Structural variation of diploid and polyploid plant genomes

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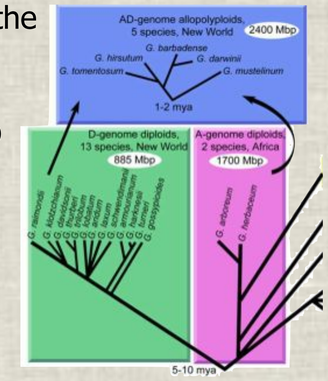
Project Background

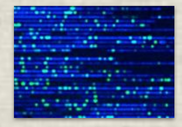
The Gossypium genome:

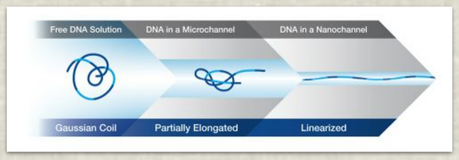
- The Gossypieae tribe is a group of long-lived perennials in the Malvaceae family with little variation in either chromosome number or DNA content
- Gossypium has about 50 species in 8 diploid genome group
- A single polyploidization event between the A- and D-genome has resulted in six extant polyploid species
  -This phylogenetic framework provides a unique, monophyletic platform to investigate the structural rearrangements



Next-Generation Physical Mapping:

- Technology developed by BioNanoGenomics
- Extremely long (high-molecular weight) DNA is labeled by incorporation of fluorophore-labeled nucleotides at a specific sequence motif throughout the genome.
- Labeled genomic DNA is then linearized in nanochannels and single molecules are imaged
- Molecules and labels have a unique signature pattern that is uniquely identifiable and detected in images by instrument software
- Molecules are assembled into genome maps





Research Plan

Assessment of BioNano Genomic technology:

- Comparing a D-genome map to the current reference sequence
- Creating physical maps for unique genetic lines of cotton
- Creating a de novo G. herbaceum (A_1) genome sequence

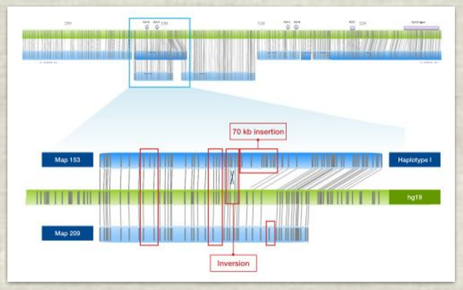
BNG scaffolds of D-genome (blue) compared to current reference sequence (green)

Structural rearrangements in diploid cotton genomes:

- Identify evolutionary fragile sites in the Gossypium chromosomes
- Identify inversions and translocations
- Identify patterns of chromosomal loss and adaptation (fusion, fission, deletion)
- Identify shared duplication within each genome / ancient duplication not shared

Structural rearrangements in polyploid cotton genomes:

- Pairwise comparisons of chromosome rearrangements of polyploid genomes
- Comparison between diploids and AxD diploid hybrid and polyploid genomes
- Recognize polyploidization vs allopatric speciation



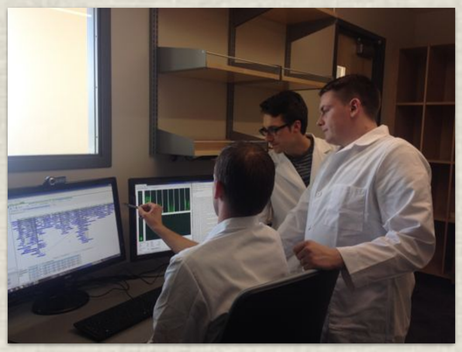
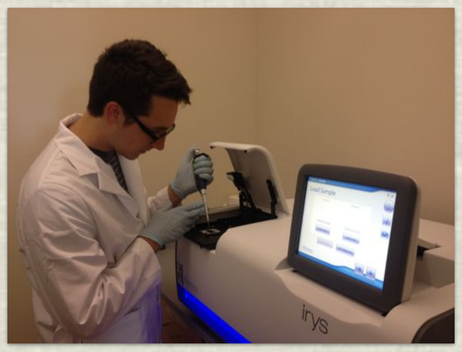
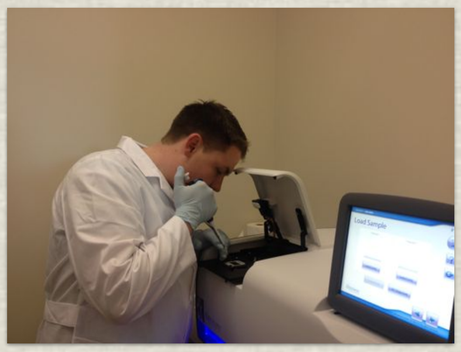
Broader impacts:

- Online educational materials on physical mapping will be developed with the Genetic Science Learning Center (GSLC) at the University of Utah
  learn.genetics.utah.edu teach.genetics.utah.edu
- Summer professional development workshops for high school biology teachers

Learn.Genetics
GENETIC SCIENCE LEARNING CENTER

Recent Activities

- Installation of Irys System and training instruction by BioNano Genomics
- Continued development of protocol for extraction of high-molecular weight DNA from cotton tissue
- Construction of G. raimondii map and increasing coverage for construction of G. herbaceum map
- Integration of Irys software with novel computational environment
- Mature cotton plants from several representative genomes grown in greenhouse

Map #	Species	Genome	Size (MB)	Progress
1	G. gossypiodes	D6	900	
2	G. thurberi	D1-8	900	in greenhouse
3	G. aridum	D4	900	
4	G. arboreum	A2	1700	in greenhouse
5	G. hirsutum	AD1	2400	collecting data
6		AD1	2400	
7	diploid F1 hybrid	A2 x D5	1400	in greenhouse
8	G. longicaylx	F	1311	
9	G. anomalum	B	1359	
10	G. sturtianum	C	2015	
11	G. bickii	G	1756	

Map #	Species	Genome	Size (MB)	Progress
12	G. tomentosum	AD3	2400	tissue prep
13	G. mustilinum	AD4	2400	tissue prep
14	G. barbadense	AD2	2400	in greenhouse
15	G. darwinii	AD5	2400	tissue prep
16	Gossypiodes kirkii		611	tissue prep
17	Cienfuegosia		1000	
18	Hampea		2900	
19	Kokia		611	
20	Lebronnecia		1760	
21	Thespesia		1600	in greenhouse
22	G. herbaceum	A1	1700	some coverage