Conservation and rearrangement: gene order in peri-centromeric regions of Triticeae genomes

Martin Mascher

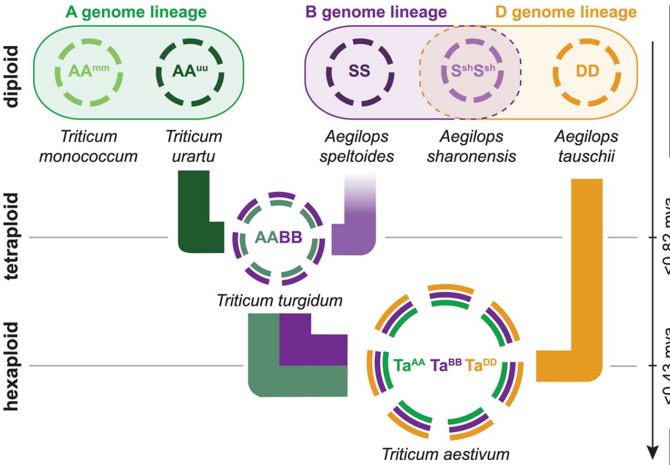
IPK Gatersleben

April 13th, 2016

Member of the Leibniz Association

IPK GATERSLEBEN

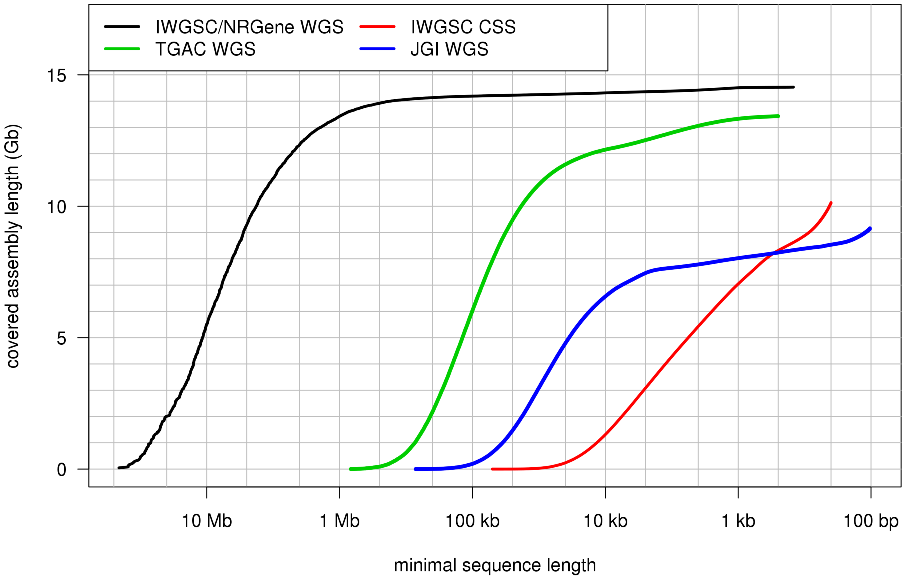
The polyploid wheat genome



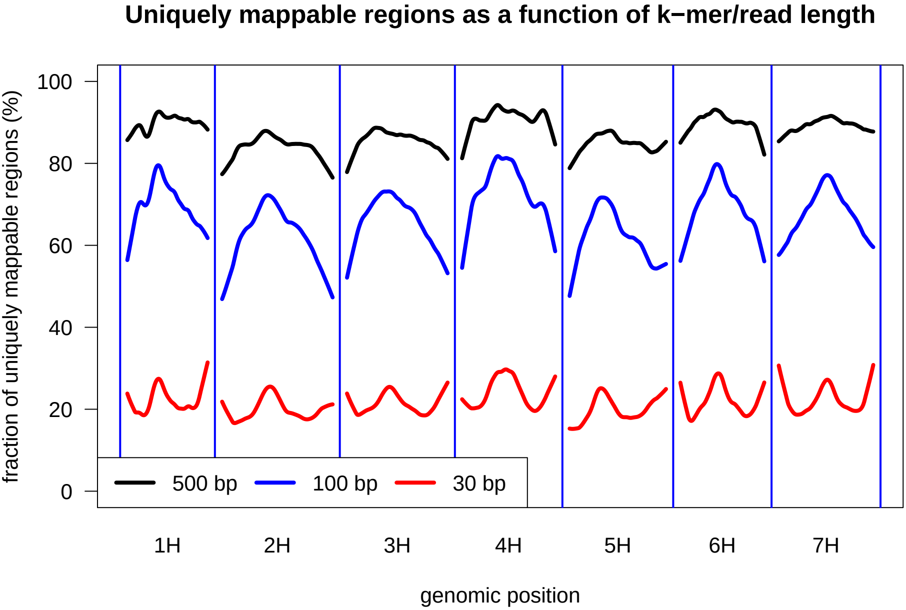
IWGSC, Science, 2014

- Genome size: ∼ 15 - 17 Gb, 3 × 7 pairs of chromosomes

Excellent contiguity and genome representation



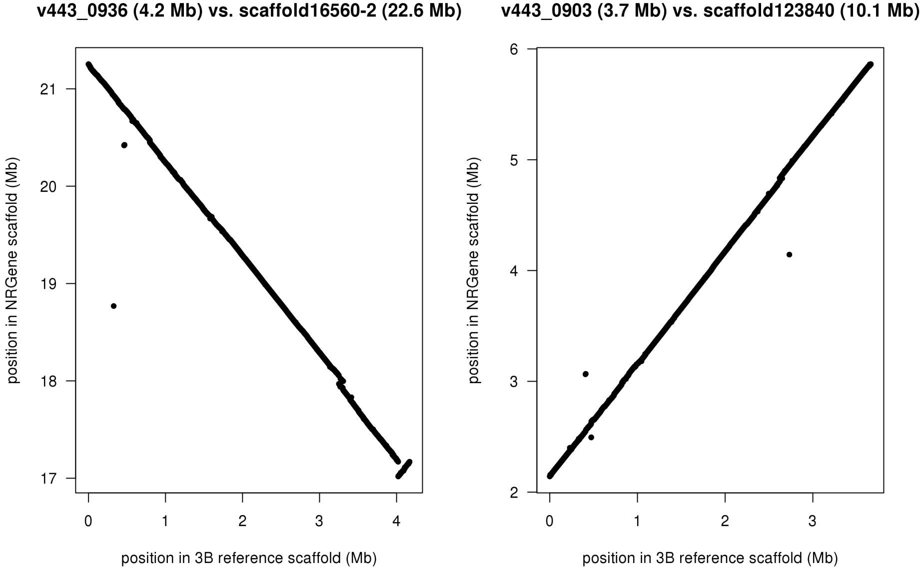
Longer read lengths improve assembly completeness



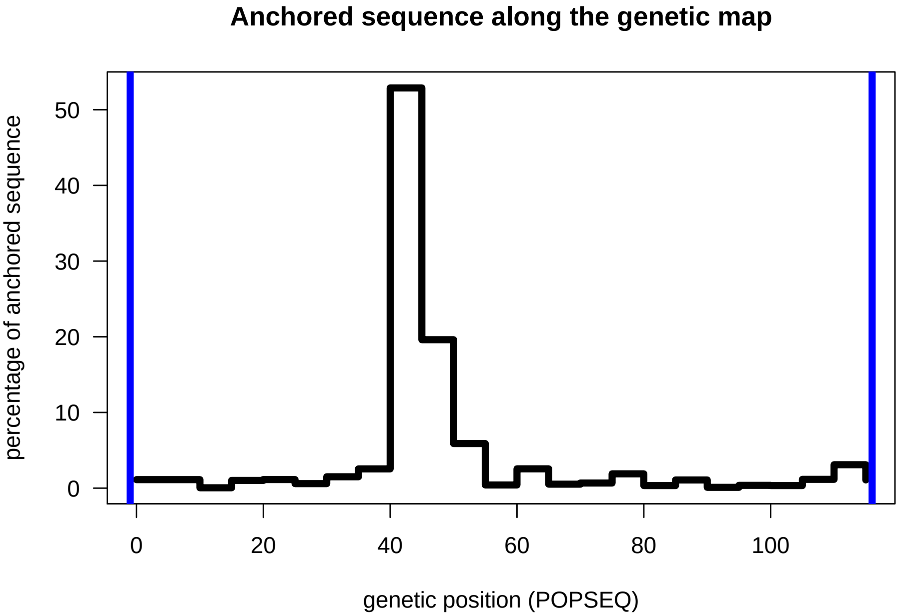
Two wheat assemblies

	Bread wheat	Wild emmer
ploidy	6x (AABBDD)	4x (AABB)
genome size	$\sim$ 15 – 17 Gb	$\sim$ 10 – 12 Gb
assembly size	14.5 Gb	10.5 Gb
N50	548 (7.4 Mb)	415 (7.0 Mb)
N90	2,276 (1.3 Mb)	1,828 (1.2 Mb)
genetically anchored	14.0 Gb (96.5 %)	10.1 Gb (95.6 %)

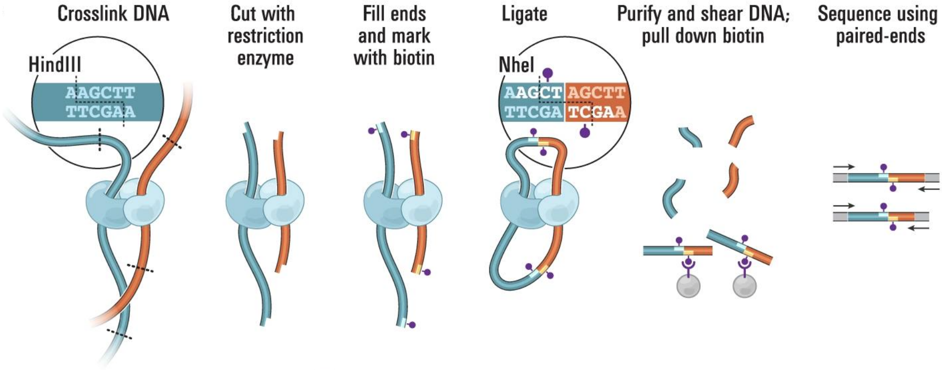
Alignment of the BAC-based reference of 3B



POPSEQ cannot order contigs in peri-centromeric regions

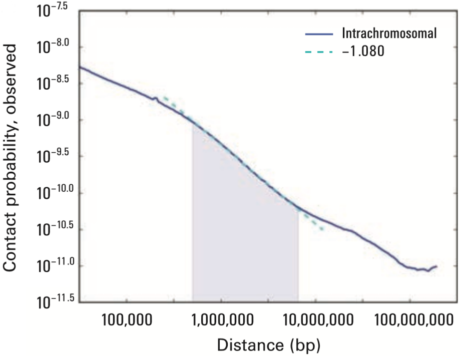


HiC: chromosome conformation capture sequencing



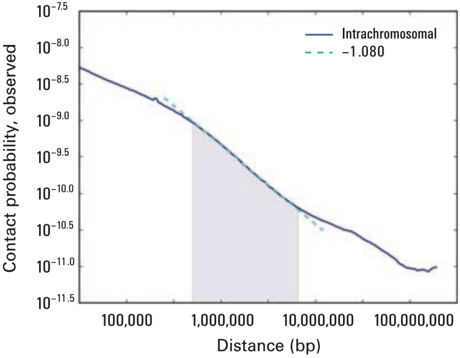
Lieberman-Aiden *et al.*, 2009

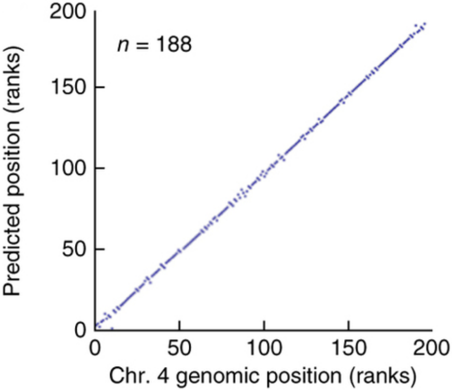
Mapping the linear genome with 3D contact matrices



Lieberman-Aiden *et al.*, 2009; Kaplan and Dekker, 2013

Mapping the linear genome with 3D contact matrices



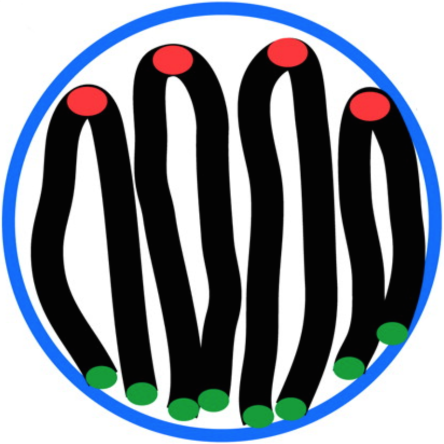


Lieberman-Aiden *et al.*, 2009; Kaplan and Dekker, 2013

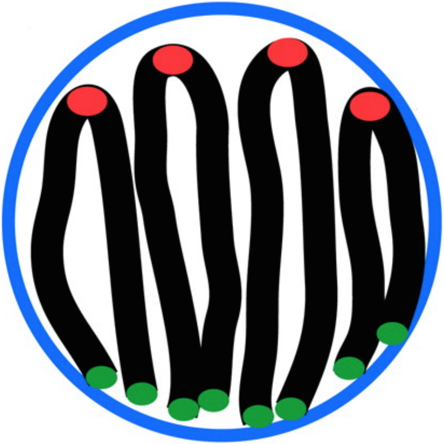
HiC maps of bread wheat and emmer

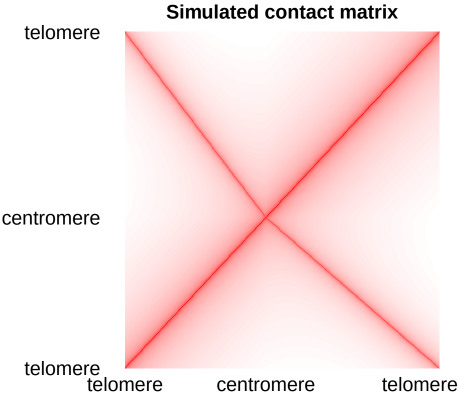
	Bread wheat	Wild emmer
assembly size	14.5 Gb	10.5 Gb
# HiC links	3.7 M	6.5 M
ordered by HiC	14.0 Gb (96.3 %)	10.1 Gb (96.0 %)
oriented by HiC	–	9.7 Gb (92.5 %)
# scaffolds per chr.	177	199

Rabl configuration of interphase nuclei



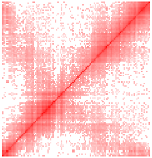
Rabl configuration of interphase nuclei



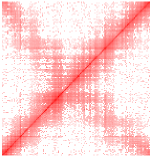


HiC contact matrices meet the expectations

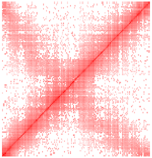
1A



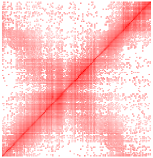
2A



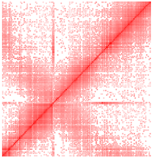
3A



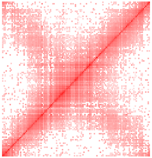
4A



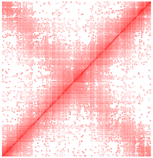
5A



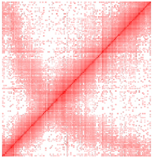
6A



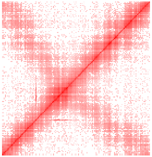
7A



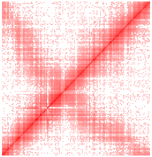
1B



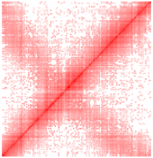
2B



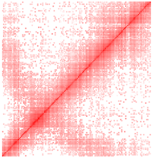
3B



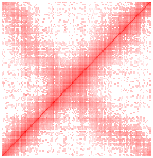
4B



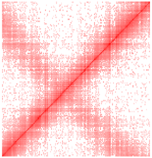
5B



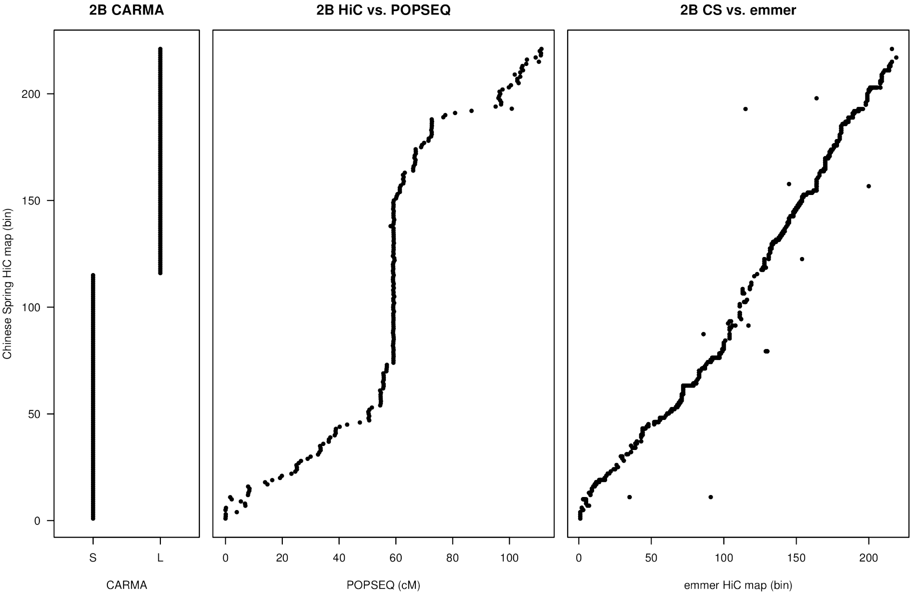
6B



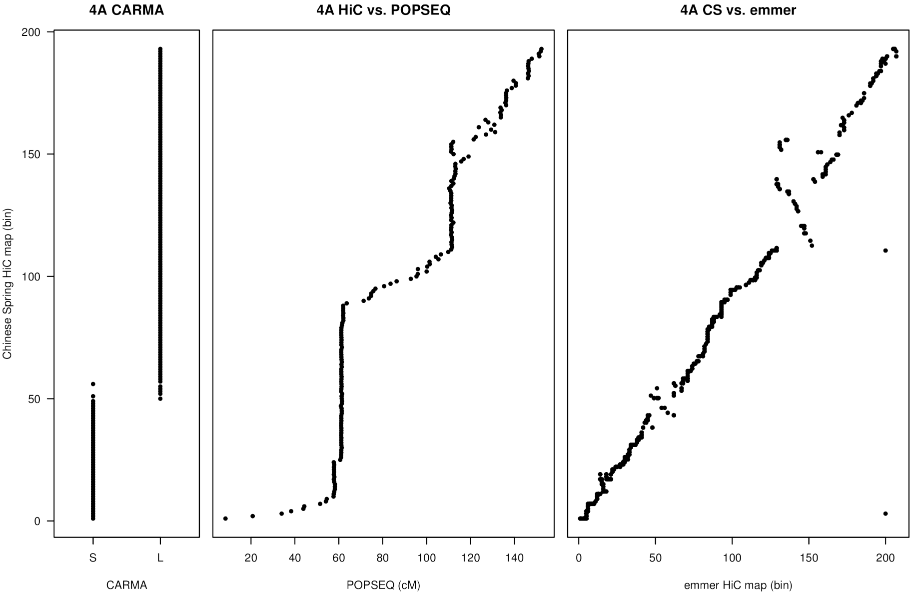
7B



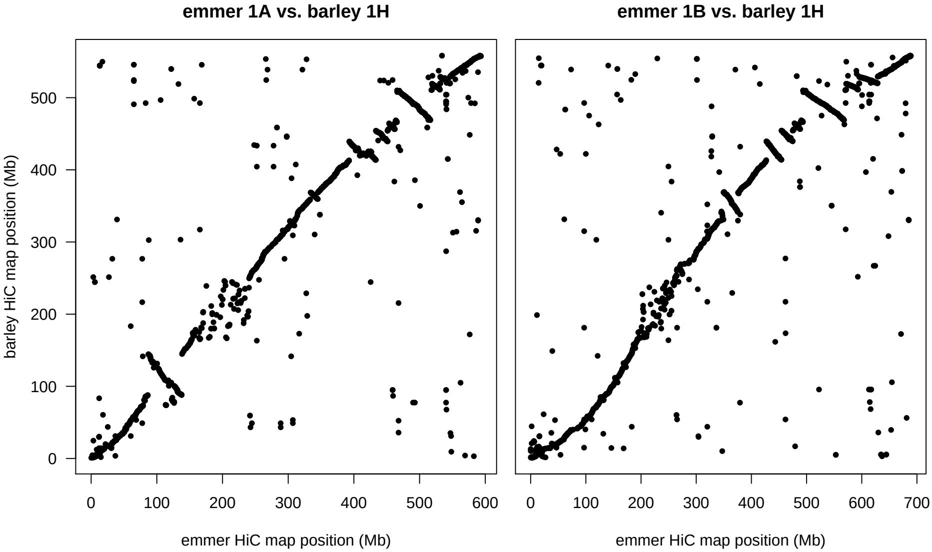
Colinearity of the HiC maps of bread wheat and emmer



Large inversions and reduced recombination



Centromeric rearrangements between wheat and barley



Outlook

- Improved HiC map of bread wheat and construction of pseudomolecules
- NRGene assembly and HiC map of durum wheat
- HiC maps for other wheat varieties to find large structural variants (inversions, deletions, insertions)

Bread wheat assembly team

- Curtis Pozniak, Andy Sharpe, University of Saskatoon
- Jesse Poland, Kansas State University
- Assaf Distelfeld, Tel Aviv University
- Gil Ronen, Omer Barad, Kobi Baruch, NRGene
- Mike Thompson, Illumina
- Fred Choulet, INRA
- Jane Rogers, Kellye Eversole, IWGSC
- Nils Stein, Axel Himmelbach, Ines Walde, IPK Gatersleben

IPK GATERSLEBEN UNIVERSITY OF SASKATCHEWAN GIFS | GLOBAL INSTITUTE FOR FOOD SECURITY K-STATE TEL AVIV UNIVERSITY NRGene illumina

Wild Emmer Wheat Sequencing consortium (WEWseq)

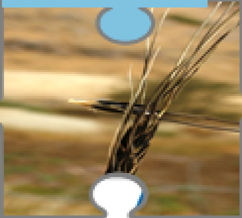
Assaf Distelfeld
Gil Ronen
Raz Avni
Sven Twardziok
Heidrun Gundlach
Martin Mascher
Moran Nave

Kobi Baruch
Omer Barad Gil
Ben-Zvi
Roi Ben-David
Hikmet Budak
Jasline Deek
Batsheva Ben-Zvi

Nils Stein
Axel Himmelbach
Jan Dvorak
Tamar Eilam
Tzion Fahima
Khalil Kashkush
Abraham Korol

Justin Faris
Iago Hale
Alvaro Hernandez
Marco Maccaferri
Klaus Mayer
Mark Mikel

Avraham Levy
Guy Golan
Zvi Peleg
Curtis Pozniak
Silvio Salvi
Ines Walde



NRGENE

Amir Sharon
Brian Steffenson
Roberto Tuberosa
Hanan Sela
Daniel Chamovitz

TEL AVIV
UNIVERSIT

הקרן הלאומית למדע
ISRAEL SCIENCE FOUNDATION

IDT