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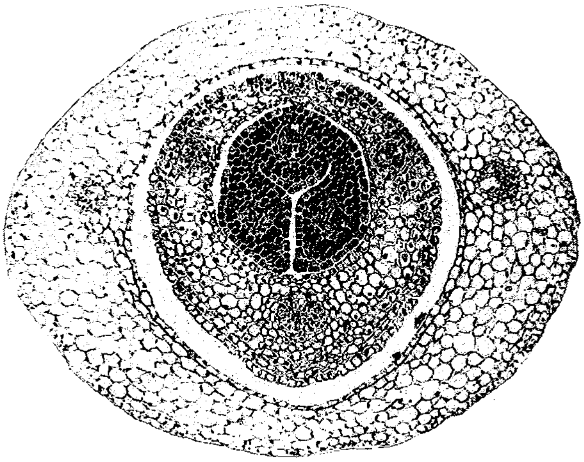

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No. 13 WIS December, 1961

I. Research Notes

Radiation effects of beta- and gamma-rays in *Triticum monococcum*

S. Matsumura
National Institute of Genetics, Misima, Japan

Dormant seeds of *Triticum monococcum flavescens* were soaked in water or ^{32}P and ^{131}I solutions for 1 and 2 days just before sowing. Radioactive solutions contained 0.2$\sim$1.2 mc/gr of ^{32}P and 0.8$\sim$1.6 mc/gr of ^{131}I. To compare the beta-radiation effects of these solutions with those of gamma-rays, the seeds were subjected to chronic gamma-radiation from a ^{60}Co source at 2, 4 and 6 kr during water-soaking. The germination rate, seedling height 4 weeks after sowing, survival rate, mature plant height, seed fertility and chromosome aberrations in PMC's of the treated plants, and the chlorophyll mutations in the X$_2$ were compared. As to the first 5 characters, the effects of beta-radiation from 0.2 mc/gr ^{32}P solution for 2 days corresponded roughly to those of 4 kr gamma-radiation for 2 days, and were slightly higher than those of 1 day beta-radiation from 0.4 mc/gr ^{32}P solution and of 1 day gamma-radiation at 4 kr. Also the effects of 1 day beta-radiation from 0.8 mc/gr ^{32}P solution coincided roughly with those of 6 kr gamma-radiation for 1 day. Further one day beta-radiation from 1.6 mc/gr ^{131}I solution for 1 day was considerably less effective than 2 kr gamma-radiation for 1 day and showed similar effects as 1 day beta-radiation from 0.2 mc/gr ^{32}P solution. In general, the effects of gamma-radiations on chromosome aberrations and gene mutations were unexpectedly small, compared with those of corresponding beta-radiations from ^{32}P and ^{131}I solutions.

If we assume that the effects of beta-radiation are confined to the embryo, we find by calculation that the 0.4 mc/gr ^{32}P solution for 1 day or the 0.2 mc/gr ^{32}P for 2 days equals 5 or 4.8 krad, respectively. This, too, will account for the obtained data.

Preliminary experiments on the relation between dose rate and radiation effect in *Triticum monococcum*

T. Fujii
National Institute of Genetics, Misima, Japan

10 and 20 kr irradiations with three different dose rates were applied to einkorn wheat seeds. The highest dose rate was 1,000 r/min of X-rays and the lowest was 0.75 r/min of 10 kr and 1.5 r/min of 20 kr gamma-radiations. 33 r/min irradiations at 10 and 20 kr were used with X- as well as gamma-rays for the check of RBE differences. Then seedling height, fertility and chlorophyll mutation rate in the X_2-generation were examined (Table 1).

Table 1. Effect of radiations with different dose rates

Dosage (kr)	Dose rate (r/min)	Seedling height (cm)	Fertility in X_1 (%)	Chlorophyll mutations in X_2 (%)
0	—	11.03	66.54	0
10	1,000	8.52	45.89	8.51
	33 (X-ray)	7.20	44.02	5.96
	33 (γ-ray)	8.64	43.94	5.42
	0.75	9.03	58.31	4.14
20	1,000	1.68	died	—
	33 (X-ray)	1.63	13.07	0
	33 (γ-ray)	3.72	30.76	8.19
	1.5	2.97	31.81	4.55

In all irradiated lots the seedlings were shorter and the fertility of the plants was reduced in comparison with the normal lot, this effect being milder in the batch of lowest dose rate than in the other three irradiated lots. 20 kr lot with the highest dose rate was the most severely damaged and all plants died after germination. The differences were not clear between intermediate and highest dose rates, especially at 10 kr.

The higher the dose rate at 10 kr, the higher was the chlorophyll mutation rate in the X_2-generation. This tendency was also observed in 20 kr gamma-irradiations. That no mutation was found at the intermediate X-ray dose rate will be due to the small number of X_2 head progenies. Similar mutation rates were obtained at 10 kr from the intermediate dose rate in X- and gamma-rays. RBE of X- and gamma-rays was about the same as for mutation rates.

Calculation of absorbed dose delivered to wheat seeds soaked in ^{32}P and ^{131}I aqueous solutions

S. Kondo and H. Ishiwa
National Institute of Genetics, Misima, Japan

We have already confirmed that the coast of wheat seeds soaked in ^{32}P or ^{131}I aqueous solutions prevent strongly radioactive isotopes from penetrating into the interior of the seeds at least for one to two days[1]. Therefore the dosimetry of seeds soaked for one or two days can be made with a good accuracy by taking account of the contribution of the isotopes assumed to be homogeneously distributed outside the seeds. Roughly speaking, the dry seeds of *Triticum monococcum flavescens* have an ellipsoidal shape with the three axes 2, 3 and 6 mm long. In this report, however, we will calculate the average embryo dose based on simplified models.

(1) Average embryo dose: Assume that the dose to the embryo of thickness h(g/cm^2) can be approximated by that to surface layer of thickness h of an infinite plane slab made of a tissue-like material with infinite thickness whose plane surface is in contact with an infinite aqueous solution with homogeneously distributed β-emitting isotopes. Then, integrating Loevinger's empirical formula[2], the average dose has been calculated.

(2) Comparison with experimental data: Comparing with Matsumura's[3] data for soaking the seeds in ^{32}P and ^{131}I aqueous solutions for two days and two day exposure of soaked seeds to ^{60}Co γ-rays, we obtain the following table.

Table 1. Comparison of the data of γ-irradiated and ^{32}P or ^{131}I β-rayed experiments with the theoretical estimations

Isotope	mc/ml	Experimental equivalent roentgens (kr)		Calculated equivalent roentgens (kr) embryo dose
		seedling heights	fertility	
^{32}P	0.15	2.6	3.7	3.9
^{32}P	0.30	4.8	4.4	7.8
^{131}I	0.6	1.6	1.9	1.75 (2.00)*

* The figures in the parentheses represent the total exposure doses corrected for γ-rays of ^{131}I.

Considering the partial shielding of β-rays by the proximity of seeds touching each other when they are soaked in the isotope solution in batches of 20 seeds per a gauze puch, from Table 1 we may conclude that the present calculation gives a fairly good estimation of the average embryo dose, because the RBE values of these β-rays relative to ^{60}Co γ-rays will be close to unity.

1) S. Kondo *et al.* Ann. Report, Natl. Inst. Genetics (Japan) No. **8**, 98 (1958).
2) R. Loevinger *et al.* in Radiation Dosimetry (G. J. Hine and G. L. Brownell, ed.) Academic Press. 1956, p. 694.
3) S. Matsumura. Wheat Information Service No. **11**, 12 (1960).
4) S. Kondo. Ann. Report, Natl. Inst. Genetics (Japan) in Japanese, No. **9**, 134 (1959).

Boron effects upon gamma-ray and thermal neutron irradiations in einkorn wheat

S. Matsumura, T. Mabuchi and S. Kondo
National Institute of Genetics, Misima, Japan

As an approach to investigation of boron effects, seeds of *Triticum monococcum flavescens* soaked in water and 0.1, 0.5 and 1.0% aqueous solutions of borax for 2 days were exposed to gamma-rays in our institute and to thermal neutrons in the Japan Atomic Energy Research Institute's Nuclear Reactor, JRR-1. Gamma-irradiation with ^{137}Cs was applied at the dosages of 0.5, 1, 2 and 3 kr. The thermal neutron flux was calculated to be 5.2×10^{9n}th/$\mathrm{cm}^2\cdot$sec when the reactor was operated at 500 watts. The thermal neutron intergrated flux ranged from 1.3 to 10.4×10^{11n}th/cm^2 for 25~200 seconds. Gamma contamination dose rate was 117 r/min. The measurements of thermal neutron fluxes and gamma contamination dosages were made with the use of glass plates with different $AgPO_3$ concentrations.

There was no marked difference in germination rate among gamma-irradiations of different dosages with different concentrations of borax. Only a slight decrease in germination rate was found in thermal neutron treatment at higher dosages, especially with high concentration of borax. The higher the dosage of gamma-rays and thermal neutrons and the concentration of borax, the more reduced was the growth of seedlings and the more increased were mitotic disturbances in the root tips after germination, as could have been expected.

On the mechanism of appearance of *gigas*-plants from nullisomic dwarf wheat

T. Ohta and S. Matsumura
Kihara Institute for Biological Research, Yokohama &
National Institute of Genetics, Misima, Japan

In the offspring of the pentaploid wheat hybrid between *Triticum Spelta* and *T. polonicm* dwarf plants possessing 40 chromosomes (20_{II}) are found. They are nullisomics, deficient in a chromosome pair of the D-genome. As it is the a∼g-chromosome in the D-genome which is missing, they are called a∼g-dwarfs. So-called giant plants of normal height and vigor appear unexpectedly in their selfed progeny. These are respectively called a∼g-*gigas*, according to the original seven different dwarfs, in which the missing D-pair is replaced by the homoeologous A- or B-chromosome pair.

Gigas-plants are assumed to appear from nullisomic dwarf wheat as a result of chromosome aberrations in MI. Various chromosome aberrations in MI and unequal distribution in AI of a∼g-dwarf lines were observed and chromosome aberration rate, theoretical and observed appearance rates of *gigas* were compared for seven dwarf lines. Except the g-dwarf (Dwl. 5), theoretical appearance rates of *gigas* are too small against the observation, amounting to 5∼10%. There are many factors involved, such as competitive fertilizatian, elimination of dwarfs and others. Still more important is the fact that the special chromosomes which are homoeologous to the deficient one, become easily aberrant. In the case of b-warf, the special chromosome is a Sat-chromosome which becomes very often a univalent.

Effects of radiation on the susceptibility of wheat seedlings to leaf rust

K. Katsuya
National Institute of Genetics, Misima, Japan

In *Triticum Spelta*, *T. vulgare* and *T. Timopheevi* a batch of seedlings with 2 leaves was irradiated by X-rays and gamma-rays at 10, 30, 50 and 70 kr. The seedlings were inoculated 1 day and 7 days after irradiation by spraying with an aqueous uredospore suspension (*Puccinia triticina* 21 B) and the effects of radiation on the susceptibility to leaf rust were observed. In the remaining seedlings of the same age the first and second leaves were cut off and the amounts of amino-nitrogen and reducing sugar were measured.

Effects of irradiation on leaf characters, namely stomata size, internal structure and viability, and sporulation capacity on irradiated leaves were examined. Rust susceptibility of irradiated plants (*T. Spelta* and *T. vulgare*) was increased, as compared with the normals. In *T. Timopheevi* that was inoculated 7 days after irradiation, the third leaf was susceptible, while the first and second leaves of the same plants were mostly resistant.

In *T. Timopheevi* seedlings, the amount of amino-nitrogen increased in the seedlings 1 day after irradiation, as compared with that of the normals, while it decreased 7 days after irradiation. The amount of reducing sugar increased in seedlings 1 day and 7 days after irradiation in comparison with the normals. Stomata size and internal structure of irradiated plants (*T. Spelta* and *T. vulgare*) did not change noticeably, as compared with the normals. Effects of irradiation on the viability of leaves were tested; when the growing point suffered radiation damage, the already developed leaves remained longer fresh than those of the normals. The redosori of leaf rust on irradiated *T. vulgare* were larger than on normal plants. Relationships between rust susceptibility and radiation await further experiments.

Triticum dicoccoides in Israel: Notes on its distribution, ecology and natural hybridization

D. Zohary and Z. Brick
Dept. of Botany, The Hebrew University, Jerusalem, Jsrael

That *Triticum dicoccoides* is distributed over large stretches of the hilly country of Israel's Eastern Galilee and also occurs in smaller areas in Samaria and Judaea is already apparent from the classical finds of A. Aaronson. The present report aims at supplying some additional information on several ecological aspects of *T. dicoccoides* in Israel, as well as on its relationships in nature with *T. durum*.

The territory of wild emmer in the Galilee is wider than was reported by Aaronson; it comprises almost the entire area east of a line drawn from the Lebanese border east of Kefar Giladi through Mt. Jermaq near Safad to Mt. Tabor and Afula. The main altitudes at which *T. dicoccoides* occurs in Israel range from sea level to 600 m (in the zone where annual rainfall is from 350 to 800 mm). At higher altitudes stands of *T. dicoccoides* are rare; the most elevated stations so far found are on the eastern slopes of Mt. Jermaq and on Mt. Kenaan, both at an altitude of approximately 800 m. Below sea level it is again rare and occurs only sparsely on the lower (and drier) parts of the slopes facing the Jordan rift valley-usually on north-facing or otherwise favourable sites.

The main habitat occupied by *T. dicoccoides* in Israel is the submediterranean or semi-steppe herbaceous shrub formation. This vegetation type which is characterized by many hemicryptophytic shrub elements and by a rich winter cover of annuals predominates on the basaltic plateaux and hard limestone hills of the Eastern Galilee. Smaller areas of such a herbaceous vegetation are also met with in Samaria. It is in such an open landscape that *T. dicoccoides* is really abundant and continuous in spread, constituting many times—together with *Avena sterilis* and *Hordeum spontaneum*—the main annual grass component of the lush harbaceous cover. It is also here that a wealth of the wild emmer varieties (of the *syrio-palaestinicum* group) can be met with. In contrast to the open semi-steppe vegetation, the truly mediterranean vegetation (i.e. mediterranean " batha " and " garigue ") contains only small and rather sporadic populations of *T. dicoccoides*. Moreover, in the latter wild emmer is restricted to edges of cultivation and other sites where the permanent cover of shrubs has been recently cleared by man. Obviously such localities can hardly be regarded as primary or stable habitats of wild emmer.

Another ecological aspect that needs clarification is the alleged confinement of *T. dicoccoides* to rocky or stony habitats. Vavilov, in particular, has stressed this correlation. To him it represented one of the main objections against considering *T. dicoccoides* a wild progenitor of the cultivated tetraploid wheats. But actually this alleged ecological confinement is not universal. It is observed only in localities subjected to severe overgrazing (as most areas in Middle Eastern countries are!). Yet, where grazing is relatively moderate, large and dense stands of *T. dicoccoides* can grow also in sites where the soil cover is deep and fairly continuous. This is particularly evident in the Eastern Galilee, where grazing practices have undergone a drastic change since 1948 and where a spectacular come-back of annual and perennial grass elements can be observed. The withdrawal of *T. dicoccoides* to rocks and stones under severe grazing parctices can be explained on a basis of the seed dispersal habits of this wild wheat. *T. dicoccoides* is a trypanocarpous plant, i.e. specialized to insert its arrow-shaped spikelets into the ground. The survival of wild emmer under natural conditions is apparently largely dependant on this ability, as is that of *Hordeum spontaneum*, *Avena sterilis* and several other annuals of the semi-steppe formation (Zohary 1960)1). In stoneless sites with a continuous soil cover, the burial of spikelets depends to a large extent on the presence of drying stalks and organic residue. When this cover is largely removed by excessive grazing, and when the bare soid surface is further hardened by continuous trampling, there is little chance for the arrow-like device of the spikelet to function effectively and to insert the seed in the soil. Among rocks and stones, however, such fruit burial is

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1) Zohary, D. Studies on the origin of cultivated barley. Bull. Res. Counc. Israel, Vol. 9D, No. 1, pp. 21-42, 1960.

easily achieved even under severe grazing and is independant of a lush cover of organic matter.

Hybrid swarms between *T. dicoccoides* and *T. durum*, as well as highly introgressed *dicoccoides* populations have been encountered in several localities in the semi-steppe hilly area of the Eastern Galilee. From our observations they are restricted to edges of cultivation and otherwise much disturbed ground on sites where cultivated hard wheat is grown in close proximity to pure populations of wild emmer. A well developed hybrid swarm (comprising several thousands of plants) was examined in detail in spring 1961 near Amiad (on the Tiberias-Safad road). It occupied the edge of a newly constructed stone terrace and the stone heaps on the margin of a field that had been cleared for cultivation several years previous. On the adjacent undisturbed hillsides pure populations of *T. dicoccoides* were growing in abundance. The swarm included many brittle *dicoccoides*-like plants, a few plants with a tough rachis identified as the local *T. durum* variety "Etit" (with which the field had been sown 3-4 years previously), and a whole range of intermediates. These exhibited a wide diversity of character recombinations ranging from lax to semi-dense ears, from narrow shaped to broad, 3-kernelled spikelets, from densely hairly rachis internodes to sparsely hairy ones—as well as wide variability in the amount of glume, pale and awn scabrosity and keel development. Types most indicative of the process of hybridization were the following recombinants: a) forms with free-threshing grains and a brittle rachis; b) forms with free-or almost free-threshing grains but an emmer-like tough rachis; c) forms with hulled or semi-hulled grains in addition to emmer-like disarticulation. Most of the intermediates and recombinants were fully or almost fully fertile.

Such hybrid swarms, as well as the ecological conditions under which they occur, resemble the situation found in Israel also in the case of *Hordeum spontaneum* and *H. sativum*. They indicate that *T. dicoccoides* and cultivated *T. durum* cannot be regarded as entirely isolated from each other. Most probably they are genetically interconnected through occasional hybridization. This type of introgression might account for a considerable part of the parallel variation found among wild and cultivated forms of tetraploid wheats in the "Fertile Crescent" of the Middle East, as well as for the origin of many of the *dicoccoides*-like varieties of the local cultivated hard wheats. Such forms are thus not necessarily "primitive" relics, but are possibly secondary products of a fairly recent hybridization.

Karyotype of *Triticum zhukovskyi* Men. et Er.

M. Upadhya and M.S. Swaminathan
Division of Botany, Indian Agricultural Research Institute, New Delhi, India

V.L. Menable and A. Eritzan described in 1957 a new hexaploid species ($2n=42$) named *T. zhukovskyi.* This species occurs in Western Georgia in the same habitat as the tetraploid *T. timopheevi.* According to Jakubziner (Proc. 1st International Wheat Genetics Symposium, 1958, pages 207–220), *T. zhukovskyi* resembles *T. timopheevi* in ear morphology and growth characteristics and may have been derived from it. During a comparative study of the karyotypes of all hexaploid *Triticum* species, we found that *T. zhukovskyi* has a pair of satellited chromosomes possessing a supernumerary constriction of the type found in *T. macha* Dek. et Men. by Bhaduri and Ghosh (Cytologia *20*, 148-149, 1955). The secondary constriction and supernumerary constriction are separated from each other by a minute chromosome segment. The pair of Sat-chromosomes with supernumerary constriction present in *T. zhukovskyi* resembled one such pair in *T. macha* with regard to relative length and index value (short arm/long arm). While two such pairs occur in *T. macha* only one pair was found in *T. zhukovskyi.*

T. macha also occurs in Western Georgia and Jakubziner believes that it might have arisen from the tetraploid species, *T. paleocolchicum* Men. The type of Sat-chromosomes with supernumerary constrictions found in *T. macha* and *T. zhukovskyi* has not so far been found in any other hexaploid *Triticum* species. We hence feel that these two species may be derived from a common stock.

Macro-mutations and sub-specific differentiation in *Triticum*

M. S. Swaminathan and M. V. P. Rao
Division of Botany, Indian Agricultural Research Institute, New Delhi, India

The genus *Triticum* offers interesting examples of the role of macro-mutations which at one step lead to the origin of taxonomic categories higher than varieties. As is well known, the speltoid suppressor factor *Q* located on the long arm of chromosome 5A, which must have arisen as a mutation in a non-free threshing tetraploid wheat, has played a dominant role in the evolution of bread wheat. The *Q* factor not only inhibits spelting but also brittleness of rachis, a development of obvious importance in cultivated forms (Mac Key, Genetica Agraria *12*, 210–30, 1960). In addition, it inhibits various classes of spikelet sterility (Frankel and Munday, WIS **11**, 1–2, 1960) and serves as a suppressor of vavilovoid expression (Swaminathan and Rao, unpublished). Another remarkable mutation, the multivalent suppressor gene (see Riley, Heredity **15**, 407–29, 1960), which along with *Q* has shaped the destiny of emmer and bread wheats, as interestingly enough taken place in the long arm of chromosome 5B.

In the *Tritium* group with 2n=42, the following seven species have been described.

Free-threshing: *T. aestivum* L.
T. sphaerococcum Perc.
T. compactum Host.

Spelt: *T. spelta* L.
T. macha Dek. et Men.
T. vavilovi Jakub.
T. zhukovskyi Men. et Er.

From the work of Nilsson-Ehle, Ellerton, Sears, Unrau and Mac Key, it is now well known that *T. compactum*, *T. sphaerococcum* and *T. spelta* are each separated from *T. aestivum* by a single gene: *C* located on chromosome 2D, *S* on 3D and *Q* on 5A respectively. A whole set of characters are controlled by each of these loci with the result that though genetically they should all be regarded as members of one species (see Mac Key, Sv. Bot. Tidskr. **48**, 579–590, 1954), taxonomists have described them as independent species.

We have studied the inter-relationships among the hexaploid *Triticum* species in two ways. First, a set of diallel crosses among these species was made and F_1, F_2 and F_3 progenies were studied both cytologically and genetically. Secondly, all the species were treated with mutagens and mutations of phylogenetic interest occurring in the M_2 and subsequent generations were studied. The data, in addition to revealing what is already known, have provided the following information.

(1) *T. sphaerococcum* could not have arisen through a deletion from *T. aestivum* as suggested by Ellerton since *aestivum* mutations readily occur in *sphaerococcum*. The *sphaerococcum* locus, which tends to behave as one unit in recombination, can be broken up by irradiation resulting in phenotypes lacking the compact growth habit and rigidity of leaves but possessing hemispherical glumes and spherical grains.

(2) The compactum locus *C* behaves in every way like *S* in mutation experiments.

(3) The gene controlling vavilovoid expression (i.e., elongation of rachillae) is also situated on the long arm of chromosome 5A between *q* and the awn inhibitor B_1. Vavilovoid expression is suppressed by *Q*; as a result, a vavilovoid mutant can occur in a free-threshing wheat (either tetraploid or hexaploid) only in conjunction with speltoidy. In crosses between *T. aestivum* and *T. vavilovi*, segregation would hence occur both for *Q* and *V* (gene for vavilovoid expression). This explains the 15:1 segregation

found by Singh, Anderson and Pal (Agronomy J. **49**, 4–11, 1957) in the crosses *T. aestivum* × *T. vavilovi* and *T. sphaerococcum* × *T. vavilovi*.

(4) As suggested by Kihara (Proc. First Int. Wheat Genetics Symposium, pages 243–248, 1959), *T. macha* has genes for both compactness of the spike and for spelting. The compacting gene of *macha* seems to be homologous with the *C* gene of *compactum*. *q* and *c* can be independently removed from *macha* resulting respectively in dense-eared and lax-eared types.

(5) The basic morphological frame of hexaploid wheats consists of two types: (a) the *aestivum sensu stricto* type and (b) the *spelta* type. From the former, *compactum* and *sphaerococcum* have developed through macromutations in chromosomes 2 D and 3 D and from the latter *vavilovi* has developed through a recessive mutation in chromosome 5A. *T. macha* and *T. zhukovskyi* appear to have genes from both these groups.

In view of the fact that the key characteristics separating the 42-chromosome *Triticum* species are controlled only by 1 or 2 genes, all of them can be considered as subspecies of *T. aestivum* L., as suggested by Mac Key. A similar situation probably prevails in the tetraploid group. The important role that macromutations appear to have played in the differentiation of the tetraploid and hexaploid species of *Triticum* suggests that this means of variation may be a potent factor in the diversification of polyploids.

An attempt to induce tetraploids with AABB from Japanese wheat varieties with AABBDD

I. Nishiyama

Faculty of Agriculture, Kyoto University, Kyoto, Japan

This paper is a preliminary note on the analysis of genome differentiation in Japanese common wheat varieties having the genome formula AABBDD.

Two wheat varieties, Shinchunaga and Igachikugo, were crossed with pollen of *Triticum* polonicum having AABB. In 1952 the pentaploid F_1 hybrids were grown and their progenies especially those having 14 bivalents were raised in the successive generations through self-pollination. In some cases the hybrid derivatives were backcrossed with the common wheat parent and their backcrossed progenies showing 14 bivalents were grown in the subsequent generations. In addition to the chromosome number the hybrid derivatives were selected on the basis of their morphology, and only plants which were less like *T. polonicum* were growon in the next generation. In 1959–60 the characteristics of hybrid derivatives with 14 bivalents were investigated in comparison with those of their parents, and the following can be said.

(1) Out of 21 characters investigated 8-14 seem to have been derived from the common wheat, 7-13 from *T. polonicum* or a part of them probably from AB genomes of the common wheat, and 0-1 is common with both parents.

(2) Most of tetraploid derivatives from the cross where Shinchunaga was used as one of the parents, showed a high sterility.

(3) Chromosome configurations at meiosis in tetraploid derivatives were usually quite normal, but $1_{IV}+12_{II}$ were observed in backcross F_1 hybrids between *T. polonicum* and one tetraploid line from the original hybrid Igachikugo × *T. polonicum.*

(4) Dwarf or rosette-type plants were found in a progeny of the original hybrid, Igachikugo × *T. polonicum*, and they behaved as simple recessive Mendelian characters.

(5) The author never found any tetraploid derivatives which were similar to *T. dicoccoides.* This fact suggests that *T. dicoccoides* was not the ancestral plant of Japanese common wheats.

Lethality and dwarfness of the hybrids between Emmer and synthesized 6x wheats (Preliminary report)

K. Nishikawa
Laboratory of Genetics and Plant Breeding, Gifu University, Gifu, Japan

Crosses between synthesized 6x wheats, ABD No. 1, ABD No. 2 and ABD (Sears),* and Emmer wheats (including 20 varieties) were made. In the hybrids with ABD No. 1, various degrees of abnormalities such as lethality, semi-lethality and dwarfness occurred, depending upon which variety of Emmer wheats was used for crossing. With ABD No. 2, only normal hybrids were produced no matter which Emmer wheat was a pollen parent. When crossed to ABD (Sears), some of Emmer wheats which gave rise to lethal hybrids with ABD No. 1, showed again lethality. Hybrid lethality and semi-lethality mentioned here were caused by necrosis due to complementary action of genes, which appeared at a definite growth stage. One of those genes was brought from Emmer wheats and the other from D gnome of synthesized 6x wheats.

On the basis of abnormality of their hybrids with three strains of synthesized 6x wheats, 20 varieties of Emmer wheats can be classified into 5 groups as shown in Table 1.

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* ABD No. 1 and No. 2 were synthesized by Kihara et al. (1950) from *T. dicoccoides spontaneonigrum* × *Ae. squarrosa typica* No. 2 and *T. durum coerulescens* × *Ae. squarrosa typica* (No. 1 × No. 2) F_1, respectively.

ABD (Sears) was synthesized by Dr. E. R. Sears from *T. dicoccum* (Vernal) × *Ae. squarrosa.*

Table 1. 5 groups into which 20 varieties of Emmer wheats can be classified, and their representative varieties.

Group	Abnormal with	Representative variety
1. normal	——	*T. dicoccoides spontaneo-nigrum*
2. dwarf	ABD No. 1	*T. dicoccum* (Vernal)
3. semi-lethal	〃	*T. durum Reichenbachii*
4. lethal (I)	〃	*T. dicoccum liguliforme*
5. lethal (II)	ABD No. 1 (Sears)	*T. dicoccum arras* (Khapli)

Three way crosses were made between ABD No. 1 and each of the F_1 Emmer hybrids which represented 5 out of 10 possible combinations among 5 representative varieties shown in Table 1. Rates of the survival plants, rates of necrotic plants, culm length, culm number and dry weight per mature plant in these triple hybrid strains are shown in Table 2.

Table 2. Some characteristics of the hybrid strains raised by three way crosses between ABD No. 1 and F_1 Emmer hybrids.

No. strain	Emmer hybrid	Rate of surviv.	Rate of necrotic.	Culm length (cm)	Culm number	Dry weight (g)
1	(1)×(2)*	100.0%	0.0%	36.5±5.53**	39.1±6.52**	18.6±4.25**
2	(1)×(3)	60.9	49.4	43.8±1.85	24.6±2.21	25.7±3.13
3	(1)×(4)	70.2	41.6	52.3±1.99	25.4±1.95	31.5±3.44
4	(1)×(5)	38.7	80.7	37.0±2.92	22.0±3.80	17.1±3.77
5	(2)×(4)	83.7	57.1	33.0±1.54	33.3±2.58	26.2±1.28

* (1), (2),....shows a representative variety of group 1, 2,.... in Table 1, respectively.

** $\bar{x}\pm s_{\bar{x}}$

No lethal plant and no necrotic one arose in strain 1. Rates of the survival plants were much over than 50% in strain 2, 3 and 5, while that in strain 4 was below 40%. Rates of necrotic plants proved to be below those of the survivals in every strain, because three survived some portion of necrotic ones in addition to all the normal plants. The ratio of necrotic to normal is not different significantly from 1:1 in strain 2, 3 and 5, and from 3:1 in strain 4. Accordingly, it may be concluded that Emmer hybrids, (1)×(3), (1)×(4) and (2)×(4) are mono-hybrid, while (1)×(5) is di-hybrid, for necrosis gene. With culm length, culm number and dry weight per mature plant, there were observed continuous variation, which covered a considerably wide range, in every strain.

II. Genetic Stocks

Seed collections of *Aegilops, Triticum* and *Secale*

D. Zohary, M. Feldman, and Z. Brick

Department of Botany
The Hebrew University of Jerusalem, Israel

Aegilops bicornis (Forsk.) Jaub et Sp. *typica* Eig	*Israel,* 2 km east of Magen, northwestern Negev, D. Zohary & D. Imber 17. 4. 1961, no. 2
〃	*Israel,* 4 km southeast of Magen, northwestern Negev. D. Zohary & D. Imber 17. 4. 1961, no. 5
〃	*Israel,* 2 km east of Dimona, central Negev D. Imber 11. 5. 1961, No. 2
Aegilops bicornis (Forsk.) Jaub et Sp. var. *mutica* (Aschers.) Eig	*Israel,* Nirim road, northwestern Negev. D. Zohary & D. Imber 17. 4. 1961, no. 4
Aegilops biuncialis Vis.	*Greece,* Athens-Thebes road. D. Zohary 10. 9. 1959, km 42861 (mixed sample containing *Ae. ovata* and *Ae. triuncialis*)
Aegilops biuncialis Vis. var. *typica* Eig.	*Israel,* Jerusalem. M. Feldman 9. 6. 1959, no. 4
Aegilops biuncialis Vis. var. *macrochaeta* (Shuttl. et Huet) Eig	*Turkey,* 4km south of Ayvalik, Western Turkey. D. Zohary 12. 8. 1959, km 35857 (sample containing intermediates between *Ae. biuncialis, Ae. ovata* and *Ae. triuncialis*).
Aegilops biuncialis Vis. var. *macrochaeta* (Shuttl. et Huet) Eig	*Turkey,* 4 km west of Balikesir. D. Zohary 12. 8. 1959, km 35698 (sample containing intermediates with *Ae. triuncialis*)
Aegilops caudata L.	*Turkey,* 32 km south of Denizli. D. Zohary 14. 8. 1959, km 36384 (mixed sample of vars. *polyathera* and *typica*)
Aegilops columnaris Zhuk.	*Iran,* 80 km east of Kermanshah. D. Zohary 2. 9. 1960, km 15522
〃	*Turkey,* 30 km southwest of Malatya. D. Zohary 26. 8. 1959, km 39218
〃	*Turkey,* 34 km southwest of Malatya. D. Zohary 26. 8. 1959, km 39222
〃	*Turkey,* Akdag, pass, 73 km southwest of Ma-

	latya. D. Zohary 26. 8. 1959, km 39261
Aegilops crassa Boiss. var. *typica* Eig	*Iran*, 80 km east of Kermanshah. D. Zohary 2. 9. 1960, km 15522
Aegilops cylindrica Host. var. *typica* Eig	*Iran*, Hamadan. D. Zohary 2. 9. 1960
Aegilops kotschyi Boiss. var. *palaestina* Eig	*Israel*, betw. Omer and Lahav, 20 km north of Beersheba. D. Zohary & M. Feldman 26. 6. 1959, no. 8
〃	*Israel*, Gilat, 20 km northwest of Beersheba. D. Zohary & M. Feldman 26. 6. 1959, no. 4
〃	*Israel*, Tel Yeroham, central Negev. D. Zohary & D. Imber 30. 4. 1961, no. 1
Aegilops ligustica Coss.	*Israel*, 3 km east of Acre. D. Zohary & D. Imber 21. 6. 1961, no. 2
〃	*Israel*, near Ashdod, Coastal Plain. D. Zohary & M. Feldman June 1959, no. 2
〃	*Turkey*, 37 km southwest of Malatya. D. Zohary 26. 8. 1959, km 39221
〃	*Turkey*, 33 km southwest of Malatya. D. Zohary 26. 8. 1959, km 39221
〃	*Turkey*, 37 km south of Maras. D. Zohary 27. 8. 1959, km 39484
Aegilops longissima Schweinf. et Muschl.	*Israel*, Beit Lidd-Natanya road, Sharon Plain. D. Zohary 13. 6. 1958
〃	*Israel*, 3 km east of Ashqelon, Coastal Plain. D. Zohary & M. Feldman 10. 7. 1959, no. 3
〃	*Israel*, betw. Omer and Lahav, 20 km north of Beersheba. D. Zohary & M. Feldman 26. 6. 1959, no. 2
〃	*Israel*, Gilat, 20 km northwest of Beersheba. D. Zohary & M. Feldman 26. 6. 1959, no. 1
〃	*Israel*, 1 km north of Dimona, central Negev. D. Zohary & D. Imber 17. 4. 1961, no. 7
Aegilops longissima Schweinf. et Muschl. × *Ae. sharonensis* Eig	*Israel*, near Ra'anana, Coastal Plain. D. Zohary & M. Feldman 3. 5. 1960, no. 2 (intermediates from spontaneous hybrid swarm)
Aegilops mutica Boiss.	*Turkey*, Ankara-Cankiri road, 1 km north of Candir road intersection. D. Zohary 20. 8. 1959,

	km 37802 (mixed sample of vars. *loliacea* and *typica*, with intermediates)
〃	*Trukey*, 40 km north of Malatya. D. Zohary 25. 8. 1959, km 39136
Aegilops ovata L. ssp. *eu-ovata* Eig	*Israel*, Jerusalem-Beit Hakerem. M. Feldman 10. 7. 1960, no. 1 (variable sample)
〃	*Israel*, Rehovot, Coastal Plain. M. Feldman 15, 7. 1960, no. 5
〃	*Turkey*, 20 km south of Yalova 70 km southeast of Istanbul. D. Zohary 10. 8. 1959, km 35379
〃	*Turkey*, 5 km south of Bursa. D. Zohary 11. 8. 1959, km 35449
Aegilops sharonensis Eig var. *typica* Eig	*Israel*, Acre Plain. D. Zohary, Z. Brick & M. Feldman 19. 5. 1961, no. 4
〃	*Israel*, Dor, northern Coastal Plain. D. Zohary & Z. Brick 4. 8. 1961, no. 1
〃	*Israel*, Qeisari (Cesarea) Sharon Plain. D. Zohary 22. 10. 1958
〃	*Israel*, near Even Yehuda, Sharon Plain. D. Zohary, Z. Brick & M. Feldman 4. 5. 1961, no. 1
〃	*Israel*, 7 km southwest of Rishon LeZion. Coastal Plain. D. Zohary & D. Imber 21. 5. 1961, no. 1
〃	*Israel*, Ashdod. Coastal Plain. D. Zohary & D. Imber 21. 5. 1961, no. 3
Aegilops speltoides Tausch var. *typica* Eig	*Israel*, 3 km east of Acre. D. Zohary & D. Imber 21. 6. 1961, no. 1
〃	*Israel*, Technion campus, Haifa. D. Zohary summer 1957
〃	*Israel*, Ashdod, Coastal Plain, D. Imber 4. 6. 1961, no. 4
〃	*Israel*, 4 km east of Ashquelon, Coastal Plain. D. Zohary & M. Feldman 10. 7. 1959, no. 1
Aegilops speltoides Tausch var. *typica* Eig	*Turkey*, 32 km southwest of Malatya. D. Zohary 26. 8. 1959, km 39220
〃	*Turkey*, 34 km southwest of Malatya. D. Zohary 26, 8. 1959, km 39222

Aegilops speltoides Tausch var. *polyathera* Eig	*Turkey*, 32 km southwest of Malatya. D. Zohary 26. 8. 1959, km 39220 (mixed sample containing also var. *typica*)
〃	*Turkey*, 60 km northwest of Gaziantep. D. Zohary 27. 8. 1959, km 39600
Aegilops squarrosa L. ssp. *eu-squarrosa* Eig var. *meyeri* Griseb.	*Iran*, 60 km southeast of Challus, Elburz Mountains. D. Zohary 16. 8. 1960
Aegilops triaristata Willd.	*Turkey*, 14 km west of Bolu. D. Zohary 2. 9. 1959
〃	*Turkey*, 17 km south of Yalova 70 km southeast of Istanbul. D. Zohary 10. 8. 1959, km 35397
〃	*Turkey*, 25 km north of Bursa. D. Zohary 10. 8. 1959, km 35418
Aegilops triaristata Willd.	*Turkey*, 5 km south of Bursa. D. Zohary 11. 8. 1959, km 35449 (mixed sample containing types with hairy and with glabrous spikelets)
Aegilops triaristata Willd.	*Turkey*, near Karacabey on Bursa-Balikesir road. D. Zohary 11. 8. 1959, km 35549
〃	*Turkey*, 6 km east of Balikesir. D. Zohary 12. 8. 1959, km 35700
〃	*Turkey*, 8 km north of Ankara. D. Zohary 20. 8. 1959, km 37716
Aegilops triuncialis L.	*Iran*, 10 km east of Kazvin. D. Zohary 3. 9. 1960, km 12931 (mixed sample of ssp. *eu-triuncialis* and ssp. *orientalis*)
Aegilops triuncialis L. ssp. *eu-triuncialis* Eig.	*Iran*, between Khurramabad and Kermanshah. D. Zohary, 1. 9. 1960, km 12248
〃	*Turkey*, 20 km south of Yalova 70 km southeast of Istanbul. D. Zohary 10. 8. 1959, km 35379
〃	*Turkey*, Karacabey. between Bursa and Balikesir. D. Zohary 11. 8. 1959, km 35594
〃	*Turkey*, 6 km west of Balikesir. D. Zohary 12. 8. 1959, km 35700
〃	*Turkey*, 20 km southwest of Malatya. D. Zohary 26. 8. 1959, km 39208
〃	*Turkey*, 25 km southwest of Malatya. D. Zohary 26. 8. 1959, km 39213
〃	*Turkey*, 97 km northwest of Gaziantep. D.

	Zohary 27. 8. 1959, km 39496
Aegilops triuncialis L. ssp. *orientalis* Eig	*Iran*, 80 km east of Kermanshah. D. Zohary 2. 9. 1960, km 15522
〃	*Iran*, between Kazerun and Shiraz. D. Zohary 27. 9. 1960, km 10681
Aegilops umbellulata Zhuk.	*Iran*, 80 km east of Kermanshah. D. Zohary 2. 9. 1960, km 15522
〃	*Iran*, 2 km northeast of Shiraz. D. Zohary 30. 8. 1960, km 11278
〃	*Iran*, between Shiraz and Kazerun. D. Zohary 27. 8. 1960, km 108607
〃	*Turkey*, near Ankara. M. Zohary July 1953
〃	*Turkey*, 34 km southwest of Malatya, D. Zohary 26. 8. 1959, km 39222
〃	*Turkey*, Akdag pass, 73 km southwest of Malatya. D. Zohary 26. 8. 1959, km 39621
Aegilops variabilis Eig. ssp. *cylindrostachys* Eig et Feinbr.	*Israel*, 10 km east of Rehovot, Coastal Plain, D. Zohary summer 1958
〃	*Israel*, 6 km north of Ashqelon, Coastal Plain. D. Zohary & M. Feldman 11. 12. 1959, no. 1
〃	*Israel*, 3 km east of Ashqelon, Coastal Plain. D. Zohary & M. Feldman 10. 7. 1959, no. 5
〃	*Israel*, between Ashqelon and Beit Guvrin, Coastal Plain. D. Zohary & M. Feldman 10. 7. 1959, no. 6
Aegilops variabilis Eig. ssp. *euvariabilis* Eig et Feinbr.	*Israel*, Rosh Pinna, Upper Galilee. D. Zohary summer 1958
〃	*Israel*, Jerusalem. M. Feldman 9. 6. 1959, no. 1
Aegilops variabilis Eig	*Israel*. Rehovot, Coastal Plain. M. Feldman 15. 7. 1960, no. 1 (sample containing ssp. *euvariabilis* and awned forms of ssp. *cylindrostachys*)
Aegilops variabilis Eig ssp. *euvariabilis* Eig et Feinbr.	*Israel*, 4 km east of Ashqelon, Coastal Plain. D. Zohary and M. Feldman 10. 7. 1959, no. 4
〃	*Israel*, between Lahav and Devira, 35 km northwest of Beersheba. D. Zohary & M. Feldman 26. 6. 1959, no. 5
Triticum boeoticum Boiss. ssp.	*Turkey*, 4km south of Ayvalik, Western Turkey.

aegilopoides (Link) Schiem.	D. Zohary 12. 8. 1959, km 35857
〃	*Turkey*, 4 km south of Beysehir. D. Zohary 17. 8. 1959, km 37103
Triticum boeoticum Boiss. ssp. *thaoudar* (Reuter) Schiem.	*Iran*, between Kermanshah and Khurramabad. D. Zohary 1. 9. 1960, km 12251
〃	*Turkey*, Ankara. M. Zohary July 1953
〃	*Turkey*, near Kangal, 80 km south of Sivas. D. Zohary 25. 8. 1959, km 39008
〃	*Turkey*, 25km southwest of Malatya. D. Zohary 26. 8. 1959, km 39213
〃	*Turkey*, 30 km southwest of Malatya. D. Zohary 26. 8. 1959, km 39218
Triticum dicoccoides Koern.	*Israel*, Meiron, Mt. Jermaq, Upper Galilee. D. Zohary & Z. Brick 18. 5. 1961, no. 1 (mixed sample containing varis. *aaronsohni*, *kotschyanum* and *spontaneonigrum*, as well as intermediate types)
Triticum dicoccoides Koern. var. *aaronsohni* Perc.	*Israel*, Rosh Pinna, eastern Galilee. D. Zohary & Z. Brick 5. 5. 1961, no. 10
Triticum dicoccoides Koern. var. *kotschyanum* Perc.	*Israel*, Rosh Pinna, eastern Galilee. D. Zohary & Z. Brick 5. 5. 1961, no. 11
Triticum dicoccoides Koern.	*Israel*, Rosh Pinna, eastern Galilee. D. Zohary and Z. Brick 5. 5. 1961, no. 12 (mixed sample of vars. *aaronsohni*, *kotschyanum*, *spontaneonigrum* and intermediate types)
Triticum dicoccoides Koern. var. *kotschyanum* Perc.	*Israel*, 7 km south of Ammiad, eastern Galilee. D. Zohary and Z. Brick, 5. 5. 1961, no. 1
Triticum dicoccoides Koern. var. *fulvovillosum* Perc.	*Israel*, 7 km south of Ammiad, Eastern Galilee. D. Zohary & Z. Brick 5. 5. 1961, no. 3
Triticum dicoccoides Koern.	*Israel*, 7 km south of Ammiad, eastern Galilee. D. Zohary & Z. Brick 5. 5. 1961, no. 5 (mixed sample of vars. *fulvovillosum*, *kotschyanum*, *spontaneonigrum* and intermediate types)
Triticum dicoccoides Koern.	*Israel*, Jerusalem. M. Feldman 9. 6. 1959 (mixed sample of vars. *kotschyanum*, *spontaneonigrum* and intermediate types)
Secale ancestrale Zhuk.	*Turkey* 15 km east of Aydin. D. Zohary 14. 8. 1959, km 36179

Secale cereale L.	*Turkey*, 56 km south of Sivas. D. Zohary 25. 8, 1959, km 38980
〃	*Turkey*, 67 km south of Sivas. D. Zohary 25. 8. 1959, km 38993
〃	*Turkey*, Malya Agric. Station near Kirsehir. D. Zohary 30. 8. 1959
〃	*Turkey*, 10 km northeast of Beysehir. D. Zohary 17. 8. 1959, km 36877
Secale montanum Guss.	*Iran*, Karaj-Challus road, Elburz Mountains. D. Zohary 15. 8. 1960
〃	*Turkey*, 25–28 km south of Tokat. D. Zohary 24. 8. 1959, km 38829
〃	*Turkey*, 4 km north of Deliktas, 60 km south of Sivas. D. Zohary 25. 8. 1959, km 38974
〃	*Turkey*, Goeroeme Valley near Nevsehir. D. Zohary 29. 8. 1959, km 40122
〃	*Turkey*, Irmasan pass, near Anseki, Taurus Mountains between Manavgat and Beysehir. D. Zohary 16. 8. 1959, km 36979

III. Editorial Remarks

Communication

I have read with great interest your articles in Wheat Information Service on the Exploration Results of the BMUK 1959. The article in the last issue (No. 12) by you and Dr. Tanaka was of particular interest because it discusses points of collection of many species of *Aegilops* in Eastern Mediterranean countries. I have been studying the reaction of species of *Aegilops* to physiologic races of leaf rust.

Toward the end of your article you discuss *Aegilops cylindrica* from Turkey and mention two varieties-a-long-awned and an awnless or few-awned form. As you probably know, *Ae. cylindrica* has become a weed in Kansas since 1918. It apparently was introduced from Russia as a mixture in the hard red winter wheat variety Turkey. There are two varieties of it, one of which has scabrous glumes, while the other has pubescent glumes. They may grow intermixed or separately. In places the grass is so abundant that roadsides are almost a solid stand of it for long distances. It invades the edges and corners of wheat fields and may become a troublesome weed. Both varieties cross readily with common wheat although F_1 plants nearly always are sterile. The heads of F_1 plants disarticulate at the base, falling away entire instead of spikelet by spikelet as in the two varieties.

I would classify both varieties as awned, although both have long apical awns and shorter awns on lower spikelets. Both varieties tiller very abundantly, are very winter hardy, and make excellent grazing for livestock. I assume that the varieties that came from Russia are no different from those you found in Turkey.

August 3, 1961

C. O. Johnston
Professor of Botany
Kansas State University
Manhattan, Kansas, U.S.A.

Correction

In the article of J. G. Th. Hermsen—"The symbolization of complementary necrosis genes in wheat: a proposal"—in WIS No. 12, the last 7 lines in page 23 should be crossed out, so that the article ends with the sentence—"Finally the symbol *Ne* can cause no confusion with other symbols, as far as the author is aware."

Announcement for further issues

WIS No. 14 will be ready for publication in February, 1962 with manuscripts in hand. Manuscripts for further issues are accepted any time. WIS is open to all contributions regarding methods, materials and stocks, ideas and research results related to genetics and cytology of *Triticum*, *Aegilops*, *Agropyron*, *Secale* and *Haynaldia*.

The manuscripts should not exceed 3 printed pages. List of stocks are not required to conform to this page limit. No illustrations are accepted for publication.

Communications regarding editorial matters should be addressed to:

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

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The Managing Editor

Coordinating Committee

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Explanation of the Figure on the Cover

A cross section of a germ of an X-ray induced mutant of *Triticum monococcum* having coleoptile-like fused primary leaf (K. Yamashita).

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