SVs Shape Population Structure in Wild Sunflowers

Michael Alonge

Massive haplotypes underlie ecotypic differentiation in sunflowers

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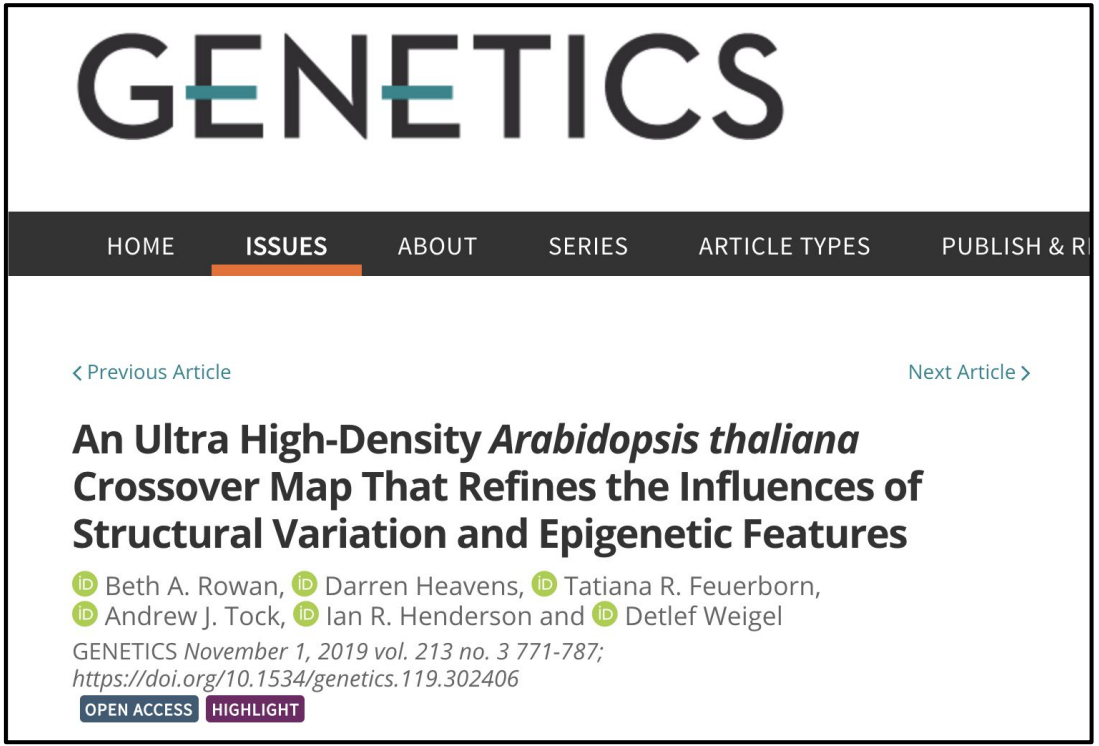
* *These authors made similar contributions to this work*

SVs Suppress Recombination

- More obvious with large SVs such as large inversions.



Ecotypic Adaptive Stability

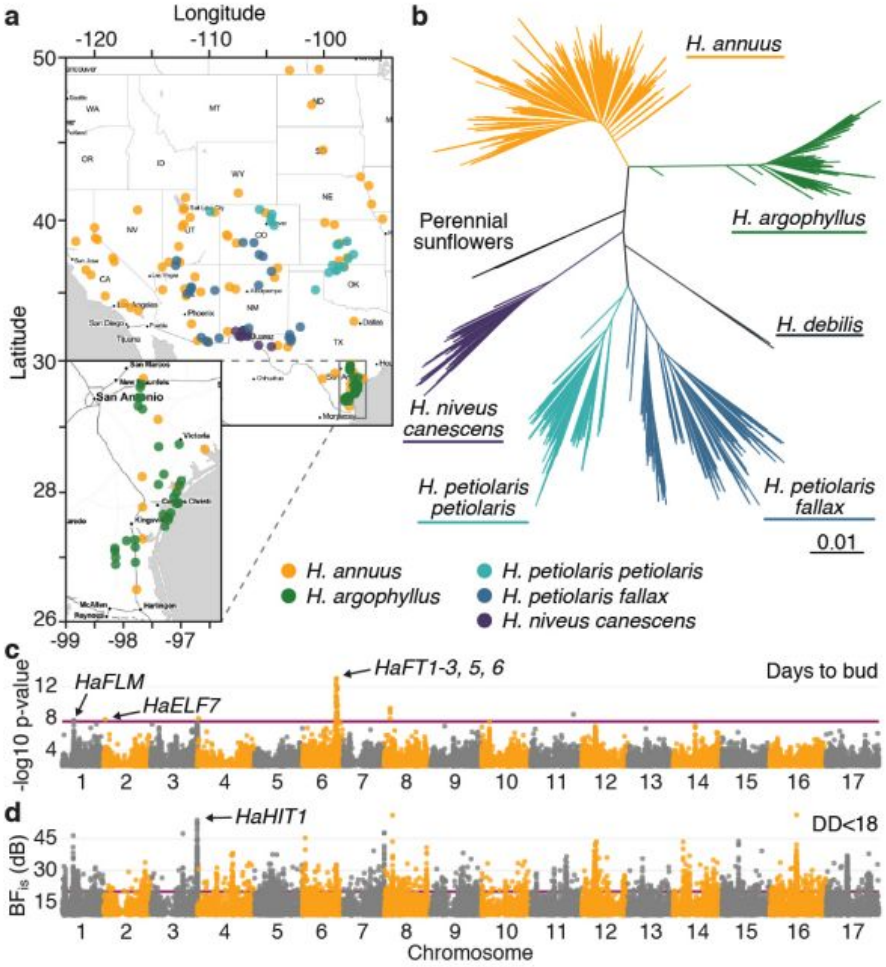
- Different wild species/ecotypes are adapted to specific environments.
- These adaptations are often maintained, even though there is often admixture that occurs (like introgression).
- How????

3 Sunflower Species Were Considered

1. *Helianthus annuus*
    a. Wild Progenitor of Modern Sunflower
2. *Helianthus petiolaris*
3. *Helianthus argophyllus*

Setup

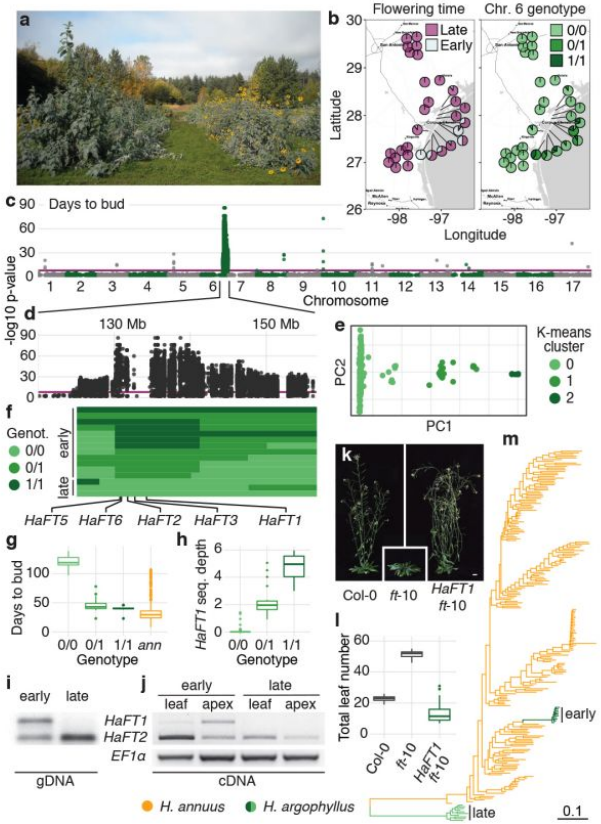
- Collected 10 plants from each of 151 populations amongst the three species.
- Crossed a random pair within the same population
- Phenotyped plants and ultimately sequenced 1401 of them.
- Enriched for genic space - still pretty low coverage
- Called SNPs w.r.t the sunflower reference
- GWAS on a bunch of different traits


a
Longitude
-120
-110
-100
50
40
30
28
26
Latitude
-99
-98
-97
San Antonio
b
H. annuus
H. argophyllus
Perennial sunflowers
H. debilis
H. niveus canescens
H. petiolaris petiolaris
H. petiolaris fallax
0.01
H. annuus
H. argophyllus
H. petiolaris petiolaris
H. petiolaris fallax
H. niveus canescens
c
-log10 p-value
HaFLM
HaELF7
HaFT1-3, 5, 6
Days to bud
d
BFis (dB)
HaHIT1
DD<18
Chromosome

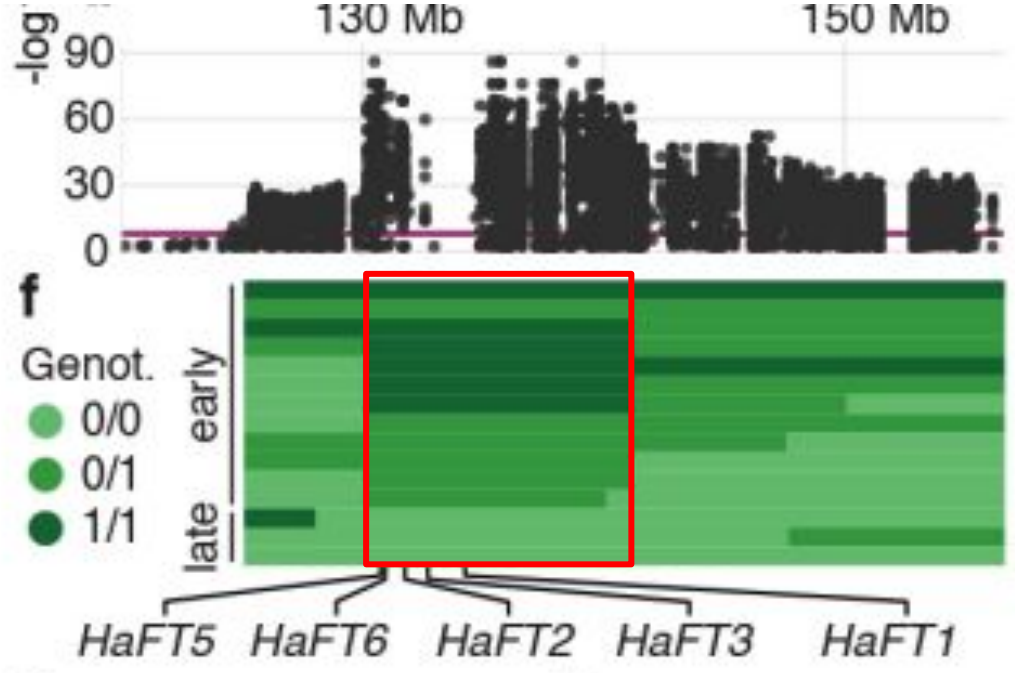
Flowering Time Between Coastal and Inland Populations

*Late flowering in inland populations has been naturally selected for - avoid flowering in hotter time of year

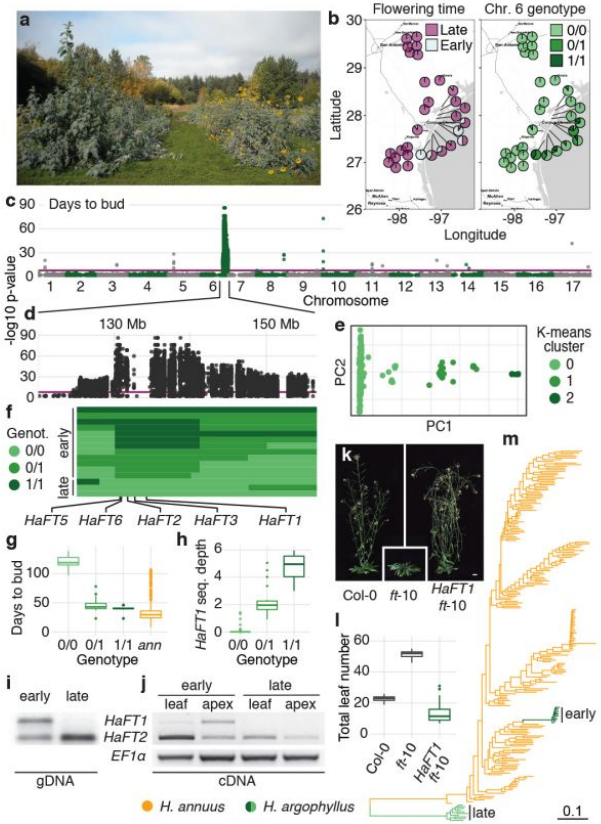
Flowering Time Between Coastal and Inland Populations



Flowering Time Between Coastal and Inland Populations



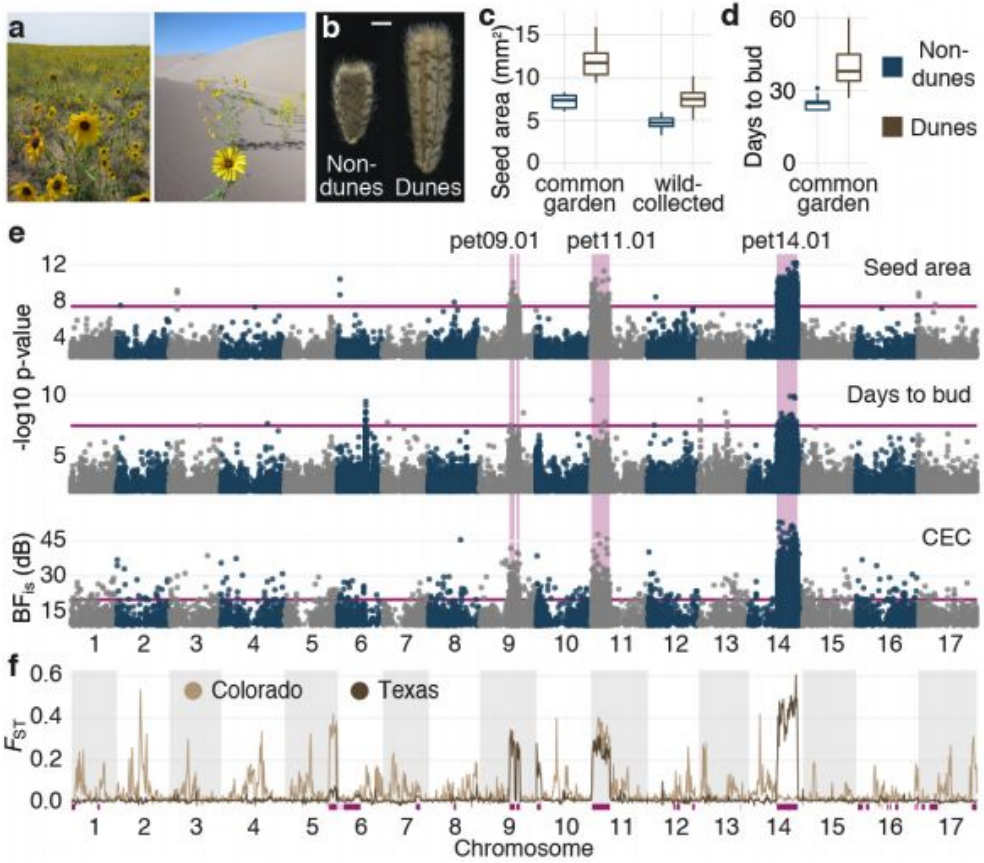
Flowering Time Between Coastal and Inland Populations

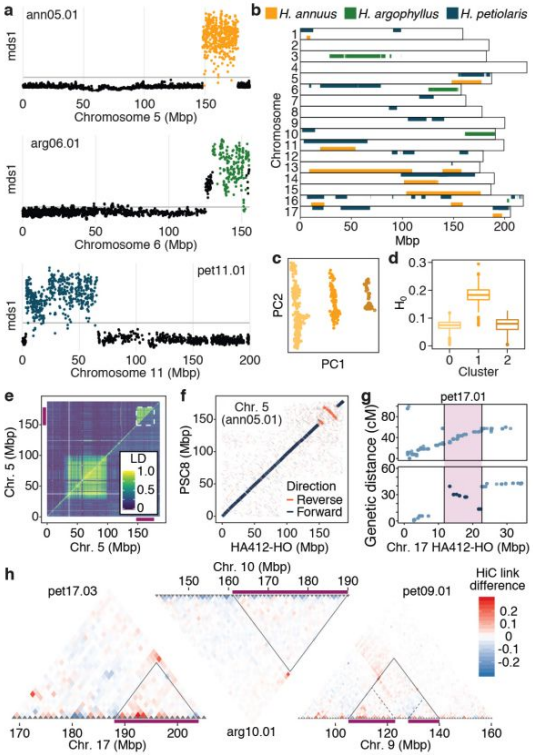


Takeaways

1. Large GWAS signal on chr6 associated with later flowering
2. A 10 Mbp haplotype explains most of the flowering time variation
3. Late flowering genotypes have a deletion of a known regulator.
4. Take an Arabidopsis plant with a AtFT mutation that flowers late
    a. Ectopically express this regulator and it flowers early again.
5. Phylogeny shows when this haplotype arose.

Seed Size


a
b
Non-dunes
Dunes
c
Seed area (mm²)
15
10
5
0
common garden
wild-collected
d
Days to bud
60
30
0
common garden
Non-dunes
Dunes
e
pet09.01
pet11.01
pet14.01
Seed area
Days to bud
CEC
-log10 p-value
BF_is (dB)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
f
Colorado
Texas
F_ST
0.6
0.4
0.2
0.0
Chromosome


a
ann05.01
mds1
0
50
100
150
Chromosome 5 (Mbp)
arg06.01
mds1
0
50
100
150
Chromosome 6 (Mbp)
pet11.01
mds1
0
50
100
150
200
Chromosome 11 (Mbp)
b
H. annuus
H. argophyllus
H. petiolaris
Chromosome
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
0
50
100
150
200
Mbp
c
PC2
PC1
d
H_o
0.3
0.2
0.1
0
0
1
2
Cluster
e
Chr. 5 (Mbp)
150
100
50
0
LD
1.0
0.5
0
0
50
100
150
Chr. 5 (Mbp)
f
Chr. 5
(ann05.01)
PSC8 (Mbp)
150
100
50
0
Direction
Reverse
Forward
0
50
100
150
HA412-HO (Mbp)
g
pet17.01
Genetic distance (cM)
80
40
0
60
30
0
0
10
20
30
Chr. 17 HA412-HO (Mbp)
h
pet17.03
Chr. 10 (Mbp)
150
160
170
180
190
pet09.01
HiC link
difference
0.2
0.1
0
-0.1
-0.2
170
180
190
200
Chr. 17 (Mbp)
arg10.01
100
120
140
160
Chr. 9 (Mbp)

Large Haploblocks Associated with More Traits