the expected values of 21 bivalents and 14 univalents was poor ($p<0.005$). In contrast heterogeneity for the total chromosome number in the SB_1 was not very high (χ^2=18.82) and the goodness of fit to the expected chromosome number of 2n=56 was acceptable but not exceptional ($p>0.25$). Heterogeneity for the bivalents decreased in the SB_2 (χ^2=11.32) with a good fit to the expected ($p>0.95$). However, the SB_2 univalent fit was still poor, though heterogenity decreased (χ^2=120.71). Also, the heterogeneity for the total chromosome number decreased in the SB_2 with a very good fit to the expected ($p>0.95$). In the third backcross heterogeneity of bivalents, univalents, and total chromosome numbers decreased giving a good fit for bivalents and total chromosome number ($p>0.95$). Heterogeneity for the SB_3 univalents was still high (χ^2=56.45), with a poor fit ($p<0.005$) caused by a lower average (2.4$_1$) than expected (3.5$_1$) indicating that the elimination of univalents is proceeding at a faster rate than expected.

Meiotic instability in this material is expressed in a high discrepancy between the observed bivalent number and the expected of 21 bivalents as well as in a high number of univalents. A high variance of chromosome numbers from cell to cell within plants and among plants of the same generation is another measure of meiotic instability.

The pooled variances of the mean (s_p^2/n) for univalent, bivalent and total chromosome numbers over all three generations are reported in Table 3. Table 4 shows the F values

Table 3. Pooled variances of the mean (s_p^2/n) for bivalents, univalents and total chromosome numbers over all three generations (SB_1, SB_2, SB_3)

Materials	s_p^2/n			d.f.
	bivalent no.	univalent no.	total chrom. no.	
SB_1	1.48	30.27	1.95	19 (16)*
SB_2	0.35	0.72	0.60	23
SB_3	0.14	0.41	0.19	27

* d.f. for total chromosome number in SB_1.

Table 4. Homogeneity of s_p^2/n over 3 generations as expressed in F values (2n=total chromosome number)

Materials	Chromosome associations
SB_1	Bivalents —20.45**—Univalents—15.52**—2n
	4.27** 42.21** 3.27*
SB_2	Bivalents — 2.07* —Univalents— 1.20 —2n
	2.47* 1.74 3.15**
SB_3	Bivalents — 2.94**—Univalents— 2.16* —2n

* $p<0.05$, ** $p<0.01$

calculated from the pooled variances of the mean of Table 3 and their p-values are indicated. The variability of univalents, bivalents and total chromosome numbers decreased from the SB_1 to the SB_3. In the SB_1 generation the variance of the univalents was much higher than that of the bivalents (F=20.45) and this difference decreased in the SB_2 (F=2.07). However, the difference between variances of univalents and bivalents increased slightly after the third substitution backcross (F=2.94). This increase indicates that after an initial very rapid stabilization of univalents from the SB_1 to the SB_2 generation (F=42.21) the rate of stabilization has slowed down to such an extent that in the SB_3 generation the univalents are still much less stable than the bivalents (Table 3). One would expect a larger p-value in the SB_8. The differences between the variances of the univalent and the total chromosome numbers (2n) are smaller than the differences between the variances of the univalent and the bivalent numbers in all 3 generations. This indicates that there is a compensation between the numbers of univalents and bivalents which results in the appearance of a more stable total chromosome number.

General discussion and conclusions

The average total chromosome number in the SB_1 generation was surprisingly low (2n=47). In a backcross to an amphidiploid (AD) *T. durum*×*A. intermedium* (2n=70) using *A. intermedium* (2n=42) as male backcross parent one expects a plant with 2n=56 chromosomes (schematic representation in: SCHULZ-SCHAEFFER 1972). The observed total chromosome number deviates from the expected by 9 chromosomes. In 1958 2n numbers for the AD generation varied from 58 to 74 and averaged 65 (SCHULZ-SCHAEFFER 1970). We assumed that the missing bivalents were from the *Agropyron* parent since they were foreign to the cytoplasm of the female *Triticum* parent and may have been eliminated as laggards in meiotic divisions. Since micronuclei had been observed in the AD and our experimental AD material was removed by 7 to 8 generations form the original cross (F_7 and F_8, respectively) such a loss of *Agropyron* chromosomes may have been possible.

A loss of 9 *Agropyron* chromosomes without the presence of the 14 *T. durum* chromosomes would very likely have been fatal. The 14 *Triticum* chromosomes must have a compensating effect on the AD plant. In hexaploid wheat, *T. aestivum* L., nullisomics (2n=40) are generally reduced in size, vigor, and fertility. Many can not be propagated. A loss of more than one pair of chromosomes is very likely to be fatal even in a polyploid.

At least two nullisomics in wheat cause partial asynapsis. [Nulli-3A (XII) and nulli-3B (III), SEARS, 1954]. Since synapsis is controlled by genes (BEADLE 1930, 1933, LI *et al.* 1945, BERGNER *et al.* 1934, BEASLEY and BROWN 1942, ENNS and LARTER 1960, GOWEN 1933) one would expect that lack of chromosomes can cause partial asynapsis.

The *Triticum* univalents apparently also have an asynaptic effect on the normal pair-

ing of the *Agropyron* homologues. Examples from *Triticum* and *Hordeum* were given earlier (SCHULZ-SCHAEFFER *et al.* 1973).

Partial asynapsis is very strongly expressed in the SB_1 generation. The average number of SB_1 bivalents was only 11.7 where 21 were expected. This is also reflected in the observed average number of SB_1 univalents of 21.0 instead of the expected 14.0. This asynaptic effect decreased rapidly in the SB_2 (19.1_{II}) so that there was little improvement possible in the SB_3 (20.2_{II}).

Total chromosome number and the asynaptic effect varied from cell to cell within the same plant and from plant to plant in the SB_1 generation. The large variation of chromosome number among the PMC's of the same plant can only be explained as a premeiotic event and may be due to non-disjunction. The high variation in chromosome number from PMC to PMC in turn would cause differences in asynaptic effect which would vary from PMC to PMC. Chromosomes responsible for synapsis may be entirely missing from specific cells causing varying degrees of asynapsis in different cells of the same plant. This facet of meiotic instability was evaluated by the computation of variances of the mean ($s_{\bar{x}}^2$) and pooled variances of the mean (s_p^2/n).

We found that with the progessive stabilization of total chromosome number within plants and between plants from the SB_1 to the SB_3 the bivalents and univalents also stabilized. The final conclusion after evaluation of the SB_2 data (SCHULZ-SCHAEFFER *et al.* 1973) still holds true after evaluation of the SB_3 data. Substitution backcrossing rapidly leads to the normalization and stabilization of meiotic behavior, elimination of *Triticum* chromosomes, and a more rapid stabilization of bivalents than univalents.

(Received May 28, 1974)

A *durum-sphaerococcum* derivative of pentaploid hybrids

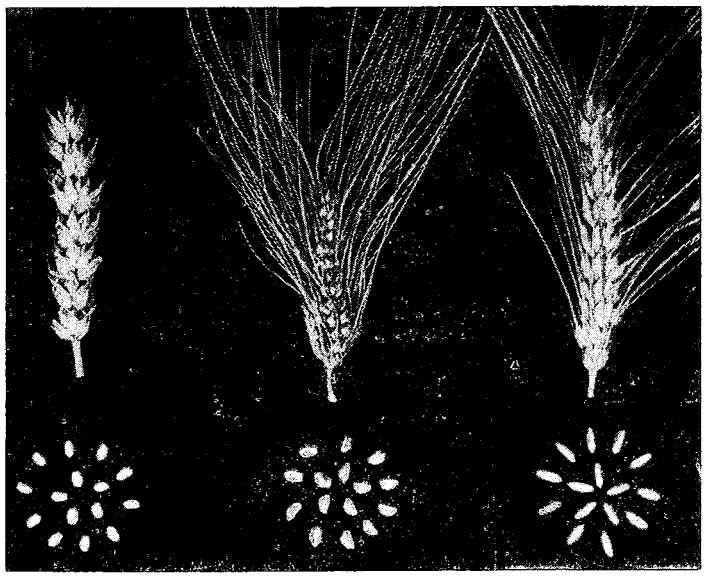
I. STANKOV[1] and D. TSIKOV[2]

The specific characters of *Triticum sphaerococcum* PERC. have been found to be controled by a pleiotropic recessive gene *s* (ELLERTON 1939), or *sp* (MATSUMURA 1954) which appears in dominant position in *T. aestivum* L. SEARS (1947) determined this gene as recessive and hemizygously ineffective (null allele) and as being localized in 3D (XVI) chromosome. SCHMIDT, WEIBEL and JOHNSON (1963) assumed that a similar effect observed in *T. aestivum* was due to one gene that was incompletely dominant and non-al-

1) "K. Malkov" Experimental Station, Sadovo village, Plovdiv district, Bulgaria.
2) Institute of Genetics and Plant Breeding, Sofia, Bulgaria.

lelic to the *s* gene in 3D chromosome. SCHMIDT and JOHNSON (1963) found a from in one population of *T. durum*, introduced from China, which showed characters of *T. sphaerococcum* and this made the authors call it *T. durum* ssp. *sphaerococcum*. Finding only 14 bivallents in it, they supposed that it was a result of a gene translocation from the D genome to the tetraploid AB genome or even that a normal gene from the A or B genome had mutated into a *sphaerococcum* gene. Thye assumed later that this *durum* form was conditioned by a gene lying outside the D genome (SCHMIDT AND JOHNSON 1966). The results obtained by BOZZINI (1965), GUPTA and SWAMINATHAN (1967), DJELEPOV and CHAVDAROV (1969), etc., with induced *sphareococcoid* type of mutants in *T. durum* and *T. diococcum* lend support to this assumption. *Durum-sphaerococcum* forms have also been found in nature and DOROFEEV (1969) considered them to be a result from spontaneous interspecific hybridization.

In hybridization of *T. sphaerococcum* PERC. with representative species of the tetraploid wheat group, the form-building process in the pentaploid hybrids obtained leads to a marked reduction in the frequency of occurernce of *sphaerococcum* type of plants. In some cases even such hybrids have not been observed (PERCIVAL 1921). Our studies on the hybrids of *T. sphaerococcum* with *T. durum* and *T. dicoccum* confirmed the above stated elimination of the *sphaerococcum* type of plants (2n=42) in these pentaploid hybrids, but



a b c

Figure 1. Spikes and grains of :
a) *T. sphaerococcum* var. *rotundatum* (2n=42)
b) *T. durum* var. *apulicum*-No. 233 (2n=28)
c) *A durum-sphaerococcum* type derivative of pentaploid hybrids (2n=28)

we demonstrated that this type of hybrids still appear in F_2 and F_3 with frequency highly restricted (4.8 and 2.7 per cent in the crosses with *T. durum*, and 2.4 and 0.6 per cent in those with *T. dicoccum*, respectively), as in the later generations they may be preserved and stabilized through selection (STANKOV and TSIKOV 1972 ab).

In the F_2 hybrid population of the pentaploid hybrids, we also observed plants of the *sphaerococcum* type with traits of *T. durum* and *T. dicoccum*. Such a form with deviations from the *sphaerococcum* type was selected in F_5 of the *T. sphaerococcum* × *T. dicoccum* cross and its plants kept the traits characteristic of *sphaerococcum* till F_8 but they were of the *durum* type (Fig. 1). They had 28 chromosomes in the root tip cells and they were, therefore, of the tetraploid (*durum*) type with *sphaerococcum* characters, namely spherical and vitreous grain, wide and erectoid leaves, short stem, resistant to lodging, but smaller ear compared to *T. durum*. Meiosis in this form was normal, with 14 bivallents recorded at diakinesis.

The F_2 hybrids of *sphaerococcum* type with characters of *T. durum* and *T. dicoccum* observed by us, as well as the deviations found in F_5 from the *sphaerococcum* type towards the *durum* type (2n=28), which might be preserved by selection, could be a result of a translocation of the block with *s*-locus of the 3D chromosome. Whether the locus with *s* (=*sp*) factor in the *durum-sphaerococcum* form lies outside the D genome, as assumed by SCHMIDT and JOHNSON (1966) or there is a translocation from the 3D chromosome with the block of this locus in the chromosome outside the D genome, as SCHMIDT and JOHNSON (1963), and STANKOV and TSIKOV (1972a, b) considered, or whether both situations are possible, are to be the subject of further and more precise studies. This will be significant genetic and phylogenetic importance.

(Received June 1, 1974)

Telocentric chromosomes obtained from calluses of nulli-5B tetra-5D of Chinese Spring wheat

T. SHIMADA[1], N. INOMATA[2], M. OKAMOTO[3] and H. ASAMI[4]

Callus tissues in the fifth successive culture of calluses obtained from seeds of nulli-5B tetra-5D were studied cytologically. The results obtained are summarized in the following table.

1) Laboratory of Genetics, Faculty of Agriculture, Kyoto University, Kyoto, Japan.
2) Laboratory of Genetics and Plant Breeding, College of Agriculture, University of Osaka Prefecture, Sakai, Osaka.
3) Institut für Pflanzengbau und Pflanzenzüchtung der Universität Göttingen, 34 Göttingen, West Germany.
4) Itami Rose Nursery Ltd., Ikenoue Aza Gogazuka Itami City, Hyogo Pref.

Chromosome number	Chinese Spring		Nulli-5B tetra-5D		
	no. of cells observed (%)	no. of cells with telo	no. of cells observed (%)	no. of cells with telo	
				1 telo (%)	2 telo (%)
31	1 (2)	—	1 (2)	—	—
36	—	—	3 (6)	1 (2)	—
37	2 (4)	—	2 (4)	—	—
38	—	—	1 (2)	—	—
39	1 (2)	—	—	—	—
40	2 (4)	—	7 (14)	1 (2)	—
41	5 (10)	—	10 (20)	4 (8)	—
42	38 (76)	—	22 (44)	3 (6)	1 (2)
44	—	—	1 (2)	—	—
45	—	—	1 (2)	1 (2)	—
56	—	—	1 (2)	—	—
67	1 (2)	—	—	—	—
84	—	—	1 (2)	—	—
Total	50	—	50	10 (20)	1 (2)

The above table shows that callus tissues from seeds of Chinese Spring similarly studied had no telocentric chromosomes. Callus tissues from seeds of nulli-5B tetra-5D at the fifth culture, however, had one telocentric chromosomes in 20% of the cells observed and two telocentric chromosomes in 2% of the cells observed.

Observation of telocentric chromosomes in the fifth culture of callus tissues of nulli-5B tetra-5D may be explained as follows.

Since there were no telocentric chromosomes at the initial step of the experiment, the telocentric must be due to misdivision of centromeres at mitosis of callus tissues.

The causes for misdivision of centromeres of chromosomes are tentatively explained by assuming (1) presence of a gene or genes for suppressing centromere misdivision on the chromosome 5B, (2) presence of a gene or genes for promoting centromere misdivision on the chromosomes 5D, and (3) interaction between absence of chromosome 5B and presence of extra dosage of chromosome 5D.

Either of the above hypothesis is correct cannot be said at the present stage of our experiments.

(Received August 25, 1974)

Anther culture of the cytoplasm substitution lines of *Triticum aestivum* cv. Chinese Spring

H. OGURA and K. TSUNEWAKI
Laboratory of Genetics, Faculty of Agriculture, Kyoto Universtiy, Kyoto 606, Japan

Anthers of a common wheat, Chinese Spring and its cytoplasm substitution lines with several *Triticum* and *Aegilops* cytoplasms were cultured *in vitro* on the RM-1964 medium supplemented with 3 mg/l of 2,4-D (LINSMAIER and SKOOG 1965). These wheat anthers containing pollen grains at the uninucleate stage were further classified by microscopical observation of the pollen grains into three sub-stages: the early, middle and late uninucleate stages. They were incubated under continuous fluorescent illumination of about 1,200 luxes and the constant temperature of 25°C. The pH of the medium was adjusted to 5.8 ± 0.1.

Callus formation was observed about 8 weeks after inoculation in the test tubes, the results being presented in Table 1. (*Squarrosa*)-Chinese Spring, (synthetic CCC^{u}C^{u})-CS (abbreviated as CS hereafter), (*triuncialis*)-CS, (*variabilis*)-CS, (*crassa* 6x)-CS as well as normal Chinese Spring wheat formed no calluses. On the other hand, (*caudata*)-CS, (*umbellulata*)-CS, (*timopheevi*)-CS, (*ovata*)-CS and (*kotschyi*)-CS formed calluses at 2.2, 0.8,

Table 1. The numbers of calluses induced from the anthers at the three different uninucleate stages of the pollen grains, when *T. aestivum* cv. Chinese Spring with various alien cytoplasms was used

Cytoplasm donors	Backcross generation	Selfed seed fert. (%)	Stage of the uninucleate pollen grains						Total	
			Early		Middle		Late			
			No. anthers inocul.	No. calli formed	No. anthers inocul.	No. calli formed	No. anthers inocul.	No. calli formed	No.	(%)
Ae. caudata	14	0	30	1	30	1	30	0	2	2.2
Ae. umbellulata	14	52	42	0	42	1	42	0	1	0.8
Ae. squarrosa	4	82	30	0	30	0	30	0	0	0.0
T. timopheevi	6	0	38	3	44	3	26	3	9	8.3
Synthetic CCC^{u}C^{u}	6	0	30	0	30	0	30	0	0	0.0
Ae. triuncialis	6	2	30	0	30	0	30	0	0	0.0
Ae. ovata	10	31	30	5	30	1	30	0	6	6.7
Ae. kotschyi	4	99	30	1	30	0	30	0	1	1.1
Ae. variabilis	4	89	30	0	30	0	30	0	0	0.0
Ae. crassa 6x	5	97	30	0	30	0	30	0	0	0.0
T. aestivum cv. Chinese Spring (Control)	—	85	38	0	52	0	40	0	0	0.0
Total			358	10	378	6	348	3	19	1.8

8.3, 6.7 and 1.1% of the cultured anthers, respectively. All the calluses formed were of filament and/or tapetum origin. *Triticum timopheevi* and *Aegilops ovata* cytoplasms significantly increased the frequency of callus formation, comparing to that of normal Chinese Spring.

Frequency of the callus-forming anthers in these five lines were 5.9, 3.4 and 1.9%, when the pollen grains were at the early, middle and late uninucleate stage, respectively. There is only one report in Triticeae indicating that the pollen grains at the middle uninucleate stage were most favorable for induction of calluses in the normal lines of wheat (OUYANG *et al.* 1973). However, in the cytoplasm substitution lines of Chinese Spring wheat, the anthers containing the pollen grains at the early uninucleate stage tended to induce more calluses.

(Received July 25, 1974)

Pollen production and shedding in male fertility restorer lines of wheat

R. B. SINGH and J. S. SINDHU
Department of Genetics and Plant Breeding, Banaras Hindu University, Varanasi, India

Effective wind pollination is a pre-requisite for exploiting heterosis in wheat. Even though significant yield heterosis is recorded (SINDHU and SINGH 1971), low outcrossing potential of the A and R lines is a barrier in economic exploitation of hybrid wheat. Factors like synchronous flowering of male and female lines, stigma receptivity and pollen shedding are likely to influence degree of outcrossing. A characterisation of these attributes in relation to cross pollination in wheat may be helpful in assuming the efficiency of hybrid seed production, under given environmental conditions involving specific A and R lines.

A few reports on anther size, pollen production and shedding (KHERDE *et al.* 1967, JOPPA *et al.* 1968, BERI and ANAND, 1971) have revealed considerable variation in the outcrossing potential of the different wheat varieties. However, none of the studies involved male fertility restorer lines.

Besides effective restoring ability a good restorer line should be an efficient outcrosser. Pollen producing ability i.e. number of pollen available for outcrossing, anther and filament size, is related with the outcrossing potential of a variety. The present study, reports on production and shedding of pollen in different male fertility restorer lines of wheat and the possibility of using this attribute as an index for selecting R-lines posses-

sing efficient outcrossing devices.

Ten anthers from each of the 10 *elite* restorer lines, namely, R-995, R-1315, R-1324, R-1326, R-1359, R-1360, R-1362, R-1363, R-1364, obtained from Dr. J.A. Wilson, U.S.A. and R-Dirk received from Dr. L. H. Shebeski, Canada, were measured for their sizes (length × width in mm^2). Filament length in mm of the corresponding stamens was also recorded. The measurements were taken with the help of occulomicrometer at X 50 under ordinary microscope.

Number of pollen grains per anther was estimated in anthers which were about to extruse. Such an anther was put on slide in one per-cent acetocarmine solution, cut in three pieces, tapped gently, spread uniformly and each piece was covered with seperate cover slip. All the pollen grains in the three pieces of an anther were counted under microscope. Number of pollen grains available for outcrossing were estimated by counting them in anthers which had just extruded and come out of the floret by applying the same method as described above.

Table 1. Filament length, anther size, number of pollen grains per anther and pollen grains used for outcrossing in ten R lines of wheat

S. No.	Fertility restorer line	Filament length (mm)	Size of anther (mm^2)	Total No. of pollen grains/ anther	No. of pollen grains shed outside per anther	% of pollen used for outcrossing
1	R-995	9.7	4.2	1385.6	797.1	57.5
2	R-1315	10.8	6.8	2317.9	972.0	41.5
3	R-1324	9.2	5.8	2177.0	1344.8	61.2
4	R-1326	8.1	4.4	1853.6	1374.0	74.1
5	R-1359	7.0	4.3	1587.6	1172.5	73.8
6	R-1360	11.6	3.4	1155.2	455.6	39.4
7	R-1362	8.4	3.7	1259.1	704.1	55.7
8	R-1363	9.1	4.4	1436.7	760.7	52.9
9	R-1364	11.9	3.2	974.9	307.6	31.4
10	R-Dirk	10.4	6.8	2773.4	1406.3	50.7

Ten different *T. timopheevi* restorers were studied for filament length, anther size, total number of pollen grains per anther and number of pollen grains used for outcrossing. Observations on these attributes are presented in Table 1.

Restorer Dirk produced the highest number of pollen grains per anther followed by R-1315, R-1324 and R-1326. Restorer R-1326, despite its lower number of total pollen grains per anther, had the second highest number of pollen grains shed outside the floret which were eventually used for outcorssing. Total number of pollen grains per anther for the 10 different restorer lines studied varied from 975 to 2773 and the pollen grains per anther used for outcrossing ranged from 308 in R-1364 to 1406 in R-Dirk. Filament

length varied from 7.0 (R-1359) to 11.9 mm (R-1364) and anther size ranged from 3.2 (R-1364) to 6.8 mm^2 (R-Dirk and R-1315). The larger anthers were found to possess more number of pollen grains. However, no association was observed between the filament length and percentage of pollen grains used for outcrossing.

(Received August 24, 1974)

Induced genetic variability for certain physical characters of grains following gamma-irradiation at two different seed moisture contents in wheat, *Triticum aestivum*, var. K-68

Rishi Muni SINGH and Devendra KUMAR*
Department of Genetics and Plant Breeding, Banaras Hindu University,
Varanasi-221005, (U.P.), India

Introduction

From the view point of genetic improvement, quality in wheat is considered as complex as the yield. Physical characters (like grain hardness and specific gravity of grains) and certain other factors greatly influence and contribute to the grain quality. For instance, intercellular structure of endosperm determines the milling quality of floor which is associated to the specific gravity of grains. Further, the specific gravity of grains is related to grain texture. (SHOLLENBERGER and COLEMAN 1926).

Hard wheats, generally rich in protein with strong gluten are consumed for chapati-making purposes, whereas soft wheats, generally low in protein with weak gluten are mainly consumed for secondary purposes (bread, bakeries etc.). Thus the grain hardness in wheat determines its use for various domestic and industrial purposes. In soft wheats the flour yield is very low as compared to hard wheats indicating a positive relationship between grain hardness and the flour yield (MOSS and STEVERT 1971). Hardness of grain is also important for proper loaf texture and dough handling characteristics. Further, SYMES (1969) has shown that genes conferring hardness are strongly associated to the loaf texture and dough handling characteristics. In addition, thousand grain weight is associated with the flour recovery. There seems to be limited variability for some of the physical characters of grain in natural wheat populations.

The present investigation was therefore initiated to determine the magnitude of variability induced in physical characters of grains using different doses of Co^{60} gamma-rays at two different seed moisture contents in bread wheat, *Triticum aestivum*, var. K-68 and to study the degree of correlation and correlated response between pairs of characters.

Materials and Methods

Seeds of bread wheat, *Triticum aestivum*, var. K-68, having 14 and 4 per-cent moisture contents were exposed to 5, 10, 15 and 20 Kr doses of Co^{60} gamma-rays. Irradiated seeds alongwith control were sown in field. Morphological abnormalities, sterility and chromosomal aberrations were used as the basis of selection of plants in M_1 generation and superior plant type in the M_2 generation. Eighteen mutant lines (stabilized in M_3 generation) alongwith the control were grown in M_4 generation (1972~73) in a Randomized-block-design with three replications using the plot size of 10 sq. meter. A random sample of ten plants from each plot was used for taking observations on different characteristics.

Specific gravity of grains was determined following the procedure of ANAND *et al.* 1970, and grain hardness by using "Hardness Tester" (Manufactured by Kiya Seisakusha Ltd., Tokyo, Japan). Both, test weight (1000 grain weight) and grain yield (per plant) were determined in gms. Data was subjected to statistical analysis in usual manner.

Results and Discussion

The data on various genetic parameters of induced variabliity are presented in Table 1. The range of variability for 1000-grain weight, specific gravity, grain hardness, and yield/plant were 24.560~49.60, 1.063~1.643, 9.420~14.820 and 7.342~22.275 respectively. When these values are compared with parental means for each character it is quite clear that considerable variability has been generated by Co^{60} gamma-rays at two moisture levels for all the characters. A precise idea of variability can be had by C.D. values at 5 per-cent level. The genotypic coefficient of variability (GCV) ranged from 0.836 to 17.776 for sepecific gravity and yield/palnt respectively. In all the cases phenotypic coefficient of variability was higher than the corresponding GCV values. Thus high genetic coefficient of variability induced through gamma-rays for grain hardness, 1000-grain weight and grain yield provides wide basis for genetic improvement in

Table 1. Parental values of different characters and various genetic parameters of induced variability following gamma-irradiation in wheat *Triticum aestivum* var. K-68

Characters	Parental values (means)	Range of induced variability	General mean	C.D. 5 %	Genotypic coefficient of variability	Phenotypic coefficient of variability	Heritability (%)	Genetic advance as % of means.
1000-grain weight (gm.)	33.410	24.560~49.600	33.278	4.704	13.904	16.479	71.174	22.178
Specific gravity	1.290	1.063~ 1.643	1.195	0.113	0.836	1.673	16.666	2.342
Grain hardness (kg.)	13.330	9.420~14.820	12.320	1.254	10.633	12.418	73.592	18.806
Yield/plant (gm.)	12.323	7.342~22.275	14.176	2.403	17.776	22.714	43.180	18.208

wheat. Since, the efficiency of selection would depend upon the magnitude of variability that is heritable and caused by genetic factors the higher values, therefore, of heritability accompanied by high genetic advance for the characters studied should be quite valuable. In our study, heritability estimates were found to be high for grain hardness (73.592) and 1000-grain weight (71.174), moderate for grain yield (43.180) and low for specific gravity of grains (16.666). Genetic advance at 5 per-cent selection intensity ranged from 22.178 to 2.343 for 1000-grain weight and specific gravity of grains respectively. Thus high heritability accompanied by high values of genetic advance was achieved for grain hardness and 1000-grain weight. Genetic improvements, therefore, can be achieved with care for these characters. ANAND *et al.* (1970) also found high heritability and high genetic advance for grain hardness in a collection of 80 different strains of wheat from diverse sources. Observations of GANDHI *et al.* (1964) on 90 wheat varieties were also similar for 1000-grain weight and grain yield.

Negative association (Table 2) between grain hardness and specific gravity reveals that combined selection for these two physical characters can not be operated because they inherit independently. Similarly grain yield does not seem to have any bearing with these two grain characters as association of grain yield with these characters is negative. On the basis of our findings we conclude that hard wheats possess low grain yield. Association of grain hardness and specific gravity of grains with 1000-grain weight was observed to be non-significant as has also been reported by ANAND *et al.* (1970). Significant positive association between 1000-grain weight and yield/plant at genotypic levels observed here is in agreement with the findings of SIKKA and JAIN (1958) and GANDHI *et al.* (1964), who emphasized the importance of test weight in grain yield. Non significant association between these characters at phenotypic levels indicates that association is influenced by environmental conditions.

Coheritability values for different pairs of characters are presented in Table 3. Coheritability values of 1000-grain weight with specific gravity and grain yield were posi-

Table 2. Genotypic and phenotypic correlations respectively between different grain characters and grain yield in wheat (*Triticum aestivum*) mutants

Characters	1000-grain weight	Grain hardness	Specific gravity of grains
Grain hardness	−0.232	—	—
	−0.233		
Specific gravity of grains	+0.046	−0.364	—
	+0.023	−0.067	
Grain yield	+0.587**	−0.420	−0.019
	+0.220	−0.381	−0.015

** Significant at P=0.01

Table 3. Coheritability between different pairs of grain characters and yield in wheat (*Triticum aestivum*) mutants

Characters	1000-grain weight	Grain hardness	Specific gravity of grains
Grain hardness	−16.809	—	—
Specific gravity of grains	+15.630	−13.109	—
Grain yield	+30.828	−15.840	−15.800

tive whereas coheritability of grain yield with specific gravity and hardness; specific gravity with grain hardness; and grain hardness with 1000-grain weight were negative. Coheritability value of 1000-grain weight with grain yield was highest whereas it was moderate in case of other pair of characters. Negative coheritability for certain character pairs indicate that they are not inherited jointly and thus correlated response should not be expected in selection experiments for one character. In contrast, high and positive joint inheritance between 1000-grain weight and grain yield suggests that significant improvements in grain yield can be obtained by practicing selection for 1000-grain weight.

(Received June 1, 1974)

II. Genetic Stock

Necrosis genes in common wheat varieties from the USSR and the East Mediterranean Region

K. Tsunewaki and Y. Nakai

Laboratory of Genetics, Faculty of Agriculture, Kyoto University, Kyoto 606, Japan

We have undertaken further investigations on the geographical distribution of necrosis and chlorosis genes, using 333 common wheat varieties (or strains) from the USSR (237 varieties, out of which 158 were from Caucasus), Turkey (67), Syria (2), Lebanon (1), Jordan (1), and Egypt (25). Those varieties were crossed to three testers, Jones Fife (*ne*$_1$*Ne*$_2$*ch*$_1$*Ch*$_2$), Prelude (*Ne*$_1$*ne*$_2$*ch*$_1$*Ch*$_2$) and Macha (*Ne*$_1$*ne*$_2$*Ch*$_1$*ch*$_2$), and their F_1 phenotypes were observed as to necrosis and chlorosis. Based on this observation, their genotype was determined as shown in the following table.

The materials used were kindly provided by Dr. I.A. Sizov of the Plant Industry Institute, Leningrad, USSR; and Dr. M. Tanaka of the Plant Germ-Plasm Institute, Kyoto University, Kyoto, Japan. We wish to express deepest appreciation to both of them.

(Received August 15, 1974)

GLKU No.	Country	Species[1]	Variety name (or Collection site)	Growth[2] habit	Awnedness[3]	Glume hair[4]	Tester[5]			Necrosis genotype	Place of collection
							× J. F.	× Prelude	× Macha		
2471	USSR	A	Odesskaja 3	W	+	−	+	+	c	$ne_1ne_2ch_1Ch_2$	
2472	〃	〃	Novoukrainka 83	〃	+	−	+	+	c	〃 〃	
2473	〃	〃	Dolis Puri	〃	+	−	n	+	c	$Ne_1ne_2ch_1Ch_2$	
2474	〃	〃	Bankuti 1201	〃	+	−	+	+	c	$ne_1ne_2ch_1Ch_2$	
2475	〃	〃	Ostka Hildebrandta	S	+	−	+	+	c	〃 〃	
2476	〃	〃	Ostka Hlopicka	〃	+	−	+	+	c	〃 〃	
2477	〃	〃	Alty-Agac	W	+	−	+	+	c	〃 〃	
2478	〃	〃	Sibirka 1818	S	+	−	+	n	c	$ne_1Ne_2ch_1Ch_2$	
2479	〃	〃	Cesium 111	〃	+	−	n	+	c	$Ne_1ne_2ch_1Ch_2$	
2480	〃	〃	Vatan	〃	+	−	n	+	c	〃 〃	
2481	〃	〃	Tulun 70	〃	+	−	+	+	c	$ne_1ne_2ch_1Ch_2$	
2482	〃	〃	Lutescens 62	〃	+	−	+	+	+	$ne_1ne_2ch_1ch_2$	
2483	〃	〃	Artemovka	〃	+	−	+	+	+	〃 〃	
2484	〃	〃	Bezostaja 1	W	+	−	?	+	c	? $ne_2ch_1Ch_2$	
2485	〃	〃	Milturum 321	S	+	−	+	+	c	$ne_1ne_2ch_1Ch_2$	
2486	〃	〃	Damkovkaja Graniatka	W	+	−	+	+	+	$ne_1ne_2ch_1ch_2$	
2489	〃	〃	Golgalos	S	+	+	n	+	c	$Ne_1ne_2ch_1Ch_2$	
2490	〃	〃	Kolhoznica	W	−	+	+	n	c	$ne_1Ne_2ch_1Ch_2$	
2491	〃	〃	Babilo	S	+	−	+	+	c	$ne_1ne_2ch_1Ch_2$	
2492	〃	〃	Surhak 5688	〃	+	−	+	+	c	〃 〃	
2493	〃	〃	Buhara-Bugdai	W	+	−	?	+	c	? $ne_2ch_1Ch_2$	
2494	〃	〃	Pseudomeridionale	S	+	+	n	+	c	$Ne_1ne_2ch_1Ch_2$	
3611	〃	〃	Byjenskar	〃	−	−	+	+	c	$ne_1ne_2ch_1Ch_2$	
3612	〃	〃	(no name)	〃	−	−	+	+	+	$ne_1ne_2ch_1ch_2$	
3614	〃	〃	Cikotaba 3	W	+	−	+	+	c	$ne_1ne_2ch_1Ch_2$	
3615	〃	〃	Moscow 4	〃	−	−	+	?	c	ne_1 ? ch_1Ch_2	
3617	〃	〃	Saru-Mgitu 283	S	+	+	+	+	c	$ne_1ne_2ch_1Ch_2$	
3618	〃	〃	Spassk 2	〃	−	−	+	+	c	〃 〃	
3620	〃	〃	〃 4	I	−	−	+	+	+	$ne_1ne_2ch_1ch_2$	

(Continued)

3622	USSR	A	USSR 33190	S	+	+	+	+	c	$ne_1ne_2ch_1Ch_2$
3623	〃	〃	〃 33586	〃	+	−	n	+	c	$Ne_1ne_2ch_1Ch_2$
3624	〃	〃	〃 33633	〃	+	+	+	+	c	$ne_1ne_2ch_1Ch_2$
3627	〃	〃	〃 36426	〃	+	−	+	n	c	$ne_1Ne_2ch_1Ch_2$
3628	〃	〃	〃 38786	〃	+	−	+	+	c	$ne_1ne_2ch_1Ch_2$
3629	〃	〃	〃 39541	〃	−	−	+	+	c	〃 〃
3630	〃	〃	〃 39544	〃	−	−	?	+	c	$?\,ne_2ch_1Ch_2$
3631	〃	〃	〃 40599	〃	−	−	+	+	c	$ne_1ne_2ch_1Ch_2$
3632	〃	〃	〃 41961	〃	+	−	?	+	c	$?\,ne_2ch_1Ch_2$
3633	〃	〃	〃 42024	〃	−	−	?	+	c	$?\,ne_2ch_1Ch_2$
3634	〃	C	〃 42129	W	+	+	+	+	c	$ne_1ne_2ch_1Ch_2$
3635	〃	A	〃 42173	S	+	−	+	+	c	〃 〃
3636	〃	〃	〃 42229	〃	+	−	n	+	c	$Ne_1ne_2ch_1Ch_2$
3637	〃	〃	〃 42283	W	+	−	+	n	c	$ne_1Ne_2ch_1Ch_2$
3638	〃	〃	〃 42490	〃	−	−	+	+	c	$ne_1ne_2ch_1Ch_2$
3639	〃	〃	〃 39805	S	+	−	+	+	c	〃 〃
3640	〃	〃	〃 43195	〃	+	−	n	+	c	$Ne_1ne_2ch_1Ch_2$
3641	〃	〃	〃 42791	W	+	−	+	n	c	$ne_1Ne_2ch_1Ch_2$
3643	〃	〃	〃 43221	S	−	−	+	+	c	$ne_1ne_2ch_1Ch_2$
3644	〃	〃	Russian No. 3	W	−	−	+	+	c	〃 〃
3645	〃	〃	〃 No. 6	〃	−	−	+	n	c	$ne_1Ne_2ch_1Ch_2$
3646	〃	〃	〃 No. 7	〃	+	−	+	n	c	〃 〃
3647	〃	〃	〃 No. 12	S	+	−	+	+	c	$ne_1ne_2ch_1Ch_2$
3648	〃	〃	〃 No. 13	〃	+	−	?	+	c	$?\,ne_2ch_1Ch_2$
3649	〃	〃	〃 No. 14	〃	+	−	+	+	c	$ne_1ne_2ch_1Ch_2$
3650	〃	〃	〃 No. 15	〃	+	+	n	+	c	$Ne_1ne_2ch_1Ch_2$
3651	〃	〃	〃 No. 17	〃	−	−	+	+	?	$ne_1ne_2ch_1?$
3652	〃	〃	〃 No. 19	〃	−	−	+	+	+	$ne_1ne_2ch_1ch_2$
3654	〃	〃	〃 No. 24	〃	+	−	+	+	c	$ne_1ne_2ch_1Ch_2$
3655	〃	〃	〃 No. 25	〃	+	−	+	+	c	〃 〃
3656	〃	〃	〃 No. 28	〃	+	−	n	+	c	$Ne_1ne_2ch_1Ch_2$

(Continued)

3657	USSR	A	Russian No. 32	S	+	−	?	+	c	? $ne_2ch_1Ch_2$	
3658	〃	〃	Leda	〃	−	−	+	+	+	$ne_1ne_2ch_1ch_2$	
3659	〃	〃	Kitchener	〃	−	−	+	+	c	$ne_1ne_2ch_1Ch_2$	
3660	〃	〃	Russian No. 36	〃	−	−	+	+	c	〃 〃	
3661	〃	〃	〃 No. 37	〃	−	−	?	+	c	? $ne_2ch_1Ch_2$	
3662	〃	〃	〃 No. 38	〃	+	−	n	+	c	$Ne_1ne_2ch_1Ch_2$	
3663	〃	〃	Vemka	W	+	−	+	+	c	$ne_1ne_2ch_1Ch_2$	
3664	〃	〃	Kooperatoika	〃	+	−	+	+	c	〃 〃	
3665	〃	〃	Ukrainka	〃	−	−	+	+	?	$ne_1ne_2ch_1$?	
3666	〃	〃	Russak	〃	−	−	+	+	+	$ne_1ne_2ch_1ch_2$	
3668	〃	〃	Yumalek-bash	〃	+	−	+	n	c	$ne_1Ne_2ch_1Ch_2$	
3669	〃	〃	Russian No. 58	S	+	−	+	+	c	$ne_1ne_2ch_1Ch_2$	
3670	〃	〃	〃 No. 59	〃	+	−	?	+	c	? $ne_2ch_1Ch_2$	
3671	〃	〃	〃 No. 61	〃	−	−	+	+	c	$ne_1ne_2ch_1Ch_2$	
3672	〃	〃	〃 No. 62	〃	−	−	?	+	c	? $ne_2ch_1Ch_2$	
3674	〃	〃	〃 No. 71	〃	+	−	+	n	c	$ne_1Ne_2ch_1Ch_2$	
3679	〃	〃	(no name)	〃	+	−	+	+	+	$ne_1ne_2ch_1ch_2$	
4315	〃	C	〃	W	+	−	+	+	c	$ne_1ne_2ch_1Ch_2$	
4320	〃	〃	〃	〃	+	−	+	+	c	〃 〃	
5001	〃 (Caucasus)	A	BEC 1521		−	−	+	+	c	〃 〃	Azerbaijan
5003	〃 (〃)	〃	〃 1523		+	−	n	+	c	$Ne_1ne_2ch_1Ch_2$	〃
5005	〃 (〃)	〃	〃 1525		+	−	+	+	c	$ne_1ne_2ch_1Ch_2$	〃
5007	〃 (〃)	〃	〃 1527		+	−	+	+	c	〃 〃	〃
5008	〃 (〃)	〃	〃 1528		+	+	n	+	c	$Ne_1ne_2ch_1Ch_2$	〃
5009	〃 (〃)	〃	〃 1529		+	−	+	+	c	$ne_1ne_2ch_1Ch_2$	〃
5010	〃 (〃)	〃	〃 1530		+	−	n	+	c	$Ne_1ne_2ch_1Ch_2$	〃
5011	〃 (〃)	〃	〃 1531		+	−	+	+	c	$ne_1ne_2ch_1Ch_2$	〃
5012	〃 (〃)	〃	〃 1532		+	−	n	+	c	$Ne_1ne_2ch_1Ch_2$	〃
5014	〃 (〃)	〃	〃 1534		+	−	n	+	c	〃 〃	〃
5016	〃 (〃)	〃	〃 1536		+	+	+	+	c	$ne_1ne_2ch_1Ch_2$	〃
5017	〃 (〃)	〃	〃 1537		+	−	+	+	c	〃 〃	〃

(Continued)

5019	USSR (Caucasus)	A	BEC	1539		+	−	n	+	c	$Ne_1ne_2ch_1Ch_2$	Azerbaijan
5020	〃 (〃)	〃	〃	1540		+	−	n	+	c	〃 〃	〃
5021	〃 (〃)	〃	〃	1541		+	−	n	+	c	〃 〃	〃
5022	〃 (〃)	〃	〃	1542		+	−	n	+	c	〃 〃	〃
5026	〃 (〃)	〃	〃	1546		+	−	+	+	c	$ne_1ne_2ch_1Ch_2$	〃
5027	〃 (〃)	〃	〃	1547		+	−	+	+	c	〃 〃	〃
5028	〃 (〃)	〃	〃	1548		+	−	n	+	c	$Ne_1ne_2ch_1Ch_2$	〃
5029	〃 (〃)	〃	〃	1549		+	−	?	+	c	$?\,ne_2ch_1Ch_2$	Armenia
5030	〃 (〃)	〃	〃	1550		+	−	n	+	c	$Ne_1ne_2ch_1Ch_2$	〃
5031	〃 (〃)	〃	〃	1551		+	−	n	+	c	〃 〃	〃
5032	〃 (〃)	〃	〃	1552		+	−	+	?	c	$ne_1\,?\,ch_1Ch_2$	〃
5033	〃 (〃)	〃	〃	1553		+	−	+	+	c	$ne_1ne_2ch_1Ch_2$	〃
5034	〃 (〃)	〃	〃	1554		+	−	+	+	c	〃 〃	〃
5035	〃 (〃)	〃	〃	1555		+	−	+	+	c	〃 〃	〃
5036	〃 (〃)	〃	〃	1556		−	+	?	+	c	$?\,ne_2ch_1Ch_2$	〃
5037	〃 (〃)	〃	〃	1557		+	−	+	+	c	$ne_1ne_2ch_1Ch_2$	〃
5038	〃 (〃)	〃	〃	1558		+	+	+	+	c	〃 〃	〃
5039	〃 (〃)	〃	〃	1559		+	−	n	+	c	$Ne_1ne_2ch_1Ch_2$	〃
5040	〃 (〃)	〃	〃	1560		+	−	+	+	c	$ne_1ne_2ch_1Ch_2$	〃
5041	〃 (〃)	〃	〃	1561		+	−	n	+	c	$Ne_1ne_2ch_1Ch_2$	〃
5042	〃 (〃)	〃	〃	1562		+	−	+	+	c	$ne_1ne_2ch_1Ch_2$	〃
5045	〃 (〃)	〃	〃	1565		+	−	n	+	c	$Ne_1ne_2ch_1Ch_2$	〃
5046	〃 (〃)	〃	〃	1566		+	+	n	+	c	〃 〃	〃
5047	〃 (〃)	〃	〃	1567		−	+	n	+	c	〃 〃	〃
5048	〃 (〃)	〃	〃	1568		+	+	+	+	c	$ne_1ne_2ch_1Ch_2$	〃
5049	〃 (〃)	〃	〃	1569		+	+	+	+	c	〃 〃	〃
5051	〃 (〃)	〃	〃	1571		+	−	+	+	c	〃 〃	〃
5052	〃 (〃)	〃	〃	1572		−	−	+	+	c	〃 〃	〃
5053	〃 (〃)	〃	〃	1573		+	−	+	+	c	〃 〃	〃
5054	〃 (〃)	〃	〃	1574		+	−	?	+	c	$?\,ne_2ch_1Ch_2$	〃
5055	〃 (〃)	〃	〃	1575		−	−	+	+	c	$ne_1ne_2ch_1Ch_2$	〃

(Continued)

5056	USSR (Caucasus)	A	BEC	1576		+	−	n	+	c	$Ne_1ne_2ch_1Ch_2$	Armenia
5057	〃 (〃)	〃	〃	1577		+	+	+	+	c	$ne_1ne_2ch_1Ch_2$	〃
5058	〃 (〃)	〃	〃	1578		−	−	+	+	c	〃 〃	〃
5059	〃 (〃)	〃	〃	1579		+	−	n	+	c	$Ne_1ne_2ch_1Ch_2$	〃
5061	〃 (〃)	〃	〃	1581		+	−	n	+	c	〃 〃	〃
5063	〃 (〃)	〃	〃	1583		+	−	n	+	c	〃 〃	〃
5064	〃 (〃)	〃	〃	1584		+	−	n	+	?	$Ne_1ne_2ch_1$?	〃
5066	〃 (〃)	〃	〃	1586		+	+	+	+	c	$ne_1ne_2ch_1Ch_2$	〃
5068	〃 (〃)	〃	〃	1588		−	+	n	+	c	$Ne_1ne_2ch_1Ch_2$	〃
5069	〃 (〃)	〃	〃	1589		+	+	n	+	c	〃 〃	〃
5070	〃 (〃)	〃	〃	1590		+	−	n	+	c	〃 〃	〃
5071	〃 (〃)	〃	〃	1591		+	−	n	+	c	〃 〃	〃
5072	〃 (〃)	〃	〃	1592		−	−	+	?	c	ne_1 ? ch_1Ch_2	〃
5073	〃 (〃)	〃	〃	1593		+	−	n	+	c	$Ne_1ne_2ch_1Ch_2$	〃
5074	〃 (〃)	〃	〃	1594		+	+	n	+	c	〃 〃	〃
5075	〃 (〃)	〃	〃	1595		+	−	n	+	c	〃 〃	〃
5076	〃 (〃)	〃	〃	1596		−	+	n	+	c	〃 〃	〃
5077	〃 (〃)	〃	〃	1597		+	−	n	+	c	〃 〃	〃
5079	〃 (〃)	〃	〃	1599		+	+	n	+	c	〃 〃	〃
5080	〃 (〃)	〃	〃	1600		+	−	n	+	c	〃 〃	〃
5082	〃 (〃)	〃	〃	1602		+	−	n	+	c	〃 〃	〃
5083	〃 (〃)	〃	〃	1603		+	−	n	+	c	〃 〃	〃
5085	〃 (〃)	〃	〃	1605		+	−	n	+	c	〃 〃	〃
5086	〃 (〃)	〃	〃	1606		+	+	+	+	c	$ne_1ne_2ch_1Ch_2$	〃
5087	〃 (〃)	〃	〃	1607		+	+	+	?	c	ne_1 ? ch_1Ch_2	〃
5088	〃 (〃)	〃	〃	1608		−	−	+	?	c	〃 〃	〃
5089	〃 (〃)	〃	〃	1609		+	−	+	?	c	〃 〃	〃
5090	〃 (〃)	〃	〃	1610		+	−	+	+	c	$ne_1ne_2ch_1Ch_2$	〃
5092	〃 (〃)	〃	〃	1612		+	−	n	+	c	$Ne_1ne_2ch_1Ch_2$	〃
5093	〃 (〃)	〃	〃	1613		+	−	n	+	+	$Ne_1ne_2ch_1ch_2$	〃
5094	〃 (〃)	〃	〃	1614		+	−	n	+	c	$Ne_1ne_2ch_1Ch_2$	〃

(Continued)

5096	USSR (Caucasus)	A	BEC 1616		+	−	+	+	c	$ne_1ne_2ch_1Ch_2$	Armenia
5098	〃 (〃)	〃	〃 1618		+	+	n	+	c	$Ne_1ne_2ch_1Ch_2$	〃
5099	〃 (〃)	〃	〃 1619		+	−	n	+	c	〃 〃	〃
5101	〃 (〃)	〃	〃 1621		+	+	+	+	c	$ne_1ne_2ch_1Ch_2$	〃
5102	〃 (〃)	〃	〃 1622		+	+	n	+	c	$Ne_1ne_2ch_1Ch_2$	〃
5104	〃 (〃)	〃	〃 1624		+	+	n	+	c	〃 〃	〃
5105	〃 (〃)	〃	〃 1625		+	+	+	+	c	$ne_1ne_2ch_1Ch_2$	〃
5106	〃 (〃)	〃	〃 1626		+	−	+	+	c	〃 〃	〃
5107	〃 (〃)	〃	〃 1627		−	−	?	+	c	$?ne_2ch_1Ch_2$	〃
5108	〃 (〃)	〃	〃 1628		+	−	n	+	c	$Ne_1ne_2ch_1Ch_2$	〃
5109	〃 (〃)	〃	〃 1629		+	−	+	+	c	$ne_1ne_2ch_1Ch_2$	〃
5110	〃 (〃)	〃	〃 1630		+	−	?	+	c	$?ne_2ch_1Ch_2$	〃
5111	〃 (〃)	〃	〃 1631		+	−	+	+	c	$ne_1ne_2ch_1Ch_2$	〃
5114	〃 (〃)	〃	〃 1634		+	−	+	+	c	〃 〃	〃
5115	〃 (〃)	〃	〃 1635		+	−	+	+	c	〃 〃	〃
5116	〃 (〃)	〃	〃 1636		+	+	+	?	c	$ne_1?ch_1Ch_2$	〃
5118	〃 (〃)	〃	〃 1638				+	+	c	$ne_1ne_2ch_1Ch_2$	〃
5119	〃 (〃)	〃	〃 1639		−	+	n	+	c	$Ne_1ne_2ch_1Ch_2$	〃
5121	〃 (〃)	〃	〃 1641		+	−	n	+	c	〃 〃	〃
5124	〃 (〃)	〃	〃 1644		+	−	n	+	c	〃 〃	〃
5125	〃 (〃)	〃	〃 1645		+	+	n	+	c	〃 〃	〃
5126	〃 (〃)	〃	〃 1646		+	+	+	+	c	$ne_1ne_2ch_1Ch_2$	〃
5127	〃 (〃)	〃	〃 1647		−	+	n	+	c	$Ne_1ne_2ch_1Ch_2$	〃
5129	〃 (〃)	〃	〃 1649		−	+	n	+	c	〃 〃	〃
5130	〃 (〃)	〃	〃 1650		−	+	n	+	c	〃 〃	〃
5131	〃 (〃)	〃	〃 1651		+	−	n	+	c	〃 〃	〃
5132	〃 (〃)	〃	〃 1652		+	−	n	+	c	〃 〃	〃
5133	〃 (〃)	〃	〃 1653		+	+	n	+	c	〃 〃	〃
5134	〃 (〃)	〃	〃 1654		+	−	+	?	c	$ne_1?ch_1Ch_2$	〃
5135	〃 (〃)	〃	〃 1655		+	−	+	+	c	$ne_1ne_2ch_1Ch_2$	〃
5137	〃 (〃)	〃	〃 1657		+	−	+	n	c	$ne_1Ne_2ch_1Ch_2$	South Tebilisi

(Continued)

5139	USSR (Caucasus)	A	BEC	1659		+	—	n	+	c	$Ne_1ne_2ch_1Ch_2$	South Tebilisi
5140	〃 (〃)	〃	〃	1660		+	—	n	+	c	〃 〃	〃
5142	〃 (〃)	〃	〃	1662		—	—	+	+	c	$ne_1ne_2ch_1Ch_2$	〃
5145	〃 (〃)	〃	〃	1665		+	—	n	+	c	$Ne_1ne_2ch_1Ch_2$	〃
5148	〃 (〃)	〃	〃	1668		—	—	+	+	c	$ne_1ne_2ch_1Ch_2$	Tebilisi
5151	〃 (〃)	〃	〃	1671		—	—	+	+	c	〃 〃	〃
5135	〃 (〃)	〃	〃	1673		+	—	+	n	c	$ne_1Ne_2ch_1Ch_2$	〃
5160	〃 (〃)	〃	〃	1680		+	—	+	n	c	〃 〃	〃
5166	〃 (〃)	〃	〃	1686		+	—	n	+	c	$Ne_1ne_2ch_1Ch_2$	Ananuri
5170	〃 (〃)	〃	〃	1690		+	—	n	+	c	〃 〃	〃
5171	〃 (〃)	〃	〃	1691		+	—	n	+	c	〃 〃	〃
5174	〃 (〃)	〃	〃	1694		—	—	n	+	c	〃 〃	〃
5176	〃 (〃)	〃	〃	1696		+	—	+	+	c	$ne_1ne_2ch_1Ch_2$	Melet
5177	〃 (〃)	〃	〃	1697		—	—	+	+	c	〃 〃	Segarengho
5186	〃 (〃)	〃	〃	1706		+	—	+	+	c	〃 〃	〃
5191	〃 (〃)	〃	〃	1711		+	—	+	+	c	〃 〃	Telavi
5198	〃 (〃)	〃	〃	1718		+	—	+	+	c	〃 〃	〃
5200	〃 (〃)	〃	〃	1720		—	—	+	+	c	〃 〃	〃
5214	〃 (〃)	〃	〃	1734		+	—	+	+	c	〃 〃	〃
5215	〃 (〃)	〃	〃	1735		—	—	+	+	c	〃 〃	〃
5219	〃 (〃)	〃	〃	1739		+	—	+	+	c	〃 〃	〃
5222	〃 (〃)	〃	〃	1742		+	—	+	+	c	〃 〃	〃
5224	〃 (〃)	〃	〃	1744		+	—	+	n	c	$ne_1Ne_2ch_1Ch_2$	〃
5225	〃 (〃)	〃	〃	1745		+	—	+	n	c	〃 〃	〃
5228	〃 (〃)	〃	〃	1748		+	—	+	+	c	$ne_1ne_2ch_1Ch_2$	〃
5233	〃 (〃)	〃	〃	1753		—	—	+	+	c	〃 〃	〃
5239	〃 (〃)	〃	〃	1759		+	—	+	?	c	$ne_1?ch_1Ch_2$	〃
5242	〃 (〃)	〃	〃	1762		+	—	+	+	c	$ne_1ne_2ch_1Ch_2$	Gori
5244	〃 (〃)	〃	〃	1764		+	—	n	+	c	$Ne_1ne_2ch_1Ch_2$	〃
5255	〃 (〃)	〃	〃	1775		+	—	+	n	c	$ne_1Ne_2ch_1Ch_2$	〃
5256	〃 (〃)	〃	〃	1776		—	—	+	+	c	$ne_1ne_2ch_1Ch_2$	〃

(Continued)

5258	USSR (Caucasus)	A	BEC	1778		−	−	+	+	c	*ne*$_1$*ne*$_2$*ch*$_1$*Ch*$_2$	Gori
5262	〃 (〃)	〃	〃	1782		+	−	+	n	c	*ne*$_1$*Ne*$_2$*ch*$_1$*Ch*$_2$	〃
5263	〃 (〃)	〃	〃	1783		+	−	+	?	+	*ne*$_1$*ne*$_2$*ch*$_1$*ch*$_2$	〃
5266	〃 (〃)	〃	〃	1786		+	−	+	+	c	*ne*$_1$*ne*$_2$*ch*$_1$*Ch*$_2$	〃
5267	〃 (〃)	〃	〃	1787		+	−	+	+	c	〃 〃	〃
5268	〃 (〃)	〃	〃	1788		+	−	+	n	c	*ne*$_1$*Ne*$_2$*ch*$_1$*Ch*$_2$	〃
5270	〃 (〃)	〃	〃	1790		+	−	+	n	c	〃 〃	〃
5271	〃 (〃)	〃	〃	1791		+	−	+	n	c	〃 〃	〃
5272	〃 (〃)	〃	〃	1792		+	−	+	n	c	〃 〃	〃
5276	〃 (〃)	〃	〃	1796		−	−	+	+	c	*ne*$_1$*ne*$_2$*ch*$_1$*Ch*$_2$	〃
5277	〃 (〃)	〃	〃	1797		−	−	+	+	c	〃 〃	Georgia
5278	〃 (〃)	〃	〃	1798		+	−	+	+	c	〃 〃	〃
5279	〃 (〃)	〃	〃	1799		−	−	+	+	c	〃 〃	〃
5286	〃 (〃)	〃	〃	1806		+	−	n	+	c	*Ne*$_1$*ne*$_2$*ch*$_1$*Ch*$_2$	〃
5290	〃 (〃)	〃	〃	1810		+	−	+	+	c	*ne*$_1$*ne*$_2$*ch*$_1$*Ch*$_2$	〃
5291	〃 (〃)	〃	〃	1811		+	−	n	+	c	*Ne*$_1$*ne*$_2$*ch*$_1$*Ch*$_2$	〃
5292	〃 (〃)	M	〃	1812		+	−	c	?	+	*ne*$_1$*ne*$_2$*Ch*$_1$*ch*$_2$	Tebilisi
5293	〃 (〃)	〃	〃	1813		−	−	c	c	+	〃 〃	〃
5294	〃 (〃)	〃	〃	1814		+	−	+	+	+	*ne*$_1$*ne*$_2$*ch*$_1$*ch*$_2$	〃
5295	〃 (〃)	〃	〃	1815		+	+	n	+	+	*Ne*$_1$*ne*$_2$*ch*$_1$*ch*$_2$	〃
5296	〃 (〃)	〃	〃	1816		+	−	+	+	+	*ne*$_1$*ne*$_2$*ch*$_1$*ch*$_2$	〃
5297	〃 (〃)	〃	〃	1817		+	+	n	+	+	*Ne*$_1$*ne*$_2$*ch*$_1$*ch*$_2$	〃
4166	Turkey	A	BMUK	3781	S	+	−	+	+	c	*ne*$_1$*ne*$_2$*ch*$_1$*Ch*$_2$	Kirikhan
4167	〃	〃	〃	3782	〃	−	−	+	+	c	〃 〃	〃
4168	〃	〃	〃	3783	〃	+	−	+	+	c	〃 〃	〃
4169	〃	〃	〃	3784	〃	−	−	+	+	c	〃 〃	〃
4170	〃	〃	〃	3785	〃	−	−	+	+	c	〃 〃	Pozanti
4171	〃	〃	〃	3786	〃	+	−	+	+	c	〃 〃	〃
4172	〃	〃	〃	3787	〃	+	+	n	+	c	*Ne*$_1$*ne*$_2$*ch*$_1$*Ch*$_2$	Ayas
4173	〃	〃	〃	3788	〃	−	+	n	+	c	〃 〃	Sivrikisar
4174	〃	〃	〃	3789	〃	+	−	?	+	c	? *ne*$_2$*ch*$_1$*Ch*$_2$	Bursa

(Continued)

4175	Turkey	A	BMUK	3790	S	−	−	+	+	c	$ne_1ne_2ch_1Ch_2$	Bursa
4176	〃	〃	〃	3791	〃	+	−	+	+	c	〃 〃	〃
4177	〃	〃	〃	3692	〃	+	−	+	+	c	〃 〃	〃
4178	〃	〃	〃	3793	〃	−	−	+	+	?	$ne_1ne_2ch_1$?	〃
4179	〃	〃	〃	3795	〃	+	−	+	+	c	$ne_1ne_2ch_1Ch_2$	Karacabay
4180	〃	〃	〃	3796	〃	+	−	+	+	c	〃 〃	〃
4181	〃	〃	〃	3797	〃	−	−	+	+	c	〃 〃	〃
4182	〃	〃	〃	3798	〃	+	−	+	+	c	〃 〃	〃
4183	〃	〃	〃	3799	〃	−	−	+	+	c	〃 〃	〃
4184	〃	〃	〃	3800	〃	−	−	+	+	c	〃 〃	〃
4185	〃	〃	〃	3801	〃	−	−	+	+	c	〃 〃	Edinak
4186	〃	〃	〃	3802	〃	−	−	+	+	c	〃 〃	Gönen
4187	〃	〃	〃	3804	〃	+	−	+	+	c	〃 〃	〃
4188	〃	〃	〃	3805	〃	+	−	+	+	c	〃 〃	Ismit
4189	〃	〃	〃	3806	〃	−	−	+	+	?	$ne_1ne_2ch_1$?	Adbozari
4191	〃	〃	〃	3809	〃	+	−	n	+	c	$Ne_1ne_2ch_1Ch_2$	Kirikkale
4192	〃	〃	〃	3810	〃	+	+	n	+	c	〃 〃	〃
4193	〃	〃	〃	3811	〃	−	−	n	+	c	〃 〃	〃
4194	〃	〃	〃	3814	〃	+	−	?	+	c	? $ne_2ch_1Ch_2$	Mecitözü
4195	〃	〃	〃	3815	〃	+	−	+	+	c	$ne_1ne_2ch_1Ch_2$	〃
4196	〃	〃	〃	3817	〃	+	−	+	+	c	〃 〃	〃
4197	〃	〃	〃	3818	〃	+	+	n	+	+	$Ne_1ne_2ch_1ch_2$	Yerköy
4198	〃	〃	〃	3819	〃	+	−	+	+	c	$ne_1ne_2ch_1Ch_2$	Cerikli
4199	〃	〃	〃	3821	〃	+	+	n	+	c	$Ne_1ne_2ch_1Ch_2$	〃
4200	〃	〃	〃	3822	〃	−	+	n	+	c	〃 〃	〃
4201	〃	〃	〃	3823	〃	+	+	n	+	c	〃 〃	〃
4202	〃	〃	〃	3824	〃	+	+	n	+	c	〃 〃	〃
4203	〃	〃	〃	3826	〃	−	+	n	+	c	〃 〃	〃
4204	〃	〃	〃	3827	〃	+	+	n	+	c	〃 〃	Ayas
4205	〃	〃	〃	3828	〃	+	+	n	+	c	〃 〃	〃
4206	〃	〃	〃	3829	W	+	−	n	+	c	〃 〃	〃

(Continued)

4207	Turkey	A	BMUK	3830	S	+	+	n	+	c	$Ne_1ne_2ch_1Ch_2$	Ayas
4208	〃	〃	〃	3831	〃	+	+	n	+	c	〃 〃	〃
4209	〃	〃	〃	3832	〃	+	−	n	+	c	〃 〃	〃
4210	〃	〃	〃	3833	〃	−	+	n	+	c	〃 〃	〃
4211	〃	〃	〃	3834	〃	+	−	n	+	c	〃 〃	〃
4212	〃	〃	〃	3835	〃	+	−	?	+	c	$?ne_1ch_1Ch_2$	〃
4213	〃	〃	〃	3836	〃	+	+	n	+	c	$Ne_1ne_2ch_1Ch_2$	〃
4214	〃	〃	〃	3837	W	+	+	n	+	c	〃 〃	〃
4215	〃	〃	〃	3839	S	−	+	n	+	c	〃 〃	〃
4216	〃	〃	〃	3840	〃	+	+	n	+	c	〃 〃	Ankara
4217	〃	〃	〃	3841	〃	−	+	?	+	c	$?ne_2ch_1Ch_2$	〃
4218	〃	〃	〃	3842	〃	+	+	n	+	c	$Ne_1ne_2ch_1Ch_2$	〃
4219	〃	〃	〃	3843	〃	+	+	n	+	c	〃 〃	〃
4220	〃	〃	〃	3844	W	+	+	n	+	c	〃 〃	〃
4221	〃	〃	〃	3845	〃	−	+	n	+	c	〃 〃	〃
4222	〃	〃	〃	3846				+	?	c	$ne_1?ch_1Ch_2$	〃
4226	〃	〃	〃	3851	S	+	+	n	+	c	$Ne_1ne_2ch_1Ch_2$	〃
4227	〃	〃	〃	3852	〃	+	−	n	+	c	〃 〃	〃
4228	〃	〃	〃	3853	〃	+	−	n	+	c	〃 〃	〃
4229	〃	〃	〃	3854	〃	+	+	+	+	c	$ne_1ne_2ch_1Ch_2$	〃
4230	〃	〃	〃	3855	〃	−	+	n	+	c	$Ne_1ne_2ch_1Ch_2$	〃
4231	〃	〃	〃	3856	I	+	−	+	+	c	$ne_1ne_2ch_1Ch_2$	Ismit
4232	〃	〃	〃	3857	S	+	−	?	+	c	$?ne_2ch_1Ch_2$	〃
4233	〃	〃	〃	3858	〃	−	−	+	+	c	$ne_1ne_2ch_1Ch_2$	〃
4235	〃	〃	〃	3860	〃	+	−	+	n	c	$ne_1Ne_2ch_1Ch_2$	Serike
4236	〃	〃	〃	3861	〃	+	−	+	n	c	〃 〃	〃
4237	〃	〃	〃	3862	〃	−	+	n	+	c	$Ne_1ne_2ch_1Ch_2$	Burdur
4161	Syria	〃	〃	3779	〃	+	−	+	+	c	$ne_1ne_2ch_1Ch_2$	
4165	〃	〃	〃	3780	〃	−	−	+	+	c	〃 〃	
4163	Lebanon	〃	〃	3778	〃	−	−	+	+	c	〃 〃	
4162	Jordan	〃	〃	3777	〃	+	−	+	+	c	〃 〃	

(Continued)

4137	Egypt	A	BMUK	3751	S	+	—	n	+	c	$Ne_1ne_2ch_1Ch_2$
4138	〃	〃	〃	3752	〃	+	—	n	+	c	〃 〃
4139	〃	〃	〃	3753	〃	+	—	+	+	c	$ne_1ne_2ch_1Ch_2$
4140	〃	〃	〃	3754	〃	+	—	n	+	c	$Ne_1ne_2ch_1Ch_2$
4141	〃	〃	〃	3755	〃	+	—	+	+	c	$ne_1ne_2ch_1Ch_2$
4142	〃	〃	〃	3756	〃	+	—	n	+	c	$Ne_1ne_2ch_1Ch_2$
4143	〃	〃	〃	3757	〃	+	—	+	+	c	$ne_1ne_2ch_1Ch_2$
4144	〃	〃	〃	3758 c	〃	+	—	n	+	c	$Ne_1ne_2ch_1Ch_2$
4145	〃	〃	〃	3759	〃	+	—	n	+	c	〃 〃
4146	〃	〃	〃	3760	〃	+	—	n	+	c	〃 〃
4147	〃	〃	〃	3761	〃	+	—	n	+	c	〃 〃
4148	〃	〃	〃	3762	〃	—	—	n	+	c	〃 〃
4149	〃	〃	〃	3763	〃	+	—	n	+	c	〃 〃
4150	〃	〃	〃	3764	〃	+	—	n	+	c	〃 〃
4151	〃	〃	〃	3765	〃	+	—	n	+	c	〃 〃
4152	〃	〃	〃	3766	〃	—	—	n	+	c	〃 〃
4153	〃	〃	〃	3767	〃	+	—	n	+	c	〃 〃
4154	〃	〃	〃	3768	〃	—	—	n	+	c	〃 〃
4155	〃	〃	〃	3769	〃	+	—	+	+	c	$ne_1ne_2ch_1Ch_2$
4156	〃	〃	〃	3770	〃	+	—	n	+	c	$Ne_1ne_2ch_1Ch_2$
4157	〃	〃	〃	3772	〃	+	—	n	+	c	〃 〃
4158	〃	〃	〃	3773	〃	+	—	n	+	c	〃 〃
4159	〃	〃	〃	3774	〃	+	—	n	+	c	〃 〃
4160	〃	〃	〃	3775	〃	+	—	+	+	c	$ne_1ne_2ch_1Ch_2$
4161	〃	〃	〃	3776	〃	+	—	n	+	c	$Ne_1ne_2ch_1Ch_2$

1) A : *T. aestivum*, C : *T. compactum*, M : *T. macha*
2) W : winter type, S : spring type, I : intermediate type
3) + : awned, — : awnless
4) + : hairy, — : non-hairy
5) + : normal, n : necrotic, c : chlorotic, ? : not tested

III. Gene Symbols

Gene Symbols for wheat

R. A. McIntosh
Department of Agricultural Botany, Univ. of Sydney, Sydney, N.S.W., Australia

A Catalogue of Gene Symbols for Wheat was accepted by the Fourth International Wheat Genetics Symposium held at Columbia, Missouri, U.S.A. in 1973. The list appears in the Proceedings and a limited number of reprints are also available. Corrections and additions should be brought to the attention of the Coordinator. It will be appreciated if the format of new sections is outlined. An annual supplementary list will be sent to the Editors of Wheat Newsletter, Wheat Information Service and Cereal Research Communications.

1974 Supplementary List

New references are suffixed with A, B etc. Other reference numbers apply to the original Catalogue.

Catalogue of Symbols

Gross morpyhology

C 2Dβ (212B)

*s*1 3Dβ (212A)

Grass Clump Dwarfness/*Grass* Dwarfness

Correction: In Symposium preprints reference 177 in this section should read 175.

List of Genotypes 66A

Reaction to Puccinia graminis

Sr9e(170A) *Srd*1^{v}(110A) *Sr*^{v}(262A) 2B(168A) *v*: Vernstein (150A)

T. turgidum cv. Vernal (262A); C.I.7778 (50A).

Sr16 i: Itha3B-Ra (145A).

Reaction to Puccinia recondita

Lr3 N.B. As *Lr3* appears to be a complex locus (79A) only Democrat and Democrat/6* Thatcher should be accepted as standard. Temporary designations: *Lr3bg* Bage (79A); *Lr3Ka* Klein Anniversario (79A).

Lr9 *v*: Arthur 71 (252A); Riley 67 (252A).

Lr11 *v*: Bulgaria 88 (38a).

Correction *Lr22* v: ...var. *strangulata* R.L. 5271,.....

Reaction to Tilletia sp.

Bt9 *v*: Ranger *Bt10* (272A).

Bt10 *v*: Ranger *Bt9* (272A).

Homelogy of Chromosome Arms

Hom.	Group 4	4Aβ=4BS=4DL	82A (replaces 83)
Hom.	Group 6 correction	6BL≒6Dβ	

Genetic Linkages

Chromosome 2B

*Sr9e/Sr9b-SrTt*1/LrG	19.6±1.9%	170A

Note: this estimate obtained using a rare *Sr9e SrTt*1 coupling stock. Earlier studies using Timvera and C.I. 12632 found little or no recombination between *Sr9* and *SrTt*1 (170A).

Chromosome 2D

C - *D1*	36.7%	175
C - *D4*	Independent	175
β arm *C* - centromere	2.26%	212A

Chromosome 3D

Rl - centromere	Independent	212A

Literature Cited

38A Browder, L. E. 1973. Specificity of the *Puccinia recondita* f. sp. *tritici: Triticuc aestivum* 'Bulgaria 88' relationship. Phystopathology **63:** 524~528.

66A Fick, G. N. and C. O. Qualset 1973. Inheritance and distribution of grass-dwarfing genes in short-statured wheats. Crop Sci. **13:** 31~33.

79A Haggag, M. E. A. and P. L. Dyck 1973. The inheritance of leaf rust resistance in four common wheat varieties possessing genes at or near the *Lr3* locus. Can. J. Genet. Cytol. **15,** 127~134.

82A Hart, G. E. 1973. Acid phosphatase of hexaploid wheat: linkage to homoeologous chromosomes of structural genes for six isozymes. Proc. 13th Int. Cong. Genet. **74** Suppl. 2, S110.

110A Kenaschuk, E. O., R. G. Anderson and D. R. Knott 1959. The inheritance of rust resistance V. The inheritance of resistance to race 15B of stem rust in ten varieties of Durum wheat. Can. J. Plant Sci. **39:** 316~328.

145A Loegering, W. Q. and E. R. Sears 1973. The gene for low reaction to *Puccinia graminis tritici* in the Thatcher-3B substitution line. Crop Sci. **13:** 282.

150A Luig, N. H. and I. A. Watson 1967. Vernstein—a *Triticum aestivum* derivative with Vernal emmer type stem rust resistance. Crop Sci. **7:** 31~33.

168A McIntosh, R. A. and E. P. Baker 1970. Cytogenetic studies in wheat V. Monosomic analysis of Vernstein stem rust resistance. Can. J. Genet. Cytol. **12:** 60~65.

170A ——, —— and N. H. Luig 1973. Recombination between genes for reaction to *P. graminis* at or near the *Sr9* locus. Proc. 4th Int. Wheat Genet. Symp. (Univ. of Missouri: in press).

212A Rao, M. V. P. 1973. Mapping the gene *Rl* for red seed colour on chromosome 3D of wheat. Wheat Inform. Serv. **36:** 9.

212B ——, —— 1972. Mapping of the *compactum* gene *C* on chromosome 2D of wheat. Wheat Inform. Serv. **35:** 9.

252A Shaner, G., J. R. Roberts and R. E. Finney 1972. A culture of *Puccinia recondita* virulent on the wheat cultivar Transfer. Plant Dis. Reptr. **56:** 827~30.

262A Smith, G. S. 1957. Inheritance of stem rust reaction in tetraploid wheat hybrids I. Allelic genes in Vernal emmer and Mindum durum. Agron. J. **49:** 134~137.

272a Sunderman, D. W. and M. Wise 1973. Registration of Ranger wheat. Crop Sci. **13:** 287.

IV. Editorial Remarks

Announcement for future issues

WIS No. 41 will be planned for publication in October 1975. Manuscripts for this issue are accepted any time, not later than July 31, 1975.

WIS is open to all contributions regarding methods, materials and stocks, ideas and research results related to genetics and cytology of *Triticum, Aegiolops, Secale, Haynaldia* and related genera. Manuscripts should be typewriten in English, and submitted with duplicates. One article should not exceed five printed pages, including one textfigure (smaller than 7×7 cm^2). Lists of stocks are exempted from this page limit. Authors receive 50 reprints of their contributions free of charge. Extra copies are printed by order at cost price. Communications regarding editorial matters should be addressed to:

Kosuke YAMASHITA
Wheat Information Service
Kihara Institute for Biological Research
Misima 411, Japan

Raise of Membership Fee

Due to the economic situations, the yearly Membership Fee has been raised up to ¥1,000 for foreign member and ¥700 for Japanese member from the fiscal year beginning April 1975. The money should be paid by the Foreign Postal Money Order, othersiwe considerable loss is caused due to the bank charges. Back numbers are available.

Acknowledgement

The cost of the present publication has been defrayed partly by the Grant in Aid for Publishing Research Results from the Ministry of Education, Government of Japan, and partly by contributions from the Flour Millers Association, Tokyo, Japan. We wish to express our sincere thanks to those organizations. We should also like to express our sincere gratitude for favorable comments regarding WIS Nos. 1~38, and valuable contributions for the present issue. Increased support would be appreciated.

The Managing Editor

Explanation of the Figure on the Cover

Spikes and grains of: a) *T. sphaerococcum* var. *rotundatum* (2n=42), b) *T. durum* var. *apulicum*-No. 233 (2n=28), c) *A durum-sphaerococcum* type derivative of pentaploid hybrids (2n=28). (I. STANKOV and D. TSIKOV, Fig. 1, p. 10, present issue of WIS).