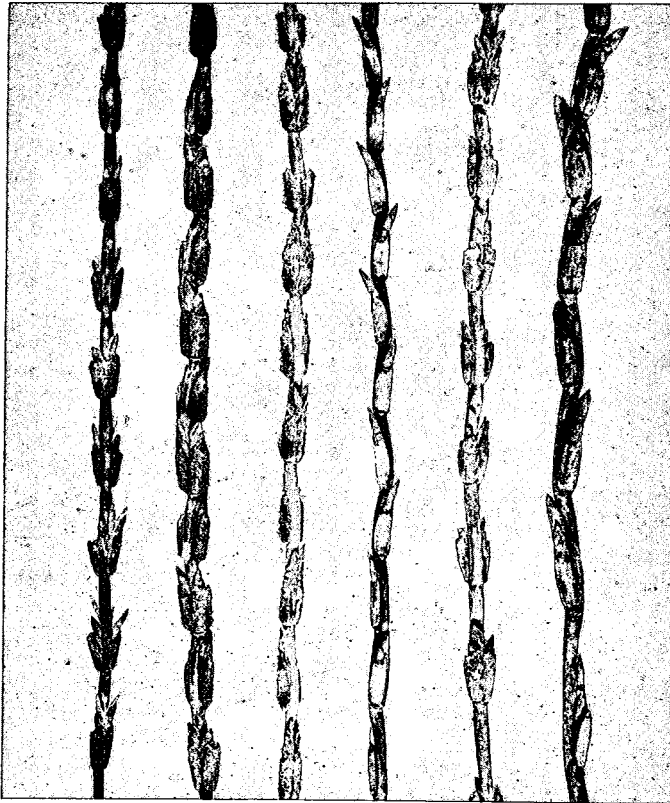


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I. Research Notes

F₁ monosomic analysis of *Triticum macha*

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Gene analysis of *Triticum macha* is important, because it seems to be the most probable progenitor of hexaploid wheat (Kihara 1958). It is also known to have a normal allele of the third necrosis gene that has not yet been identified (Sachs 1954, Hermsen 1960).

The authors studied this species by crossing it to 21 monosomic lines of Chinese Spring. F₁ plants were grown in the green house under long day conditions and their chromosome numbers were determined in root-tip mitosis.

Due to semi-lethality of the hybrids, only a few F₂ seeds were produced, which did not allow to carry out the monosomic analysis to the F₂ generation. The results obtained in the F₁ generation are reported here.

Number of disomic and monosomic F₁ plants obtained and their phenotypes in respect to necrosis and some other characters are recorded in Table 1.

Necrosis. In the F₁ generation, all the disomics and 20 monosomics (except mono-XVI) were necrotic with the exception of a single mono-II plant that seemed to be not a typical plant originated from asynapsis in Chinese mono-II parent. On the other hand, F₁ mono-XVI's were all normal. These findings indicate that chromosome XVI of Chinese Spring carries a necrosis gene, whose interaction with *macha*'s genes causes necrosis and semilethality of the hybrids. As chromosome XVI belongs to D genome, the authors' finding confirms Sachs' conclusion that a necrosis gene should be present in the D-chromosome set of 6x wheats.

Previously, Tsunewaki (1960) reported that Prelude and Kharkov carry *Le*₁ gene on chromosome V and *Le*₂ gene on chromosome XIII, respectively. Chinese Spring carries normal alleles of both genes. No homoeology exists between *Le*₁, *Le*₂ and the necrosis gene of the authors, because chromosomes V, XIII and XVI belong to the homoeologous groups 5, 2 and 3, respectively.

Table 1. Phenotypes of di- and monosomic F₁ plants produced from crosses,
T. macha × Chinese Spring monosomics

Strains	Number of plants			Growth habit ¹⁾	Awned-ness ²⁾	Plant height (cm)	Average number of seeds produced (selfed)
	Total	Necrotic	Normal				
Disomics	23	23	0	S	—	52	5.6
Mono-I	5	5	0	S	—	59	7.2
" -II	4*	3	1	S	—	41**	0.3**
" -III	4*	4	0	S	—	61	21.7
" -IV	2	2	0	S	—	49	0.0
" -V	4	4	0	S	—	32	0.0
" -VI	3	3	0	S	—	43	0.0
" -VII	4	4	0	S	—	46	1.3
" -VIII	2	2	0	S	±	33	0.0
" -IX	5	5	0	W	?	23	?
" -X	3	3	0	S	±	39	0.0
" -XI	2	2	0	S	—	40	0.0
" -XII	2	2	0	S	—	52	3.0
" -XIII	5	5	0	S	—	52	3.4
" -XIV	3	3	0	S	—	44	0.3
" -XV	3*	3	0	S	—	37	0.0
" -XVI	5	0	5	S	—	108	55.4
" -XVII	4	4	0	S	—	52	4.5
" -XVIII	4	4	0	W	?	19	?
" -XIX	5	5	0	S	—	40	0.0
" -XX	4	4	0	S	—	52	0.8
" -XXI	3	3	0	S	—	44	0.0

1) S and W indicate spring and winter growth habit, respectively.

2) — and ± indicate awnless and awnletted, respectively.

* One plant in each strain had 40 chromosomes.

** Excluded the exceptional, normal plant.

Complying with Hermesen's proposal (1961), the authors designate the necrosis genes on chromosome V, XIII and XVI with Ne_1 , Ne_2 and Ne_3 , respectively. The probable genotypes of the four investigated wheats are shown in Table 2.

Performance of the hybrids as to plant height and seed-setting was best in mono-XVI, due to absence of necrosis. Among the necrotic, monosomic F₁ plants, however, some difference in the tolerance to necrosis was found, namely, the F₁ mono-III performed better as to plant height and, especially, seed-setting, than any other necrotic di- and monosomics. It is reasonable to assume from this result that chromosome III of Chinese Spring carries a gene that conditions severe necrosis. This modifier on chromosome III may or may not be homoeologous of the necrosis gene on chromosome XVI, because those two chromosomes are homoeologous.

Growth habit. Monosomic F₁ plants for either chromosome IX or XVIII of Chinese Spring had winter growth habit, indicating that those chromosomes of *T. macha* carry

Table 2. Probable genotypes of four 6x wheats in respect to necrosis

Material	Location (Chromosome)		
	V	XIII	XVI
Prelude	<i>Ne</i> ₁	<i>ne</i> ₂	<i>Ne</i> ₃
Kharkov	<i>ne</i> ₁	<i>Ne</i> ₂	<i>Ne</i> ₃
Chinese Spring	<i>ne</i> ₁	<i>ne</i> ₂	<i>Ne</i> ₃
<i>T. macha</i>	<i>Ne</i> ₁	<i>Ne</i> ₂	<i>ne</i> ₃

recessive genes controlling winter growth habit. These genes seem to be the same as those found in other hexaploid wheats (Tsunewaki and Jenkins 1959, Morrison 1960).

Awnedness. Monosomic F₁ plants for chromosome VIII or X were awnletted, whereas all the other hybrids were awnless. This result indicates that *T. macha* carries *hd* and *b*₂ on chromosomes VIII and X, respectively. An awn-suppressor of *T. macha* could not be identified.

Introduction of telocentric chromosome of Chinese Spring wheat into Emmer wheat*

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In spite of repeated trials of many workers, monosomics of emmer wheats have not been obtained except monosomic 6A (VI) of Ld 222, a variety of durum wheat (late John Longwell, Jr., unpublished). Apparently the cells from which one whole chromosome is deficient are rarely or never transmitted, either through the male or the female.

For some purposes, telocentric chromosomes would be fully as useful as monosomes. The loss of only one arm of a chromosome should, in many cases, be tolerated without serious deleterious effect.

Trials are now being made to introduce telocentrics for the chromosomes of the A and B genomes of Chinese Spring wheat into emmer wheats. Plants carrying the telocentrics were crossed by emmer, and repeated backcrosses are in progress in order to eliminate the D-genome chromosomes.

Plants with a telocentric for the long arm (carrying *Q*) of chromosome 5A (IX) and one normal 5A, and free from D-genome univalents have already been obtained. These plants were just as fertile as the parent emmer wheat.

The telocentrics that can be obtained in tetraploid wheat will be used for studies on the nature of the differentiation of the A genome.

* This work was supported in part by a grant from the National Science Foundation to Dr. E. R. Sears.

The Rivet wheat in north-western China :
A comment of Dr. Hosono's hypothesis on the route of
introduction of wheat to China

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Following the successful synthesis of *Triticum vulgare* by H. Kihara and F. A. Li-
lienfeld (1948) by crossing *Triticum persicum* with *Aegilops squarrosa*, they assumed
that the place of origin of *T. vulgare* may be the whole area where *Ae. squarrosa* grew
wild, e.g. the border region between Iran and Afghanistan. In 1951, O. Sinoda discussed
the time and route of introduction of *T. vulgare* into China, suggesting that *T. vulgare*
was not introduced into China until the time of Han Wa Ti (漢武帝) (ca. 200 B.C.).
Since he correlated the introduction of *T. vulgare* with the expedition of Chang Ch'ien
(張騫) to Sinkiang (新疆), he seemed to hint strongly that wheat was introduced into
north-western China through the so-called "silk route".

It is regrettable that there seems to be no Chinese report on the species and varieties
of wheat in the Chinese Mainland. According to Hosono (1935), there are papers dealing
with this subject by Flaksberger (1911, '15, '29), Percival (1921), Vavilov (1923) and Orlov
(1923). Hosono's survey is the most detailed, and he stated that there were nineteen
varieties of *T. vulgare*, five varieties of *T. compactum* and one variety of *T. turgidum*
in the Chinese Mainland. The variety of *T. turgidum* was found in Yünnan Province
(雲南省). Based on the number and resemblance of varieties of *T. vulgare* in Yünnan
and the neighboring provinces of Kwangsi (廣西), Kweichow (貴州), Szechwang (四川), and
on the presence of *T. turgidum* in Yünnan, Hosono (1954) reasoned that wheat was
introduced into Yünnan from India. His hypothesis is sound from the plant geographical
viewpoint of Vavilov. But since there is no confirmation in the Chinese literature, there
is no way of determining whether wheat was actually introduced into China through
such a route or what portion of the present day wheat varieties in China are descendents
of those first introduced into Yünnan from India.

After careful reading of Hosono's report (1935), I noticed that he did not have any
specimens from Kansu (甘肅) and Shensi (陝西), the two important provinces along the
silk route. Therefore he could not possibly obtain any material evidence in favor of the
silk route, which is the most likely route of wheat introduction into China. Indeed this
is a big drawback of Hosono's report. As I have never been in Kansu and Shensi, I have
no knowledge of the wheat in those two provinces. However in 1939, while I was in
Liuchow (柳州), Kwangsi, a friend coming from Shensi presented me with some specimens
of *T. turgidum* var. *lusitanicum* which he said was cultivated to a considerable extent

in or near Paocheng (郫城) Shensi, and had the native name of "Lan-Mei" (藍麥) or blue wheat. Again in 1941, while I was in Chengtu (成都), Szechwang, another friend sent me from Lanchow (蘭州), Kansu, some specimens of *T. turgidum* var. *columbianum*, which he said was cultivated there to some extent and had the native name of "Fu-Shu-Shao-Mei" (佛手小麥), or wheat with an ear resembling the fruit of the horned orange tree (*Citrus medica* L. var. *sarcodactylis* Swingly). On the basis of these facts, it is quite certain that *T. turgidum* has been introduced into Kansu and Shensi.

In conclusion, I think that the silk route is more important as a route by which wheat was introduced into China. I regret that I did not have the opportunity to witness the common wheat in Kansu and Shensi. I am therefore unable to contribute anything to Hosono's report concerning *T. vulgare* and *T. compactum*.

This short report, or rather a recollection has been written upon the encouragement of Dr. K. Yamashita. And I wish to express my best thank to Dr. Ketellapper for his kindness to read the manuscript.

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Dosage Effect of the *spelta* Gene q_1 *

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Spontaneous or artificial speltoid mutation in the hexaploid common wheat, *Triticum aestivum*, is considered, in almost all cases, to be a deficiency for a segment including the speltoid-suppressing or squarehead gene *Q* on chromosome 5A (IX). It has been suggested that *T. spelta*, which resembles the speltoids, also originated as a deficiency for *Q*.

Sears (unpublished) obtained the dosage series of the *spelta* gene q_1 (an allele of *Q*) up to 4 doses and found that q_1 behaved as a null allele. As Sears (1954, 1956) pointed out, however, if the *Q* gene arose by a mutation from q_1 , the latter could not be a

* This work was supported by a grant from the National Science Foundation to Dr. E. R. Sears.

deficiency. In this case, the most likely explanation for the null effect of q_1 would be that it is an amorph or that it is a hypomorph with an effect so feeble that four doses of q_1 scarcely have a recognizable effect on the phenotype.

It is therefore of interest to obtain a plant with five or more doses of q_1 . Such a plant was discovered in the process of combining monosome 5B (V) with tetrasome 5A (IX) $q_1q_1q_1q_1$ from *T. spelta*.

From a tri-5A ($q_1q_1q_1$) monotel-5B plant, 16 offspring were obtained. Fifteen of them showed the expected *spelta* expression, but one was squarehead. It had short culms, and the tips of the spikes were compact and infertile. That this plant was not a contaminant was clear from the fact that it had a pair of telocentrics. It also apparently had an isochromosome for the long (q_1 -carrying) arm of chromosome 5A plus three normal 5A's. From this plant, 29 seeds were sown, and 23 of the resulting offspring were analyzed cytologically. The chromosome constitution varied from 21_{II} (two doses of q_1) including one ditelosome to $20_{II}+1_{IV}+1_{I iso}$ (six doses of q_1) including one ditelosome. The plants with five doses of q_1 showed the same phenotype as the parent. All the plants which had from two to four doses of q_1 showed *spelta* expression. The plant with six doses of q_1 had a spike still more compact than those with five doses.

Evidently q_1 is an allele which has an effect similar to that of Q but of lesser degree. Since q_1 is an active gene, not merely a deficiency, *T. spelta* can not have originated from *T. aestivum* in the way that speltoids arise. The fact that q_1 is a hypomorph strengthens the view of Kuckuck that *aestivum* (i.e., Q) originated from *spelta* through a duplication of q_1 .

Genetic effects of pile neutrons on bread wheats

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During the mutation genetics programme in bread wheats the seeds were treated with pile neutrons from Atomic Energy Establishment, Bombay, India. Four doses viz. 13.5×10^{18} np/cm²; 4.5×10^{18} np/cm²; 1.5×10^{18} np/cm² and 0.5×10^{18} np/cm² were administered to see the genetic effects of pile neutrons on two varieties, RS 31-1 and C 591, of bread wheat. Germination percentage, growth rate of seedling, spike fertility and chromosomal aberrations, clubbing of ear and chlorophyll deficiency in the X_1 and X_2 variants were compared. There was no germination of X_1 seeds in C 591 with 13.5×10^{18} np/cm² dose. The treated plants showed general lateness in flowering, and maturity was observed to be 15 days later over control.

Doses 4.5×10^{18} np/cm² and 1.5×10^{18} np/cm² roughly proved to be effective in changing the germination percentage, rate of seedling growth, spike fertility, chromosomal aberrations and chlorophyll deficiency in some of the plants. The higher the dose of pile

Table 1. Table showing the various effects of different doses of pile neutrons in bread wheats.

Doses	Germination percentage	Seedling length after 15 days in cm	Plants with clubbed ears	Chromosomal aberrations in PMC's %	Chlorophyll deficient mutants %
Control	88.00	12.54	—	—	—
13.5×10^{18} np/cm ²	1.55	3.41	—	70.13	18.55
4.5×10^{18} np/cm ²	50.83	7.45	0.008	50.57	14.56
1.5×10^{18} np/cm ²	39.50	8.67	0.001	20.31	5.34
0.5×10^{18} np/cm ²	49.87	10.51	—	2.50	2.57

neutrons, the more delayed were germinations and the more inhibited was seedling growth.

In the X₂ progeny of the treated plants white and yellow seedlings were often found in 4.5×10^{18} np/cm² and 1.5×10^{18} np/cm² treatments. These seedlings, however, did not survive for long. The frequency of chromosomal aberrations and chlorophyll deficient variants is directly proportional to the rate of dose. No difference in the various treatments due to varieties was observed. In conclusion, it may be suggested that increased dose of radiation possibly damages the embryo, and hence germination percentage was lower in higher doses.

**Studies on the induction of mutations by P³² in wheat. III.
Chromosomal aberrations in R₁ generation, with special
reference to the differences of chromosome numbers
and of meiotic behaviors**

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In the autumn of 1958, dry seeds of a wheat variety, "Aoba-Komugi", were soaked for two weeks in the solutions of Na₂HP³²O₄ with the doses of 1, 2.5, 5, 7.5 and 10μc per seed, respectively. The experiment was aimed to obtain some knowledges about the cytological effects of P³² on wheat.

The percentage of survived plants decreased with the dosage increase; no plant survived at 10μc. But the percentage of chromosomal aberrations per spike increased in direct proportion to the increase of the dosage. The types of the chromosomal aberrations observed at MI of PMC's were translocation, deficiency, non-pairing and their various combinations. It is especially interesting to note that the differences of chromosome numbers and of meiotic behaviors were found not only among florets of a spikelet but also among anthers of a floret. In Table 1 the data are given. Such ab-

normality of chromosomes in R₁ generation might have caused further abnormalities in R₂ generation.

Table 1. Difference of meiotic behavior or chromosome number among florets of a spikelet in R₁ generation irradiated at the dosage of 5.0 μ c.

Individuals	Spikes	Florets	Anthers	2n	Configurations
10	10	1	1	42	21 Π
			2	42	"
		2	1	42	1 IV +19 Π
12	1	1	2	42	"
			1	41	1 IV +18 Π +1 I
			2	41	"
		3	41	"	
		2	1	40+1f	1 IV *+18 Π +1 I
4	16	1	2	40+1f	"
			3	40+1f	"
			1	42	21 Π
		2	1	42	21 Π
			2	42	"
			3	42	"
			3	1	37~47
5	4	1	1	42	21 Π , often 20 Π +2 I
		2	1	41+1 iso	20 Π +1 I +1 iso
		3	1	41+1 iso	18 Π +5 I +1 iso
7	1	1	1	42	20 Π +(1 Π)***
			2	42	"
			3	42	21 Π
4	10	1	1	42+1 iso	1****+20 Π or 21 Π +1 iso
			2	42	21 Π
			3	42	"
9	10	1	1	41	20 Π +1 I
			2	41	"
			3	41	20 Π +1 I , often 1 IV +18 Π +1 I

* A tetravalent formed by pairing of 3 normal chromosomes with a fragment,

** Chromosome mosaics,

*** Heteromorphic pairing,

**** Pairing of a normal bivalent with an iso-chromosome.

Radiation effects of fast and thermal neutrons on wheat:

III. Relation between ploidy and radiation effects

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Thermal neutron irradiations for *Triticum durum* and *T. vulgare* were conducted by the Reactor JRR-1, as in the case of *T. monococcum*. Exposure to fast neutrons of 14 MeV in ORNL was simultaneously carried out with *T. monococcum*, *T. durum* and *T. vulgare*. The dosage ranged from 2.5 to 20 krad for *T. durum* and *T. vulgare*. After exposure to 37.5×10^{12} n_{th}/cm² (V) of thermal neutrons and 5 krad of fast neutrons, *T. monococcum* did not germinate, while the seeds of *T. durum* and *T. vulgare* germinated but most of the seedlings died in an early stage. At 20.6×10^{12} n_{th}/cm² (IV) of thermal neutrons and 2~2.5 krad of fast neutrons most of the seedlings of *T. monococcum* died, while in *T. durum* and *T. vulgare* slow growth of the seedlings continued. The higher was the dosage of thermal and fast neutrons, the more delayed were germination and growth of seedlings and the more reduced were survival rate, height of mature plants and seed fertility. These relationships were ascertained in *T. durum* and *T. vulgare*, as well as in *T. monococcum*. In general, *T. monococcum* is the most sensitive to thermal and fast neutrons and *T. durum* is unexpectedly the most resistant. There is no significant difference between *T. durum* and *T. vulgare*. The 1 r equivalent effects produced by thermal neutrons are calculated for 2x, 4x and 6x species as Table 1 shows, in comparison with the results obtained by X- and gamma-irradiations in ORNL at 10 and 20 kr.

Table 1. Comparison of the 1 r equivalent effects produced by thermal neutrons ($\times 10^9$ n_{th}/cm²) in 2x, 4x and 6x wheats

Ploidy	Length of seedlings	Seed fertility	Chromosome aberrations	Chlorophyll mutations
2x	1.6	2.6	4.1	0.73
4x	3.6	2.7	2.4	—
6x	4.9	5.1	2.0	—

Table 2. Comparison of RBE of the fast neutrons in 2x, 4x and 6x wheats

Ploidy	Germination rate	Length of seedlings	Seed fertility	Chromosome aberrations	Chlorophyll mutations
2x	4	10	12	8	10
4x	3	6	20	25	—
6x	3	6	~15	~10	—

RBE of fast neutrons is calculated as shown in Table 2, in comparison with X- and gamma-rays. RBE is lower for the characters observed in earlier stages (germination rate, length of seedlings) than those of mature plants (seed fertility, chromosome aberrations), especially in polyploids.

Susceptibility of nullisomic wheat dwarfs and their respective gigas-plants to leaf-rust, *Puccinia triticina*

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Dwarf plants possessing 40 chromosomes (20_{II}), found among the offspring of the pentaploid hybrid, *Triticum polonicum* × *T. Spelta*, are nullisomics, deficient in a chromosome pair of the D-genome. Depending on which of the a~g D-chromosomes is missing, they are called a~g-dwarfs. The respective gigas-plants with 42 chromosomes found among the offspring of nullisomics are called a~g-gigas. They also may be termed D-nulli- and AB-tetrasomics.

In order to examine the susceptibility of nullisomics and their gigas-plants to leaf rust, a~g-dwarfs and a~g-gigas were tested at the first leaf stage with *Puccinia triticina* 21B. One parent, *T. polonicum*, was susceptible, while the other, *T. Spelta*, showed resistance to rust. Because all e-dwarfs and their gigas-strains were susceptible, it has been concluded that the gene for resistance is located on the e-chromosome of the D-genome. A strain of g-dwarfs was susceptible, but a gigas-strain originating from another g-dwarf was resistant. The c-dwarfs and their gigas-plants exhibited resistance or moderate resistance and b-dwarf and its gigas-plants were resistant. Though a-dwarf was resistant, among a-gigas plants resistant and susceptible strains were observed. It has been assumed that the supernumerary chromosomes of resistant and susceptible a-gigas-strains were different. Among d- and f-dwarfs resistant and susceptible strains were found, and also the correspondent gigas-strains showed resistance and susceptibility, respectively. We supposed that more genes for susceptibility are located on the chromosomes of the A- and B-genomes, in addition to the epistatic genes of the D-genome.

**New amphidiploids, synthesized 6x-wheats, derived from
Emmer wheat × *Aegilops squarrosa***

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All the amphidiploids listed in the following table were produced by the union of unreduced gametes, as reported in WIS Nos. 6 and 8. According to Dr. N. Hiratuka (unpubl.), ABD No. 22 is resistant to leaf rust (*Puccinia recondita* f. sp. *tritici*, strain No. 21B).

List of new amphidiploids

Stock No. ¹⁾	Cross combination
ABD 9	<i>T. dicoccoides spontaneonigrum</i> × <i>Ae. squarrosa strangulata</i> (KUSE ²⁾ 2124)
ABD 10	" " × " <i>typica</i> (" 2129)
ABD 11	<i>T. persicum stramineum</i> × " <i>strangulata</i> (" 2135)
ABD 12	<i>T. dicoccoides spontaneonigrum</i> × " " (" 2112)
ABD 13	<i>T. dicoccum</i> (Vernal) × " " (" ")
ABD 14	<i>T. durum</i> (Gulab) × " " (" 2118)
ABD 15	" × " <i>typica</i> (" 2129)
ABD 16	" × " <i>Meyeri</i> (" 2144)
ABD 17	<i>T. persicum stramineum</i> × " <i>typica</i> (" 2107)
ABD 18	" " × " <i>strangulata</i> (" 2112)
ABD 19	" " × " " (" 2118)
ABD 20	" " × " <i>typica</i> (" 2129)
ABD 21	" " × " " (" 2130)
ABD 22	" " × " <i>Meyeri</i> (" 2144)
ABD 23	<i>T. orientale insigne</i> × " <i>strangulata</i> (" 2112)

1) Stock number in the Laboratory of Genetics, Faculty of Agriculture, Kyoto University, Kyoto, Japan.

2) Material No. of the Kyoto University Scientific Expedition to the Karakoram and Hindukush, 1955.

Identification of the wheat chromosome carrying leaf-rust resistance
from *Aegilops umbellulata*

E. R. SEARS

U.S. D. A. and Missouri Agricultural Experiment Station, Columbia, Mo., U.S.A.

The strain of wheat designated T47 (sometimes referred to under the name Transfer) differs from the variety Chinese Spring only by carrying a small intercalated piece of one of the chromosomes of *Aegilops umbellulata*. This introduced segment provides resistance to leaf rust, *Puccinia recondita*. Since the strain has now been distributed to wheat breeders in nine different countries and in 13 different states of the U.S.A., information as to which chromosome carries the introduced segment may be of interest.

Data obtained by means of routine monosomic analysis failed to identify the chromosome. The 32:2 segregation that resulted in F_2 from the cross of T47 with monosomic 6B (X) differed significantly from 3:1, but one of the two susceptible individuals proved to be disomic 6B, and one of the resistant segregates was nullisomic 6B. Barring error, this was impossible if chromosome 6B actually carried the resistance.

To check chromosome 6B further, a cross was made of T47 onto a plant disomic for the *Aegilops* chromosome and monosomic for chromosome 6B. This material had been synthesized some years before in order to test the possibility of substituting the *Aegilops* chromosome for chromosome 6B. Similar *Aegilops* substitutions were available for chromosomes 3B (III), 4B (VIII), 7B (VII), and 2D (XX), and these lines were also crossed by T47.

From these crosses all the offspring carried the *Aegilops* chromosome and the T47 translocated chromosome, and all those studied were deficient (monosomic) for one particular wheat chromosome. Where chromosome 3B, 4B, 7B, or 2D was involved, maximum pairing proved to be $1_{III}1_{VII}1_I$, the trivalent consisting to the *Aegilops* chromosome, the T47 translocated chromosome, and the corresponding wheat chromosome. The univalent was the chromosome under test. With chromosome 6B a different pairing pattern was found—a maximum of 21 pairs and never a trivalent. The translocated chromosome must therefore be 6B. There being no normal 6B present in this F_1 , the translocated 6B could only pair with the *Aegilops* chromosome, and no trivalent was possible.

The frequency of pairing of the translocated 6B with the *Aegilops* chromosome was low—only 11 pairs in 100 cells. This confirms the conclusion previously made that the translocated segment is small. When normal 6B was also present, 23 of the 249 microsporocytes examined had a trivalent—approximately the same frequency of pairing as with normal 6B absent. Thus it appears that the small segment of *Aegilops* chromatin inserted in chromosome 6B can pair with the homologous portion of the *Aegilops* chromo-

some almost equally well whether the wheat portion of the translocated chromosome is paired or not.

The failure of monosomic analysis to identify chromosome 6B as the one concerned was evidently due to contamination at the time of pollination of mono-6B by T47. Two F₁ plants were used, one of which must have come from a contaminant pollen grain, presumably from resistant translocation line T41 or T44, both of which were being used in crosses at the time.

Excluding the data from mono-6B, 479 resistant and 180 susceptible plants were observed in F₂—a reasonable fit to a 3:1 ratio.

New interspecific and intergeneric hybrids involving *Agropyrum*

Y. CAUDERON and B. SAIGNE

Station d'Amélioration des Plantes, Route de Pont du Chateau
Clermont-Ferrand, France

In a recent paper¹⁾ we reached conclusions about the genome formulae and phylogenetic origins of some *Agropyrum* species based mainly on the meiotic chromosome behaviour of *Agropyrum* species, and of interspecific or intergeneric hybrids.

We have produced and studied the following new hybrids (hypothetical genome constitution in brackets):

- *Agropyrum repens* (L.) P.B. (R₁R₂Z₁ genomes) × *Hordeum secalinum* Schreb. (2 unknown genomes) 2n=35
- *Agropyrum junceum boreo-atlanticum* (L.) S.G. × *Agropyrum elongatum* (Host) P.B. (J₁J₂ genomes) (E genome) 2n=21
- *Agropyrum junceum boreo-atlanticum* (L.) S.G. × *Agropyrum repens* (L.) P.B. (J₁J₂ genomes) (R₁R₂Z₁ genomes) 2n=35

The meiotic chromosome behaviour of the three hybrids is recorded below:

Hybrid combination		2n	Number of cells observed	Meiotic chromosome behaviour at MI							
♀	♂			I		II		III		IV	
				Range	Average	Range	Average	Range	Average	Range	Average
<i>A. repens</i> n=21	<i>H. secalinum</i> n=14	35	25	3~15	8.28	8~16	12.52	0~2	0.40	0~1	0.12
<i>A. junceum boreo-atlanticum</i> n=14	<i>A. elongatum</i> n=7	21	100	0~7	3.40	0~9	4.50	0~7	2.76	0~1	0.08
<i>A. junceum boreo-atlanticum</i> n=14	<i>A. repens</i> n=21	35	206	5~29	15.30	3~15	9.70	0~2	0.09	0~1	0.00

The amount of pairing is very high: 76, 84 and 56% respectively. However these hybrids are pollen and seed sterile, as are all the hybrids we have studied in this group.

Dealing with each hybrid separately it may be noticed that:

$$1. \quad A. \textit{repens} \times A. \textit{secalinum} \left(\frac{R_1 R_2 Z_1}{2 \text{ unknown genomes}} \right).$$

This was the only successful hybrid amongst all those attempted between *Agropyrum* and *Hordeum* species. It demonstrates the close relationship between *Agropyrum* and *Hordeum* we had previously supposed from *Agropyrum repens*. The good pairing at MI (with four genomes associated as bivalents) is an indication of the close homology between the chromosomes of *A. repens* and *H. secalinum*.

In addition there is probably autosyndesis between chromosomes of the R_1 and R_2 genomes of *A. repens*, but there is probably no autosyndesis between chromosomes of the *H. secalinum* genomes (cf. *H. bulbosum* × *H. secalinum* hybrids).²⁾

Consequently the Z_1 *Agropyrum* genome and one of the *H. secalinum* genomes, which we shall call Z_2 , must be closely related.

$$2. \quad A. \textit{junceum boreo-atlanticum} \times A. \textit{elongatum} \text{ hybrid } \left(\frac{J_1 J_2}{E} \right).$$

From the high frequency of trivalents at MI, it can be concluded that there is close relationship between the J_1 , J_2 and E genomes. Similar conclusions can be drawn from karyotype analysis.¹⁾

$$3. \quad A. \textit{junceum boreo-atlanticum} \times A. \textit{repens} \text{ hybrid } \left(\frac{J_1 J_2}{R_1 R_2 Z_1} \right).$$

This hybrid behaves very likely the natural hybrid *Agropyrum acutum* R. and S. The chromosome pairing observed does not weaken the conclusion about genome formula which has been proposed for both species, that is to say, homeology between J_1 and J_2 genomes and between R_1 and R_2 genomes; all the associations were autosyndetic.

It can be concluded: first, that there is probably a Z_1 genome in *Hordeum secalinum* which is homeologous with the *Agropyrum repens* genome Z_1 , and secondly, that the E genome (*A. elongatum*) and the J genome (*A. junceum boreoatlanticum*) are closely related.

1) Y. CAUDERON: Etude cytogénétique des *Agropyrum* français et de leurs hybrides avec les Blés. Ann. Amél. des Plantes pp. 389-567, 1958.

2) Y. et A. CAUDERON: Etude de l'hybride F1 entre *Hordeum bulbosum* L. et *H. secalinum* Schreb. Ann. Amél. Plantes, pp. 307-317, 1956.

**List of the *Agropyrum* and interspecific hybrids of *Agropyrum*
(and of some *Hordeum*) grown at The Plant Breeding
Institute of Clermont-Ferrand**

Y. CAUDERON

Station d'Amélioration des Plantes, Route de Pont du Chateau
Clermont-Ferrand, France

Collection No.	Species	2n	Source and year of introduction			
			Country	Town or place	Collector	Nature and year ⁽¹⁾
	<i>Agropyrum elongatum</i>	14*	F. ²⁾ (Var)	St Aygulf	M. Simonet	seeds, 48
535	<i>Agropyrum junceum boreo-atlanticum</i>	28*	F. (Loire (Aque)	Le Croisic	M. Simonet	clone, 48
600		—	F. (Charente M.)	Ars en Ré	Y. Cauderon	clone, 56
603		28	F. (Gironde)	Soulac s/s Mer	Y. Cauderon	clone, 56
604		28	F. (Landes)	Biscarosse	Y. Cauderon	clone, 56
605		28	F. (Gironde)	Cap Ferret	Y. Cauderon	clone, 56
637		—	F. (Landes)	Seignosse	Y. Cauderon	clone, 59
638		28	F. (B. Pyrénées)	Hendaye	Y. Cauderon	clone, 59
639		28	F. (B. Pyrénées)	Anglet	Y. Cauderon	clone, 59
640		—	F. (Landes)	Vieux Boucau	Y. Cauderon	clone, 59
641		28	F. (B. Pyrénées)	Anglet	Y. Cauderon	clone, 59
644	—	F. (Charente M.)	Royan	B. Salvat	seeds, 54	
468	<i>Agropyrum junceum mediterraneum</i>	42*	F. (Hérault)	Palavas	M. Simonet	clone, 48
471		42	F. (Hérault)	Palavas	M. Simonet	clone, 48
162		42*	F. (B. du-Rhône)	Stes Maries de la Mer	Y. Cauderon	seeds, 48
499	<i>Agropyrum littorale</i>	42	F. (Var)	St Aygulf	M. Simonet	clone, 48
502		42*	F. (Var)	l'Almanare	M. Simonet	clone, 48
642		42	F. (B. Pyrénées)	Hendaye	Y. Cauderon	clone, 59
643		42	F. (B. Pyrénées)	Biarritz	Y. Cauderon	clone, 59
26	<i>Agropyrum repens</i>	42	C. ²⁾ Saskatchewan)	Saskatoon	—	seeds, 48
27		42	C. (Saskatchewan)	Saskatoon	—	seeds, 48
495		42*	F. (Hérault)	Montpellier	M. Simonet	clone, 48
496		42*	F. (Hérault)	Montpellier	M. Simonet	clone, 48
599		42	F. (S. et Oise)	Bailly	Y. Cauderon	clone, 55
627		42	F. (P. de Dôme)	Soulasse	Y. Cauderon	clone, 58
631		42	F. (P. de Dôme)	Soulasse	Y. Cauderon	clone, 58

(Continued)

Collection No.	Species	2n	Source and year of introduction			
			Country	Town or place	Collector	Nature and year ¹⁾
75	<i>Agropyrum intermedium</i>	42*	C. (Saskatchewan)	Saskatoon	—	seeds, 48
76		42*	C. (Saskatchewan)	Saskatoon	—	seeds, 48
506		42*	F. (P. de Dôme)	Clermont-Fd	M. Simonet	clone, 48
545		42	F. (P. de Dôme)	Clermont-Fd	M. Simonet	clone, 48
625		42	F. (P. de Dôme)	Soulassse	Y. Cauderon	clone, 58
626		42	F. (P. de Dôme)	Soulassse	Y. Cauderon	clone, 58
628		42	F. (P. de Dôme)	Soulassse	Y. Cauderon	clone, 58
629		42	F. (P. de Dôme)	Soulassse	Y. Cauderon	clone, 58
630		42	F. (P. de Dôme)	Soulassse	Y. Cauderon	clone, 58
634		42	F. (P. de Dôme)	Soulassse	Y. Cauderon	clone, 58
309	<i>Agropyrum campestre</i>	56	F. (I. et Loire)	Tours	A. de Cugnac	seeds, 50
457		56*	F. (A. Maritimes)	Grasse	M. Simonet	clone, 48
485		56*	F. (Hérault)	Montpellier	M. Simonet	clone, 48
488		56	F. (Hérault)	Montpellier	M. Simonet	clone, 48
492		56*	F. (Hérault)	Montpellier	M. Simonet	clone, 48
645	<i>Agropyrum Smithii</i>	56				seeds, 51
1	<i>Agropyrum elongatum</i> (10 ×)	70*	C. (Saskatchewan)	Saskatoon	—	seeds, 50
2		69*	C. (Saskatchewan)	Saskatoon	—	seeds, 50
	Nat. hybrids or unknown types					
450	<i>Agropyrum acutum</i>	35*	F. (Loire Aque.)	Le Croisic	M. Simonet	clone, 48
531	"	35	F. (Loire Aque.)	Pornichet	M. Simonet	clone, 48
646	"	—	F. (Nord)	Bray-Dunes	M. Caenen	clone, 56
472	<i>Agropyrum Duvallii</i>	42	F. (Hérault)	Palavas	M. Simonet	clone, 48
501	" <i>mediterraneum</i>	42*	F. (Var)	l'Almanare	M. Simonet	clone, 48
490	<i>Agropyrum Tallonii</i>	49*	F. (Hérault)	Montpellier	M. Simonet	clone, 48
617	<i>A. campestre</i> × <i>A. repens</i> ?	49	F. (P. de Dôme)	Maringues	C. Kiss	clone, 58
624	<i>A. campestre</i> × <i>A. repens</i> ?	49	F. (P. de Dôme)	Marmillat	C. Kiss	clone, 58
616	?	63	F. (P. de Dôme)	Maringues	C. Kiss	clone, 58
632	<i>A. intermedium</i> × <i>A. repens</i>	42	F. (P. de Dôme)	Soulassse	Y. Cauderon	clone, 58

(Continued)

Collection No.	Species name	2n	Sources and year of introduction							
			Country	Town or place	Collector	Nature and year				
	Artificial interspecific hybrids		} Obtained by Y. et Cauderon							
153	<i>A. junceum</i> × <i>A. elongatum</i> ³⁾	21*								clone, 57
152	<i>A. junceum</i> × <i>A. repens</i> ³⁾	35*								clone, 57
173	<i>A. junceum</i> <i>med.</i> × <i>A. littorale</i>	42*								clone, 49
123	<i>A. junceum</i> <i>med.</i> × <i>A. intermedium</i>	42*								clone, 51
156	<i>A. junceum</i> <i>med.</i> × <i>A. campestre</i>	49*								clone, 50
157	<i>A. campestre</i> × <i>A. repens</i>	49*								clone, 50
11	<i>A. campestre</i> × <i>A. intermedium</i>	49*								clone, 52
13	<i>A. intermedium</i> × <i>A. littorale</i>	42*								clone, 52
149	<i>Hordeum bulbosum</i> × <i>Hordeum secalinum</i> ⁴⁾	28± *								clone, 48
—	<i>Hordeum bulbosum</i> ⁴⁾	28*	F. (S. Maritime)	Rouen	Botanical Garden	clone, 46				
—	<i>Hordeum secalinum</i>	28*	F. (S. Maritime)	Rouen	Botanical Garden	clone, 46				

1) 46, 48, etc.....instead of 1946, 1948, etc..... 2) F.=France; C.=Canada.

*. Meiosis studied; 3) Unpublished; 4) *An. Am. Plantes*, p. 307, 1956; other plants in *Ann. Amel. Plantes* p. 389, 1958.

**Interspecific and intergeneric hybrids in Hordeae produced and grown
at The Plant Breeding Institute of Clermont-Ferrand**

Y. CAUDERON

Station d'Amélioration des Plantes, Route de Pont du Chateau
Clermont-Ferrand, France

Accession number	Hybrid combination	2n	Number of cells observed	Meiotic chromosome behaviour							
				I		II		III		IV	
				Range	Average	Range	Average	Range	Average	Range	Average
153	<i>A. junceum boreo-atlanticum</i> × <i>A. elongatum</i>	21	100	0~7	3.40	0~9	4.50	0~7	2.76	0~1	0.08
152	<i>A. junceum boreo-atlanticum</i> × <i>A. repens</i>	35	206	5~29	15.30	3~15	9.70	0~2	0.09	0~1	0.00
173 ¹⁾	<i>A. junceum mediterraneum</i> × <i>A. littorale</i>	42	12	2~16	9.83	9~14	11.17	1~4	2.17	0~3	0.83
123 ¹⁾	<i>A. junceum mediter.*</i> × <i>A. intermedium</i>	42	47	1~13	6.80	5~13	8.40	0~8	4.34	0~3	0.98
156 ¹⁾	<i>A. junceum mediter.*</i> × <i>A. campestre</i>	49	44	4~10	5.57	13~22	18.75	0~3	1.02	0~3	0.57
157 ¹⁾	<i>A. campestre</i> × <i>A. repens</i>	49	21	11~24	17.66	8~19	13.66	0~2	0.38	0~2	0.71
11 ¹⁾	<i>A. campestre*</i> × <i>A. intermedium</i>	49	28	4~13	9.14	8~19	14.18	0~5	1.64	0~3	1.32
13 ¹⁾	<i>A. intermedium*</i> × <i>A. littorale</i>	42	21	1~10	5.38	6~17	12.24	0~4	1.62	0~4	1.33
143	<i>A. repens</i> × <i>H. secalinum</i>	35	25	3~15	8.28	8~16	12.52	0~2	0.40	0~1	0.12
138	<i>S. cereale</i> × <i>A. intermedium</i>	28	—	—	no results	—	—	—	—	—	—
149 ²⁾	<i>H. bulbosum</i> × <i>H. secalinum</i>	29	50	7~19	13.58	4~11	7.50	0~1	0.14	—	0
73	(<i>Ae. ventricosa</i> × <i>T. dicocum</i>) × <i>A. intermedium</i>	49	500	19~47	36.38	0~11	5.43	0~4	0.57	0~1	0.01
74 ⁴⁾	(<i>T. dicocum</i> × <i>A. intermedium</i>) × (<i>Ae. ventricosa</i> × <i>T. dicocum</i>)	53~(44)	50	26~34	28.86	5~9	7.24	1~2	0.22	—	0
75 ³⁾	(<i>T. dicocum</i> × <i>A. intermedium</i>) × <i>S. cereale</i>	42	500	25~40	33.78	0~7	3.45	0~2	0.44	—	0

A = *Agropyrum*; Ae = *Aegilops*; S = *Secale*; T = *Triticum*; H = *Hordeum*

Reference: 1) *Ann. Amél. Plantes* p. 389, 1958; 2) *Ann. Amél. Plantes* p. 307, 1956.

3) *Bull. Soc. Pharm. Bordeaux* p. 145, 1957.

4) This plant presented somatic elimination of chromosomes; the chromosome number in root tips was 2n=63 in the first year and it was fixed at 2n=44 in the second year.

* 123+0.11V(0-1)+0.13VI(0-1)+0.02VII(0-1)

156+0.10V(0-1)+0.02VI(0-1)

11+0.21V(0-1)+0.04VI(0-1)

13+0.33V(0-1)+0.05VI(0-1)

**List of the *Triticum-Agropyrum* hybrids produced and grown
at The Plant Breeding Institute of Clermont-Ferrand**

Y. CAUDERON

Station d'Amélioration des Plantes, Route de Pont du Chateau
Clermont-Ferrand-France

Accession number	Hybrid combination	Year	2n	Characteristic	
25*	<i>T. dicoccum</i> × <i>A. intermedium</i>	1952	35	Perennial, sterile, creeping grasses	
		12			
26	<i>T. persicum rubiginosum</i> × <i>A. intermedium</i>	1952	35		
14	<i>T. durum mahmoudi</i> × <i>A. intermedium</i>	1954	35		
		28*	<i>T. Timopheevi</i> × <i>A. intermedium</i>		1952
29	1952	35			
502	<i>T. dicoccum</i> × <i>A. campestre</i>	1953	42		
133	<i>T. Timopheevi</i> × <i>A. campestre</i>	1951	42		
<i>T. vulgare:</i>					
137	var. Magdalena	} × <i>A. intermedium</i>	1951		Perennial, sterile, slightly creeping grasses
146	var. Progress		1951	42	
149	var. Hybride de Bersée		1951	42	
151	var. Docteur Mazet		1951	42	
265	var. Vilmorin 27		1951	42	
139	var. <i>persicum rubiginosum</i> 6x(Kihara)		1956	42	
420	<i>T. vulgare</i> var. Progress × <i>A. elongatum</i> (10x)	1950	56±	Perennial, slightly fertile, caespitose grasses	
168	<i>A. elongatum</i> (10x) × <i>T. vulgare</i> var. Progress	1950	56		

The meiosis of these F₁ was published in *Ann. Am. Plantes*, pp. 389-567, 1958 (except for No. 139 unpublished).

* Two different F₁ with two different clones of *Agropyrum*.

**Amphiploids of (*Triticum* × *Agropyrum*) Hybrids produced and grown
at The Plant Breeding Institute of Clermont-Ferrand**

Y. CAUDERON

Station d'Amélioration des Plantes, Route de Pont du Chateau
Clermont-Ferrand, France

Accession number	Hybrid combination	Year	Chromosome number	Characteristic
514*	<i>T. Timopheevi</i> × <i>A. intermedium</i>	1953	70±	Perennial, fertile, slightly unstable creeping grasses.
513*	<i>T. dicoccum</i> × <i>A. intermedium</i>	1953	70±	
80	<i>T. dicoccum</i> × <i>A. intermedium</i> **	1955	70±	
81	<i>T. persicum</i> var. <i>rubiginosum</i> × <i>A. intermedium</i>	1955	70±	
195	<i>T. durum</i> var. <i>mahmoudi</i> × <i>A. intermedium</i>	1959	70±	
78*	<i>T. vulgare</i> var. Docteur Mazet × <i>A. intermedium</i>	1955	80±	Perennial, slightly fertile, fairly unstable grass.

* Meiosis studied (*Ann. Amél. des Plantes*, p. 389, 1958).

** 513 and 80 amphiploids were obtained with two different clones of *Agropyrum*.

Morphological analysis of Sando derived wheat × wheat-grass hybrids

K. L. MEHRA¹⁾ and J. S. BAKSHI²⁾

Oklahoma State University, Stillwater, Oklahoma, U.S.A.

A collection of 542 wheat × wheat-grass derivatives have been maintained at the Oklahoma Agricultural Experiment Station since 1955. These hybrids were made by Dr. W. J. Sando of the United States Department of Agriculture (retired) by crossing various species of the genus *Triticum* with its related genera in different combinations. The bulk of the material is, however, composed of the derivatives of the crosses between the species of the genera *Triticum* and *Agropyron*. Although this material represents a valuable source of germplasm which could be of immense value in the wheat improvement programs, relatively little is known about the nature of the genetic diversity prevalent in these plants.

1) Presently, at the Division of Botany, Indian Agricultural Research Institute, New Delhi 12, India.

2) Presently, at the Wheat Breeding Sub-station, Tutikandi, Simla, India.

In studying such populations 'plant type' has been used by most of the workers as the criterion to classify the individual plants into various categories. Schmidt et al. (1953), Marshal and Schmidt (1954), and Schlehuber et al. (1959) classified *Agrotriticum* into three types; grass-like, intermediate and wheat-like. Schlehuber et al. (1959) prepared a key for the identification of 542 wheat×wheat-grass hybrids on the basis of several morphological characters and the leaf rust reaction of individual plants. A preliminary analysis of the morphological data indicated that although several of these plants could be grouped as either wheat like or grass like; some of the plants showed a varying degree of complex combinations of the characters of the two genera, *Triticum* and *Agropyron*. The present study was, therefore, undertaken to analyse the pattern of morphological variation present in this collection, and for this purpose an elite population comprising of 40 hybrids selected at random from these derivatives was studied.

Agropyron species are generally distinguished by the presence of the following characters; scabrous foliage, a long but lax spike with a brittle rachis, and straight sided glumes that adhere to the grain and are not beaked.

Triticum aestivum varieties usually have a tender foliage, a dense spike with a non-brittle rachis, and glumes that are beaked. The grains thresh from the glumes.

The following seven morphological characters were studied in the selected plants; length of the longest internode of the rachis, length of the spike, difference in lengths of the peduncle and sheath (of the flag leaf), number of undeveloped spikelets, length-width ratio of the lower glume, and the number of ridges on the glumes. Pictorialized scatter diagrams were prepared by the length of the longest internode of the rachis and the length of the spike as the ordinate and abscissa respectively. Hybrid indices for forty plants were prepared by the technique devised by Anderson (1949, 1957).

Character association analysis for the seven morphological characters indicated that these characters were associated in two well defined groups, as described below;

(a) Wheat like:—

The following combination of characters was observed; short rachis internodes, short spikes, peduncle much longer than the sheath of the flag leaf, several undeveloped spikelets, low length-width ratio of the lower glume, and few ridges on the glumes.

(b) Grass like:—

The following combination of characters was observed; long rachis internodes, long spikes, peduncle equal in length or shorter than the sheath of the flag leaf, few or no undeveloped spikelets, longer and less broader glumes, and the presence of several ridges on the lower glumes.

Besides these two distinct types, there were several plants which represented varying recombinations of the characters of the two extreme types.

The variation pattern of the material seemed to be discordant (Anderson, 1951), which is characteristic of strongly introgressed populations. The loose association between

the seven characters and the recombinations between some of them could be explained by assuming hybridization, segregation and subsequent introgression between the species of the genera *Triticum* and *Agropyron*. An analysis of the hybrid indices revealed that a few of the plants were grass-like, but majority of them were wheat-like. It would, thus, seem more likely that the introgression is from *Agropyron* into *Triticum*.

The utilization of the pictorialized scatter diagram method, in studying the variation of wheat×wheat-grass hybrids seems significant. With the use of even such a small sample, by using comparative characters and hybrid indices, the relative amount of variation could be approximately ascertained.

The symbolization of complementary necrosis genes in wheat: a proposal

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Heritable remature necrosis in wheat hybrids has been studied by several research workers who all came to the conclusion that necrosis as such is determined by the in-

Year	Authority*	Symbols used or proposed for the genes (probably) located in the genomes			Designation of phenotype
		A	B	D	
1936	Kostyuchenko	<i>T</i>	<i>L</i>		premature perishing
1936	Mc Millan**	<i>F_b</i>	<i>F_a</i>	<i>F_o</i>	firing
1943	Caldwell and Compton	<i>Le₂</i>	<i>Le</i>		progressive necrosis
1943	Heyne et al.	<i>Le₂</i>	<i>Le</i>		progressive necrosis
1946	Ausemus et al.	basic symbol <i>F</i>			firing
1946	Ausemus et al.	basic symbol <i>Le</i>			lethal seedling
1953	Sachs	<i>m^a</i>		<i>m^b</i>	hybrid semi-lethality
1954	Nat. Comm. of Genet. and Breed. of the Japan Sci. Council	basic symbol <i>Le</i>			lethal seedling
1957	Hermesen	<i>B</i>	<i>A</i>		semi-lethality
1959	Schmalz	<i>B</i>	<i>A</i>		subvitalität (sub-vitality)
1959	Hermesen	<i>N_A</i>	<i>N_B</i>	<i>N_D</i>	2 types of progressive necrosis
1960	Tsunewaki	<i>Le₂</i>	<i>Le₁</i>		lethality
1961	Hermesen***	<i>Ne₂</i>	<i>Ne₁</i>	<i>Ne₃</i>	several types of necrosis
1961	Tsunewaki****	<i>Ne₂</i>	<i>Ne₁</i>	<i>Ne₃</i>	—

* A list of references can be had on application from the present author.

** Location in genomes uncertain and identity with genes of progressive necrosis not yet proved.

*** Proposal in this note on the basis of extensive investigations on varied material.

**** Private communication.

teraction of complementary genes. The symbols for these genes as used or proposed in the literature are, with the authors' designation of the phenotype, given in the table. The genes are arranged on the basis of their location or probable location in the wheat genomes.

A new basic symbol covering all types of complementary necrosis is needed since none of the foregoing symbols is in agreement with the rules for nomenclature and symbolization of genes in wheat as recommended by both the American and the Japanese Committee for Nomenclature and Symbolization of genetic Factors in Wheat:

1. The symbols *Le* (lethality) and *m* (probably an abbreviation of *macha* or of mortality) do not give the chief phenotypic effect (=necrosis) and do not hold true for all cases of necrosis because in many necrotic cross combinations no lethality occurs, neither in F_1 nor in F_2 and following generations (Hermsen, 1960).
2. The symbol *F* is only related to the "firing"-type of necrosis which in comparison with other types of necrosis is fairly rare, even though it is genetically related to these types (Hermsen, to be published).
3. The symbols *A* and *B* may be confused with the generally used designation of the wheat genomes (Kihara).
4. The use of two symbols for genes determining one character is not recommended by the above mentioned committees.
5. The symbol *N* proposed by the author in 1959 did not account for the symbol *N* for nematode reaction proposed by Ausemus et al. (1946).

The author proposes to use exclusively the basic symbol *Ne* (of necrosis) for the following reasons.

Necrosis and not lethality is the chief phenotypic effect of the complementary genes. Lethality only occurs in definite hybrids in consequence of necrosis. The symbolization *al* for albino, *Cd* for chlorophyll deficiency and *D* for dwarfism which in given hybrids may also cause lethality, are in close agreement with the symbolization *Ne* for complementary necrosis. Furthermore the Symbol *Ne* covers all types of necrosis (progressive necrosis, firing) and also the cases where no lethality occurs. Finally the symbol *Ne* can cause no confusion with other symbols, as far as the author is aware.

There are three necrosis genes (Hermsen 1959, 1960) each located in another wheat genome (Tsunewaki 1960 and unpublished). To distinguish these genes we proposed to add the indices *A*, *B* and *D* to the basic symbol *Ne*. Of each of these genes some clearly different forms exist, probably multiple alleles (Hermsen 1960 and unpublished). To indicate these different forms we propose to use the indices 1, 2, ..., *n*.

Summarizing the proposed symbolization the following series are obtained:

$$Ne_{A_1}, \dots, Ne_{A_n}; Ne_{B_1}, \dots, Ne_{B_n}; Ne_{D_1}, \dots, Ne_{D_n}.$$

II. Exploration Results of the BMUK 1959, II.

Some aspects regarding the collected materials of *Triticum* and *Aegilops* from the eastern Mediterranean countries. II.*

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6. Section Comopyrum of *Aegilops* from Turkey and Greece

In the section Comopyrum are involved diploid species of *Aegilops*, namely *comosa* (genome symbol MM), *Heldreichii* (genome symbol MM) and *uniaristata* (genome symbol M^uM^u). Among these, the latter two species were collected. *Ae. Heldreichii* occurred in many habitats, while *Ae. uniaristata* in only one (Table 10).

Table 10. Collection of Comopyrum species of *Aegilops*

Habitat	Material
Turkey: Istanbul-Izmit (65 km W of Izmit)	<i>Ae. Heldreichii</i> var. <i>subventricosa</i>
Greece: Olympia	<i>Ae. Heldreichii</i> var. <i>subventricosa</i> <i>Ae. uniaristata</i>
Chania-Souda (Crete Island)	<i>Ae. Heldreichii</i> var. <i>biaristata</i>

Ae. Heldreichii (Holz.) Eig var. *subventricosa* Boiss. was collected in a habitat of 65 km W of Izmit, Turkey, and also in the ruins of Olympia and on the hill side of Drova in the village of Olympia, Greece. The Drova hill was covered by a mixed very rich vegetation of *Aegilops*; namely *Ae. caudata*, *Ae. Heldreichii*, *Ae. triaristata* and *Ae. triuncialis* occurred in a common population. It was usual to see the flocks of sheep graze *Aegilops* everywhere, which hurted the feeling of the *Aegilops* hunters, but there were no trace of damage by grazing. This was supposedly because of the moral code of shepherds to keep their sheep away from the historic spots. In the ruins of Olympia, *Aegilops* occurred abundantly too. The wild vegetations of *Aegilops* are thus preserved together with the historic remains.

A few plants of *Ae uniaristata* Vis. were also found mixed in the population of *Ae. Heldreichii* in the ruins of Olympia.

In Crete Island, specimens of *Ae. Heldreichii* were collected along the highway from

* Contributions of the BMUK 1959, No. 3.

Chania to Souda. They were identified as var. *biaristata*.

Ae. comosa Sibth. et Sm. was not found.

7. *Aegilops caudata* from Syria (U.A.R.), Turkey and Greece

Ae. caudata L. ($2n=14$, genome symbol CC) was collected in various habitats (Table 11) in Syria (U.A.R.), Turkey and Greece. Especially in Turkey this species occurred almost everywhere along the highway or on the hillside in Central Turkey.

Based on the collection data, approximate border of its distribution in the north, west and south were estimated, while the eastern limit remains unknown. Anyhow, it can be said that the center of its distribution is in Central Turkey, where only awned forms, var. *polyathera*, were found. While, the species collected in Greece, Syria (U.A.R.) and Southern Turkey, where are thought to be the peripheral area of the distribution, were all awnless forms, var. *typica*.

As var. *typica* was the one which was missing in our former collection, it was our exultation when we found it firstly in a poor vegetation along the highway, 53 km N of Hama in Syria (U.A.R.). But it was found abundantly afterwards in Olympia, Greece.

These two varieties occurred separately, and no mixed population was found. Sup-

Table 11. Collection of *Aegilops caudata* L.

Habitat	Material
Turkey:	
Amasya-Çorum ((16 km W of Amasya)	var. <i>polyathera</i>
* Çorum-Çerikli (14 km SW of Çorum)	"
* Yozgat-Çerikli (6 km E of Çerikli)	"
Çerikli-Ankara (50 km E & 74 km E of Ankara)	"
Suburbs of Kayseri	"
* 46 km S & 60 km S of Ankara	"
* Suburbs of Ankara	" (waxy plant mixed)
Suburbs of Ayas	"
20 km W of Ayas	"
Ankara-Eskisehir (87 km E & 98 km E of Eshisehir)	"
Konya-Antalya (Suburbs of Akseki)	"
Bandirma-Bursa (39 km W & 80 km W of Bursa)	var. <i>typica</i>
Syria:	
Aleppo-Hama (53 km N of Hama)	"
Greece:	
Suburbs of Volos	"
Olympia	" (waxy plant mixed)
Chania-Souda, Crete Is.	" "
Iraklion (Agia Irini)	" "

* *Ae. caudata* (genome symbol CC) and *Ae. cylindrica* (genome symbol CCDD) were found mixed in common populations.

posedly, the awned form in the centre is the primitive type and the awnless form in the periphery the advanced type. Waxy character was also found in some populations.

Ae. cylindrica, which is 4x with the genomes CCDD, was found in common populations with *Ae. caudata* in the area of Samsun-Amasya-corum-cerikli-Ankara-Ayas-Eskisehir, in Turkey.

8. *Aegilops umbellulata* from Syria (U.A.R.) and Turkey

Aegilops umbellulata Zhuk. ($2n=14$, genome symbol C^uCu) was collected from various habitats in Syria (U.A.R.) and Turkey as listed in Table 12. Based on the collection data, the centre of the distribution of this species is presumed to be Central Turkey, and the skirt area of Mt. Hermon in Syria (U.A.R.) will be the southern limit of its distribution.

The habitat in Amasya, Turkey, is the steep rocky hill which is the ruin of an

Table 12. Collection of *Aegilops umbellulata* Zhuk.

Habitat	Material
Syria:	
Damascus-Mt. Hermon (6 km WS of Katana)	var. <i>typica</i>
Turkey:	
Adana-Ankara (55 km E of Adana)	" (immature with no seeds)
* Kayseri (near Mt. Ali)	"
Samsun-Amasya (4 km N of Amasya)	"
Amasya (stony mountain side)	"
Amasya-Çorum (37 km W of Amasya)	"
Çorum-Samsun (16 km EW of Çorum)	"
* Ankara-Çerikli (54 km WS of Çerikli)	"
* Ankara-Çerikli (50 km E of Ankara)	"
* Ankara & suburbs of Ankara	"
50 km N of Ankara	"
20 km N of Ankara	"
Ankara-Ayas (12 km E of Ayas)	"
* 20 km W of Ayas	"
* Ankara-Adana (60 km S of Ankara)	"
* Ankara-Eskisehir (81 km ES of Eskisehir)	"
suburbs of Kutahya	"
Izmir-Bergama	"
Denizli	"
Burdur (lake-side of Burdur)	"
Burder	{ var. <i>typica</i> var. <i>pilosa</i>
* Akseki (Antalya-Konya)	"

* *Ae. caudata*, *Ae. umbellulata* and *Ae. triuncialis* were found as mixed population in these habitats.

ancient stronghold, rising about 100 m up from the town level. There occurred *Ae. umbellulata*, *Ae. biuncialis*, *Ae. cylindrica*, *Ae. ovata* and *Ae. triuncialis* in a small spot on the top of the hill.

In the area of Cerikli-Ankara-Ayas-Eskisehir-Akseki-Kayseri in Turkey, mixed populations of *Ae. umbellulata*, *Ae. caudata* and *Ae. triuncialis* were found. This is very interesting because Kihara (1944) has established that *Ae. triuncialis* (genome symbol $C^u C^u CC$) is of the amphidiploid origin from the hybrid *Ae. umbellulata* ($C^u C^u$) \times *Ae. caudata* (CC).

In Burdur and Akseki, var. *typica* with nonpubescent glumes and var. *pilosa* with pubescent glumes occurred mixed.

9. *Ae. triuncialis* from Syria (U.A.R.), Turkey and Greece

Ae. triuncialis L. ($2n=28$, genome symbol $C^u C^u CC$) was collected in the habitats listed in Table 13. As pointed out by Eig (1929), this species occurred very widely;

Table 13. Collection of *Aegilops triuncialis* L.

Habitat	Material
Turkey:	
Samaun-Amasya-Çorum-Yozgat-Çerikli-Ankara (continuous distribution)	ssp. <i>eu-triuncialis</i> and <i>Ae. biuncialis</i> \times <i>Ae. triuncialis</i> ? (3 km N of Amasya)
Suburbs of Ankara	" and <i>Ae. triuncialis</i> \times wheat ? (12 km N of Ankara)
Ankara-Ayas, 20 km W of Ayas	" and <i>Ae. triuncialis</i> \times wheat (14 km W of Ayas)
Suburbs of Kayseri	"
Ankara-Eskisehir	"
Bursa-Bandırma-Gönen	"
Istanbul-Izmit	"
Suburbs of Kütahya	"
Suburbs of Bergana	"
Suburbs of Afyon	"
Suburbs of Denizli	"
Suburbs of Burdur	"
Konya-Antalya	" ssp. <i>orientalis</i> and var. <i>assyriaca</i> (suburbs of Akseki) mixed
Kirikhan-Aleppo	"
Syria (U.A.R.):	
Aleppo	" (immature with no seeds)
Kemshly	" "
Greece:	
Suburbs of Lachanas	"
Suburbs of Portaria	"
Suburbs of Volos	"
Olympia	"

namely we found it almost everywhere we travelled except Egypt (U.A.R.), Jordan, Lebanon, Crete Island (Greece) and Sicily Island (Italy).

This species consists of 2 subspecies, viz. *eu-triuncialis* Eig and *orientalis* Eig. The majority of our collection were ssp. *eu-triuncialis* with awns, while a few specimens collected from Konya-Akseki in Turkey were found to belong to ssp. *orientalis* var. *assyriaca* with no or vestigial awns. While, in 1955 Yamashita collected ssp. *orientalis* abundantly in the region of Maimana-Herat in Afghanistan, and ssp. *eu-triuncialis* was rather scanty there. There occurred an intermediate type in addition. From these facts, it can be said that ssp. *orientalis* is the derivative from ssp. *eu-triuncialis*. It is also interesting to know the fact that in Central Turkey, where is presumed to be the centre of the distribution of *Ae. triuncialis*, also an awned form of *Ae. caudata*, viz. var. *polyathera*, occurs widely as stated before (under 7).

Spontaneous hybrid specimens of probably *Ae. triuncialis* × *Ae. biuncialis* (or a certain wheat species) were found in the habitats of 3 km N of Amasya, 12 km N of Ankara and 14 km W of Ayas in Turkey.

10. *Aegilops cylindrica* from Turkey

Aegilops cylindrica Host ($2n=28$, genome symbol CCDD) was collected from various habitats in Central Turkey and from the suburbs of Dogubayazit near the Iranian border (Table 14). We visited the town under a sudden hail on June 27. Mt. Ararat showed

Table 14. Collection of *Aegilops cylindrica* Host

Habitat	Variety
Suburbs of Dogubayazit	intermediate type
Amasya (in the stony mountain side)	
23 km W of Amasya	var. <i>typica</i>
33 km W of Amasya	
9 km NE of Çorum	
78 km NE of Çorum	
5 habitats in Çerikli-70 km NE of Çerikli	var. <i>typica</i> + var. <i>pauciaristata</i>
Ankara & Suburbs of Ankara	
Suburbs of Ayas	var. <i>typica</i>
160 km E of Eskisehir	
4 habitats in 50-70 km S of Ankara	var. <i>typica</i> + var. <i>pauciaristata</i>

her peak morosely from the clouds now and then. I longed for the days past when I travelled to Azerbaijan, Iran, in 1955 on the occasion of our last expedition (KUSE 1955), when I caught people speak Persian in a restaurant where we had a short recess.

This species was collected by Kihara in 1955 (KUSE) in the suburbs of Teheran, Iran, where will be the eastern limit of its distribution. According to Eig (1929), *Ae. cylindrica* involves 2 varieties, viz. *typica* Host and *pauciaristata* Eig, being the former

an awned form and the latter an awnless or few awned form. These two forms were found in a mixed population or in neighboring separate populations, and the intermediate (hybrid) types were found occasionally.

Ae. cylindrica is an allotetraploid arisen from the hybrid *Ae. caudata* (CC) × *Ae. squarrosa* (DD) (Kihara 1941, 1944, Sears 1946). Accordingly the place where this species arose, can be said to be Eastern Turkey, where, after Dr. O. Tosun, Professor of Ankara University, *Ae. squarrosa* occurs. This species was actually collected from Azerbaijan, Iran by KUSE 1955, though the eastern limit of distribution of *Ae. caudata* remains still unknown.

(Reference: A map showing the habitats of *Triticum* and *Aegilops* in WIS No. 11.)

III. Editorial Remarks

Communications from 3 foreign members of the Coordinating Committee

Thank you very much for your letter of October 13 in which you invite me to serve as one of the three foreign members of the Coordinating Committee of the Wheat Information Service. Naturally I am pleased to accept your kind suggestion, though I doubt that I will be of much service to you. *A. Müntzing*

Thank you very much for your letter dated October 13, 1960. I am glad to note that the first volume of the W.I.S., Nos. 1-10, have been completed. They constitute a very valuable record of work on wheat.

I am very grateful for the invitation to serve as a member of the Coordinating Committee and I have much pleasure in accepting the same. *P. P. Pal*

I am honored to be proposed as a foreign member of the Coordinating Committee for WIS, and I accept with pleasure.

May I compliment you on the excellent job you have done in editing WIS and wish you every success in continuing this very useful little publication. *E. R. Sears*

Extension of page limit

The page limit of each paper was 2 printed pages, but it has been extended to 3 *printed pages* from the present number.

Announcement for the Next Issue, No. 13

WIS No. 13 will be ready for publication in August, 1961. It is open to all contributions regarding methods, materials and stocks, ideas and research results related to genetics and cytology of *Triticum*, *Aegilops*, *Agropyron*, *Secale* and *Haynaldia*.

Contributions should be type written in English. The authors are cordially requested to present—**not later than July 31, 1961**—their manuscripts which should not exceed 3 printed pages. Lists of stocks are not required to conform to this page limit. No illustrations are accepted for publication.

Manuscripts and communications regarding editorial matters should be addressed to:

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Explanation of the Figure on the Cover

Variation in the original ears of *Aegilops mutica* collected from the Ayas population in Turkey; left 3 ears: var. *typica* and right 3 ears: var. *lohiacea* (see a map showing the habitats of *Triticum* and *Aegilops* in WIS No. 11). (BMUK 1959)

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The Managing Editor

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