

ASBC Annual Meeting

June 4–7 ■ Fort Myers, Florida

See what SCIENCE can brew for you

MCCLXXXIV.

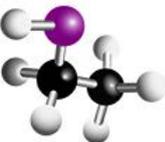
Breeding Hops A Quick Overview

Nicholi Pitra



Hop breeding overview

- The plant
- The steps taken by breeders
- Some challenges
- Where do brewers fit in to all of this?
- Molecular overview



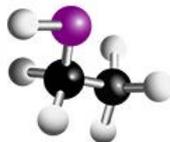
Hop breeding overview

- Perennial

Comes back every year

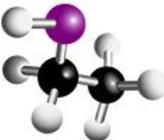
- Out crossings species

Must have sex; male and female required



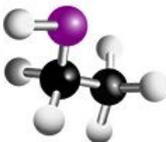
Hop breeding overview

- Unlike breeding other plants
- Much more like breeding clonal immortal cattle that can have 1000s of clonal immortal kids
- Looking for the Few that stand apart



Hop breeding overview

- The data can get exponentially large
- Data management is one of the biggest challenges in modern hop breeding

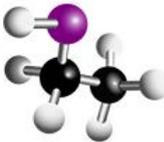


Hop breeding overview

Parental Selection

- Intuition
- Experience
- Data
 - Yield
 - Disease
 - Aroma flavor
 - Market

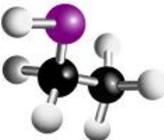
CROSS ID	# Plants to town	# with disease	Dead	% Susceptible	Female Parent	Male Parent	Comments
5581	321	216	0	0.672897	Hall Mf	198165	male: 50% Cascade, 50% HAPPY male
5582	321	121	0	0.376947	N. Brewer	2312123	male: 50% Cascade, 50% HAPPY male
55855	37	16	0	0.432432	Tettngang	46556464	male: 50% Cascade, 50% HAPPY male
5586	213	8	0	0.037559	Saaz	1215513	male: 50% Cascade, 25% Ahil, 12.5% green bullet
5587	2185	1121	0	0.513043	Hall Mf	21320	male: 50% Cascade, 25% Saaz
5588	4210	175	0	0.041568	N. Brewer	65420	male: 50% Cascade, 25% Saaz
5589	2133	105	1	0.04925	Tettngang	312151	male: 50% Cascade, 25% Saaz
5590	74	14	0	0.189189	Centennial	5312120	male: 50% Cascade, 25% Saaz
5591	34	10	0	0.294118	654564	222323	male: 50% Cascade, 25% Saaz
5592	354	80	0	0.225989	189156	21561603	male: 50% S. Galena, 50% Saaz
55955	4	1	0	0.25	548996	32131	male: 50% S. Galena, 50% Saaz
5594	668	187	2	0.280781	33249	56515151	50%wilam., 25%mntre
5595	386	81	5	0.212598	786556	551521212	50%wilam., 25%mntre
5596	74	5	2	0.069444	985525	32121315	50%wilam., 25%mntre
5597	6	1	0	0.166667	15256	5305.523	50%wilam., 25%mntre
5598	55	11	0	0.2	9856	55111155	50%wilam., 25%mntre
5599	478	50	2	0.105042	85656	131231531	50%wilam., 25%mntre
400	668	218	5	0.328808	985484	31531531	50%wilam., 25%mntre
401	2143	141	3	0.065888	3255	31231531531	50%wilam., 25%mntre
4055	3521	47	0	0.013348	852741	51531233	male: 75% magnum B, 25% Saaz
404	2173	1121	4	0.516828	963852	20300	male: 50% saaz, 25% Saaz
405	2135	2111	4	0.990615	369258	153351	male: 50% saaz, 25% Saaz
406	399	187	9	0.479487	147258	3515131	male: 50% saaz, 25% Saaz
407	2109	2101	4	0.9981	258147	55303	male: 50% saaz, 25% Saaz
408	87	76	0	0.873563	369258	5135135120	50% yakima, 50% HAPPY
409	2177	1214	0	0.557648	14725	350251	50% yakima, 50% HAPPY
410	343	81	0	0.236152	252525	1566	50% Casc, 25% green



Hop breeding overview

Crossing

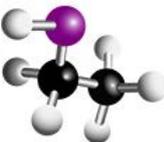
- Collect Pollen
 - Or side arms
- Monitor females to know when they are ready
- Pollen bags



Hop breeding overview

Seeds

- Collected from mature cones
- Spend several months in freezer
- This cold period is necessary for germination

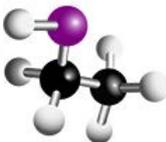


Hop breeding overview

Year 0 – 1

Seedlings

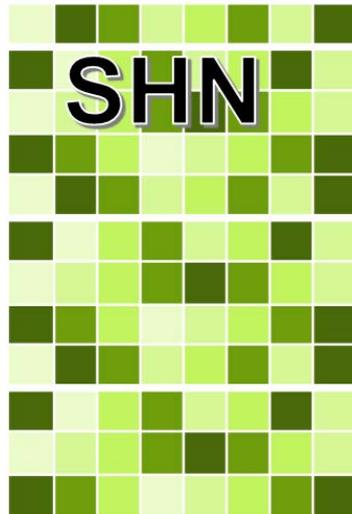
- Seedling Screening
 - Diseases
- Segregation of traits
 - Learn about genetics of parents
- Marker screening
- 50 crosses, can produce approx 25,000 seedlings



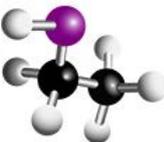
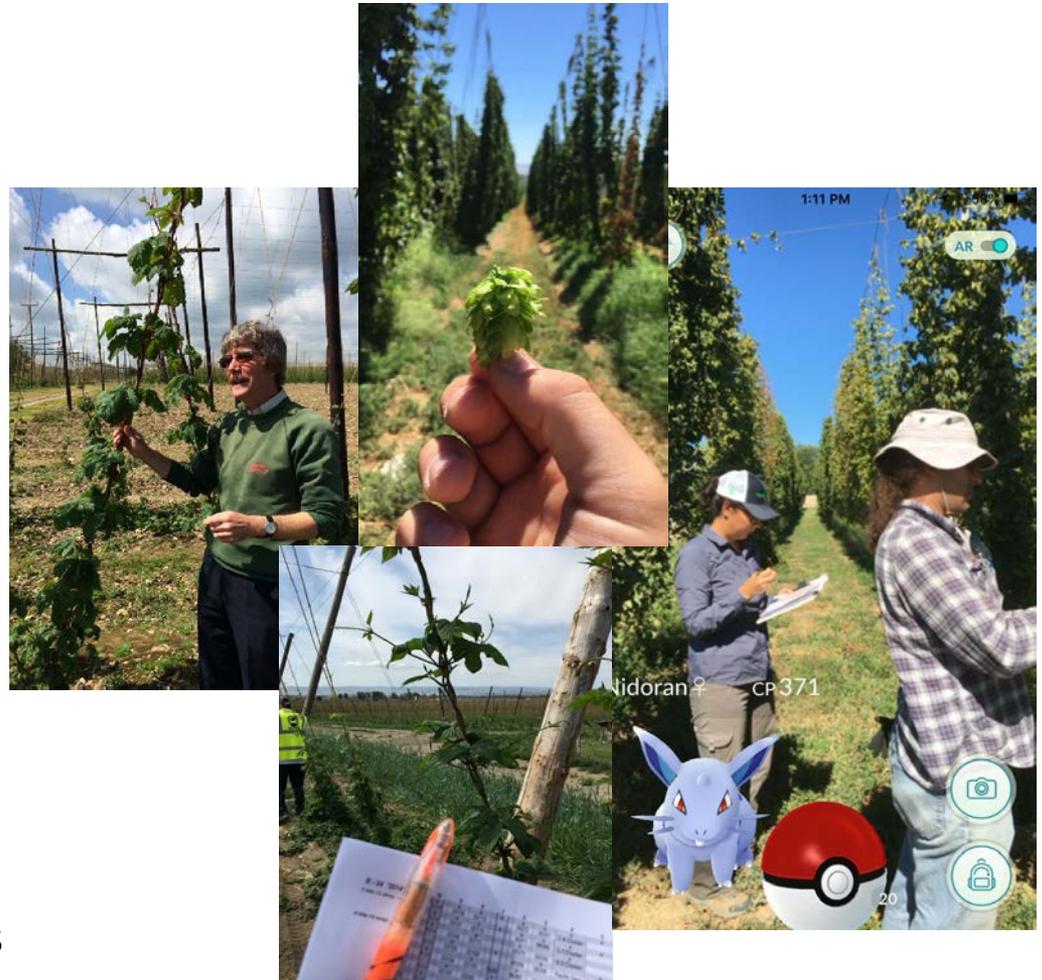
Hop breeding overview

Year 2 – 3 Single Hill Evaluation

- Takes these plants 2 years to mature
- Chemical traits
- Maturity time
- Cone traits
- Disease resistance



≈7,000 plants

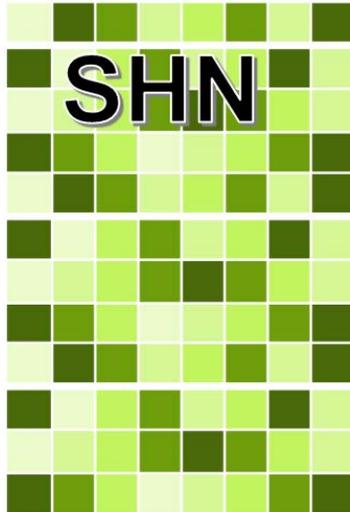


Hop breeding overview

Year 2 – 3

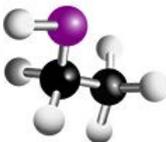
Single Hill Evaluation

- Disease resistance
- One of the Biggest industry challenge



≈7,000 plants

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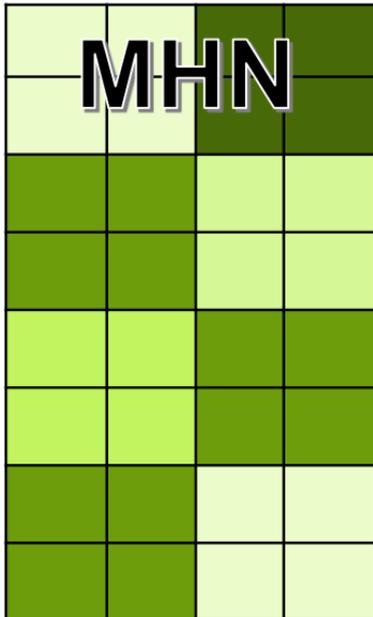


Hop breeding overview

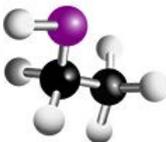
Year 4 – 6

Multi Hill Evaluation

- Chemical traits
- Aroma stability
 - across plants and locations
- 1st brewing trials
- BREWER INVOLVMENT STARTS HERE



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Hop breeding overview

Year 7 – 10

Semi Commercial

- Large scale Confirmation on agronomic
- Large scale Confirmation chemical traits
- Extensive brewing tests
- This is where brewers can take a hop to the NEXT level

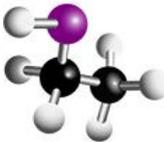


MHN			
5 acre			
OR			
40 to 80 hill			



2 varieties/year

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Hop breeding overview

Think about **10 years**.....

- The typical breeding cycle can take nearly 10 years
- In 10 years it will be 2027
- 10 years ago it was 2007

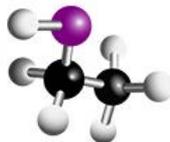


Ginormous



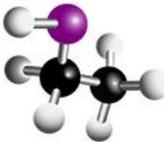
Sometimes I just pop up for no reason at all. Like now.

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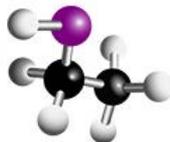
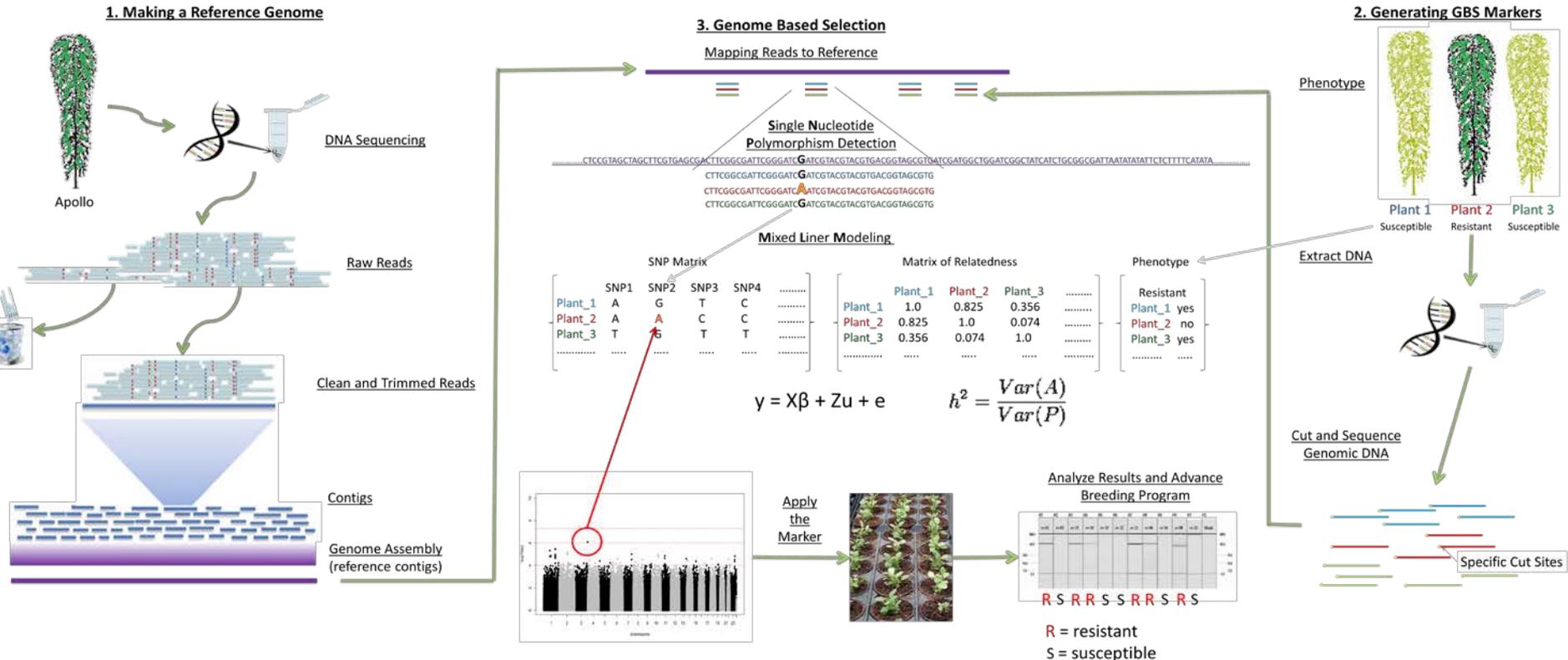
Hop Molecular Breeding Overview

- 2015 Suntory published the first draft of the hop genome
- Since then Molecular markers for many hop traits have been published
 - Sex
 - PMR
 - Chemical traits
- Some parts of the industry have turned to molecular breeding
 - Save time in breeding turnaround
 - Enrich breeding yard with more potential “winners”
 - Phenotyping abilities that were previously unattainable
 - Gain over all knowledge of the crop



Hop Molecular Breeding Overview

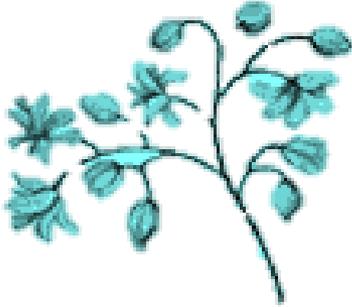
MAKING A GENETIC MARKER



Hop Molecular Breeding Overview



Resistant Female
MOM resistance



Resistant Male
DAD resistance

ALL Resistant KIDS

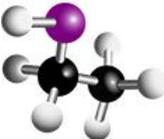


MOM resistance

BOTH

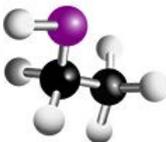
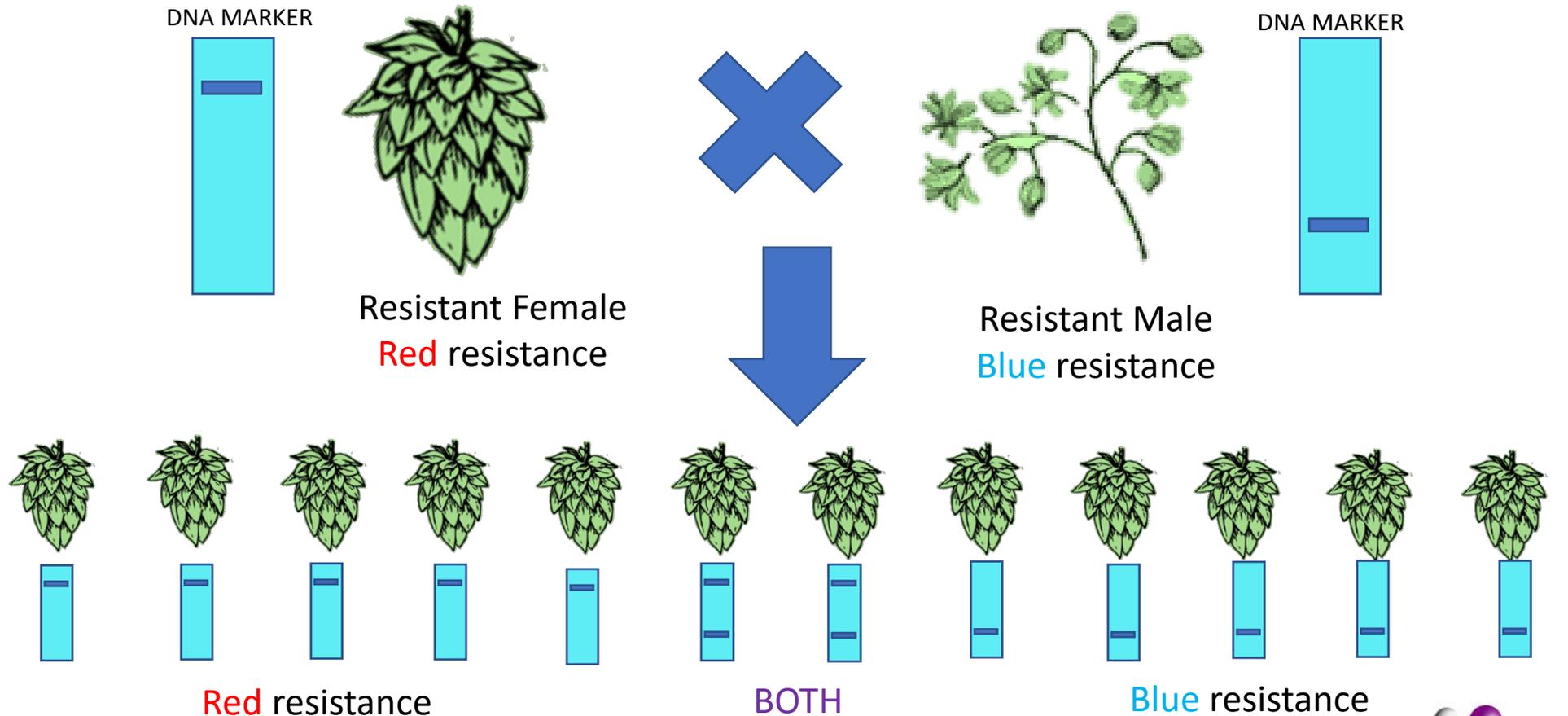
DAD resistance

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Hop Molecular Breeding Overview

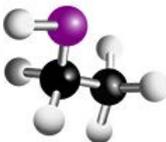
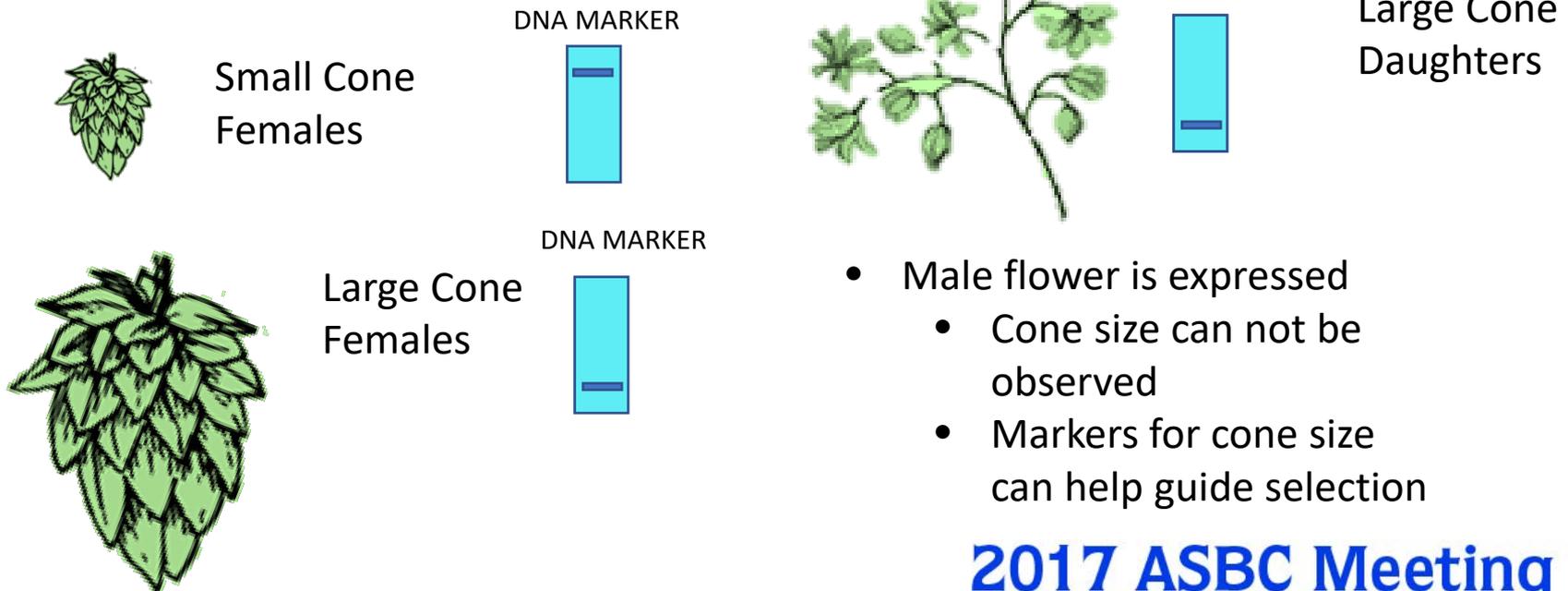
- In reality you can not see this with your eyes.
- With genetic markers you can



Hop Molecular Breeding Overview

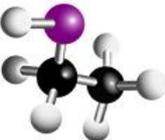
- Phenotyping males in this outcrossing plant is also very important
- Previously very little has been done
 - Disease
 - Vigor
- Using genetic markers we can ask males about the potential traits of there daughters

EXAMPLE: A Study finds:



Hop Molecular Breeding Overview

- Molecular breeding can help breeders
 - Make better crosses
 - Make better selections
 - Confidently advance lines accelerating the processes
- Help the industry by helping breed in more durable resistances and/discovering new ones
- Many other applications and I love talking about this so if you want to know more please feel free to contact me or stop me out at the beach party.



THANKS.