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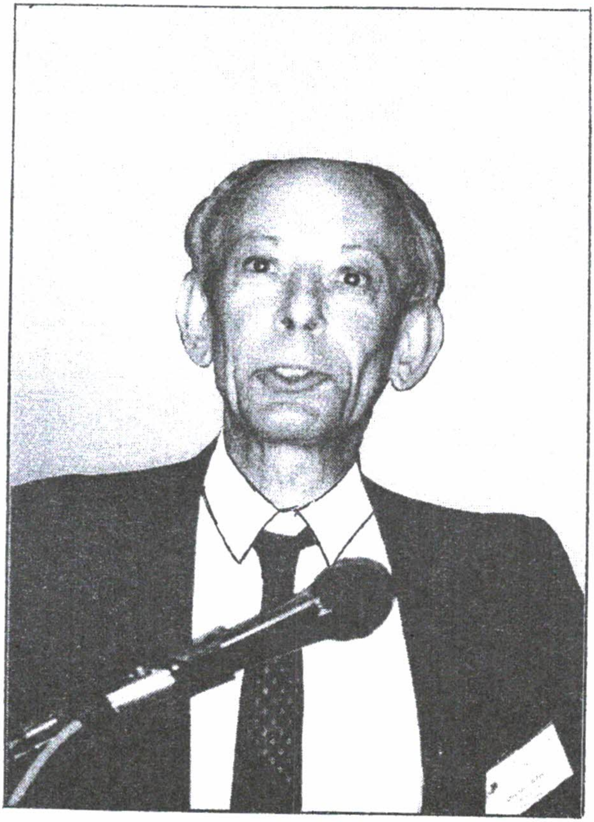

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THE EUROPEAN WHEAT ANEUPLOID CO-OPERATIVE. ITS HISTORY AND THE INVOLVEMENT OF OLGA MAYSTRENKO

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Bread wheat *Triticum aestivum* (2n=6x=42) is an allohexaploid carrying seven pairs of chromosomes from each of its three ancestral diploid parents. The allohexaploid constitution of bread wheat with its triplicated genetic information allows it to tolerate changes to its basic chromosome number. Riley and Kimber (1961) showed that 2 to 3% of the seed of commercial wheat varieties have altered or aneuploid chromosome constitutions. The aneuploids may show reduced or increased dosages of individual chromosomes or of chromosome arms (telocentrics). The most common form of aneuploids are monosomics that have a single chromosome missing (2n=41).

The pioneering work of Professor Ernie Sears in the 1950's first alerted the world to the benefits of using wheat aneuploids for research and breeding. Sears isolated complete series of aneuploids with several different chromosome constitutions in the variety Chinese Spring. These included monosomics (2n=41), nullisomics (2n=40), tetrasomics (2n=44) and lines with various telocentric combinations (Sears, 1953, 1954). Sears was also able to demonstrate how the monosomics could be used to identify which chromosomes carried a particular gene.

In further developments it was shown that once a monosomic series had been developed in one variety, the monosomic could be transferred to a second variety by backcrossing (Sears, 1953; Unrau, 1958). In the second backcrossing scheme individual chromosomes from one variety could be individually transferred or substituted into a second variety providing very precise stocks for genetic analysis (Sears et al., 1957).

At the Plant Breeding Institute, Cambridge, UK, Professor Colin Law recognised that the task of developing the precise genetic stocks would be very time-consuming and laborious. To overcome these difficulties, he proposed that an informal organisation known as the 'European Wheat Aneuloid Co-operative' (EWAC) should be set up to co-ordinate the European Development and utilisation of wheat aneuploids (Riley, Law, 1966).

In 1967 an inaugural meeting of EWAC was held in Cambridge, UK to set out a framework for the collaboration of European wheat cytogeneticists. The meeting was attended by 49 participants from 22 countries. They included Olga Maystrenko and two colleagues from the Institute of Cytology and Genetics of the Academy of Sciences, Novosibirsk, Russia. The meeting agreed on six key points for future co-operation that comprised:

1. The prevention of duplicated effort in development of plant material or the extraction of information.
2. The European exchange of information to ensure that the maximum benefit is derived from aneuploid studies.
3. Free exchange of cytogenetically verified stocks.
4. Joint work to be undertaken to develop plant material that will yield the maximum agricultural and scientific benefits.
5. Co-operative study and testing of lines in a range of environmental conditions.
6. Arrangements for training in the techniques and application of aneuploid methods.

The meeting agreed that a joint effort should be initiated to develop monosomic series in 4 varieties that could be regarded as key varieties for West Europe, East and South-East Europe, Central Europe and Mediterranean Europe. Once developed the four new monosomic series would be used directly to locate agronomically important genes using the techniques of monosomic analysis pioneered by Sears (1953, 1954). The monosomic series would also be used to produce reciprocal intervarietal substitution series between each of the four key European varieties. It was also agreed that in each of the four key European regions additional monosomic series should be developed in locally adapted varieties. It was envisaged that the additional monosomic series could be compared to the regional key variety to link regional analysis with a wider European programme.

The development of monosomic series in the four key varieties was completed successfully and to the extent that two separate monosomic series were developed in Bezostaya 1 in Bulgaria and Romania and a series was developed in sister line Bezostaya 2 in Russia. Besides, the monosomic series developed in the key varieties an additional 38 monosomic series were developed in regionally adapted varieties from throughout Europe (Table 1).

The monosomic series were used directly in genetic analysis to locate a number of agronomically important genes influencing traits like disease resistance, plant height and flowering time. Initially the main method of analysis utilized was monosonic analysis in which a variety carrying a character of interest was crossed onto a monosomic series in a variety that carried an alternative allele for the character of interest. This method was used by Maystrenko to locate genes for vernalisation response *Vrn-A1* (formerly *Vrn1)* in Saratovskaya 29 and Saratovskaya 210 and to confirm the location of *Vrn-DI* (formerly *Vrn3)* on chromosome 5D of Chinese Spring (Maystrenko, 1974). Later various new techniques were developed to improve the efficiency of using monosomics in the genetic analysis. These modifications included reciprocal monosomic analysis (McKewan, Kaltsikes, 1970) in which monosomics for the same chromosome are crossed reciprocally to permit the critical chromosomes of the two parental varieties to be compared individually against a similarly heterozygous background and backcross reciprocal monosomic analysis (Snape, Law, 1980) which extends the use of the reciprocal monosomic analysis technique to varieties in which no monosomic series is available. This is achieved by the first crossing of a variety of interest onto available monosomics and then reciprocally crossing monosomic F_1 progeny with the recipient monosomic. In EWAC the reciprocal monosomic technique was successfully used (Law et al., 1984) to study the 4D chromosome of Hobbit sib carrying the dwarfing gene *Rht-BId* (formerly *Rht2)* and the reciprocal backcross monosomic technique by Snape and Law (1980) to detect plant height differences associated with chromosome 5A from a range of European varieties.

Table 1. Monosomic Series Developed in Europe

Belarus	Opal
Bulgaria	BEZOSTAYA 1, Roussalka, Sadovo 1
Czech Republic	Zlatka
France	Courtot
Germany	Caribo, Carola, Kranich, POROS, *T.spelta* saharense
Hungary	Mironovskaya 808, Rannyaya 12
Italy	MARA
Kazakhstan	Kazakstanskaya 126
Netherlands	Starke
Poland	Grana, Luna
Romania	BEZOSTAYA 1, Favorites
USSR	Aurora, Bezostaya 2, Diamant II, Kavkaz, Milturum 533, Saratovskaya 29, Skorospelka 35
Spain	Aragon 03, Ariana 8, Pawe 247
Switzerland	Probus
U.K.	Bersee, CAPPELLE - DESPREZ, Glennson 81, Hobbit sib., Holdfast, Koga II, Mercia
Ukraine	Novostepniachka, Priboy
Yugoslavia	Novosadska Rana, Sava

The main aim for developing monosomic series was to utilise them as reciprocal backcross parents in the development of intervarietal chromosome substitution lines. The EWAC collaborative project to develop reciprocal substitution series between the 4 key EWAC varieties has, however, never been fully realised. In Cambridge, UK, chromosomes of varieties Bezostaya 1, Mara and Poros were successfully substituted into Cappelle-Desprez. Elsewhere the introduction of Bezostaya 1, Cappelle-Desprez and Mara chromosomes into Poros was commenced but halted at an early stage. No attempt was made to substitute chromosomes into Bezostaya 1 or Mara.

The substitution lines developed into a Cappelle-Desprez background have proved extremely useful in genetic analysis and can only hint at what might have been achieved if all reciprocal substitution lines had been developed. The lines substituting Bezostaya 1 chromosomes into Cappelle-Desprez have been widely used in studies to detect the chromosomal location of agronomically important genes influencing characters such as bread-making quality, disease resistance and plant height (Law, Worland, 1996). They have also been utilized in the detection of many genetic, cytological and molecular markers.

Lines substituting individual chromosomes from the Italian variety Mara into Cappelle-Desprez have been used in many collaborative EWAC studies to locate and evaluate genes influencing plant height and adaptability. A pair of linked genes *Rht8* and *Ppd-D1* (formerly *Ppd1)* located on the short arm of chromosome 2D have been shown to be crucial to the adaptability of Southern European wheats with *Ppd-D1* promoting a yield increase of at least 30% in Southern European environments (Worland, Law, 1986; Worland et al., 1996). Recent collaborative EWAC experimentation has located a microsatellite molecular marker for *Rht8*. So, this important dwarfing gene can be detected and studied in segregating populations (Korzun et al., 1998; Worland et al., 1998).

Whilst the prime collaborative experimental aims of EWAC have concerned intervarietal variation, many of its active members have been studying alien genetic variation. Over the past 30 years individual laboratories have developed a wealth of alien genetic stocks adding or substituting alien chromosomes to the bread wheat genome. Many of these stocks have been used to introduce agronomically important genes from the aliens into wheat. In the spirit of EWAC the alien genetic stocks have been freely exchanged amongst members. In recent years new molecular staining techniques have opened up new fields for precise studies of alien introductions and even for precise analysis of the mechanisms of chromosome pairing (Reader et al., 1997). Again, in the spirit of EWAC, training has been offered between laboratories in the use of the new molecular cytogenetic techniques.

Since the formation of EWAC in 1962, 11 meetings have been held (Table 2) all of which have proved useful venues for the exchange of scientific ideas and for the fostering of new collaborative projects. Information has also been exchanged in the EWAC Newsletter that now tends to report the proceedings of EWAC meeting with additional articles contributed by members unable to attend meetings.

Table 2. EWAC meetings.

1967	Cambridge, England
1970	Weihenstephan, Germany
1974	Novi Sad, Yugoslavia
1979	Cambridge, England
1981	Wageningen, Holland
1984	Versailles, France
1987	Martonvasar, Hungary
1990	Cordoba, Spain
1994	Gatersleben, Germany
1997	Viterbo, Italy
2000	Novosibirsk, Russia

At the 10th EWAC meeting, Viterbo, Italy 1997 a new collaborative project was proposed by Boerner, Korzun and Worland (1997) on "The deletion and mapping of agronomically important genes in wheat". This project to take EWAC into the 21st Century aims to verify the correctness of three divergent EWAC substitution series and to use them as a basis for detecting and tagging genes of agronomic importance. Fittingly one of the three chosen sets of intervarietal substitutionlines was developed by Olga Maystenko and Raisa Gaidalenok between Saratovskaya 29 and Janetzkis Probat.

During the 33 years since its formation EWAC has achieved a great deal in developing precise genetic stocks, training scientists and bringing together European and International scientists for discussions and collaborative experimentation. We hope that the meeting in Novosibirsk, Siberia will promote a safe future for EWAC into the 21st Century.

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