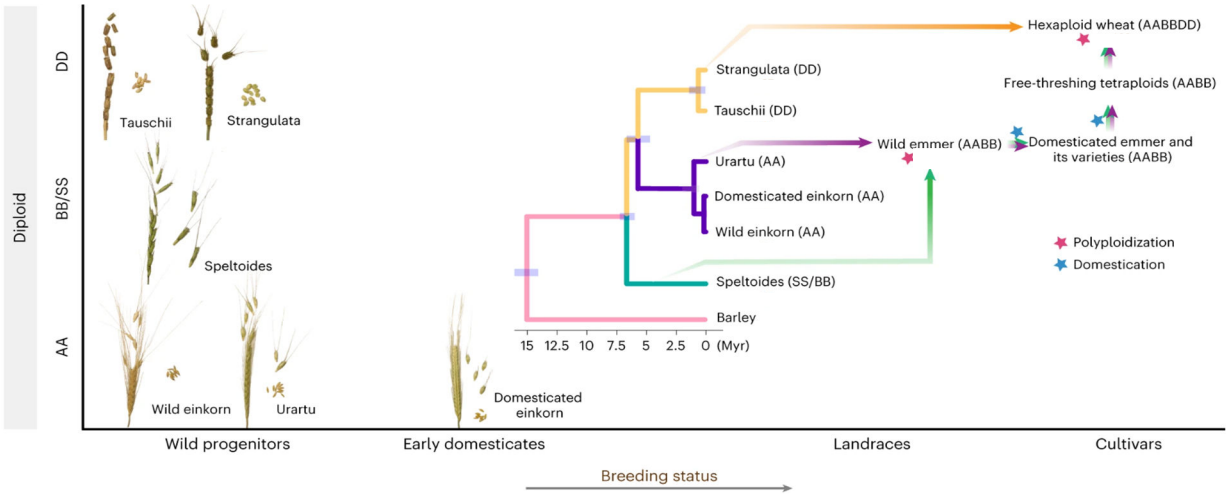
The wheat genome

Formation

Zhao et al, 2023



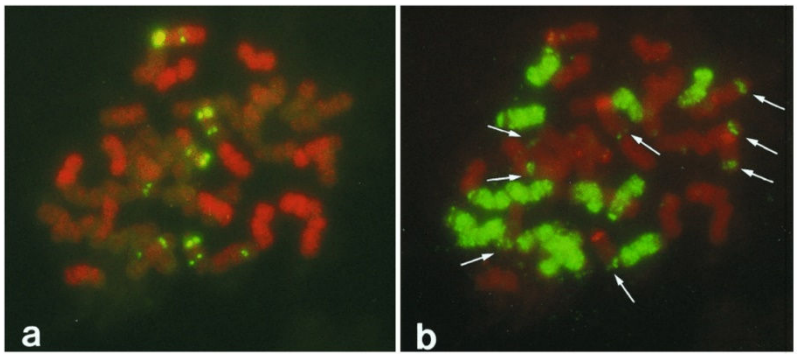
Assigning individual chromosomes to subgenomes

Pairing

A	B	D
T. urartu	*Ae. speltoides*	*Ae. tauschii*
1A	1B	1D
2A	2B	2D
3A	3B	3D
4A	4B	4D
5A	5B	5D
6A	6B	6D
7A	7B	7D

Landmarks + GISH

Linares et al., 1998

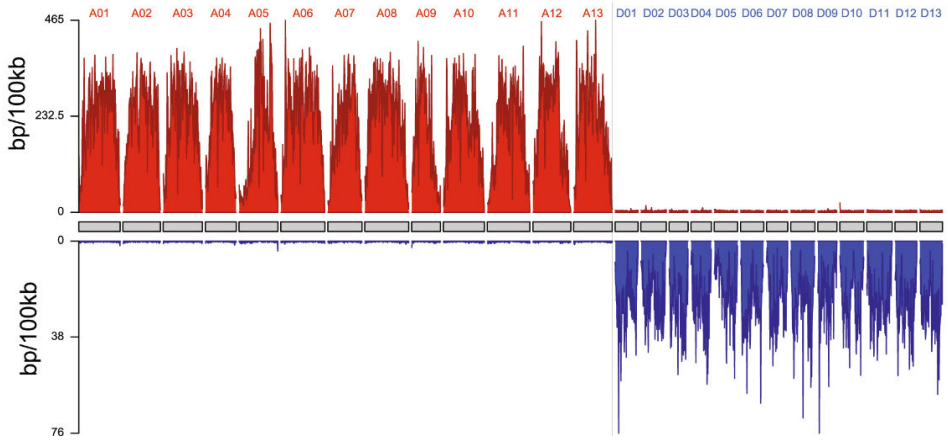


a) *Green = digoxigenin-labeled pTa794 (rDNA, bright spots in bw); orange = rhodamine-labeled pAs120 (medium gray in bw) from the A genome. Unlabeled chromosomes appear dark gray*

b) *Same cell - Green = digoxigenin-labeled pAm1 (C genome) rhodamine-labeled pTa71 (rDNA-specific).*

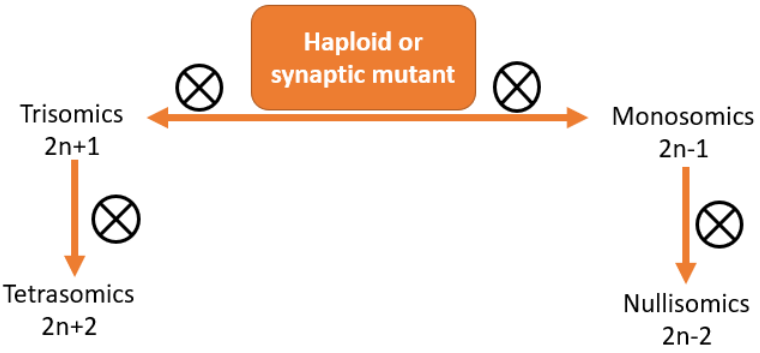
Transposon insertions

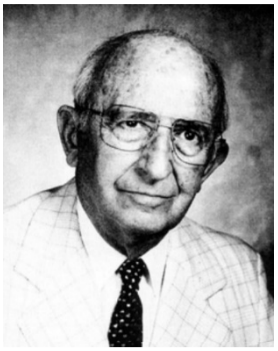
Session and Rokhshar, 2023



Aneuploids in wheat

Sears, 1953





Ernest Robert Sears
(1910-1991)

Behavior of univalents

Behavior of monosomes

n-1 ♀\♂	n (96%)	n-1 (4%)
n (25%)	2n (24%)	2n-1 (1%)
n-1 (75%)	2n-1 (72%)	2n-2 (3%)

Behavior of trisomes

n+1 ♀\♂	n (75-80%)	n+1 (2-25%)
n (60%)	2n	2n+1
n+1 (40%)	2n+1	2n+2 (1-10%)

Substitution lines

Ising, 1966

Ifafa lily hybrids, 2n = 16


Cyrtanthus parviflorus* × *C. mackenii var cooperi.
https://i.pinimg.com/736x/6b/b7/45/6bb745fbbf3f135bde6cbc3e1c203f35.jpg & Wikipedia Commons

Deriving substitution lines

Sears, 1969

Thatcher (recipient) × (donor) Timstein
(6B nullisomic)
↓
× hybrid monosomic for 6B
↓
× ×
× ↓
↓
Thatcher with one 6B from Timstein
↓ ⊗
Thatcher with two 6B from Timstein = substitution line

Using substitution lines

Eg, **Berke et al., 1992**

	Wichita chromosomes in Cheyenne background			Cheyenne chromosomes in Wichita background	
Chromosome	Seed Yield (Mg ha^{-1})	Height (cm)		Seed Yield (Mg ha^{-1})	Height (cm)
1A	0.17	1.6		-0.12	-2.4
3A	0.45*	-7.6*		-0.45*	2.6
6A	0.33*	-2.9*		-0.61*	-.01
2B	-0.01	-0.2		0.06	5.1*
3B	-0.62*	0.0		-0.09	-3.9*
5D	0.12	0.1		0.04	1.0

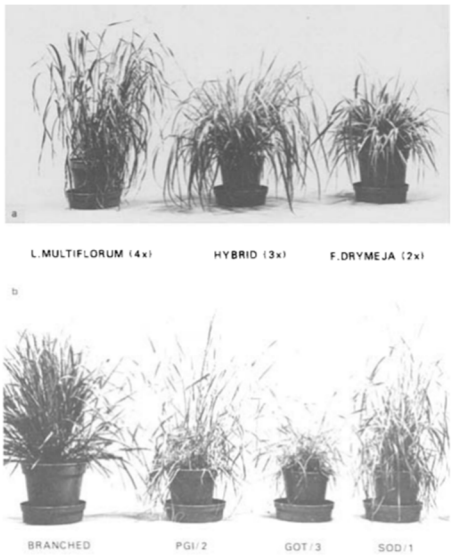
Monosomic alien addition lines

Figure 1. Alien addition lines of Allium fistulosum with chromosomes from A. cepa. From Sigyo et al., 1996. Genes Genet. Syst. 71:363-371

Using addition lines

Distinguish effects of specific alien chromosomes

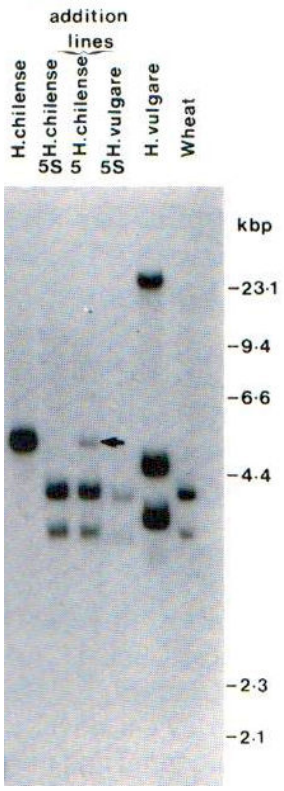
Eg, **Morgan, 1991**



Detect homoeologies between chromosomes of different species

Assign genes to chromosomes

Eg, Cannell et al., 1992



Limitations to alien addition/substitution lines

Jiang et al., 1994

Using addition line translocations in breeding

Ln-9 gene for leaf rust resistance from *Aegilops* to wheat

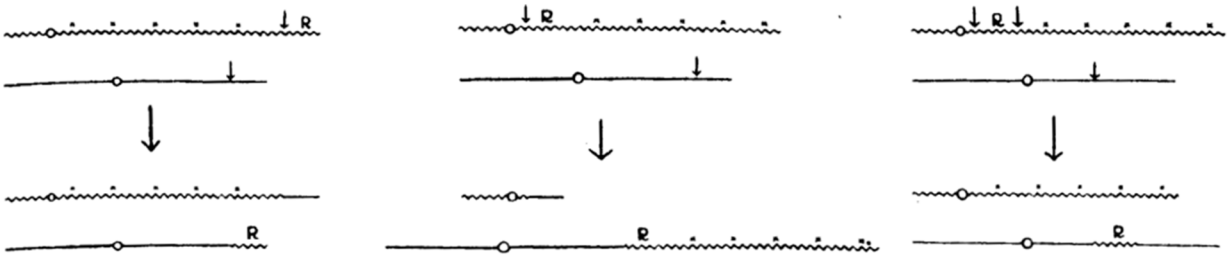
Eg, Sears, 1956

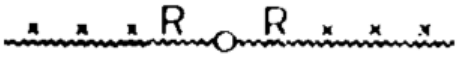
Leaf rust and spikes of wheat cv. 'Chinese Spring' and of Aegilops umbellulata.

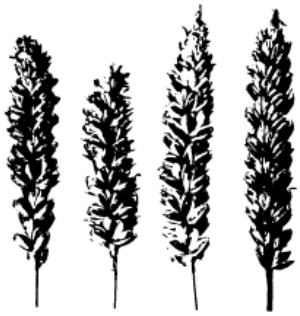
L to R: Chinese Spring with 0, 1, and 2 copies of the Aegilops chromosome.

L: A univalent from Aegilops; C: An isochromosome from Aegilops; R: A bivalent of the Aegilops chromosome

.







L-R: Chinese Spring; homozygous for reciprocal (middle pair) and interstitial (right) translocations.

Friebe et al, 1996

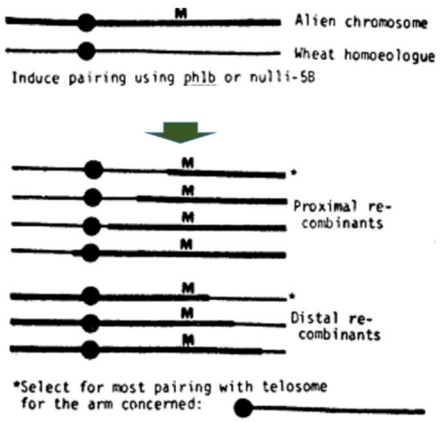
More translocations

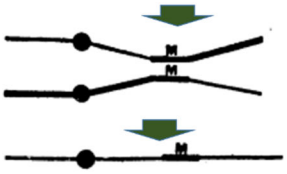
Jiang et al, 1994

Introgression via pairing genes

Review by Jones et al, 1995

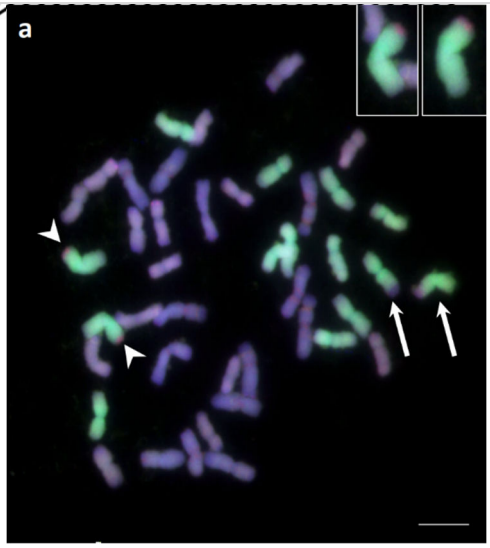
Sears 1983





Monitoring with GISH

Eg, **Gao et al., 2021**



- *Red- N genome from Aegilops uniaristata*
- *Green – A genome probe from T. urartu*
- *Insert: chromosome 2A*
- *Arrowheads → 2NvS-2AS translocation*
- *Arrows – ancestral translocation between 4AL and &BS*
- *Bar – 10 µm*

Continued introgressions

Islam & Shepherd, 1992