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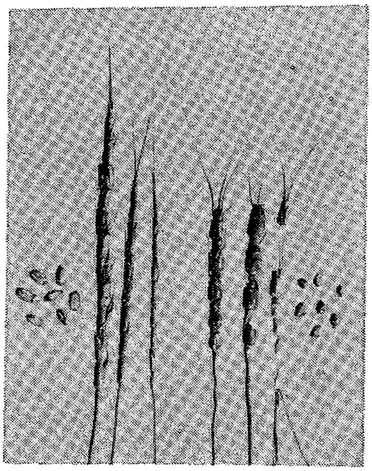

Fig. 1

Fig. 2

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Wheat Information Service
Biological Laboratory, Kyoto University
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I. Research Notes

New dates for recent cultivation of *Triticum monococcum* and *Triticum dicoccum* in Jugoslavia1)

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Einkorn is still a regular crop in 4 villages in Kroatia, Herzegowina and Macedonia. It was astonishing to hear that Emmer is even more abundantly cultivated there, because Emmer has quite disappeared in Middle Europe since the beginning of this century, while some new places have been realized in South Germany and Switzerland, where Einkorn is cultivated by simple peasants.

Emmer is still found in 7 villages in Kroatia, and one in Bosnia, Herzegowina and Montenegro respectively. The specimens of both species come from regions with very different climatic and ecological conditions (cf. the following table); poor, even the worst soils are preferred showing the low requirements of these crops.

In Macedonia, Einkorn is also cultivated *on heavy soil* in an eastern-continental climate; it is said to be more spread in other parts of the country (for which no details were given) as a crop or sporadically as a weed among other cereals. There is no Emmer registered for Macedonia. It is interesting to find both crops in Herzegowina at a place with *Mediterranean* climate—again indeed on poor soil—and, last but not least, to hear that Emmer gives *best* yields in the hills of Bosnia and is used there as bread-grain still now-a-days.

Einkorn is always found in pure cultures. It is much appreciated for the fine white flour, which is fit for bread and sweets; besides it is used as fodder for horses and pigs. There is nothing known about use of the straw to fasten vines—as in Germany. Emmer is grown as a pure crop in Herzegowina, Bosnia and Montenegro, but in Kroatia only in 2 of the 7 villages; in the other 5 it is but scarcely found and then mixed to barley or oats as fodder-plant, especially for pigs; only in bad years it is used for bread. In Montenegro, where it is said to have been an important crop for man's nutrition 30 years ago, it is grown only sporadically as fodder, thus obviously going back.

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1) The material was kindly given to me by Prof. Z. Turcović and Dr. I. Kovacević. Thanks for their help !

The small variability of the two species is well known. Nevertheless, as one should expect for local forms (so-called "Landsorten") the specimens taken directly from the fieldcrop were not uniform, but varied in density and colour of the ears—from white, yellow-white, yellow to red (brown) and grey in Einkorn, from yellow-white, bright yellow, yellow to bright and dark brown, with or without wax in Emmer.

No.	Region	Breeding-type	Soil	Climate	Level m	Use	
						fodder	bread (+)
I. *T. monococcum:* Kroatia District Lika							
3a	Sluny	pure	sour, Karst	rough winters, dry summers	338	cattle, fowl, pigs	+, white flour
	Herzegowina						
1a	Posusje	pure	alluvial	—	—	—	—
6a	Mostar	pure	alluvial, coarse rubble-stone, the worst soil	Mediterranean	38	horses, pigs	+ in bad years
	Macedonia						
5a	Kumanova	pure	heavy, without Ca	eastern continental	340	— much spread in Macedonia; enters the crops as a weed	—
II. *T. dicoccum:* Kroatia District Lika							
2b	Brinje	pure	sandy, very permeable, sour, Karst	mountain-climate	630	pigs	—
3b	Sluny	pure	Karst, sour	rough winters, dry summers	338	—	—
7b	Perušić	mixed with barley and oats	little sour, Karst	—	400–500	cattle	—
9/1	Gospić	rare; mixed with oats, 3:1	Karst, high-tableland	continental	500	cattle	—
9/2	Gospić	rare; mixed with barley and oats 1:1:1	sandy loam, on many years fallow ground	continental	500	cattle	—
9/3	Gospić	rare; pure	Karst; plough land without manure	continental	500	cattle	—
9/4	Gospić	rare; mixed with oats 1:1, after barley	Karst; plough land without manure	continental	500	cattle	—
	Herzegowina						
6b	Mostar	pure	alluvial, coarse rubble stone, the worst soil	Mediterranean	38	horses, pigs	+ in bad years
	Bosnia NW						
4b	Sanski Most	pure (good yield)	hills	—	200	—	+
	Montenegro Orna Gora						
8b	Nikšić	pure	worst soil, skelettoid alluvial soils	subalpine	610–630	cattle	+ 30 years ago, not now

White proved to be constant; the variability of the yellows seems to depend on the weather during harvest; red, grey and some brown types were constant; other browns split for dark and bright or for wax. The plots were too small for gene-analysis. There was little variability within but some between the different strains in Einkorn; more so in Emmer. The first culm (sometimes 2–3) is always much higher than the rest, though nearly all ripen well. The number of culms is usually higher in Einkorn than in Emmer.

It must be of interest to know, that out of the 8 different ear-types of Einkorn selected from the original specimen, 7 proved to have but one grain per spikelet, whilst only one ear (No. 3a in the table) contained 12 spikelets with 2, and 8 with one grain.

Further analysis in comparison to the Dahlem assortment is prepared.

Triticum dimococcum, a new amphidiploid from the hybrid *Triticum dicoccum* × *monococcum*

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The hypothesis of F. and K. Bertsch, published in 1939, that *Triticum compactum* arose in Middle Europe (viz. in Schwaben) as a hybrid from *T. monococcum* × *T. dicoccum*, cannot be maintained for cytological reasons (as shown by Schiemann in 1940) since it does not explain the occurrence of genome D in hexaploid wheats; nor can it be maintained for morphological reasons. Though since 1944 the provenance of the D-genome from *Aegilops squarrosa* has been verified by McFadden & Sears and Kihara, K. Bertsch, basing on prehistoric results, still in 1949 and 1950 holds his hypothesis which had been explicitly refuted by Lang in 1948. It is of interest, therefore, to produce the postulated $6x$ amphidiploid experimentally and compare it with the natural $6x$ wheats. We have performed the synthesis of the amphidiploid *T. dicoccum* × *T. monococcum*—we call it *T. dimococcum*—and analyzed the morphology of the $6x$ hybrid and its progeny, which should be of interest regarding the morphological variability in the hexaploid wheats.

The parents are: *T. monococcum* (Einkorn) from Württemberg (South Germany) T. 482, and *T. dicoccum* (Emmer) from Oerlikon (Switzerland) T. 551. The two species are known to cross with difficulty. The cross *monococcum* × *dicoccum* gave 25 grains = 4.6% out of 514 pollinated flowers and the reciprocal cross 20 grains = 1.8% out of 1072 pollinated flowers. Colchicine treatment—0.025% for 2, 6, or 12 hours—resulted in 20 hybrid plants. They equalled morphologically in both directions; only 2 plants with *dicoccum* as mother proved partly amphidiploid. The grains from 1953 were planted as C_2 in 1954 and the plants were analyzed.

The chromosome number (from root tips) is $2n=42$, as expected. *T. dimococcum* stands morphologically between its parents, the habitus nearer to *dicoccum*; all parts are more vigourous than in the parents. The spikes are much longer; but there are fewer spikelets in the spike. This shows in the density, which might be called extremely dense in *monococcum*, dense in *dicoccum* and moderately dense in *dimococcum*, as given in the following table.

Each difference between *T. dimococcum* and both parental species is significant with $P=0.0002$.

	a) length of 1st spike (mm) $\bar{x}\pm S\bar{x}$	b) number of spikelets per spike $\bar{x}\pm S\bar{x}$	c) density of 1st spike[1] $\bar{x}\pm S\bar{x}$
T. monococcum	61.9±0.702	28.2±0.246	45.8±0.3340
T. dicoccum	72.3±1.328	24.7±0.233	34.5±0.3325
T. dimococcum	83.2±1.660	21.5±0.379	26.3±0.2870

1) $\frac{\text{number of spikelets} \times 100}{\text{length of rachis in mm}}$

The occurrence of fully brittle plants in C_1 and C_2 must be explained as hybrid combination; the spikes disarticulate like *dicoccum* (wedge type).

The empty glumes resemble both parents; they are sharply keeled and have a big long, inwardly bent keel-tooth like *dicoccum*, and a straight, pointed, smaller 2nd tooth like *monococcum*. The palea is undivided as in *dicoccum*. The grains are firmly enclosed in the glumes, as in both parents.

The fertility of pollen is reduced in C_2 and C_3 varying from 50–90% against the parents with 96% and 97%. The fertility on the female side in C_2 is still more reduced and more variable. Assuming that 1 grain per spikelet is normal for *monococcum* and 2 for *dicoccum* and *dimococcum*, the variability is from 86 to 100% in *monococcum*, 68 to 97% in *dicoccum* and 0 to 95% in *dimococcum*.

As a result the experimentally synthesized amphidiploids show none of the characters of hexaploid wheats, (especially of the naked wheats), which separate them from the tetraploids.

1) *T. compactum* is a naked wheat—*T. dimococcum* a spelted wheat.
2) The form of the empty glume separates *T. dimococcum* from the hexaploid spelted wheats as well as from the naked ones.
3) The disarticulation of *T. dimococcum* is of the *dicoccum*, not of the *Spelta*-type (wedge-, not barrel-type).

The *compactum* problem remains unsolved until the following facts are reconciled.

a) *T. compactum* is verified archaeologically until now only for neolithic Middle Europe, together with Einkorn, Emmer and barley.

b) *T. compactum* is a cultural relict in Middle and Northern Europe up to recent times.

c) *T. compactum* is found in every extensive area of *T. aestivum* in the Near and Middle East, either as an admixture or as a locally limited crop (thus it is found also in the area of *Aegilops squarrosa*).

d) The problem of *T. compactum* is in the end always connected to the *Spelta*-problem.

Neatby's virescent

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The virescent gene *v* discovered by Neatby has been found to lie on chromosome III and when present in two doses to cause a retardation in the development of chlorophyll. In one dose, whether heterozygous or hemizygous, it has no obvious effect if the light intensity is normal; but when the light is poor, *Vv* and *-v* show a reduced amount of chlorophyll. In three doses the gene caused albinism.

As Neatby noted, *vv* plants often have sectors of green or white tissue, and *vv* also gives rise to green or white offspring. Obviously these mutations might be due to a simple change in dosage of *v* to one or three as a result of non-disjunction of chromosome III. If, as seems likely, non-disjunction proves to be the sole or even major cause of mutation in *vv*, this gene could be useful as an indicator of the mitotic and meiotic stability of various varieties.

Special interest attaches to *v* because of the fact that, unlike defective-chlorophyll genes in diploid plants, it is not simply a deficiency. It is a gene which actively interferes with chlorophyll production. Its normal allele *V* acts like a deficiency in dosage series, no effect being discernible of increasing its dosage from 0 to 4; yet *V* cannot be a deficiency, because it gave rise to *v*. It is possible that *V* is a gene concerned with chlorophyll production but non-essential because it is duplicated at other loci. Thus it would be free to mutate in ways that would not be possible in a diploid, where it would be lethal unless it continued to perform its chlorophyll-making function.

In order to determine whether *V* may be concerned with chlorophyll production, an attempt is being made to eliminate both it and one of its duplicate genes, which presumably lie on the homoeologous chromosomes XII and XVI. Deficiencies for *v* (which are dominant in *vv* material) have been obtained by X-ray treatment, and will be combined with nulli-XII and nulli-XVI. If these two chromosomes, and only these, carry duplicates of *V*, the dosage of *V* will be reduced from 6 to 2, and chlorophyll production may be affected adversely.

Structural relationships between non-homologous chromosomes

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When haploid plants of Chinese Spring wheat were pollinated by normal Chinese, 15 reciprocal translocations were obtained. Since these translocations are presumably the result of crossing over between homologous regions of non-homologous chromosomes in the haploid, identification of the chromosomes involved in the translocations will show which chromosomes of wheat are structurally related. The analysis is of particular interest in connection with the homoeologous groups which have been identified in hexaploid wheat.

The analysis is being made by crossing each translocation line onto the 21 different nullisomics or monosomics. If the chromosome in question is not included in the translocation, the monosomic offspring have $18_{\mathrm{II}}+\textcircled{4}+1_{\mathrm{I}}$ or $18_{\mathrm{II}}+\lfloor 4 \rfloor+1_{\mathrm{I}}$. If the chromosome is included in the translocation, the monosomic offspring have $19_{\mathrm{II}}+\lfloor 3 \rfloor$.

Eight translocations have been fully analyzed and two partially analyzed, with the following results;

Translocation	Chromosomes involved			Translocation	Chromosomes involved		
81	VI	and	XIX	93	XII	and	XVI
82	XVI	〃	?	94	II	〃	XX
87	VI	〃	XIX	95	IX	〃	XI
91	IV	〃	XII	96	VI	〃	XVIII
92	VI	〃	?	99	II	〃	VIII

Of the eight fully analyzed translocations, only two involve the same chromosomes (VI and XIX). Of the seven different translocations, three involve homoeologous chromosomes, and four involve non-homoelogous ones. Chromosome VI is involved in four of the ten translocations.

Nucleolar activity of lagging chromosomes in wheat

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The monosomic series in wheat makes possible the examination of large numbers of micronuclei for any chromosome or chromosome arm desired. At meiosis each monosomic gives a large percentage of telophase laggards, some of which then form micronuclei. A study of the nucleolar activity of these lagging chromosomes was undertaken (1) to determine whether or not all the chromosomes were capable of forming a nucleolus in their micronuclei and to what extent, and (2) to identify if possible the nucleolus organizing chromosome of the D genome.

Iso-X^R (the isochromosome for the right arm of chromosome ten) showed a small nucleolus in 36.9% of its micronuclei, telo-X^R in 24.7%, normal X in 17.8%, and I in 17.1%. The D-genome monosomics showed none to 0.8%, with the exception of mono-XVIII, which showed 5.5%.

These results indicate that in wheat only those micronuclei which contain nucleolar chromosomes can form nucleoli. Diakinesis studies confirm the nucleolar organizing abilities of chromosome I, X, and XVIII. Both telo-X^R and normal I have been found attached to the nucleolus. Although the third nucleolar organizer in this material is evidently relatively inactive, a cell was found which shows monosome XVIII attached to the nucleolus, and this monosome was once found at first metaphase with a very pronounced secondary constriction. Also, 2.2% of the microspores of tetrasomic XVIII showed 4 nucleoli, as contrasted with a negligible percentage in that class for di-XVIII. Indications are that it is the short arm of XVIII which is responsible for nucleolus formation.

The other chromosomes of the A and B genomes are being investigated to determine whether one or more of them, as well as chromosome XVIII, may sometimes be responsible for the development of the third nucleolus. Also, nucleolus size is being studied in the sporocytes of plants with both increased and decreased dosages of known nucleolar chromosomes.

No evidence has been found that the disappearance of the so-called "matrix" material of wheat chromosomes is dependent upon the formation of a nucleolus, or that the reappearance of the matrix is dependent upon the contribution of nucleolar material to the chromosomes.

Development of the aneuploid series and whole chromosome substitution lines in the varieties Thatcher and Lemhi

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Once the aneuploid series have been established in certain varieties, genetic and breeding studies can be undertaken by making substitutions of whole chromosomes from other varieties. Seed of substitution lines having the chromosomal complement of the recipient variety with the exception of the substituted chromosome can be increased so that comparative replicated field trials can be conducted in which the genetic effects of the substituted chromosome can be studied on a population basis rather than on an individual plant basis. It is thus possible to use statistical methods in studying the results, making it possible to attribute quite accurately portions of the difference, in even quantitative characters, that are caused by the substituted chromosome.

Very clear-cut genetic effects of chromosomes from the donor varieties Timstein, Thatcher and Hope in the genetic background of the variety Chinese Spring on such characters as yield, lodging resistance, earliness, protein content, etc., have been obtained in the last three years of testing. A detailed report will be published elsewhere.

It should be possible, however, to get an even clearer picture of the genetic makeup and effects of the individual chromosomes if reciprocal chromosome substitution lines were developed in two varieties which had rather contrasting characteristics. For the purpose of studying more precisely the genetic control of the important characters of yield, earliness and quality, the aneuploid series have been developed in the variety Thatcher, a hard red spring variety, and the variety Lemhi, a soft white spring variety. The reciprocal whole chromosome substitution lines are now being developed, but at least three more substitution backcrosses will be required before they are ready for field trials.

Four other chromosome substitutions are fairly well along. These are of primary interest in the rust breeding projects. In the varieties Lemhi and Thatcher we are developing lines that have chromosome XX substituted with the homologous chromosome from the variety McMurachy. It has been shown that the gene for resistance to stem rust race 15 b is carried by chromosome XX in this variety.

The other two substitutions involve chromosome X of the variety Timstein. Rodenhiser and Sears have shown that two genes for resistance to a number of races of stem rust are located on chromosome X in the variety Timstein. We are well along in transferring chromosome X from Timstein to the varieties Lemhi and Thatcher.

Once the single substitutions have been completed, it is planned to combine them into a single line, i.e. a line of Thatcher which has chromosomes XX from McMurachy and chromosomes X from Timstein. The same combination will be made in the variety Lemhi.

Two further chromosome substitution lines are being developed in the variety Thatcher. Chromosome IX is being substituted for the homologous chromosome from the winter wheat variety Kharkov MC_{22}. Previous work has shown that Thatcher carries a gene or genes for winter habit of growth on chromosome XVIII. The gene or genes for spring habit on chromosome IX apparently are epistatic to those on chromosome XVIII. By replacing Thatcher IX by the homologous chromosome from a winter variety, it was expected that the substitution line so developed should have winter habit of growth. Results so far obtained indicate that the expectation was correct.

The other substitution involves chromosome XVIII. As indicated, this chromosome in Thatcher carries a gene or genes for winter habit of growth. It is to be replaced by chromosome XVIII from the very early variety Prelude. It is considered probable that this substitution may result in greater earliness in the variety Thatcher.

Misdivisions and non-disjunctions of the C chromosome in β-series speltoid wheat

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Misdivisions and non-disjunctions of the C chromosome during meiosis were observed in the offsprings of β het speltoids and Type I subcompactoids, as summarized in the following table.

Material	Misdivisions		Non-disjunctions		
	I. T.	II. T.	I. T.		II. T.
			C chromosome goes to one pole without splitting.	Two daughter halves go to the same pole.	Two daughter halves are included in one nucleus.
β het speltoid	24/1120 2.13%	33/253 13.04%	31/1120 2.73%	12/1120 1.07%	23/182 12.63%
Type I subcompactoid	28/1325 2.14%	38/292 13.12%	45/1643 2.74%	18/1643 1.16%	26/196 13.26%

The numerator indicates the number of PMC's with misdivision or non-disjunction, while the denominator indicates the total number of PMC's observed.

The C chromosome breaks sometimes at first telophase into the long and the short arm, both becoming telocentrics, Ctl and Cts, or iso-chromosomes, Cil and Cis. A comparatively large number of isochromosomes frequently break into telocentrics, Ctl and Cts, at second telophase. However, lagging chromosomes are sometimes observed at this stage. Frequently they are not included in the daughter nuclei and form micronuclei.

The percentages of misdivisions at first telophase are distinctly less than 39.7% found in monosome IX in Chinese Spring wheat by Sears (1952), rather approaching 1.7% found in Swedish wheat by Sanchez-Monge and MacKey (1948). But at second telophase the percentages of misdivisions are slightly lower than 16% observed in Swedish wheat by Sanchez-Monge and MacKey (1948), and again markedly lower than 39.7% observed in Chinese Spring wheat by Sears (1952).

As to the cause of the misdivision, the assumption of Sanchez-Monge (1950) is supported. Namely, when the insertion of the spindle fibre is carried out normally, a normal disjunction may take place, while when an erroneous insertion of the spindle fibre occurs or when the centromere fails to react to the spindle fibre, a misdivision may happen. A contributing factor may also be the elastic repulsion and δ-factor of Oestergren (1943, 1949). Division is also affected by the cytoplasmic current (Carlson, 1938) in some measure.

The percentages of non-disjunctions at first and second telophase are close to 2.5% observed in Swedish wheat by Sanchez-Monge and MacKey (1948). The percentages of the inclusion of two split halves in one nucleus are slightly lower than 19.8% observed in Swedish wheat by Sanchez-Moge and MacKey (1948). The differences are probably due to different wheat varieties used.

The misdivisions and non-disjunctions of the C chromosome in PMC's of β het speltoids are supposed to be the main cause of the C-series speltoids and various types of compactoids.

Chromosome aberrations in Einkorn wheat induced by radiations

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When the relation between the frequency of chromosome aberrations in the PMC's of *Triticum monococcum* and the wave length of X-rays was studied, dormant seeds were exposed to X-rays of different wave lengths (at 80, 130 and 180 KVP), and different intensities (r/min) at the same dose (8,100 r) without filter, as reported in the foregoing report. In the present experiment X-rays of different wave lengths were used at the same dose (8,100 r) and intensity (95 r/min), with different filters, and also γ-radiations by Co^{60} were compared. The thickness of the filter was adjusted in inverse proportions to the wave length; that is, at 80 KVP no filter was inserted into Matsuda's Type KXC-17 apparatus, while at 130 KVP a filter 0.3Cu+0.5Al, and at 180 KVP one of 0.8Cu+1.5Al was used. At 50 KVP and 20 KVP, irradiation was applied by another apparatus, a modified Type KR-75 and Type TX-20 (Grenz-rays) without filter, respectively. The data are shown in Table 1.

Table 1. Relation between wave length of X- and γ-rays and frequency of chromosome aberrations in *Triticum monococcum*

Dosage (r)	Voltage (KVP)	Filter	Current (mA)	No. of observed ears	No. of aberrations (%)
Control	—	—	—	42	0 (0.00)
8,100(6,190)*	180	0.8Cu+1.5Al	3	178	15 (8.43)
8,100(6,190)	130	0.3Cu+0.5Al	3	106	6 (5.66)
8,100(6,580)	80	—	4	114**	5 (4.42)
8,100(6,250) 8,100(8,350)	50	{0.5Al (1953) — (1955)	30(1953) 10(1955)	103 {46 57	11 (10.68) {5(10.87) 6(5.26)
—(8,100)	20	—	10	44	1 (2.27)
8,100	γ-ray (Co^{60})	—	—	86	12 (13.95)
12,150	γ-ray (Co^{60})	—	—	62	21 (33.87)

* ( ) measured by Siemen's Universal Dosemeter.
** One was haploid.

At 80–180 KVP, the results obtained in the foregoing report were confirmed, but at 50 KVP the aberration frequency was unexpectedly high. The question to be answered was, whether the dosages were measured correctly by Matsuda's dosemeter or "r"-meter. Therefore, measurements were again checked by Siemen's Universal Dosemeter. It became clear that the dosages at 80–180 KVP by Type KXC–17 decreased to 6,190–6,580 r from 8,100 r, while the dosage at 50 KVP increased to 8,350 r.

There were marked differences between the effects upon the germination rate and the aberration frequency at irradiation with X- and γ-rays. The effects of γ-rays were heavier than those of X-rays. At 16,200 r of γ-rays, all seedlings were uniformly small and died out about one month after germination, while in the case of X-rays the disturbances were small and variable.

Virido-albina mutant in diploid wheat induced by X-rays

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Chlorophyll mutants, besides often occurring spontaneously, are induced frequently by ionizing radiations. Most of them are Mendelian recessives. Matsumura and Fujii (1955) found several chlorophyll mutants such as albina, chlorina, virido-albina, basi-viridis and striata etc. by X-irradiation of Einkorn wheat (*Triticum monococcum flavescens*). Virido-albina mutant appeared in the X_2-generation from seeds treated with 8,100 r dose at 180 KVP. About 3/4 of the base of each leaf of this mutant were white, while the rest was light green. The characteristics of this mutant appeared already at the seedling stage and it was completely lethal in the field during the low temperature period.

When this mutant was placed in the phytotron (20°C) and exposed to fluorescent light (about 4,000 lux), the leaves became gradually green starting from the veins, and about 15 days late it resembled the basi-viridis mutant with a light green leaf base. It required further 30 days of treatment to recover a chlorophyll content similar to that of the normals. Similar results were obtained with the basi-viridis mutant with regard to increasing of chlorophyll content in the phytotron. On the other hand, albina, chlorina and striata did not increase their chlorophyll content under the same treatment. The chlorophyll content in the normals and several chlorophyll mutants are shown in table 1 by optical density ($T = -\log I/I^0$) of 10 times dilution of fresh leaves.

Eventually, virido-albina mutants was heading in the phytotron, while being lethal in the field. Time of heading and ripening was delayed about 15 days, and plant height, number of tillers and fertility were significantly reduced in comparison with the normals. Seeds of the recovered virido-albina showed a relatively high germination rate of about 80%. Of course, the seedlings were virido-albina. When the recovered virido-albina was returned to the field, the successive leaves showed virido-albina character and the mutants died out in winter.

Table 1. Relative chlorophyll content in several chlorophyll mutants by spectrophotometer (10 times dilution of fresh weight)

Mutants	Optical density in 4230 Å	
	in field	in phytotron
Normal	.47	.51
Chlorina	.35	.41
Virido-albina	.29	.51
Basi-viridis I	.36	.50
Basi-viridis II	.39	.49

Oxygen consumption or respiration rate was measured by Warburg respirometer. This rate in the virido-albina mutant was about half of that of the normals, and the rate of the recovered virido-albina was rather higher than that of the normals. But the activity of cytochrome oxidase in the mutants, grown in the field and in the phytotron, was similar to that of the normals. Fujii (1955) reported already a similar tendency toward a decrease of the chlorophyll content and activity of cytochrome oxidase in the chlorina mutant. From these results, it has been assumed that a recovery of the chlorophyll content without a normal activity of cytochrome oxidase would be not possible.

Synthesis of a permanent RT-hetegozygote in Einkorn wheats

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Various RT-types induced by X-rays in Einkorn wheats, *Triticum aegilopoides* and *T. monococcum*, were analyzed for their chromosome constitution, and a series of RT-types involving all 7 chromosomes from a to g was established. Subsequently, all the possible combinations of rings and pairs have been realized by successive crosses among them (Yamashita, 1951 and elsewhere). This is the situation in *Oenothera*, except for the balanced lethal mechanism.

In the meantime, however, considerable progress has been made in the linkage analyses for induced mutations, and 2 lethal genes, lethal-1 and -2, have been located on the d- and f-chromosome respectively (Yamashita, 1953). Consequently, crosses have been made in an attempt to combine these lethal genes into a ring complex, according to the plan which is as follows.

$$\left.\begin{array}{l} m\text{T2}\,(=\text{d--e}) \times \text{hetero for lethal-2} \rightarrow \text{hetero for d--e, f}^{l} \\ m\text{T1}\,(=\text{e--f}) \times \text{hetero for lethal-1} \rightarrow \text{hetero for d}^{l}\text{, e--f} \end{array}\right] \times \rightarrow \textcircled{6} = \frac{\text{d--e f}^{l}}{\text{d}^{l}\text{ e--f}}$$

f^l-chromosome involves lethal-2.
d^l-chromosome involves lethal-1.

The final crosses were made in the 1955 season and the permanent RT-heterozygosity should be maintained in the plants, with a ring of 6 chromosomes, due to the balanced lethal mechanism as in the case of *Oenothera.*

Studies on the quality of *Triticum* and *Aegilops*

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According to the genome analysis, Dinkel wheat involves 3 different genomes, namely A, B and D. *Triticum monococcum* belongs to the diploid species with AA and *Aegilops squarrosa* with DD, while the diploid species with BB has not yet been discovered. The present writers are very much interested in the studies on the quality of these species. The experiments are still in early stages but the preliminary results will be reported here. A report, "Milling and Baking Tests of Einkorn, Emmer, Spelta and Polish Wheat," was published by J. A. LeClerc, L. H. Bailey and H. L. Wessling (1910). Yamashita (1953) also studied on the quality of *Triticum monococcum,* while there are no reports for either *Ae. squarrosa* or the synthesized hexaploid wheats.

Materials used here are *Ae. squarrosa, T. monococcum, T. dicoccum, T. vulgare, T. Spelta* and the synthesized hexaploid wheats (ABD No. 1). The Kjeldahl method was adopted for the chemical analysis of the quality. The results are given in the following table.

Material	Protein (%)	Ash (%)	Absorption (%)	Gluten (%)		Loaf volume (ml)
				dry	wet	
T. vulgare	7.29	1.00	70.0	11.3	28.0	130
Ae. squarrosa	8.75	2.21	76.7	19.3	74.7	120
T. monococcum	8.75	1.78	52.0	9.3	24.7	100
T. dicoccum	10.20	2.12	65.0	14.3	65.0	—
T. Spelta	10.20	2.76	72.0	20.3	40.0	137
Synthesized hexaploid wheat, ABD No. 1	13.12	2.59	73.3	28.7	52.7	125

The appearance of the loaf of *Ae. squarrosa* was poorer than *T. vulgare,* but when mixed with *T. vulgare* as to contain 11% protein, the loaf was soft as *T. vulgare.* The taste of the bread of *Ae. squarrosa* was good.

Hybrids between synthesized 6x wheat, ABD No. 4, and a Japanese commercial wheat variety, Nōrin No. 25

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Chromosome pairing and fertility: One of the synthesized hexaploid wheats, ABD No. 4 (*Triticum persicum* var. *stramineum* × *Aegilops squarrosa* No. 2), was crossed with a Japanese commercial wheat variety, Nōrin No. 25. The F_1 plants were vigorous and showed fairly good chromosome pairing at MI (Table 1). Pollen-fertility of one of the

Table 1. Chromosome conjugation in an F_1 plant

Chromosome conjugation	Number of PMC's observed
21_{II}	19
$1_{IV}+19_{II}$	1
$20_{II}+2_{I}$	15
$19_{II}+4_{I}$	8
$1_{III}+18_{II}+3_{I}$	1
$18_{II}+6_{I}$	4
$17_{II}+8_{I}$	1
$16_{II}+10_{I}$	1
Total	50

Table 2. A few characters in some F_1, F_2 and F_3 plants

Materials	Pollen-fertility (%)	Seed-fertility 1) (%)	Flowering time 2)	Seed weight 3) (gr)	Seed size 4)	Flint value 5)
ABD No. 4	81.1	82.1	May 25	3.0	43.8	45
Nōrin No. 25	90.0	97.0	Apr. 22	3.0	49.3	50
F_1	80.0	84.2	May 12	4.0	56.8	60
F_2-1	97.2	100.0	May 4	3.3	58.5	50
-2	93.8	97.6	May 6	3.6	58.9	55
-3	95.7	95.6	May 4	4.0	70.2	45
-4	91.9	100.0	Apr. 22	4.0	69.1	65
-5	90.4	90.0	May 6	3.5	60.1	50
F_3-1	—	98.8	Apr. 26	4.0	64.7	60
-2	—	93.2	Apr. 23	3.5	60.9	55
-3	—	96.3	Apr. 23	4.5	72.5	50

Note: 1) By selfing, 2) date of the beginning of the flowering, 3) weight per 100 seeds (average of ten measures of random samples), 4) average length (mm) × width (mm) × thickness (mm) of 100 seeds, 5) $\sum d/n \times 100$, where d: flint value of each seed (=1.0, 0.5 and 0.0 in this experiment), n: number of examined seeds (=100 in this experiment).

F_1 plants was 80.0%, and its seed-fertility by selfing was 84.2%. 39 F_2 individuals derived from this F_1 plant also showed fairly good chromosome pairing, but the pollen-fertility fluctuated from 48.9 to 100%, and the seed-fertility by selfing from 5.0 to 100.0%, with an average of 90.0%. F_3 plants showed comparatively high fertility.

Characters of F_1, F_2 and F_3 plants: Some of the F_1, F_2 and F_3 plants were examined for a few characters in comparison with their parents as given in Table 2. F_1 was intermediate in the flowering time, but in size and weight of the seeds and in flintiness it was superior to the parents. 5 out of 39 F_2 individuals were still better with respect to the flowering time, size and weight of the seeds and the flintiness.

3 out of 30 F_3 offspring derived from F_2-4 were as good as the mother plant in certain respects (Table 2).

Amphidiploids from the hybrids *T. Timopheevi* × *Ae. umbellulata* and *T. vulgare* × *Ae. Kotschyi*

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In 1935, the amphidiploids from *T. Timopheevi* (AAGG) × *Ae. umbellulata* (C^uC^u) and *T. vulgare* (AABBDD) × *Ae. Kotschyi* ($C^uC^uS^vS^v$) were induced by colchicine treatment. The former amphidiploid and its progeny always showed fairly good pairing at MI, such as $21_{II}+2_{I}$. In the latter amphidiploid and its offspring the chromosome pairing was not very good and often univalents were seen, while polyvalents were rare.

On a natural hybrid between *Aegilops triuncialis* and *Triticum aestivum* found in Iran and its cytogenetical significance

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During his activity as an expert for plant breeding in Iran under the "Expanded Technical Assistance Program" of the Food and Agriculture Organization of the United Nations from 1952–1954, the senior author availed himself of the opportunity to collect specimens of *Aegilops* on a large scale on his excursions through the country. Whereas a survey of the distribution of the various species of *Aegilops* and their chromosome numbers is planned for one of the forthcoming issues of WIS, this paper is dealing with a natural *Aegilops* × *Triticum* hybrid having arisen in a sample of *Aegilops triuncialis*. This specimen was taken from a locality in Azerbaijan in August 1954, labelled as Nr. 260 c in the order of the author's whole collection; the locality is situated 162 km south from the capital Tabriz on the road to Miani, between 47/48 degrees of longitude and 37/38 degrees of latitude on 1240 m altitude above sea level. This population of *Aegilops* *triuncialis* was spread along the edge of a wheat field; some plants were found inside the field which occurs very seldom. The population was distinguished by plants with white and brownish-black coloured glumes. The wheat field was grown by a population of *Triticum aestivum* which exhibited a great variation regarding the shape and length of the ears and the colour of their glumes: white, brown, violet.

For the first time seeds of this *Aegilops* specimen were grown in 1954 at the Iranian Experimental Station of Agriculture at Karaj, 40 km west from Teheran. Among 10 plants 3 of them proved to be hybrids. Unfortunately they were discovered too late to carry out controlled pollination. In the following year the stored seeds of the original specimen were resown at the Institute of Plantbreeding in Hannover-Herrenhausen, Germany, which gave rise to another hybrid among 5 true breeding *Aegilops* plants.

The cytological investigation of this last mentioned hybrid plant revealed in the early stage of its development the somatic chromosome numbers approaching the expected 35 ($n_1=14$ and $n_2=21$). There were only small deviations of this number in some metaphases, e.g. 31, 36, 37, 38. But in the later development after the heading period greater deviations of chromosome numbers were observed; it was stated that they were varying from 9 to 50.

The first hybrids grown at Karaj after free pollination yielded 72 seeds, which could be classified in 3 groups:

The first group consisted of 7 grains, normally developed of *Triticum* similar type. The width-length index was approximately 1. All seeds germinated, but only two of them survived in the early stage.

The second group comprised 26 seeds, also with normally developed endosperm, but smaller and with a width-length index of approximately 1/2; on the whole they appeared to be of *Aegilops* type. The germination was poor, although all were swollen; 23 died off in the very early stage. Only 2 of 3 plants could be preserved and grown up.

The third group consisted of grains with poor or without any endosperm, they were *Aegilops*-like in respect to colour and width-length index. After germination of nearly all grains had been initiated the majority died off. 10 of the strongest embryos were released from the seed-coat and cultivated in KNOP's solution with a supplement of 15% cane sugar. Cell divisions of all 10 embryos commenced but with irregularities regarding the number of primary roots and the differentiation in coleoptile and root. Only two of them could be grown up and the others remained in a vegetative stage without heading up to date.

These F'_2-hybrids exhibited characteristics of pure *Aegilops*, pure wheat and intermediate characteristics on the very same plant in mosaic-like pattern. The auricle, the expression of which is known not to be modified by environmental conditions, was observed over a longer period on all F'_2-hybrids. It was observed that sometimes auricles of *Aegilops* and *Triticum* type not only change from stalk to stalk but also from sheath to sheath on the very same stalk. In addition to this some auricles appeared to be half-side *Aegilops* type and *Triticum* type. Similar somatic segregations could be also observed for other taxonomical characteristics, such as length of leaf and stalk, colour of nodes, hairing, etc.

But these latter characteristics are too variable for proving the existence of a cytogenetical mosaic. Nevertheless, in the F_2 a mosaic of characteristics corresponds with a mosaic of chromosome number.

Further investigations not only of the mitosis but also of the meiosis of the F_1 and F_2 revealed besides the already described cytological mosaic further great deviations from the normal division in other respects, such as multipolar spindles, etc.

Right- and left-handedness in *Triticum* and *Aegilops*

III. The effects of external factors

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Each species of *Triticum* and *Aegilops* has its own specific value of $\overline{C}$, as previously reported (Kojima, 1945). In the present experiments, it has been observed that the $\overline{C}$ value is affected in *Triticum monococcum* var. *flavescens* by nutritional conditions and X-ray irradiation.

1) Nutritional condition: the $\overline{C}$ value showed a significant difference between plants under normal conditions in the field and those under deficient nutrition in pots. A marked reduction in the $\overline{C}$ value was noticed when the nutrition was deficient at the time of spikelet differentiation.

A quantitative analysis of the relationship between the concentration of culture media and the change of the $\overline{C}$ value was carried out under sand culture conditions recommended by Dr. Kasai of the Research Institute for Food Science, Kyoto University. Twelve pots, each with four plants at the time of spikelet differentiation, were divided into four groups, which were supplied with solutions of 1, 1/2, 1/10 and 1/30 of the standard concentration, respectively. The result is shown in Table 1.

Table 1. The change of $\overline{C}$ value (%) according to different nutrient concentration

Concentration		1	1/2	1/10	1/30
Replication	A	89.5	83.5	75.0	72.5
	B	84.5	79.0	76.5	71.0
	C	80.5	78.5	86.0	76.5
Mean		84.8	80.3	79.2	73.3

According to the variance analysis, the regression mean square is significant, while the remainder mean square is not. The relation of $\bar{C}$ value to the solution concentration may be represented by a straight line; $\bar{C}=6.66 \log (X)+84.15$; that is, the relation will be expressed by a function of $\bar{C}$ value to the logarithm of the nutrient concentration. The value of $\bar{C}$ varies linearly, from 71.0% to 89.5%.

2) X-ray irradiation: in the middle of March the seedlings in a pot were subjected to X-rays. The $\bar{C}$ value of the spikelets, which developed after the irradiation, was remarkably reduced as shown in Table 2.

Table 2. The $\bar{C}$ value (%) of X-rayed plants

Dosage (r)	X-rayed spikelets	control	Year
1600	64.83±1.47	69.33±0.85	1952
2000	66.22±5.12	74.78±4.92	1954
3200	65.20±2.83	82.65±2.48	1950
6400	68.06±2.92	〃	〃
9600	64.47±2.05	〃	〃
9600	66.09±1.48	81.17±1.21	1951
12800	65.37±1.98	82.65±2.48	1950
16000	64.51±2.06	〃	〃

Table 3. The reduction of $\bar{C}$ value (%) in the subsequent generations

Dosage (r)	Year of irradi.	2nd gen.	3rd gen.	4th gen.
9600	15.08**±2.04 (1951)	3.50* ±1.48 (1952)	3.04**±0.49 (1953)	1.85±5.29 (1955)
2000	8.56**±5.45 (1954)	3.93**±2.19 (1955)		
1600	4.50* ±1.73 (1952)	3.34 ±1.33 (1953)	1.26 ±1.87 (1955)	

*: significant on 5% level. **: significant on 1% level.

The $\bar{C}$ value was much lower in these experiments than in the nutrition experiments described above.

A reduction of the $\bar{C}$ value was also noticed in the subsequent generations, as indicated in Table 3. Regarding this peculiarity in the transmission of the effect of X-ray on the $\bar{C}$ value, two alternative mechanisms, genic and cytoplasmic, are possible. Namely, it may be due either to the ***drift*** of the frequencies of mutant genes from one generation to the next, or to a certain cytoplasmic change, which resembles the phenomenon of "Dauermodifikation" (Jollos, 1939).

Accordingly, the following two experiments were carried out, namely, 1) the reciprocal crossing experiments between the X-rayed and non-treated plants, 2) the artificial selection of mutant genes concerning $\bar{C}$ value among the X-rayed plants. From the results of the preliminary experiments, it may be said that the transmissible X-ray effects on the $\overline{C}$ value are caused by some genic mutation and not by a cytoplasmic change, and that the remarkable reduction of the $\overline{C}$ value in X-rayed plants themselves may be due partly to a certain physiological disturbance caused by irradiation.

Chlorophyll variegation which appeared in male-sterile Emmer wheat

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Male-sterile emmer wheats with *ovata* cytoplasm, which were obtained by successive backcrosses, show a conspicuous chlorophyll variegation of whitish dots or stripes on the leaves, like a variegation caused by virus infection. Its appearance varies according to the growing stages. Table 1 shows the results observed during the period from Nov. 1953 to May 1954. The variegation takes place only when *durum* genomes were combined with the *ovata* cytoplasm. Therefore, the variegation is attributed to the interaction between the *ovata* cytoplasm and the *durum* genomes.

Table 1. Seasonal change of the chlorophyll variegation

Materials	Date of observations				
	Nov. 20	Dec. 2	Jan. 6	Mar. 6	May 2
Triticum durum var. *Reichenbachii*	–	–	–	–	–
male-sterile *durum*	–	+, ++	+++	++	–, +
male-sterile *durum* × *T. durum* var. *coerulescens*		+	+++	++	–
male-sterile *durum* × *T. dicoccum* (Khapli)[1]		–	–, +	–	–
Restoration *durum*		–	–	–	–
Aegilops ovata		–	–	–	–

+++: All leaves strikingly variegated, ++: some leaves variegated and the others slightly or not at all, +: a few leaves variegated, –: no leaves variegated.

[1] A progeny of Khapli after successive three backcrosses with *dicoccum* pollen.

A paper-chromatographic analysis and an absorption method using the photoelectric colorimeter were adopted in order to compare the chlorophyll content of the normal and the variegated leaves. From these tests it was found that the chlorophyll content of the variegated leaves was reduced to about 70% of that of the normal green leaves.

Morphological evidence for the origin of the B genome in wheat

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Morphological comparison between both cultivated and wild members of the *T. monococcum* (Einkorn) group of wheats on the one hand and the tetraploid Emmer wheats on the other, followed by the use of Anderson's method of extrapolation, indicates that the Emmer wheats arose as amphiploids between the diploid Einkorns and another species or species group having the following characteristics: rachis internodes long and narrow; spikelets with 3 or more florets; glumes with one inconspicuous keel, with more than 6 veins, with the tip 1-toothed, and with a thick margin; lemmas all long awned, the shoulder inconspicuously dentate or blunt; the palea not splitting at maturity; the grain large, thick, and grooved. These characters are all approached or equalled by *Aegilops speltoides* var. *ligustica*. The hypothesis is therefore advanced that the tetraploid Emmer wheats evolved from amphiploids between *T. monococcum* and its relatives on the one hand and various diploids similar to *Ae. speltoides* on the other. The amphiploidy is believed to have occurred several times, and to have been followed by evolution on the tetraploid level which consisted of hybridization between different raw amphiploids, accompanied by chromosome rearrangement and gene mutation. In this way, it is postulated that the *monococcum* type A and the *speltoides* type S genomes became modified to form the A and B genomes of the modern Emmer as well as the hexaploid wheats.

Discussion in Correspondence

Yamashita: I am very much interested in the fact that you consider one of the ancesters of Emmer wheat as *Ae. speltoides*. Under the guidance of Dr. Kihara, Mr. Tanaka obtained an amphidiploid, *Ae. longissima* × *T. aegilopoides*. The former parent is related to *Ae. speltoides*. According to the genome analysis, *Ae. longissima* has S^{l}- and *Ae. speltoides* S-genome. In the hybrid between the amphidiploid and Emmer wheat, the chromosome pairing was not too good.

Stebbins: We did not consider the evidence of Mr. Tanaka on *Ae. longissima* × *T. aegilopoides* as critical, since Sears found little pairing in the cross between *Ae. longissima* and *Ae. speltoides* var. *ligustica*. Sarker is continuing the work by studying the relation between *T. monococcum* × *Ae. speltoides* amphidiploid and tetraploid wheat.

Chromosome pairing and fertility in the hybrid between the new amphidiploid-S^lS^lAA and Emmer-wheat

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The present writer has obtained an amphidiploid from the cross, *Aegilops longissima* (genome formula, S^lS^l) × *Triticum aegilopoides* (genome formula, AA). Data on chromosome pairing and fertility in the amphidiploid (genome formula, S^lS^lAA) are summarized in Table 1.

Table 1. Chromosome pairing and fertility of the amphidiploid S^lS^lAA

Year	Bivalents	Univalents	Complexes	Fertility (%)		
				Pollen	Seed	
					self	open
1954	11–14 (14)	0–2 (0)	1_{IV}	90.3	59.6	65.9
1955	13–14 (14)	0–2 (0)	—	84.3	54.57	69.60

Crosses between the amphidiploid (S^lS^lAA) and *T. durum* (AABB) were made to test the chromosome homology (Table 2).

Table 2. Chromosome pairing and fertility in the hybrid S^lS^lAA × *Triticum durum* var. *coerulescens*

Year	Bivalents	Univalents	Complexes	Fertility (%)	
				Pollen	Seed
1955	5–9 (7)	10–18 (14)	0	0	0

In the hybrid, S^lS^lAA × *T. durum*, 5–9 (mode at 7) bivalents were observed (Fig. 2 on the cover), and the F_1 hybrid was entirely sterile. The 7 pairs of chromosomes observed might be attributed to allosyndesis between the A genomes of the parents. This indicates that the A-genomes of the parents are homologous. However, from the genome-analytic point of view, the S^l-genome cannot be homologous to B-genome.

From the morphological point of view, the S group, incl. *Ae. speltoides* (S), *Ae. Aucheri* (S), *Ae. bicornis* (S^b), *Ae. longissima* (S^l) and *Ae. sharonensis* (S^l), especially *Ae. longissima* and *Ae. sharonensis*, has some characteristics of the B-genome of Emmer- and Dinkel-wheats. For example, *Ae. longissima* has a hollow straw with a thick wall, which is one of the main characteristics of the B-genome. The amphidiploid resembles the Emmer wheat in some characteristics, i.e., the empty glume is narrow and has an apical tooth in place of awn, but the keel is sharp, the palea does not split, and the ears break according to the wedge type. But it differs from the Emmer wheats in other characteristics. The ears are long and narrow, and as the awns of the lemmas are of equal length, the tips of the awns are not at the same level, and the straw is slightly hollow.

Spring- and winter-growing habit in *Aegilops squarrosa* var. *typica*

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In WIS No. 1, the spring- and winter-growing habits of many species and varieties of *Aegilops* and *Triticum* were listed. Generally speaking, the wild types, especially the diploid species, have the winter-growing habit. Therefore, it may be postulated that the ancestral type of *Aegilops* and *Triticum* is of the winter-growing type. Recently, however, the spring-growing habit was found in one strain of *Ae. squarrosa* var. *typica* (DD-species). The result of the observations are as follows.

Aegilops squarrosa var. *typica*:
No. 1, from Derbent (Caucasus): winter-growing habit
No. 2, from Palestine: 〃
No. 3, from Tashkent (Turkestan): 〃
No. 4, from Quetta (Pakistan): spring-growing habit

Hybrids between *Aegilops triaristata* (4x) and *Ae. comosa*, *Heldreichii* and *uniaristata*

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Though a great many hybrids have been reported in the genus *Aegilops*, no reports have appeared concerning the combination, *Ae. triaristata* ($2n=28$) and *Ae. comosa* ($2n=14$), which the author has successfully produced. One hybrid plant was raised from 7 seeds obtained from 10 florets of the cross, *Ae. triaristata* No. 3×*Ae. comosa* No. 1. The characteristics of the hybrid were intermediate in respect to the parents. The chromosome number was counted in the root-tip cells as $2n=21$. The meiotic behavior of the chromosomes was not studied in detail as the anthers degenerated, but a few configurations at first metaphase in which 2 or 3 bivalents and many univalents occurred were observed. The stigmas of the hybrid were dusted with pollen grains of *Ae.*

triaristata and ***Ae. comosa*** with negative results, namely, no seeds were obtained from 204 pollinated florets. The cause of the complete sterility of the hybrid may be attributed to the degeneration of the embryo-sacs.

From the following cross combinations carried out at the same time, 68 seeds were obtained from 386 florets, the success being 17.62%, but there were some seeds which did not germinate (Table 1).

Table 1. Crossing results between *Ae. triaristata* and *Ae. comosa*, *Ae. Heldreichii* and *Ae. uniaristata* (1947)

Cross combinations1)	Number of florets	Number of seeds	Fertility
Ae. triaristata No. 1 (6*x*)×*Ae. comosa* No. 1	30	3	10.00%
〃 〃 ×*Ae. Heldreichii*	32	13	40.62
〃 〃 ×*Ae. uniaristata* No. 1	54	14	25.92
〃 No. 3 (4*x*)× 〃 〃	40	10	25.00
〃 No. 4 (4*x*)×*Ae. comosa* No. 1	4	1	25.00
〃 〃 × 〃 No. 2	23	0	0
〃 〃 ×*Ae. uniaristata* No. 1	26	0	0
〃 No. 5 (4*x*)×*Ae. comosa* No. 1	20	7	35.00
〃 〃 ×*Ae. uniaristata* No. 2	38	9	23.68
〃 No. 6 (4*x*)×*Ae. comosa* No. 1	22	3	13.63
〃 〃 ×*Ae. uniaristata* No. 1	37	3	8.18
〃 No. 7 (4*x*)×*Ae. comosa* No. 1	60	5	8.33
Total	386	68	

1) The pollen parents, *Ae. comosa*, *Ae. Heldreichii* and *Ae. uniaristata*, are diploid species with $2n=14$ chromosomes.

Cytological studies of hybrids involving *Triticum durum* and *Secale cereale*

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Hybrids were secured from crosses between *Triticale*, the allopolyploid of *T. durum* variety Carleton and *Secale cereale*, and the *durum* varieties Iumillo, F.P.I. 94587 and Stewart, and spring rye. At MI, PMC's with $14_{II}+7_{I}$ were observed most frequently in the hybrids between *Triticale* and the *durum* varieties F.P.I. 94587 and Stewart. Hybrids with 31 and 32 somatic chromosomes were derived from a cross between *Triticale* and Iumillo. The high frequency of PMC's with 14 bivalents indicated that these hybrids probably originated from the fertilization of a *Triticale* egg of ABS-3 or ABS-4 constitution by a gemete of the AB constitution of tetraploid wheat. Quadrivalents usually in the form of a ring of four chromosomes were observed in all hybrids involving ***durum*** varieties. The frequency of microsporocytes with quadrivalents in the hybrids involving Iumillo ranged from 19.0 to 37.1%. Self and backcross progenies of the hybrids segregated into ring forming and normal plants, which indicated the presence of a reciprocal translocation between the wheat chromosomes.

Six hybrids, two with 27, three with 26 and one with 25 somatic chromosomes were obtained from a cross between ***Triticale*** and spring rye. Phenotypically, the 27 chromosome hybrids showed the hairy-neck characteristic of both parents; the others were characterized by non-pubescence of the peduncle. Pollen mother cells with 5 bivalents were observed most frequently at MI in the non-hairy neck plants. One of the 27 chromosome plants had a mode of 3 bivalents at MI while the other had a mode of 6 bivalents. Approximately 38 percent of the PMC's in the latter plant had trivalents.

A 29 chromosome plant monosomic for chromosome I of rye was derived from a backcross of the hybrid between ***Triticale*** and F.P.I. 94587 to Khapli. The presence of the rye chromosome adversely affected plant height and increased the frequency of asynapsis of one or two pairs of wheat chromosomes.

Some aspects of backcrossing for disease resistance in cereals

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It would appear that the time has arrived when consideration should be given to the establishment of an internationally recognized centre vested with the responsibility of maintaining "type" material of known genetic constitution closely paralleling that already operative for genetic stocks of maize. With respect to disease resistance the F.A.O. world catalogue of genetic stocks falls far short of modern cereal breeders' requirements and I should imagine has been little used by them in their work. The classification of stem rust resistance on a 0–9 scale without reference to the identity of the physiologic races involved is far too vague for devotees of backcrossing. A much more satisfactory system could be inaugurated if some center, actively engaged in cereal work, would take upon themselves the task of assembling such material as is described in the literature from time to time. In this way authenticity of material could be guaranteed and, because the scheme would commence in a small way, there would be scope for modification and development as time went on. (Extract from the J. Aust. Inst. Agric. Sci., 21, 1955).

Frequency of bivalents in meiosis of intergeneric F_1 hybrids between Emmer or *Timopheevi* wheat and *Secale*

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Hybrid combination	2n	Number of PMC's with bivalents								Total	Mode	Mean±S.D.	Coefficient of variation
		0	1	2	3	4	5	6	7				
T. durum ×*S. cereale*	21	707 (62.51)	269 (23.78)	111 (9.81)	38 (3.36)	6 (0.53)				1131 (99.99)	0_{II} (62.51)	0.56±0.27	47.80
T. durum ×*S. africanum*	21	4092 (58.46)	1999 (28.56)	698 (9.97)	188 (2.69)	22 (0.31)	1 (0.01)			7000 (100.00)	0_{II} (58.46)	0.58±0.25	43.85
T. durum ×*S. montanum*	21	1172 (29.30)	1019 (25.48)	1017 (25.43)	551 (13.78)	189 (4.73)	48 (1.20)	4 (0.10)		4000 (100.02)	0_{II} (29.30)	1.43±1.25	87.08
T. turgidum ×*S. cereale*-1	21	666 (54.59)	346 (28.36)	137 (11.23)	61 (5.00)	9 (0.74)	1 (0.08)			1220 (100.00)	0_{II} (54.59)	0.69±0.29	41.87
T. turgidum ×*S. cereale*-2	22	121 (61.73)	45 (22.96)	21 (10.71)	8 (4.08)	1 (0.50)				196 (99.99)	0_{II} (61.73)	0.59±0.28	47.31
T. turgidum ×*S. cereale*-3	22+ 1 fr.	38 (7.32)	58 (11.18)	84 (16.18)	176 (33.91)	119 (22.93)	33 (6.36)	9 (1.73)	2 (0.39)	519 (100.00)	3_{II} (33.91)	2.82±1.39	49.34
T. turgidum ×*S. cereale*-4	23	134 (25.43)	321 (60.91)	58 (11.00)	13 (2.47)	1 (0.19)				527 (100.00)	1_{II} (60.91)	0.91±0.22	23.82
T. turgidum ×*S. cereale*-5	23	51 (21.89)	88 (37.77)	62 (26.61)	21 (9.15)	9 (3.86)	1 (0.86)			233 (100.14)	1_{II} (37.77)	1.38±1.09	79.32
T. turgidum ×*S. africanum*	21	3456 (49.37)	2118 (30.26)	1015 (14.50)	318 (3.54)	83 (1.19)	10 (0.34)			7000 (99.00)	0_{II} (49.37)	0.78±0.30	38.38
T. turgidum ×*S. montanum*	21	1557 (31.14)	995 (19.90)	1114 (22.28)	656 (13.12)	434 (8.68)	169 (3.38)	58 (1.16)	17 (0.34)	5000 (100.00)	0_{II} (31.14)	1.65±1.54	93.45
T. persicum ×*S. cereale*-1	21	1010 (26.44)	1272 (33.30)	1008 (26.39)	436 (11.41)	94 (2.57)				3820 (100.11)	1_{II} (33.30)	1.30±1.06	81.04
T. persicum ×*S. cereale*-2	23	257 (25.70)	188 (18.80)	351 (35.10)	148 (14.80)	49 (4.90)	7 (0.70)			1000 (100.00)	2_{II} (35.10)	1.57±1.20	76.54

Hybrid combination	2*n*	Number of PMC's with bivalents								Total	Mode	Mean±S.D.	Coefficient of variation
		0	1	2	3	4	5	6	7				
T. persicum ×*S. cereale*-3	23	602 (25.51)	405 (17.16)	697 (29.53)	432 (18.31)	183 (7.75)	41 (1.73)			2360 (99.99)	2_{II} (29.53)	1.71±1.33	77.59
T. persicum ×*S. africanum*	21	3025 (49.02)	1852 (30.11)	981 (15.93)	268 (4.36)	24 (0.39)				6150 (99.81)	0_{II} (49.02)	0.77±0.28	37.03
T. persicum ×*S. montanum*	21	1768 (38.43)	1068 (23.22)	1022 (22.22)	508 (11.04)	194 (4.22)	40 (0.87)			4600 (100.00)	0_{II} (38.43)	1.22±1.23	100.98
T. dicoccum ×*S. cereale*	21	835 (52.72)	557 (35.21)	164 (10.37)	29 (1.83)					1585 (100.13)	0_{II} (52.72)	0.61±0.23	37.52
T. dicoccum ×*S. Vavilovii*	21	1087 (67.94)	392 (24.50)	106 (6.63)	14 (0.88)	1 (0.06)				1600 (100.01)	0_{II} (67.94)	0.41±0.21	51.31
T. dicoccum ×*S. africanum*	21	2853 (51.87)	2192 (39.86)	416 (7.56)	39 (0.71)					5500 (100.00)	0_{II} (51.87)	0.57±0.21	36.01
T. dicoccum ×*S. montanum*	21	2015 (37.79)	2301 (43.15)	798 (15.00)	185 (3.47)	32 (0.60)				5331 (100.01)	1_{II} (43.15)	0.86±0.26	30.81
T. pyramidale ×*S. cereale*	21	446 (39.09)	479 (41.98)	175 (15.34)	40 (3.51)	1 (0.88)				1141 (100.80)	1_{II} (41.98)	0.084±0.26	30.69
T. pyramidale ×*S. africanum*	21	2411 (80.37)	463 (15.43)	114 (3.80)	12 (0.40)					3000 (100.00)	0_{II} (80.37)	0.24±0.17	69.05
T. pyramidale ×*S. montanum*	21	715 (31.36)	626 (27.40)	582 (25.53)	260 (11.40)	83 (3.64)	14 (0.61)	1 (0.04)		2280 (99.98)	0_{II} (31.36)	1.31±1.17	89.59
T. polonicum ×*S. africanum*	21	3067 (76.68)	757 (18.93)	159 (3.98)	17 (0.43)					4000 (100.00)	0_{II} (76.68)	0.28±0.18	62.34
T. polonicum ×*S. montanum*	21	3081 (44.73)	2062 (29.94)	1185 (17.20)	445 (6.46)	103 (1.49)	12 (0.17)			6888 (99.99)	0_{II} (44.73)	0.91±1.02	112.03
T. Timopheevi ×*S. africanum*	21	1978 (39.56)	1074 (21.48)	1071 (21.42)	607 (12.14)	217 (4.34)	42 (0.84)	8 (0.16)	3 (0.06)	5000 (100.00)	0_{II} (39.56)	1.24±1.28	103.07

Note: The value in the bracket in the table shows the percentage. For fuller details see the following reports: Jap. Jour. Gen. 13: 177–184, do. 25: 139–148, do. 25: 191–199, La Kromosomo 11: 410–415, Cytologia 17: 144–155, La Kromosomo 14: 525–535, Cytologia 18: 43–49, do. 18: 122–127, Jap. Jour. Bot. 14: 194–214, do. 15: 1–9, La Kromosomo 22–24: 816–823, Cytologia 20: Vol. 20, No. 4, La Kromosomo in the press, Jap. Jour. Breed. 5: in the press.

Frequency of bivalents in meiosis of intergeneric F_1 hybrids between Dinkel wheat and *Secale*

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Hybrid combination	$2n$	Number of PMC's with bivalents								Total	Mode	Mean±S.D.	Coefficient of variation
		0	1	2	3	4	5	6	7				
T. vulgare (L) ×*S. cereale*	28	198 (33.00)	124 (20.67)	165 (27.50)	105 (17.50)	8 (1.33)				600 (100.00)	0_{II} (33.00)	1.67±0.31	18.78
T. vulgare (C) ×*S. cereale*	28	222 (60.66)	83 (22.68)	38 (10.38)	17 (4.64)	6 (1.64)				366 (100.00)	0_{II} (60.66)	0.64±0.30	47.34
T. vulgare ×*S. Vavilovii*	28	6346 (60.55)	2417 (23.06)	1214 (11.58)	365 (3.48)	106 (1.01)	19 (0.18)	9 (0.09)	4 (0.04)	10480 (100.00)	0_{II} (60.55)	1.62±0.30	47.39
T. vulgare ×*S. africanum*	28	4770 (63.08)	1579 (20.88)	813 (10.75)	316 (4.22)	76 (1.01)	4 (0.05)	1 (0.01)		7562 (100.00)	0_{II} (63.08)	0.60±0.29	48.10
T. vulgare ×*S. montanum*	28	619 (21.56)	592 (20.71)	812 (28.40)	472 (16.51)	250 (8.74)	95 (3.32)	19 (0.67)		2859 (100.01)	2_{II} (28.40)	1.81±1.38	76.10
T. compactum ×*S. cereale*	28	2764 (67.41)	869 (21.20)	330 (8.05)	104 (2.54)	33 (0.81)				4100 (100.01)	0_{II} (67.41)	0.48±0.26	53.39
T. compactum ×*S. Vavilovii*	28	3228 (54.90)	1423 (24.20)	805 (13.70)	295 (5.18)	99 (1.70)	30 (0.51)			5880 (100.03)	0_{II} (54.90)	0.76±1.03	135.71
T. compactum ×*S. africanum*	28	4565 (83.00)	789 (14.35)	142 (2.58)	4 (0.07)					5500 (100.00)	0_{II} (83.00)	0.20±0.15	74.70
T. compactum ×*S. montanum*	28	4464 (89.28)	442 (8.84)	94 (1.88)						5000 (100.00)	0_{II} (89.28)	0.13±0.12	93.54
T. Spelta ×*S. cereale*	28	1220 (48.01)	570 (22.43)	495 (19.48)	208 (8.19)	48 (1.86)				2541 (100.00)	0_{II} (48.01)	0.94±1.08	86.57
T. Spelta ×*S. Vavilovii*	28	425 (25.00)	535 (31.47)	545 (32.06)	158 (9.29)	37 (2.18)				1700 (99.99)	2_{II} (32.06)	1.33±1.01	76.24
T. Spelta ×*S. africanum*	28	2030 (56.39)	855 (23.75)	476 (13.22)	198 (5.50)	33 (0.97)	8 (0.22)			3600 (100.05)	0_{II} (56.39)	0.72±0.31	43.17

Hybrid combination	2*n*	Number of PMC's with bivalents								Total	Mode	Mean±S.D.	Coefficient of variation
		0	1	2	3	4	5	6	7				
T. Macha ×*S. cereale*	28	1401 (26.43)	1946 (36.72)	1420 (26.79)	442 (8.34)	91 (1.72)				5300 (100.00)	1_{II} (36.72)	1.22±0.31	25.51
T. Macha ×*S. Vavilovii*	28	970 (32.33)	1242 (41.40)	551 (18.37)	174 (5.80)	51 (1.70)	12 (0.40)			3000 (100.00)	1_{II} (41.40)	1.04±0.31	29.62
T. Macha ×*S. africanum*	28	1000 (25.64)	2162 (55.44)	640 (16.41)	98 (2.51)					3900 (100.00)	1_{II} (55.44)	0.96±0.23	23.77
T. Macha ×*S. montanum*	28	2187 (33.65)	2517 (38.72)	1098 (16.89)	490 (7.54)	145 (2.23)	48 (0.69)	15 (0.23)		6500 (99.95)	1_{II} (38.72)	1.09±1.08	99.27
T. sphaerococcum ×*S. cereale*	28	2233 (61.86)	892 (24.71)	411 (11.39)	68 (1.88)	6 (0.17)				3610 (100.01)	0_{II} (61.86)	0.54±0.25	45.97
T. sphaerococcum ×*S. Vavilovii*	28	3461 (53.25)	1821 (28.02)	904 (13.91)	267 (4.11)	47 (0.72)				6500 (100.01)	0_{II} (53.25)	0.71±0.29	40.27
T. sphaerococcum ×*S. africanum*	28	2224 (41.65)	1504 (28.16)	1027 (19.23)	414 (7.76)	152 (2.82)	19 (0.36)			5340 (99.98)	0_{II} (41.65)	1.03±1.11	107.57
T. sphaerococcum ×*S. montanum*	28	1197 (34.20)	898 (25.66)	759 (21.65)	404 (11.54)	178 (5.09)	55 (1.57)	7 (0.20)	2 (0.06)	3500 (100.01)	0_{II} (34.20)	1.34±1.30	97.23

Hybrid combination	2*n*	Number of PMC's with bivalents							Total	Mode	Mean±S.D.	Coefficient of variation
		5	6	7	8	9	10	11				
T. vulgare (C) ×*S. cereale*−2	28	6 (3.94)	17 (11.18)	45 (29.61)	33 (21.71)	24 (15.79)	13 (8.55)	14 (9.21)	152 (99.99)	7_{II} (29.61)	7.98±1.56	19.62

See the foot-note of the table on page 26.

Fertility in *Triticale*

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Triticale-type with 42 chromosomes have been obtained at the Aula Dei Station from the hybrids *Triticum durum* × *Secale cereale*, *T. dicoccum* × *S. cereale* and *T. dicoccoides* × *S. cereale*.

The fertility[1] of such types has been studied in comparsion with the wheat ancestors and with several 56-chromosome *Triticale*-types kindly supplied by Prof. Müntzing of Lund's University (types A, C, C×A, O, C×Standard and Svea×Rag) and Prof. Jorgensen of Copenhague University (type Pajbjirg Ideal×Petkus). The results are summarized in the following table.

Type or species	$2n$	Fertility (%)			Number of plants obsvd.
		Individual plant (maximum)	Individual plant (minimum)	Average	
T. durum	28	115.8	60.9	95.4	20
T. durum × *S. cereale*, amph.	42	107.9	0.0	58.8	165
T. dicoccum	28	96.2	41.7	81.0	20
T. dicoccum × *S. cereale*, amph.	42	75.9	0.4	46.7	222
T. dicoccoides	28	138.3	77.1	105.6	20
T. dicoccoides × *S. cereale*, amph.	42	69.8	0.3	36.2	97
T. aestivum "Pajbjirg Ideal"	42	101.7	44.2	74.6	20
"Pajbjirg Ideal" × "Petkus", amph.	56	70.4	7.9	56.9	15
Triticale A	56	43.2	23.8	35.3	9
Triticale C	56	45.2	2.3	25.8	9
Triticale C×A	56	41.4	12.0	29.0	7
Triticale O	56	58.0	3.8	35.6	12
Triticale C×Standard	56	31.2	11.5	19.6	10
Triticale Svea×Rag	56	58.8	1.2	33.6	7

These results seem to indicate that, at least under Spanish conditions, the 42-chromosome *Triticale* compares favourably in fertility with the 56-chromosome ones. Some plants have fertilities approaching that of the wheat ancestor.

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1) Fertility is measured as the percent of seed in relation to flower number. Flower number is taken as the double of spikelet number.

Crossability of tetraploid wheat species with cultivated rye

E. Sanchez-Monge
Estación Experimental de Aula Dei, Zaragoza, Spain

Species	Number of genotypes		Total number of flowers pollinated	Total number of F_1 plants	Crossability	
	crossed	giving F_1 plants			%	Range for genotypes
T. durum	33	16	13,409	123 (5)	0.9	0.0–36.7
T. turgidum	12	7	4,853	17	0.4	0.0– 5.3
T. polonicum	3	1	715	2	0.3	0.0– 4.5
T. carthlicum	4	3	2,597	6	0.2	0.0– 5.0
T. dicoccum	6	3	1,847	8 (3)	0.4	0.0–10.7
T. dicoccoides	3	1	1,261	2 (1)	0.2	0.0– 2.5
T. Timopheevi	3	2	1,444	4	0.3	0.0– 1.6
Total	64	33	26,126	162 (9)	0.6	0.0–36.7

In brackets are given the numbers of different 42-chromosome *Triticale*-types obtained.

Spring wheat breeding and the transfer of economic characters from related species and genera

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Work on the Translocation of bunt resistance and in separate material the translocation of combined leaf and stem rust resistance from tall wheatgrass, *Agropyron elongatum* $2n=70$ to hexaploid wheats, is going forward. The dominant bunt resistance of tall wheatgrass is carried on one extra chromosome in resistant derivatives obtained by continuous backcrossing to a susceptible winter variety. Through both irradiation and continuous backcrossing a number of 42 chromosome resistant plants have been obtained. Progeny tests of these are being made this year. Both 42 and 43 chromosome X_4 plants have also been obtained from an X_3 progeny row homozygous for resistance to the various biotypes of 15 b and other stem and leaf rust races in the rust nursery of the Dominion Cereal Laboratory at Winnipeg in the summer of 1955. This material arose from an 18,000 *r* X-ray treatment of the F_0 seed ($2n=49$) obtained from the cross between a rust-resistant 56 chromosome wheatgrass derivative and a susceptible spring variety.

During the year a number of octaploid wheat-like materials have been assembled for intercrossing and irradiation in an attempt to develop new wheat types at this chromosome level.

An F_1 hybrid between *T. durum* 8x and *Agropyron trichophorum*

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An F_1 hybrid between induced *Triticum durum* var. *hordeiforme* 8x (AAAABBBB) and *Agropyron trichophorum* ($2n=42$) revealed $2n=50$, although $2n=49$ was expected.

The mode of chromosome conjugation at MI is shown in Table 1. Most of the bivalents were of the closed type, but a few of them were of the open type with terminal connection. Fourteen bivalents which conjugated strongly must have been due to autosyndesis of chromosomes belonging to A and B genomes derived from octaploid *T. durum*. Only one trivalent was observed. This was considered to be due to a gamete having an extra chromosome from octaploid *T. durum*. This suggests also that no homology exists between the genomes of *A. trichophorum* and Emmer.

Table 1. Chromosome pairing in a hybrid *T. durum* 8x × *A. trichophorum*

Conjugation	Frequency
$1_{III}+11_{II}+25_{I}$	1
$13_{II}+24_{I}$	3
$14_{II}+22_{I}$	7 1)
$1_{III}+13_{II}+21_{I}$	2
$15_{II}+20_{I}$	16
$1_{III}+14_{II}+19_{I}$	8
$16_{II}+18_{I}$	8
$1_{III}+15_{II}+17_{I}$	3
$17_{II}+16_{I}$	1
$1_{III}+16_{II}+15_{I}$	1
Total	50

1) Similar types of conjugation are bracketed.

The remaining 0–3 bivalents should be due to pairing between the chromosomes of genomes of *A. trichophorum*, but their number is too small to be attributed to two supposedly homologous genomes of *A. trichophorum*. This result supports the view that the 3 genomes of *A. intermedium*, which seems to have the same genome constitution with *A. trichophorum*, are not homologous (Muramatsu 1955, WIS No. 2).

Pollen-fertility was 20.4% and one seed was obtained from artificial self pollination. The somatic chromosome number of this F_2 plant, examined in root tip cells, was $2n=54$.

II. A Summary of the Results of the Kyoto University Scientific Expedition to the Karakoram and Hindukush
May-August, 1955

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and Biological Laboratory, Kyoto University, Kyoto, Japan

In the summer of 1955, the Kyoto University, Koyto, Japan, organized the Scientific Expedition to the Karakoram and Hindukush. Kihara was the leader and eleven specialists in their respective fields, botany, anthropology and geology, two cameramen and a reporter joined the party. They started from Japan in the middle of May and returned home early in September, 1955.

The writers wish to express their appreciation to Dr. Kuckuck and Dr. Mudra, who facilitated the expedition with the informations of their experiences in Iran. A map of Dr. Kuckuck's collection was especially useful.

Some of the results will be briefly reported in the following paragraphs.

Table 1. Number of strains and habitats collected of *Triticum*

Region	Einkorn		Emmer		Dinkel	
	Strains	Habitats	Strains	Habitats	Strains	Habitats
Pakistan:						
Quetta	0	0	0	0	47	6
Afghanistan:						
Kabul	0	0	0	0	73	39
Pulikumuri	0	0	0	0	2	2
Maimana	0	0	0	0	9	4
Herat	0	0	0	0	3	1
Iran:						
Meshed	0	0	0	0	18	9
Elburz	0	0	2	2	52	10
Gorgan	0	0	8	3	21	17
Pahlavi	0	0	1	1	44	21
Tabriz	0	0	0	0	31	15
Isfahan	0	0	6	3	46	20
Unknown	3[1]	2	3	2	8	2
Total	3	2	20	11	354	146

1) A species given by the courtesy of Dr. M. Atai. University of Tehran, Iran, revealed $2n=28$, which is the chromosome number of Emmer wheat.

Table 2. *Secale, Hordeum and Avena* collected

	Wild type	Cultivated type	Total	
			Strains	Habitats
Secale	4	37	41	32
Hordeum	36	48	84	75
Avena	1	20	21	21

Table 3. Number of strains and habitats collected of *Aegilops*

Region	*squarrosa*		*crassa*		*cylindrica*		*triuncialis*	
	Strains	Habitats	Strains	Habitats	Strains	Habitats	Strains	Habitats
Pakistan:								
Quetta	13	11	0	0	0	0	0	0
Afghanistan:								
Kabul	37	24	9	2	0	0	0	0
Pulikumri	31	15	12	8	0	0	12	10
Maimana	24	15	8	5	0	0	19	11
Herat	0	0	3	2	0	0	5	2
Iran:								
Meshed	0	0	1	1	0	0	1	1
Elburz	14	6	4	1	16	3	50	8
Gorgan	20[1]	14	0	0	0	0	1	1
Pahlavi	28	14	0	0	3	2	0	0
Tabriz	9	6	10	7	29	16	32	15
Isfahan	0	0	0	0	0	0	0	0
Unknown[2]	3	1	11	1	9	4	32	1
Total	179	106	58	27	57	25	152	49

1) Mostly *Aegilops squarrosa* var. *strangulata*

2) Given by the courtesy of Dr. M. Atai, University of Tehran, Iran and Mr. M. Mojitahedi, Department of Agriculture, Tehran, Iran. This involves 2 strains of *Ae. umbellulata* in addition.

Aegilops squarrosa, one of the ancestors of our common wheat, was found around Quetta, Pakistan, in the beginning of the expedition by Kihara and Yamashita, which is probably the south-easternmost limit of the distribution of this genus. This species was found mostly in association with cultivated wheat everywhere, except the northern district of Afghanistan, where a large natural population of this species was found.

The tour from Quetta, through Afghanistan, to Azerbaijan, Iran, was made from late May to early August. Along a distance of over 5,000 km. *Aegilops squarrosa* var. *typica* was seen widely distributed, and its specimens were collected in over 100 different localities (Fig. 1, left, on the cover). *Aegilops squarrosa* var. *strangulata* was, however, found only in a restricted area in Gorgan, Iran (Fig. 1, right, on the cover). A large number

Table 4. Number of species and strains collected of cereals other than *Triticum*, *Secale*, *Aegilops*, *Hordeum* and *Avena*

Name of genus	No. of species	No. of strain	Name of genus	No. of species	No. of strain
Agropyron	4	17	*Cynosurus*	1	1
Agropyron ?	2	19	*Phleum*	more than 1	5
Taeniatherum	1	5	*Polypogon*	1	1
Lolium	more than 3	36	*Alopeculus*	1	1*
Brachypodium	1	3	*Phalaris*	1	3
Bromus	4	29	*Setaria*	1	1*
Festuca	4	6	*Paspalum*	1	1*
Poa	1	2	*Echinochloa*	more than 1	4
Eragrostis	1	2*	Other genera	5	12
Dactylis	more than 1	3			

* Mature seeds were not obtained.

of specimens of other *Aegilops* species, wheats, ryes, oats, etc., were also collected. Kihara has succeeded in confirming his theory that our bread wheat originated in the Caucasus through hybridation between emmer wheat and *Aegilops squarrosa.*

Kitamura collected approximately 4,000 sheets of specimens representing about 1,000 wild plant species in Afghanistan, chiefly in the Hindukush regions, including Nuristan. The flora of Nuristan, where the climate is humid, is closely related to that of the Himalayas. There were found many wild growing fruit trees such as the apple, apricot, jujube, pomegranate and walnut. Along the Bamian river, fig trees, pomegranates and platans were observed. Whether these plants are wild or naturalized is one of the most interesting problems for future investigation.

Iwamura and Okasaki visited parts of the Tribal Territory in Waziristan for a preliminary survey of Buddhist remains. Their survey, though it was rather brief, will contribute to identifying some of the Buddhist countries and towns described in the narratives of the ancient Chinese Buddhist pilgrims, Fa-chien and Hsüantsang. With Yamasaki and Umesao, they proceeded to Afghanistan, visiting villages in remote mountains of the Hindukush where they succeeded in locating the Mongols and investigating an old type of the Mongolian language surviving among these descendants of the Chingiscanid Mongols. Yamasaki and Umesao remained in Afghanistan for further detailed studies of these people, while Iwamura and Okasaki crossed the Afghan border to Iran, where they travelled as far as Tabriz.

Imanishi observed the behavior of the Hunza, Nagir and Baltit porters. These porters were subjected to the Rorschach test. According to the test their basic parsonality proved to belong to the colour type, predominantly CF.

Matsushita and Huzita made a survery of the western Karakoram mountains. It was found that the area was composed of a basement complex and a Quarternary deposit, the former consisting of metamorphic sedimentaries and a granite gneiss injected with pegmatite. The Quarternary deposit is fluvioglacial or glacial and fluviatile, forming terraces and fans along some of the larger valleys. These observations will contribute to the study of the Himalayan orogenism and the Quarternary climatic change.

In Hunza, which was known as "Healthy Hunza", Harada found that many were suffering from asthma, rheumatism, goiter, tuberculosis and stone diseases, while some from cancer and heart diseases.

Nakao observed the ecological aspects of the vegetation in high Karakoram. He found that in the arid land there is sparcely covered by xerophytic bushes, while some island-like green patches were mainly occupied by Sino-Himalayan plants.

III. Information of Nōrin Wheat Varieties in Japan

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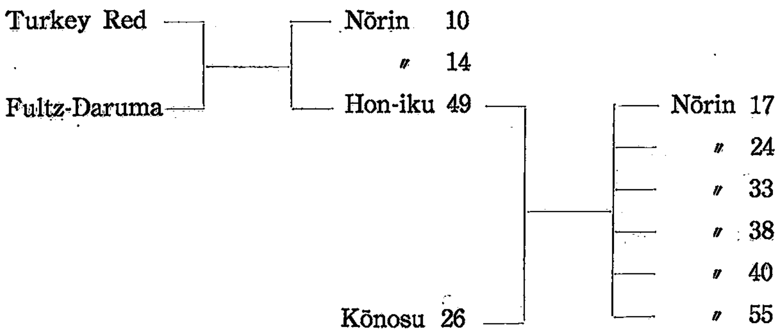
and Faculty of Agriculture, Kyoto University, Kyoto, Japan

The wheat varieties of standard productivity recommended by the government to the farmers are registered by the Nōrin numbers. Nōrin is the abbreviation of the Department of Agriculture and Forestry. From 1926 up to the present, 90 Nōrin varieties have already been established. Through the studies on various hybrid progenies it became clear that high productivity together with early maturing habits and disease resistance can be secured only by crossing of selected parents. Therefore, the parents of the Nōrin varieties are few in number. For example, Nōrin winter wheats for the snowy parts of Japan have been raised as follows:



IV. Circulation List of WIS

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BASU, M. C.: Department of Agriculture, Victoria, Australia

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V. News

(March 15, 1956)

1956 Genetics Symposia, September 6–12, 1956, in Tokyo and Kyoto, Japan.

The Agenda for the 1956 Genetics Symposia, as was announced in the circulars from the Japan Science Council, is now complete. Drs. Müntzing, Jenkins, Unrau, Harington and other wheat geneticists are expected to attend. An informal meeting of these visitors and the Japanese wheat geneticists will be planned for the evening of September 12 in Kyoto after the closing ceremony of the Symposia. The subjects to be discussed will be: 1) the possibility of Wheat Genetics Symposium in Montreal, Canada, in 1958, 2) gene symbols, 3) future management of the "Wheat Information Service", and 4) various important problems in wheat genetics and cytology, such as nullisomics, B-genome, and others. Any suggestion would be appreciated.

Wheat Newsletter

Dr. E. G. Heyne, Department of Agronomy, State College of Kansas, Manhattan, Kansas, U. S. A., is preparing another Wheat Newsletter for 1955. He says: "It is an informal presentation of wheat research being conducted in the United States and Canada and is for limited distribution to people working in wheat research." 1954 Wheat Newsletter (Vol. 1) was published in April, 1955.

Wheat Monograph

An English translation of the "Studies on Wheat" published in 1954 in Japanese will be presented shortly by Mr. M. Okamoto with the assistance of Dr. Sears' group, University of Missouri, Columbia, Missouri, U. S. A. Dr. Sears will look through it and send it to us before long. The writers will then complete it with necessary additions pertaining to new data which have appeared after the Japanese edition was published. If necessary, Dr. Kihara himself will visit the U. S. A. and Europe in order to fill up the gap of the manuscript.

Loss to the Scientific World

It is with regret that we announce the passing away of the following three distinguished wheat geneticists. This is really a great loss to the scientific world. It is not necessary to mention their invaluable contributions to wheat genetics, cytology and breeding, which will long remain with us.

Dr. Georg Kattermann died on October 6, 1943, in Russia, Dr. Åke Åkerman in April, 1955, in Svalöf, Sweden, and Dr. E. S. McFadden on January 6, 1956 in College Station, Texas, U. S. A.

The following is an extract of Dr. Kihara's letter expressing his sympathy to Dr. McFadden's family through Mrs. Meta Brown: "I had a chance to meet Dr. McFadden in 1953, and we had a long talk on the origin of common wheat. I liked him for his unassuming demeanor and the quite objective way of discussing our common problems. His name will always remain with the first synthesis of common wheat."

Miscellaneous

Dr. H. Kihara was appointed Director of the National Institute of Genetics, Misima, Japan. He will retire in April, 1956, from the position at the Kyoto University, where he will be succeeded by Dr. I. Nishiyama, one of his oldest pupils.

Copies of WIS No. 1 and No. 2 are available. They will be sent free on application.

VI. Announcement for the Next Issue, No. 4

WIS No. 4 will be ready for publication in October, 1956. It is open to all contributions dealing with informations on methods, materials and stocks, ideas and research notes related to wheat genetics and cytology, including *Triticum*, *Aegilops*, *Agropyron*, *Secale* and *Haynaldia*.

Contributions should be typewritten in English. The authors are cordially requested to present ***not later than September 30, 1956***, their manuscripts which should not exceed two printed pages. Lists of stocks are not required to conform to this page limit. No illustrations can be accepted for publication.

Manuscripts and communications regarding editorial matters should be addressed to:

Dr. Kosuke Yamashita
Wheat Information Service
Biological Laboratory
Kyoto University, Kyoto, Japan

VII. Acknowledgement

The cost of the present publication has been defrayed by contributions from the following Japanese organizations, to which we wish to express our sincere thanks.

Flour Millers Association, Tokyo, Japan
Nisshin Flour Milling Co., Ltd., Tokyo, Japan
Nippon Flour Mills Co., Ltd., Tokyo. Japan
Showa Sangyo Co., Ltd., Tokyo, Japan
Nitto Flour Milling Co., Ltd., Tokyo, Japan

We should like to express our sincere gratitude for favorable comments regarding WIS No. 1 and No. 2 and valuable contributions for the present number. Increased support for further issues would be appreciated.

Explanation of the Figures on the Cover

Fig. 1. Ears and seeds of *Aegilops squarrosa* collected by the Kyoto University Scientific Expedition 1955. ×ca. 1/2.5 Left, var. *typica*; right, var. *strangulata* (H. Kihara and K. Yamashita, s. page 33).

Fig. 2. Meiotic chromosomes at first metaphase in the hybrid, $S^{l}S^{l}AA$ × *Triticum durum*, showing $7_{\text{II}}+14_{\text{I}}$. ×ca. 900 (M. Tanaka, s. page 21).

Errata of WIS No. 1 and No. 2

WIS No. 1

Page 2, line 22: For "Maliahi", read "Maliani".
〃 3, 〃 5: For "Sanches", read " " Sanchez".
〃 〃 〃 13: For "Tavca", read "Tavča".
〃 12, 〃 13: Cross out "." between "Diploid" and 'species".
〃 17, Table: Transfer "Sitopsis" over "*Ae. speltoides*".
〃 29, line 4: For "resitance", read "resistance".
〃 〃 〃 7: For "reistance", read "resistance".
〃 41, bottom: For "TANKA", read "TANAKA".

WIS No. 2

Page 21, line 8: For "Atai, S." read "Atai, M.".
〃 27, 〃 34: For "106", read "108".
〃 28, 〃 32: Cross out "Sumi-".
〃 29, 〃 8: For "Uppsola", read "Uppsala".
〃 30, 〃 3: Insert "," between "The agenda" and "programme".
〃 〃 〃 4: For "Japan, 1956 have", read "Japan, 1956, have".
〃 31, 〃 8: For "expedition is", read "expedition was".
〃 32, 〃 15: For "List of stock", read "Lists of stocks".
〃 〃 〃 15: Insert "." between "limit" and "No illustra-".
Cover iii, in frame: For "Information in WIS are", read "Information in WIS is".

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