Copy:

United States Deptt. of Agriculture
Agricultural Res. Service
Crops Research Division
October 18, 1963.

Stated University Station,
Fargo, North Dakota.

AIR MAIL

Dr. M. S. Swaminathan,
Divn. of Botany, I.A.R.I.,
New Delhi-12.

Dear Dr. Swaminathan,

You mentioned at the Wheat Genetics Symposium in Lund that you would like to have seed of stem rust resistant durums. I have sent packets of seed of 14 varieties to Dr. J. C. Craddock, Beltsville, Maryland, who will handle inspection of the seed and will forward the seed to you by air. The varieties I have sent are listed as follows:

1) Wells
2) Lakota
3) Yuma
4) Ramsey
5) Langdon
6) Golden Ball
7) P.I. 192179
8) C.I. 7805
9) ST.464
10) C.I.3255
11) P.I. 94701
12) P.I. 192168
13) C.I. 8155
14) Khapli emmer.

The first five varieties were developed at North Dakota, but the remaining ones were selected from the World Collection of Wheat. These varieties are resistant or partially resistant to the races of rust prevalent in the durum gorwing area of North America. Khapli emmer was the main source of resistance for Wells, Lakota, Langdon and Yuma. None of these 4 varieties possess all of the Khapli resistance genes. P.I.94701 was the source of resistance for Ramsey. Golden Ball and C.I.3255 probably have the same major gene for resistance as P.I.94701. ST.464, P.I.192179, C.I. 8155 and C.I. 7805 are similar in resistance and each have at least 2 major genes which provide us with a high degree of resistance. P.I. 192168 probably has a resistance gene different from any of those represented in the other 13 varieties. I would be greatly interested in hearing from you how these varieties perform in your area, especially with respect to resistance to stem rust.

It was a great pleasure for me to meet you and talk with you at the meetings. I hope the seed will reach you in time for planting.

Sincerely yours,

Sd/- Norman D. Williams,
Geneticist.

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THE SECOND INTERNATIONAL WHEAT GENETICS SYMPOSIUM, LUND.

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The recent progress in wheat genetics was surveyed. at the Second International Wheat Genetics Symposium held at the Genetics Institute, University of Lund, Sweden, from August 19-24, 1963. There were 8 sessions in all dealing with quality, plant breeding methods, disease resistance, taxonomy and phylogeny, amphiploids, aneuploidy and cytogenetic structure as applied to wheat. The speakers in the first seven sessions had all been chosen by an International Organizing Committee and there were no contributed papers in these sessions. From the papers offered voluntarily by different contributors ten were chosen for oral presentation at the last session. There was a business meeting on August 24, 1963, to decide upon the venue and date for the next International Wheat Genetics Symposium. It was decided to hold the next Symposium in Australia just before the 12th International Congress of Genetics which is scheduled to be held in Japan in 1968. A new International Wheat Research Co-ordination Committee comprising Prof. J. Mac Key of Sweden (Chairman), Dr. E.R. Sears (United States), Dr. D.R. Knott (Canada), Dr. R. Riley (U.K.), Dr. A.T. Pugsley (Australia), Dr. T. Matsumura (Japan) and Dr. M.S. Swaminathan (India) was constituted to plan and organise the next International Wheat Genetics Symposium.

There were 201 participants at the Symposium drawn from 45 countries. Dr. B.C. Jenkins of Canada acted as the General Chairman of the Symposium. In addition to the Scientific discussions, excursions had been organised to see the cereal breeding work in progress at Weibullsholm Plant Breeding Institute, Landskrona and the Swedish Seed Association, Svalof. Opportunities were provided to hold discussions with the research workers at the Institute of Genetics, Lund, on problems in fundamental genetics. There was adequate time both for formal and informal discussions and the Swedish hosts headed by the dynamic organising Secretary. Prof. J. Mac Key, left nothing to be desired in the way of catering to the intellectual needs as well as physical comforts of the participants. I give below a summary of the important findings reported at the Symposium.

Contd....p/2.

1. Wheat Quality:

In this session there were three invited papers dealing with recent research on the estimation of protein quality in wheat in relation to baking and milling properties. Dr. F.J.R. Hird of Australia dealt with frictional changes brought about by changing disulphide bonds. He stressed the fact that the introduction of the aleurone layer in milling will harm the dough. Electro-phoretic analysis of protein structure has revealed that many Australian wheats differ in the presence or absence of certain bands as well as in the intensity of the different bands. Dr. O. Hall of Sweden also presented evidence on the usefulness of electrophoretic analysis of proteins in relation to the determination of quality. This technique is of great value in genetic analysis and there is evidence to suggest that T. durum has duplications of certain bands seen in aestivum varieties. Dr. E.A. Favret of Argentina showed that chromosome 5D of wheat carries genes for gluten strength. Thus, the D genome seems to contribute towards quality.

2. Plant Breeding Methods in Wheat:

Dr. C.F. Konzak of U.S.A. outlined the results of mutation breeding in wheat. He showed that through the use of chemical mutagens a wide spectrum of mutations can be obtained. In this way the chances of picking up a desirable mutation can be enhanced. He confirmed the findings made at the Indian Agricultural Research Institute that awned mutants in an awnless wheat can yield 10-15 per cent more than the parent strain. Mutations for quality, both deleterious and beneficial, can be obtained. Mutations conferring straw stiffness are frequent in the progenies of varieties treated with ethyl-methane-sulphonate. Dr. R.E. Scossiroli of Italy dealt with induced mutations in characters governed by many genes. He pointed out that while mean values for a quantitative trait are usually adversely affected in irradiated populations, the variance is much higher. Scope hence exists for selection of some superior genotypes. The genetic component of variance is much higher in the irradiated population. Also, the environmental variance is increased thereby indicating that the interaction with the environment is greater.

Dr. S. Borojevic of Yugoslavia dealt with the estimation of combining ability in wheat crosses.

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He observed transgressive segregations for height and earliness in crosses involving varieties drawn from different geographic regions. Under the conditions in which wheat grows in Yugoslavia earliness could be used as an index of yield and heading date was found to be a good index of earliness. He, however, stressed that it is difficult to assess combining ability from any one criterion. Dr. J.W. Schmidt outlined the experience of American workers in the field of hybrid wheat production. Derivatives of _T. timopheevi_ provided both male sterility and fertility restorer factors. The inheritance of fertility restorers is very complex. The extent of heterosis has been found to be about 12 per cent. There are several problems relating to seed production and quality which have to be overcome before hybrid wheat can become a practical proposition.

3. Disease Resistance in Wheat:

In this session Dr. R.C.F. Macer of U.K. dealt with the genetical analysis of resistance to stripe rust (_Puccinia striliformisz_) in wheat. Resistance is generally dominant and only one gene is involved in most cases with reference to one physiologic race. The heterozygotes usually show an intermediate pustule type. Monosomic analysis of a cross between Chinese Spring and Red Bobs for race 2B revealed that chromosome 2A carried gene Yr_1 in the long arm. The genetic constitution of different varieties with regard to resistance to stripe rust is given in Table 1.

Table 1.

Genotype of different varieties for stripe rust resistance

Variety	Physiologic race				
	2B	5	8	8B	27/53
Chinese 166	Yr_1	Yr_1	Yr_1	Yr_1	-
Heine VII	Yr_2	Yr_2	Yr_2	-	Yr_2
Minister	Yr_3	-	-	-	-
T. spelta	Yr_5	Yr_5	Yr_5	Yr_5	Yr_5
Peko	Yr_6	-	-	Yr_6	-
Thatcher	Yr_7			Yr_7	

Contd...p/4.

Dr. R.G. Anderson of Canada dealt with the inheritance of resistance to leaf rust in wheat varieties. Thatcher has one major gene for resistance to race 5 but its effects are modified by other genes. Seedling susceptability is some times followed by post-seedling resistance; hence the stage of development is important in genetic studies. Several workers have reported complementary genes for resistance but on further analysis such resistance has proved to be due to the two varieties used in the cross possessing resistance to two separate races. Thus, when a mixture of races is used, the two varieties will be individually susceptible but will prove to be resistant in a hybrid combination. Dr. D.R. Knott of Canada described the work on stem rust resistance in wheat. Several different sources of resistance genes have been identified in *Triticum* and *Agropyron*. By a remarkable piece of chromosome engineering Dr. Knott succeeded in transferring the Sr_6 gene for stem rust resistance located on chromosome 2D of *T. aestivum* to *T. durum*. Chromosome 2D was isolated by back crossing the pentaploid hybrids to *T. durum* and the transfer of the Sr_6 gene was accomplished through a neutron induced translocation. Thus, not only has a new form of resistance become available in tetraploid wheat but it has also become feasible to study the effect of gene dosage on resistance by crossing *durum* with *aestivum*. In serological studies, none of the tests revealed the presence of an antigen specific to the genotype. Hence Flor's views could not be confirmed in wheat. Dr. W.Q. Loegering dealt with the relationship between the host and the pathogen in wheat. In general, similar patterns of major gene effects are visible with reference to resistance to all fungal pathogens. Dr. Loegering proposed the use of the term "aegricorpus" to indicate the infected organism. The host-pathogen-environment reaction conditions the aegricorpus. This concept will be very valuable in explaining the differences in the genetic results obtained by different investigators and phenomena such as reversal of dominance. Dr. Loegering expressed disappointment that the resistance transferred from allied genera has proved to be unstable. Dr. A.T. Pugsley dealt with mildew resistance in wheat. About 30 physiologic races have been isolated in the mildew organism and six different genes have been identified in 17 varieties. The six genes and the names of the varieties in which they were first identified are given in Table 2.

Table 2.

Genes for mildew resistance

Gene symbol.	Variety in which first identified
Ml_1	Thew
Ml_3	Sonora
Ml_u	Ulka
Ml_c	Chul
Ml_a	Asosan
Ml_b	Birdproof

Contd...p/5.

Dr. E.E. Sebesta of the United States outlined the genetics of resistance to viruses in wheat. In the United States the "Take-all" disease has appeared in an epidemic form during the last few years. The mosaic virus is also important. Derivatives from crosses between Agropyron and Triticum species are promising from the point of view of breeding for resistance. Only one pair of chromosomes in Agropyron controls the local lesion reaction to mosaic virus. Hence, the inter-generic transfer of resistance can be brought about without much associated adverse effects.

4. Wheat taxonomy and phylogeny:

In this session there were papers by Drs. Zohary of Israel, Y. Cauderon of France, E.B. Wagenaar of Canada and J. Mac Key of Sweden. Dr. Zohary pointed out that there must be one pivotal genome common to all tetraploid Triticums and one genome which may get modified. Many ofthe so-called species did not show clear morphological discontinuity and hence they should be referred to as "species clusters". The possibility of introgression from allied genera may explain the occurrence of several "super genes" in wheat. Miss. Cauderon provided data to show that the chromosomes of Agropyron and Triticum species do not pair with each other, while Dr. Wagenaar showed that chromosomal differences exist within the Triticum timopheevi complex. Dr. Mac Key, who had earlier merged all the hexaploid species of Triticum as sub-species of Triticum aestivum L., now proposed that a similar merger as shown in Table 3 should be adopted with regard to the tetraploids:

Table 3.

Mac Key's scheme of taxonomic classification of spcies in Triticum

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Somatic Chromosome Number.	Species.	Sub-species.
14	T. monococcum	Monococcum Aegilopoides
28	T. turgidum	Dicoccum Carthlicum Polonicum Turgidum
28	T. timopheevi.	Timopheevi Araraticum
42	T. aestivum	Vulgare Sphaerococcum Compactum Spelta Macha Vavilovi

Contd..p/6.

5. Amphiploids and addition to wheat of characters from related genera:

Prof. A. Muntzing of Sweden presented the data obtained by Prof. Pissrav of the U.S.S.R. and himself in breeding studies with rye-wheat hybrids. Prof. Pissrav finds that the high protein content of rye-wheats can be transferred to soft wheats through hybridisation. Since the D genome of wheat introduces susceptibility to many diseases, he is attempting to replace the D genome with the rye-genome. Prof. Muntzing pointed out that in Sweden very good rye-wheat strains have been evolved by using self-fertile strains of rye. Some of the features of rye-wheat in relation to wheat are given in Table 4.

Table 4.

Characteristics of Rye-wheat strains produced in Sweden.

Character	Rye-wheat	Wheat parent
1000 Kernel weight	58 to 60 gms.	46-50 gms.
Kernel quality (grading value)	9.86	10
Yield (% of wheat)	90 to 98	100
Crude protein content (relative value)	120.6	100

The tendency for pre-germination in rye-wheat is not desirable from the point of view of baking quality and hence attempts are being made to eliminate this character. Rye-wheat shows very good winter hardiness. Dr. B.C. Jenkins of Canada described the various substitutions and additions of rye-chromosomes brought about in wheat. Similarly, Dr. A. Wienhues of Germany described the substitutions of Agropyron pairs for wheat pairs. The question whether an alien pair could be expected to replace only a homoeologous wheat pair with which it has had a common evolutionary origin, is still open since the evidence at present available is insufficient to clarify this issue. Prof. H. Kihara of Japan described the production of male sterile forms of wheat by transferring wheat nucleus into the cytoplasm of various other species. In certain combinations, such as timopheevi cytoplasm plus durum nucleus, haploids occur frequently. Thus the interaction between the cytoplasm and the nucleus can be used as another method for the production of haploids.

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6. Aneuploidy in wheat genetics:

There were four papers in this session. Owing to its hexaploid constitution, *T. aestivum* is a difficult material for conventional linkage analysis but Dr. E.R. Sears of the United States demonstrated how this could be accomplished by using telocentric chromosomes. The linkage distance between single major genes and the centromere can be estimated with precision by this method. In this way he has already gathered data on some of the genes located in chromosomes 3B and 6B. The gene for leaf rust resistance introduced from *Aegilops umbellulata* has been found to be located in a distal segment of chromosome 6B. The usefulness of aneuploid analysis in varieties of bread wheat was demonstrated by Dr. R.I. Larson of Canada with regard to soild stem characters andby Dr. J. Kuspira of Canada with reference to quantitative characters like yield. Aneuploid analysis has been difficult in tetraploid wheats because aneuploids do not survive so readily in them. However, Dr. Noronha Wagner of Portugal working with *T. durum* was able to obtain nullisomic-tetrasomic combinations for some chromosomes. From these studies it is clear that there is considerable gene homology between the A and B genomes. From a lantern slide shown by Dr. Wagner, I pointed out that the ear of nulli 7B-tetra 7A has sphearococcoid characters and glume discolouration. This suggests that the sphearococcoid character could well arise through duplication of a genepresent in chromosome 7A together with the absence of a gene in chromosome 7B.

7. Cytogenetic structure of Wheat:

Dr. R. Riley of U.K. provided data in confirmation of the hypothesis that homoeologous meiotic pairing and recombination occur when the effect of the multivalent suppressor gene in chromosome 5B is removed. The pairing taking place in the absence of the gene in chromosome 5B is largely between the homoeologous chromosomes in the different genomes. Dr. Riley postulated that the multivalent suppressor gene should have evolved as a mutation after the tetraploid wheats arose. He also suggested that *Aegilops mutica* is as likely as *Aegilops speltoides* to have been the B genome donor. The fact that the removal of 5B promotes allosyndetic pairing can be exploited in wheat Breeding. Another interesting point made by Dr. Riley

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is that a high frequency of polyhaploids occur in the progenies of plants monosomic for chromosome 1A. Dr.M. Okamoto of Japan provided experimental evidence to suggest that mutations affecting pairing can occur in wheat. Dr. J.G.T. Hermsen of the Netherlands showed that Triticum macha carries on different chromosomes one gene for necrosis and another gene for chlorosis.

My paper entitled "Mutational analysis in the hexaploid wheat complex" was also included in this session. I showed how the free threshing gene Q evolved through a series of tandem repeats starting with the initial Q present in einkorn wheat. In einkorn, Q ensures organised flower morphogenesis . In the presence of Q several lethal and semi-lethal factors can be present in cultivated wheats. I suggested that the existence of such "harmful genes" may not be due to "genetic inertia" facilitated by polyploidy but may have some bearing on fitness and vigour. The paper dealt with the probable evolutionary history of the Q, C and S loci in wheat.

8. Contributed Papers:

A series of papers were presented by Russian workers indicating how Spring wheat can be converted into winter wheat through adaptation. Vernalization at 2-3°C has been found to be effective in increasing protein content. Two papers of interest in this session were one dealing with adaptation of varieties by Dr. K.W. Finlay of Australia and another by Dr. R.M. Caldwell of U.S.A. on the genetics of resistance to Hessian Fly (Phytophaga distructor). Three genes have been found for resistance to Hessian fly and four races (A,B,C and D) have so far been isolated in the flies. Thus, the old view that physiologic specialisation may not occur in insects seems to be incorrect.

The proceedings of the Second International Wheat Genetics Symposium will be published as a supplement to "Hereditas". When published, this will be a compilation of great value to the geneticists and breeders working on wheat.

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II. THE FIRST INTERNATIONAL BARLEY GENETICS SYMPOSIUM, WAGENINGEN

This symposium was held from August 26-30, 1963 at Wageningen, the Netherlands. There were several Sessions dealing with the origin, genetics, breeding and quality of barley. The papers were exceedingly interesting, and of a very high standard. There was also a visit to a few Breweries. I was asked to serve on a Committee constituted to discuss the possibilities of International Co-operation in the field of Barley Research. My suggestion that a composite bulk of all the tetraploid barley varieties produced in different countries (be established) so that a maximum genotypic diversity can be generated for fertility characters was welcomed. Dr. H. Gaul of Germany was assigned this work.

The other measures for coordinating barley research which were decided upon are as follows:

i. <u>Genetic Marker Stocks</u> - Dr. D.W. Robertson

It is proposed that Dr. Robertson maintain the genetic seed stocks and serve as overall coordinator for genetic linkage studies.

Individuals responsible for the coordination are as follows:

Overall coordinator - Dr. D.W. Robertson
Chromosome 1 coordinator - Dr. R.G. Shands.
2 - Dr. G.W.R. Walker.
3 - Dr. R. Takahashi
4 - Dr. D.W. Robertson
5 - Dr. Henry Shands
6 - Dr. C.R. Burnham (?)
7 - Dr. Arne Hagberg (?)

<u>Procedure for seed stocks:</u>

Seed samples of all new described mutants should be sent to Dr. D.W. Robertson to make them available to other workers. Include:

a. variety in which obtained
b. description of mutant
c. origin of mutant - spontaneous or induced (if induced, give agent)
d. any genetic data obtained.

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Dr. Robertson and his committee on assigning gene symbols will then assign the character a symbol.

In order to provide worldwide coordination for genetic studies, other persons have been assigned responsibility for individual chromosomes. It is desirable that individuals conducting genetic studies inform the coordinators of their projects. Those interested in initiating a particular genetic study are invted to inquire of the various coordinators whether their proposed project is being carried out by other investigators as well as inform the coordinators of the proposed investigation. Coordinators should also be sent data or information relative to their respective chromosomes.

This is a concept where coordinators will act as a clearing house and data will be handled confidentially. Research workers will be referred to those doing work on the particular project rather than be given the information by the coordinator. Properly used, (i.e. workers sending information to, and requesting information from) this coordinator arrangement should prevent duplicative efforts and provide more coordinated research.

ii) Translocation and tertiary trisomic stocks - Dr. R.T. Ramage.

It is proposed that Dr. Ramage maintain the translocation and tertiary trisomic stocks and serve as coordinator for translocation studies.

Procedure:

Seed samples of all new translocations should be sent to Dr. Ramage with the following information:

1. originator's designation (number, etc)
2. cytological data on breakpoints, if available
3. variety or hybrid in which induced
4. methods of induction (mutagenic agent).
5. authority
6. chromosomes involved
7. linkage data, if available, in the following form:

Cross	Type of data	a e	b f	c g	d h	Total	P. ± S.E.
T2-4 axor	F2	33	17	33	17		50 ± ?

After information and seed stocks have been received the translocation stock will be assigned a letter designation.

iii) Trisomic and Aneuploid Stocks - Dr. T. Tsuchiya

It is proposed that Dr. Tsuchiya maintain these stocks and serve as coordinator for aneuploid studies.

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Procedure:

Seed samples of all new aneuploids should be sent to Dr. Tsuchiya with the following information:

a. variety in which obtained
b. cytology data if available
c. methods of induction
d. authority
e. chromosome(s) involved.
f. linkage data, if available, giving class numbers.

iv) Inversion stocks - Dr. R. A. Nilan.

It is proposed that Dr. Nilan maintain and serve as coordinator for inversion studies.

Procedure:

Seed samples of all new inversion stocks should be sent to Dr. Nilan with the following information:

a. variety
b. origin (induced or spontaneous)
c. authority
d. chromosomes involved.

v) Disease Resistance Stocks - Dr. J.G. Moseman

It is proposed that Dr. Moseman maintain the disease resistance stocks:

Procedure:

Seed samples of all resistance sources (except those with U.S.D.A. "C.I." Numbers) should be sent to Dr. J.G. Moseman along with the following information:

a. disease concerned (Latin name).
b. name of variety.

i) natural resistance, or
ii) mutant

1) spontaneous, or
2) induced

c. number and designations of cultures used
d. method and technique of testing material
e. authority.

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vi) Barley literature - Dr. R.A. Nilan

It is proposed that Dr. Nilan maintain the comprehensive summary of barley literature. Dr. Nilan should be sent reprints of all publications dealingwith barley. The current summary, "Cytology and Genetics of Barley, 1951 - 1962" is in press and will soon be published by the Washington State University Press.

III. THE XIth INTERNATIONAL CONGRESS OF GENETICS, THE HAGUE

The XIth International Congress of Genetics was held at the Hague from September 2-10, 1963. Prof. E.Hadorn of Switzerland was the President of the Congress and I was one of the Vice Presidents, this being the first time for an Indian Scientist to hold this position. At the opening function the highest title of the Netherlands was conferred upon Prof.M.J. Sirks of the University of Groningen by the Queen of the Netherlands. The Congress was extremely well organised and there were many interesting Symposia and Sessions. I presented the following two papers at the Congress:

1. Induced Mutations at the "Q" locus in relation to the phylogeny of hexaploid Triticum species.

2. Incidence of mutations in D. melanogaster fed on irradiated medium.

I also acted as the Chairman of the Session dealing with Plant Genetics held on September 9, 1963. I had many discussions with the leading Geneticists of the world and the Congress proved to be a stimulating experience. I was invited by the Queen of the Netherlands as well as the Ambassadors of the United States and U.S.S.R. for Dinner. It was a great joy to see the amount of interest which the Governments of Countries in Europe and United States take in Scientists.

IV. LECTURES AT THE AGRICULTURAL UNIVERSITY, WAGENINGEN.

I gave a series of four lectures at the Agricultural University at Wageningen. These had been widely publicised and I enclose a copy of the Notice issued by the University.

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There was a very enlightened audience at all the meetings and every lecture was followed by detailed discussions. The Rector Magnificus of the Agricultural University expressed a keen desire to have close relationships with Indian Agricultural Scientists. The Dutch have had extensive expereience of tropical agriculture and they hoped that the Indian Embassy at the Hague will take some interest in establishing contacts with Wageningen.

CONCLUSIONS

The participation in these International Symposia was of great value in learning the trends of thought and experimentation currently underway in foreign countries. The contacts established ha . helped in obtaining very valuable genetic material. I enclose as an example a copy of a letter received from Dr. Williams of North Dakota.

ACKNOWLEDGEMENTS

I am grateful to the organisers of the International Wheat and Barley Genetics Symposia and the International Congress of Genetics as well as the authorities of the Agricultural University, Wageningen, for inviting me to deliver these lectures and meeting all my expenses. My sincere thanks are also due to the Government of India and to Dr. B.P. Pal, Director, Indian Agricultural Research Institute for permitting me to accept these invitations and experience a great intellectual treat.

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