



**HOME
BREW
CON**
2022

What makes a hop American?

*... and where are
American hops headed?*

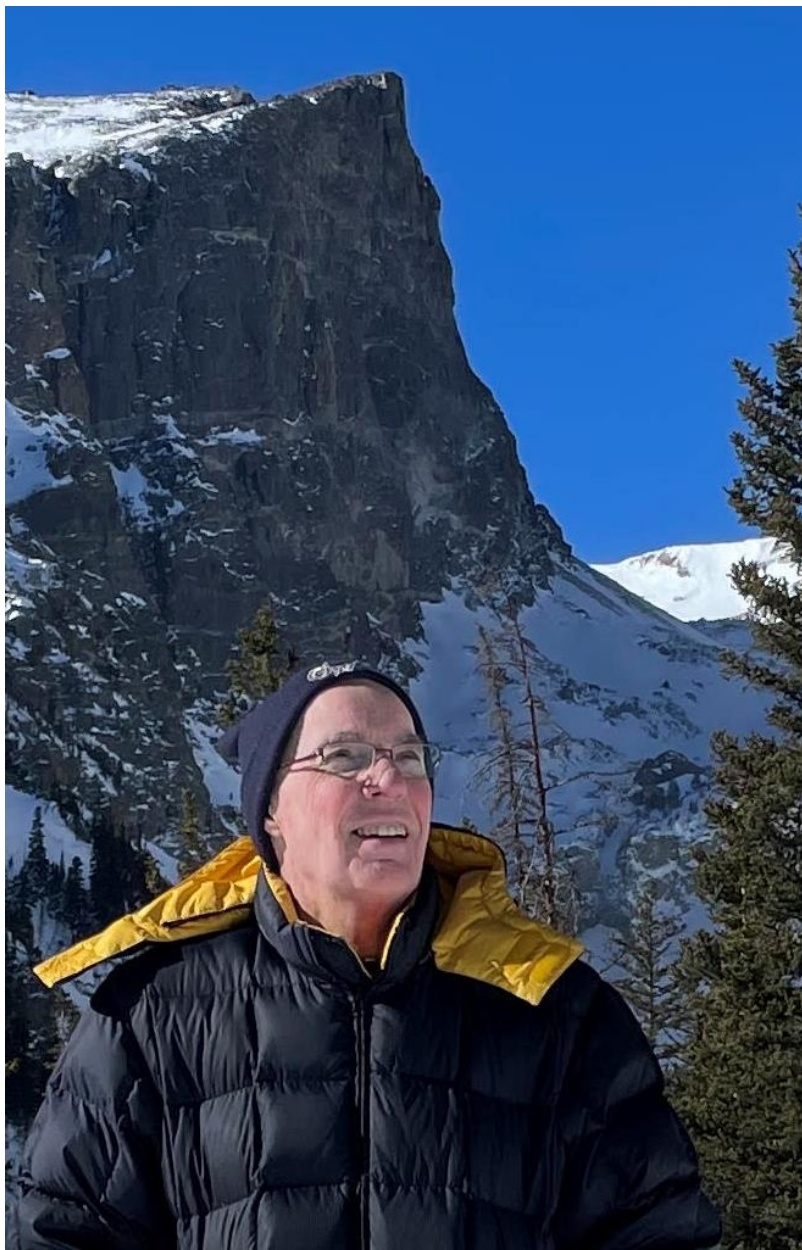


#HOMEBREWCON

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Stan Hieronymus

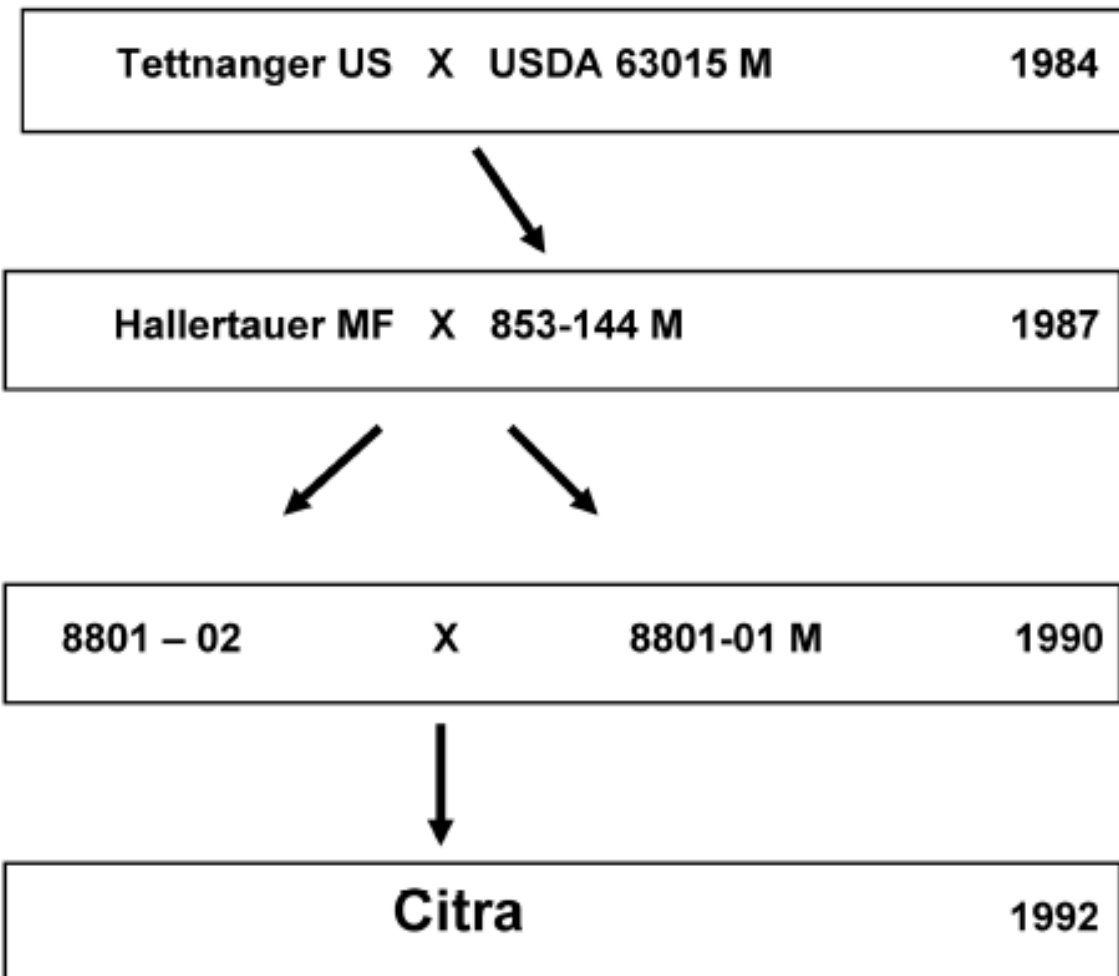
Author

For the Love of Hops

Brewing Local

Brew Like a Monk

Brewing With Wheat



Pedigree of Citra:

Hallertauer MF	50%
Tettnanger US	25%
Brewers Gold	19%
East Kent Golding	3%

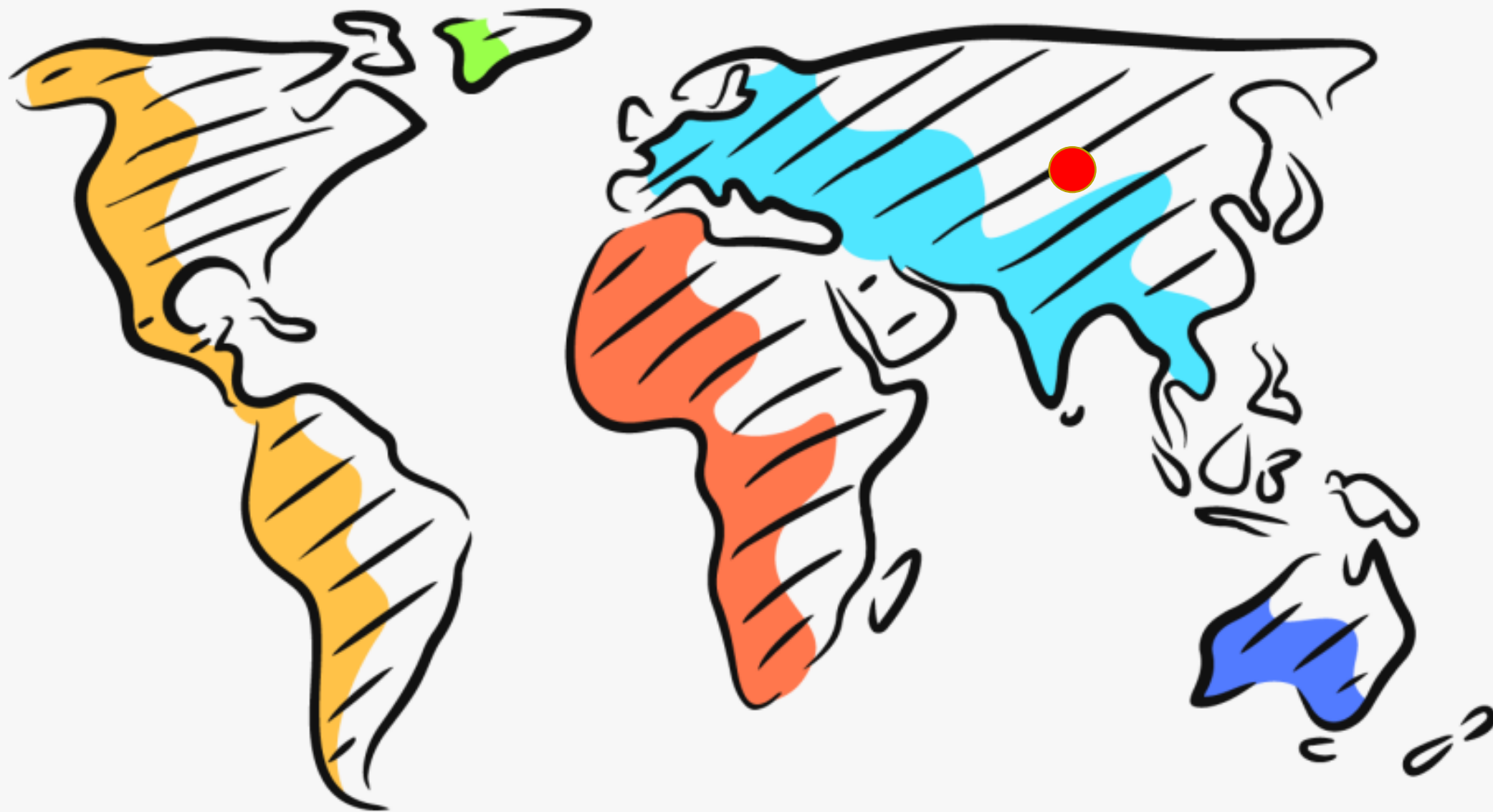
A long time ago, in land far, far away...

The flavor of Manitoba

Genotypes: Who's your mama?

Phenotypes: Sister, that's a new look

Did you get that number?







5 botanical varieties of *Humulus lupulus*

cordifolius (found in Eastern Asia, Japan)

lupuloides (Eastern and north-central North America)

lupulus (Europe, Asia, Africa; later introduced to North America)

neomexicanus (Western North America)

pubescens (primarily Midwestern United States)



Landrace varieties

“We like the hop that grows on this side of the road. We’re not so happy with the hop that grows on that side of the road.”

- Fuggle and Golding from England
- Tettnanger, Spalter and Hallertauer Mittelfrüh from Germany
- Saaz from Bohemia (now the Czech Republic)

	Alpha acids	Beta acids	A/B ratio	Cohumulone	Total Oil
Canadian wild	2.42	3.57	.74	55.37	.31
U.S. wild	3.60 (1.41)	3.93	1.00	56.52	.56
U.S. cultivars	8.72 (3.20)	4.38	2.01	33.78	.67
Mixed cultivars	8.13	5.12	1.59	27.97	.94
Caucasian wild	2.39 (0.85)	2.89	0.84	21.19	.13
European wild	2.38 (1.25)	3.66	0.69	24.27	.26
European cultivars	2.57 (0.97)	3.55	0.82	26.80	.55

Source: “Evaluation of genetic variability of wild hops in Canada and Caucasus region by chemical and molecular methods,” J. Patzak, et al





“American hops may also be dismissed in a few words.

“Like American grapes, they derive a coarse, rank flavor and smell from the soil in which they grow, which no management, however careful, has hitherto succeeded in neutralizing.

“There is little chance of their competing in our markets with European growth.”

-The Edinburgh Review, 1862

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“

All our books tell us that the varieties of hops cultivated over the world have all arisen from the one species, *Humulus lupulus*. I am convinced that this is not the case.

”

- E.S. Salmon



English brewers' evaluation of Brewer's Gold

Mr. C. Gibson Tosswill has detected in it a difference from the usual American aroma, and has characterized it on several occasions as a distinctive “Manitoba” aroma, also commenting on a “pungent ‘Manitoba’ flavor.”

J.S. Ford of the Wm. Younger & Co.'s Brewery in Edinburgh, Scotland:

- Physical examination “pronounced, unpleasant nose.”
- In the dry hop tests at 4 ounces per barrel, “too bitter, rank and slightly unpleasant.”

“It (the American hop) is rather a stronger bitter than the European hop, and with a stronger scented flavor in many cases.”

“It will probably be found that the ‘tang’ which American varieties of hops impart is bound up with the α -acid constituent of the soft resins, a high percentage of which is found both in American varieties and in the New Varieties.”

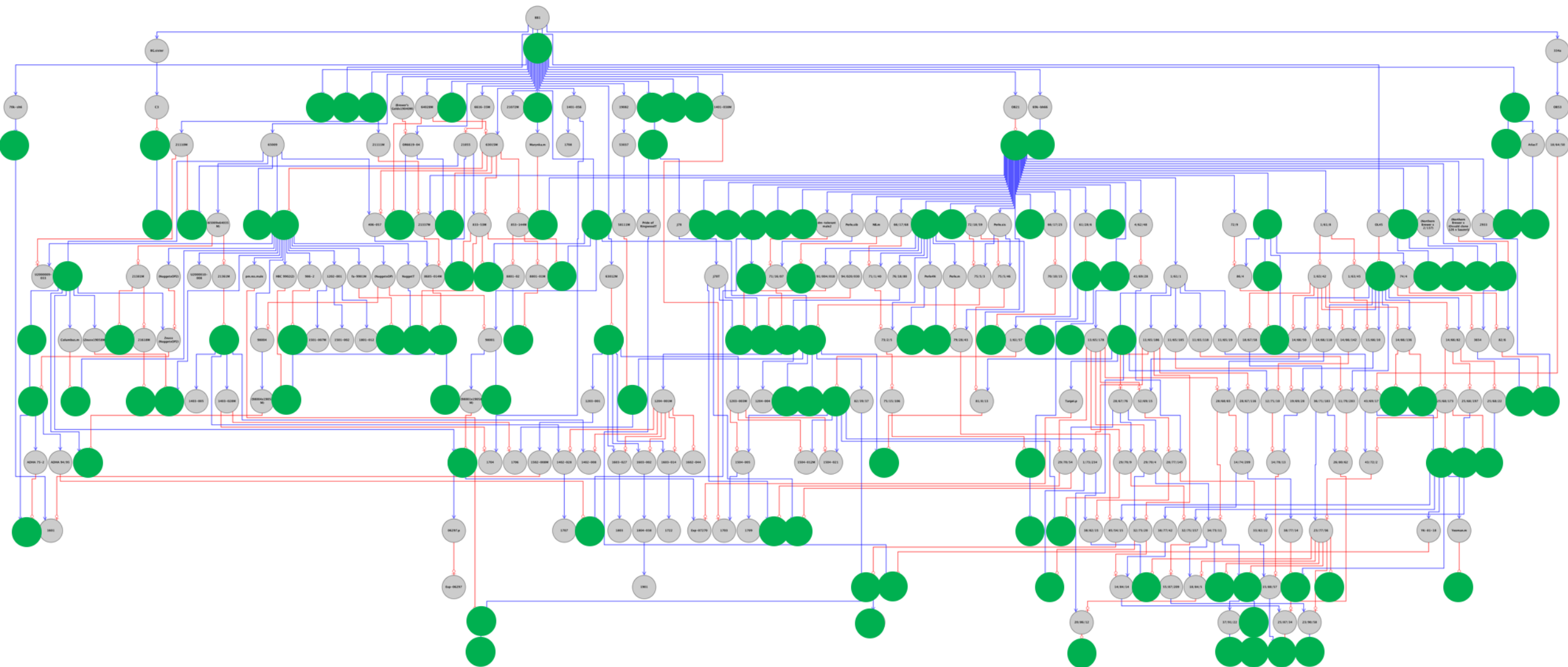
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Credit: Josh Havill, University of Minnesota



In an article in 1940, Salmon describes BB1 as being *H. americanus* and refers this to a paper in 1915 where he describes the *americanus* species based on Nuttall (1847). In 1978, Small states that the *americanus* specimens used by Nuttall and cited by Salmon are *lupuloides* and “unquestionably not assignable to *H. l. var neomexicanus*.” In 1980, Small specifically addresses the origin of BB1 but concludes ambiguously that “there is pronounced intergradation between *lupuloides* and *neomexicanus*.” He assigns some of the progeny of BB1 to *lupuloides* and some to *neomexicanus*, which suggests that BB1 carries traits of both subspecies.

In a paper of 1915, Salmon notes that he has been distinguishing male and female accessions of *neomexicanus* from *lupulus* since 1908. He used the term *neomexicanus* for several of his accessions and records from 1914 and 1921, which covers the period when he obtained and used BB1. But he did not use this term for BB1, which, by implication, suggests that Salmon did not consider BB1 to be *neomexicanus*. Together with Small’s re-examination of Nuttall’s specimens, I think the evidence suggests that BB1 was predominantly *lupuloides*, but perhaps with a little *neomexicanus* in its parentage.

– Peter Darby

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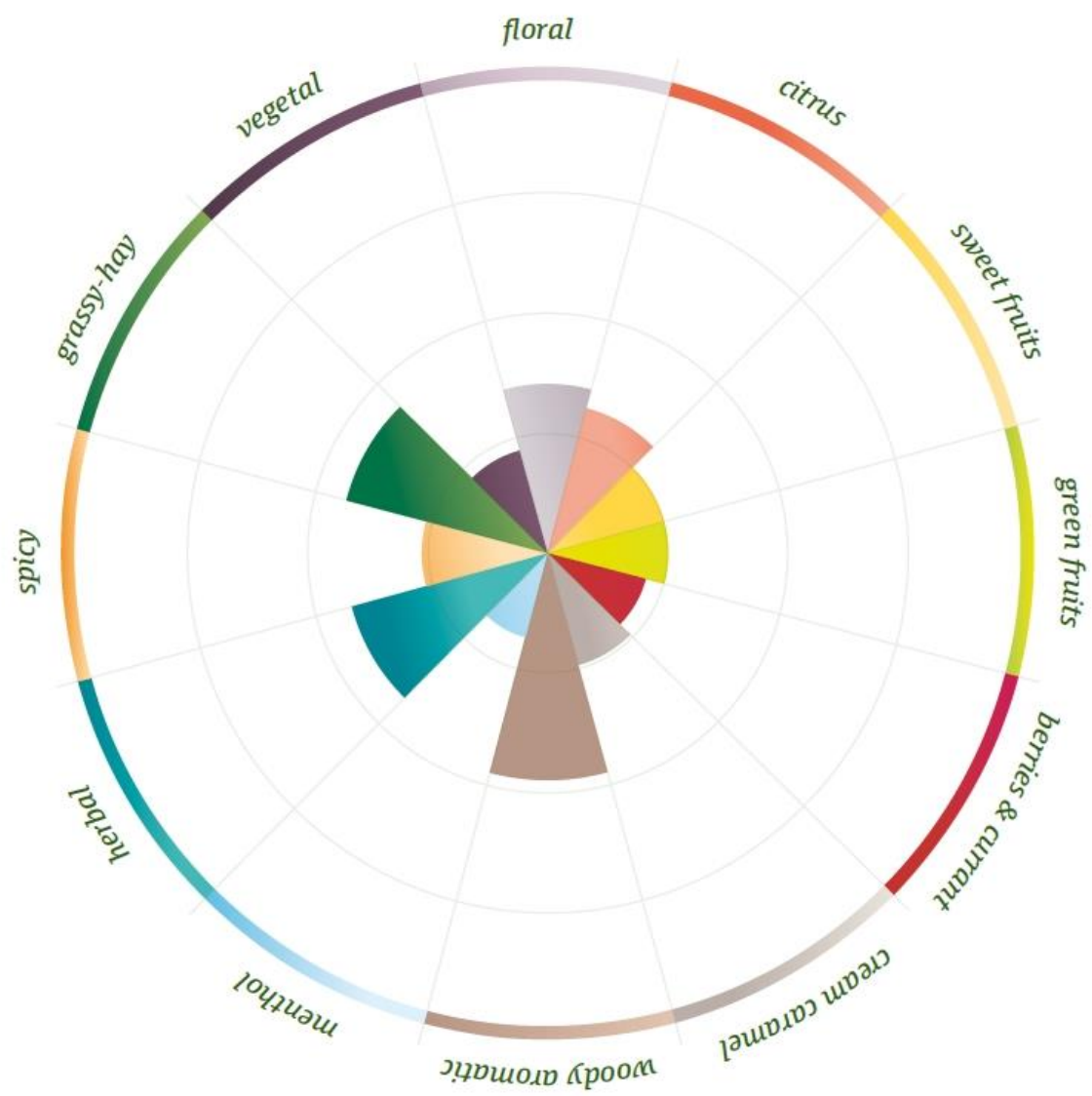
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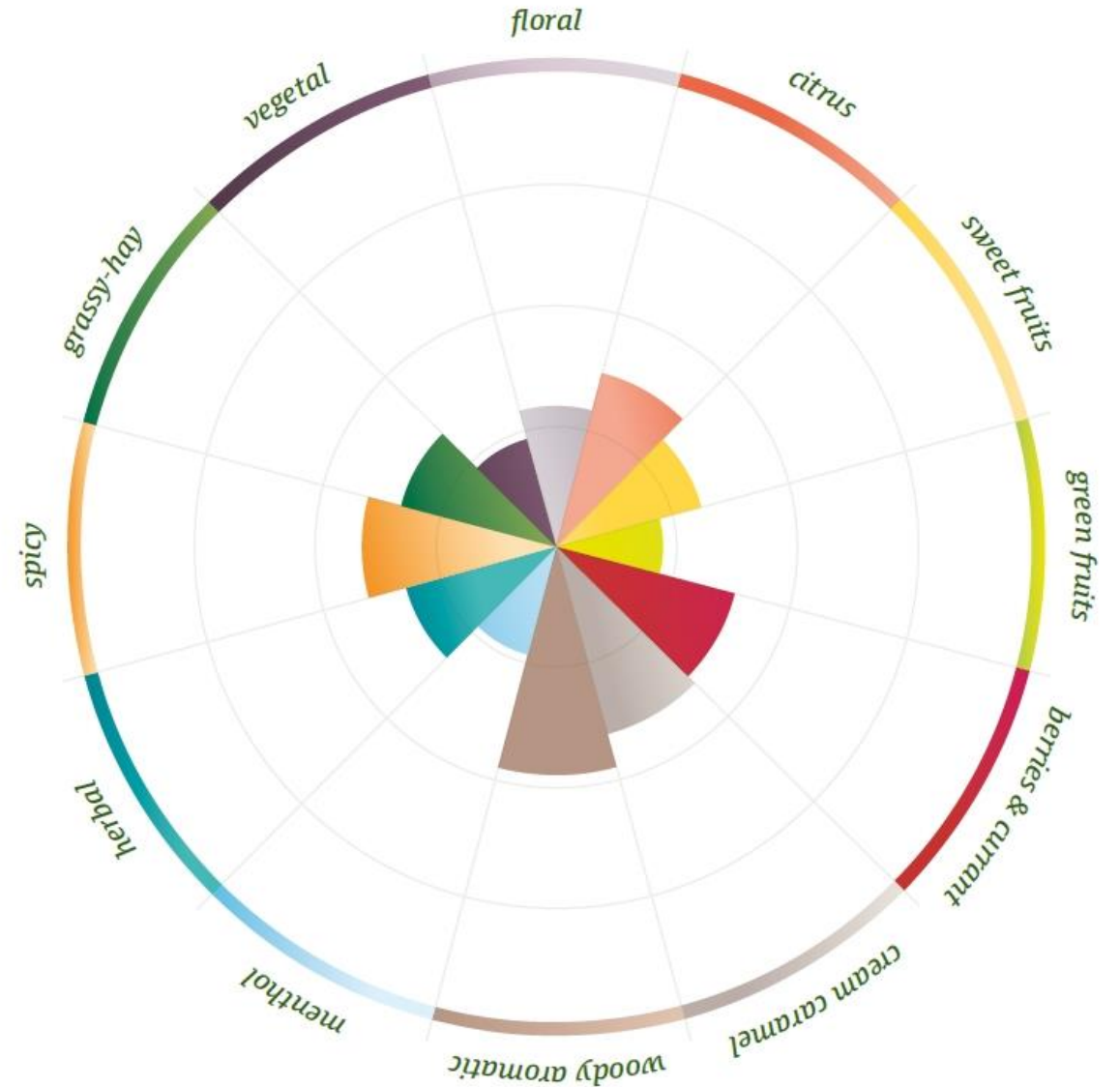
Did you get that number?

Terroir

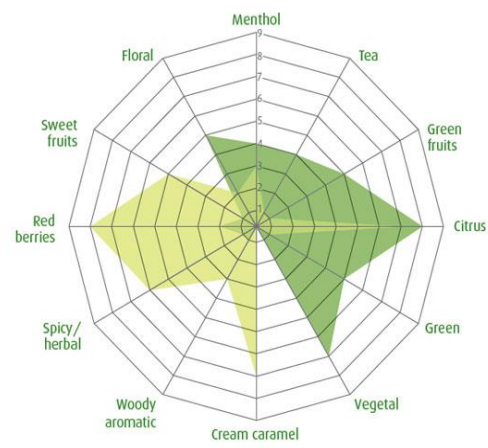
- Environment and epigenetics combine to make hops from a particular area unique.
- All plant species have methylated DNA, which causes some genes to be “switched on” more easily than others.
- Differences in soil, day length, temperatures, amount of rainfall, and terrain all may influence the methylation process.
- The underlying DNA does not change, but the methylation pattern can be different.



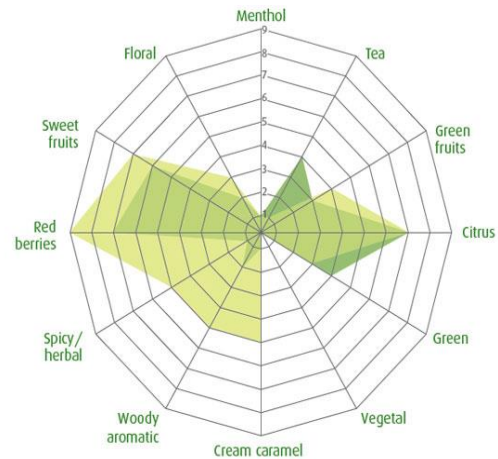
Saaz



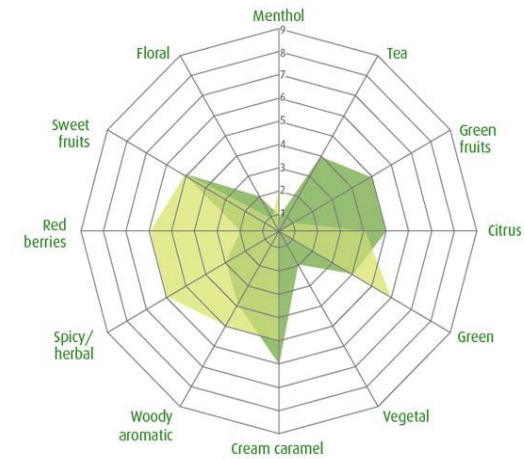
Tettnanger



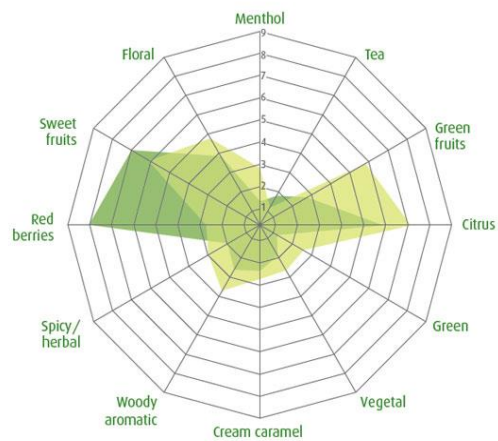
① ■ Cascade USA (cold infusion*) ■ Cascade USA (raw hops)



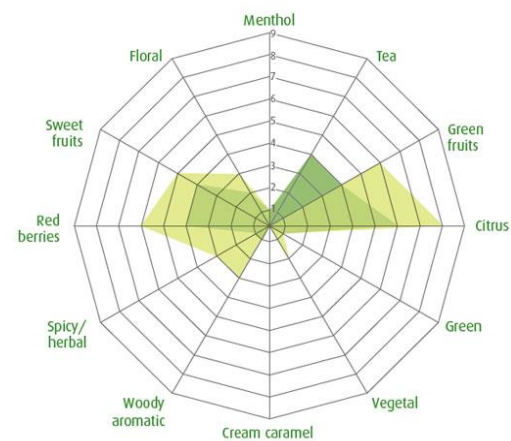
① ■ Cascade Australia (cold infusion*) ■ Cascade Australia (raw hops)



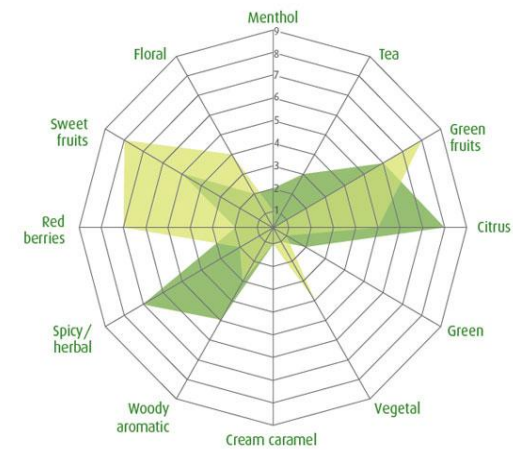
① ■ Cascade UK (cold infusion*) ■ Cascade UK (raw hops)



① ■ Cascade New Zealand (cold infusion*) ■ Cascade New Zealand (raw hops)



① ■ Hallertau Cascade (cold infusion*) ■ Hallertau Cascade (raw hops)



① ■ Hersbrück Cascade (cold infusion*) ■ Hersbrück Cascade (raw hops)



BARTHHAAS

“

I will only say that Americans like *too much* in the glass. There's always *too much* going on. Other than that, if we're living on Planet America, that's not necessarily the fault of Americans.

”

- Antonio Terni, Italian winemaker

	Alpha acids	Beta acids	A/B ratio	Cohumulone	Total Oil
Canadian wild	2.42	3.57	.74	55.37	.31
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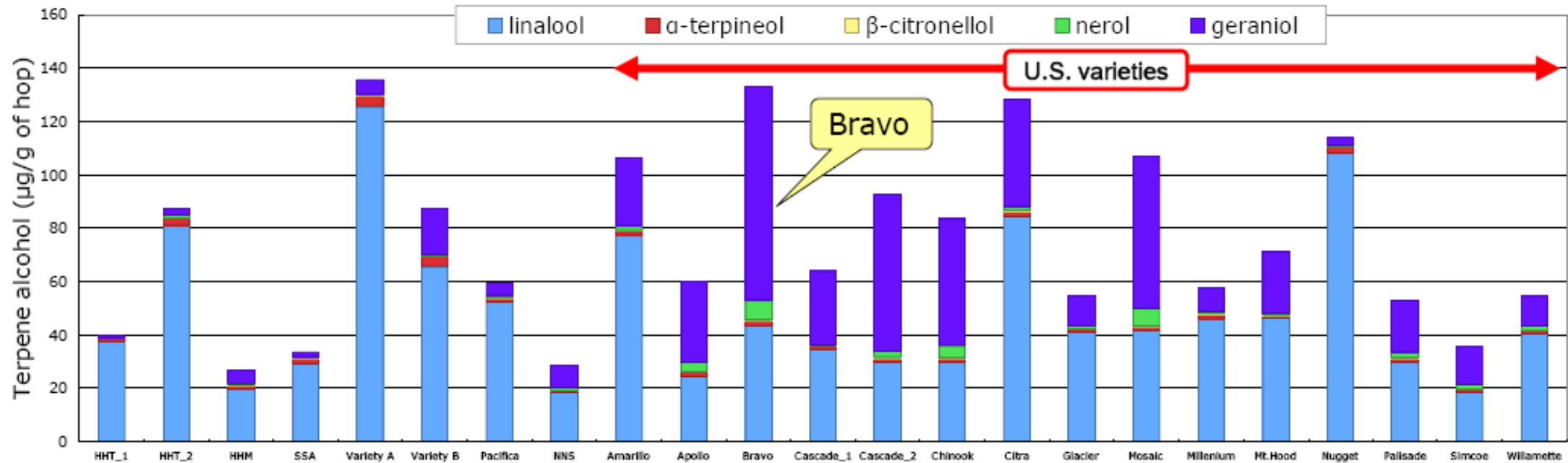
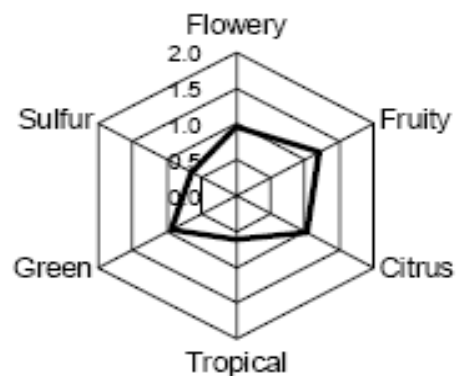


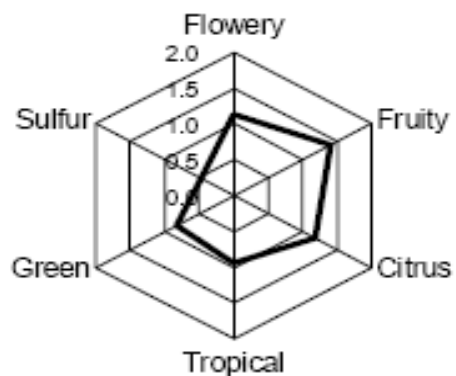
Figure 3. Comparison of monoterpene alcohol compositions in various hops: 2007 crop (HHT_1, HHM, Variety A, Variety B, Pacifica, NNS, Cascade_1, Citra, Millennium and Nugget); 2008 crop (Amarillo, Apollo, Bravo, Cascade_2, Chinook, HBC369, Glacier, Mt. Hood, Palisade, Simcoe and Willamette); 2009 crop (HHT_2 and SSA).

Source: "Analysis of Hop-Derived Compounds in the U.S. Hops," Kiyoshi Takoi, et al.



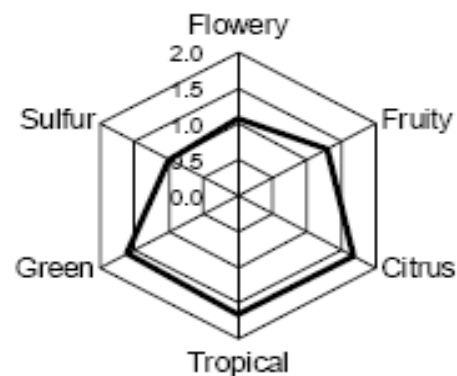
Bravo

Linalool	78	µg/L
β-citronellol	36	µg/L
Geraniol	69	µg/L



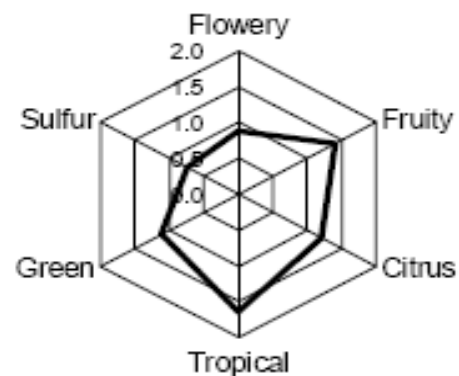
Cascade

Linalool	36	µg/L
β-citronellol	29	µg/L
Geraniol	22	µg/L



Citra

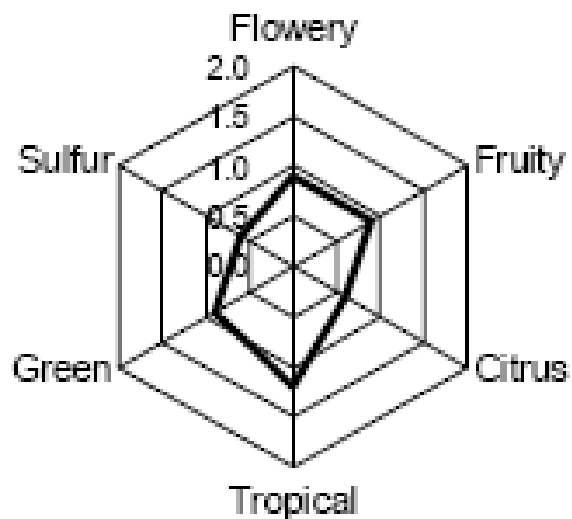
Linalool	108	µg/L
β-citronellol	27	µg/L
Geraniol	23	µg/L



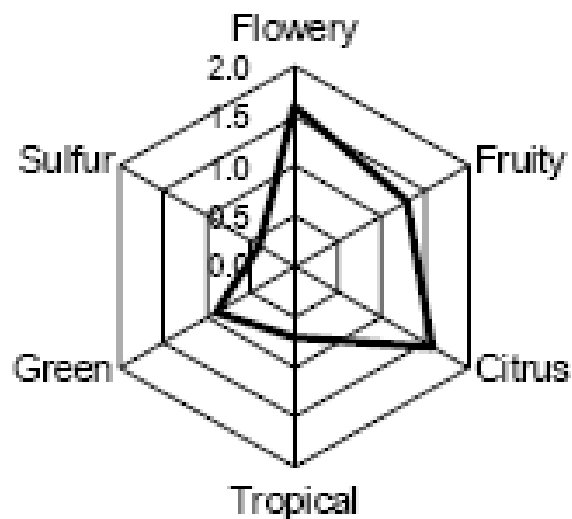
Mosaic

Linalool	70	µg/L
β-citronellol	28	µg/L
Geraniol	47	µg/L

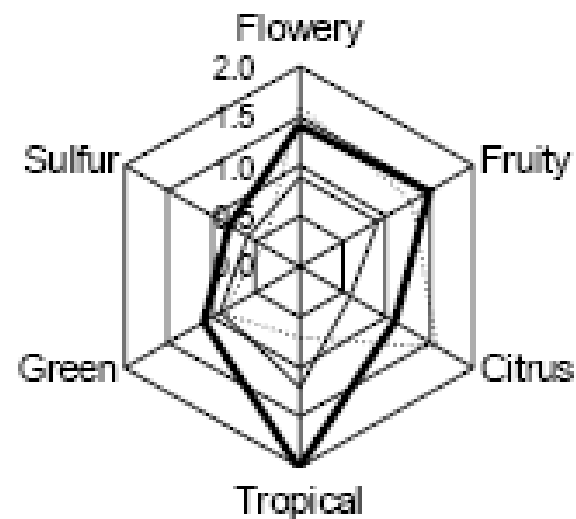
Source: "Control of Hop Aroma Impression of Beer with Blend-Hopping using Geraniol-rich Hop," Kiyoshi Takoi, et al., Brewing Science



4MSP



LGC mix

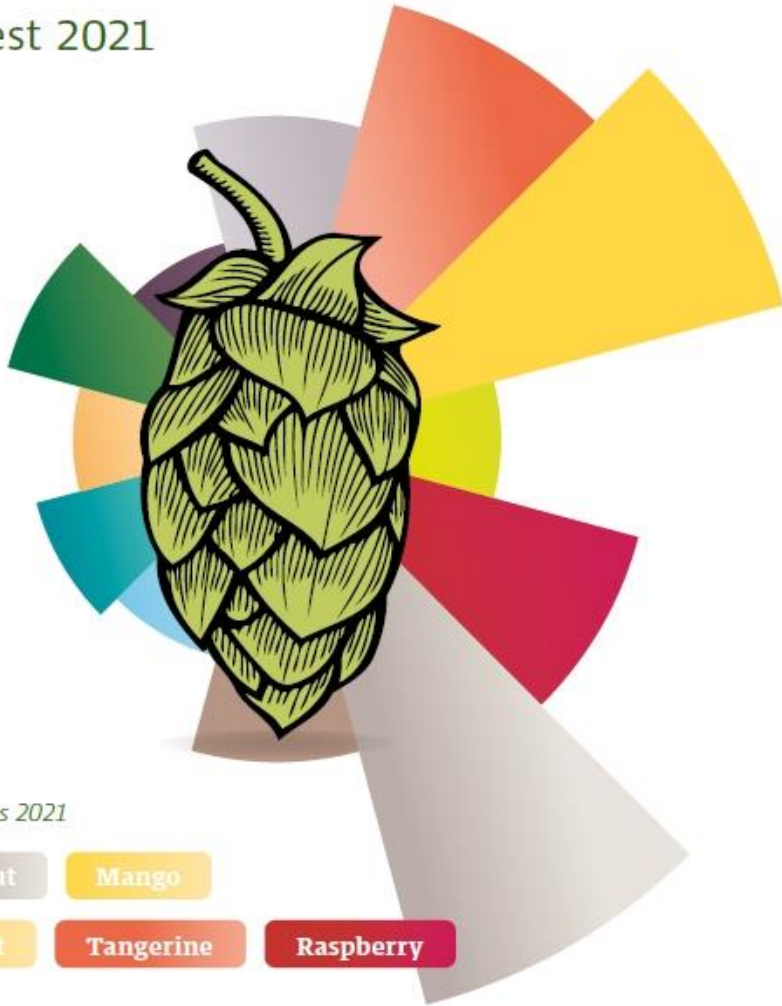


4MSP + LGC mix

Sabro®

HBC 438 c.v.

Harvest 2021



Key Flavors 2021

Coconut

Mango

Apricot

Tangerine

Raspberry

American characteristics

- Higher alpha acids
- Higher alpha/beta ratio
- More essential oil, much of it myrcene
- More monoterpene alcohols, particularly geraniol
- More thiols, free and bound

American influence

Australia – Cluster and Brewer's Gold (via her offspring) have both been used in the Australian breeding program.

New Zealand – Several varieties, including Nelson Sauvignon, are offspring of Cluster.

Germany – Mandarina Bavaria, Huell Melon, Hallertau Blanc and Tango are all offspring of Cascade.

England – Jester, Godiva, Harlequin and Olicana and several other relatives trace their “new world” character back to Cascade.

France – Mistral and Elixir are both daughters of Cascade.

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New names, new numbers

Vista – Newest public variety.

Luminosa – Daughter of Sorachi Ace (but no dill).

ADHA 1624 – Berry, green mango, but also pine and a bit of dank.

HBC 630 – Raspberry, cherry-like candy aroma.

HBC 586 – Mango, guava, lychee.

HS 17701 – 62% “other oil.”

Helios – Producing alpha using fewer resources.

Next generation sequencing, next generation hops

- The first reported identification of **molecular markers** (SNPs, single-nucleotide polymorphisms) in hops was in 1995.
- Four years later, only 224 had been discovered.
- Today, **more than one million SNPs** have been found across the thousands of hop cultivars worldwide.
- Problem No. 1: **Matching markers and desirable traits**—whether they are for disease resistance or unique flavors—may take longer for some characteristics than others.
- Problem No. 2: Hop do not always reproduce as expected. That means no matter which desirable characteristics they might exhibit, **certain cultivars may still not be suitable for breeding**.

Shawn Townsend, OSU (Indie Hops breeding)

- More “boutique” hops that may specialize in one to a few flavors and brewers simply “paint” with these specialized hops to achieve a desired flavor and aroma. Gene editing and other genetic technologies may have a big impact on creating these designer hops.
- We'll still have the Stratas, Citras, Mosaics and Cascades to provide a backbone for the boutique hops. Time will tell, but I suspect Luminosa may be one of these boutique cultivars that really needs something else there to provide the backbone/foundation for all of the fruit notes that it provides.
- Agronomic characteristics that can mitigate the effects of climate change will become more important than they are today. We talk about this cultivar being fruity or that cultivar being citrusy, but how often do you hear people say that this cultivar is very water-use efficient, or that cultivar has excellent heat tolerance?
- We'll always be playing whack-a-mole with the various pests and pathogens, including new ones. Pest- and pathogen-resistant cultivars are still the preferred way to deal with these biotic stresses.

Josh Havill, University of Minnesota

- Breeders will be targeting a variety of traits, all which likely result from a changing climate.
- All of these changes are likely to influence traits that breeders are bound to be selecting for. Hotter and drier summers might mean that **diseases like downy mildew have less of an impact** because conditions are less conducive for disease establishment or spread but that means the weather might be more favorable to diseases such as powdery mildew or pests such as spider mites. That may also mean that growing season may be lengthened.
- Climate change is going to **affect different regions . . . differently**. We may see breeding for all of those traits simultaneously. We're going to need to boost the yield of aroma varieties, we'll likely continue to explore and develop new aromas (or combinations), we'll continue to and likely change the diseases or pests we target breeding for resistance (possibly because a new disease/pest emerges or is introduced, such as spotted lantern fly in the Eastern US), and we'll probably have to identify varieties that **thrive under hyper-variable weather conditions**.

Kayla Altendorf, USDA, Prosser, Washington

- I hope they are developed using **marker assisted selection or genomic selection** and will have known, well-described disease resistance packages.
- Their development time from cross to release is less - current average for USDA varieties is around 13 years. I hope we're at 8 years or fewer.
- Unique aromas, but also still a strong appreciation for the classics.
- We will have knowledge of their **water use efficiency** relative to other varieties, and will be actively evaluating and making selections using this information on an annual basis.
- Since HGA's report of drying being the most energy intensive part of hop production, I suspect we will be working towards having a better understanding of how certain cone morphologies and how irrigation or management practices can enable **more efficient drying**.
- We will have knowledge of optimal irrigation practices for new varieties.



The last word – Peter Darby

“Choosing the mother and father; all the creativity is in that stage.”

“This is still the same despite the advances in sequencing of hop genes. It is still likely to be the case that there is a choice of parents carrying the gene(s) of interest and I doubt whether the sequencing will be so complete as to define all the myriad of features that makes one parent superior to another. The experience and intuition of the breeder will still be needed to choose between several similar parents.”

Parting gifts

Geraniol rich

A not definitive list of varieties with relatively large amounts

Bravo, Centennial, Chinook, Citra, Idaho 7, Mosaic, Motueka, Simcoe, Warrior

Maybe not large, but big

Amarillo, Cashmere, Cascade, Cluster, Columbus, Comet, Crystal, Ekuanot, Hallertau Blanc, Loral, Polaris, Summit, Tomahawk, Vic Secret, Zeus

3MH/3SH

Another not definitive list

Nelson Sauvin, Amarillo, Mandarina Bavaria, Mosaic, Citra, Cascade, Calypso, Tomahawk, Columbus, Zeus

And maybe

Pahto, Centennial, Sabro, Idaho 7, Comet, Ekuanot

4MMP/4MSP

High levels: Citra, Simcoe, Eureka!, Summit, Apollo, Topaz, Mosaic, Sabro, Ekuanot, Galaxy, Nelson Sauvin, Talus

Significant levels: Zeus, Cluster, Chinook, Cascade, Centennial, Amarillo, German Northern Brewer, Hallertau Blanc, German Cascade, Mandarina Bavaria, Polaris

Measurable but low: Bravo, Calypso, Sultana, Galena, Lemondrop, Sorachi Ace, Super Galena, Willamette, Hallertau Tradition, Herkules, Perle, Taurus, Tettnanger, Styrian Golding, New Zealand Pacific Gem (perhaps Saaz)

None: Hallertau Mittelfrüh, Hersbrucker, Hüll Melon, Magnum, Saphir, Spalter Select, Bramling Cross, East Kent Golding, First Gold, Fuggle, Pilgrim, Progress, Wye Challenger, Wye Target

Related Resources

Find hundreds of other member resources on [HomebrewersAssociation.org](https://homebrewersassociation.org)

- Zymurgy Article: [Hop Experiment: American vs. German Hops in Pilsners](#)
- Zymurgy Article: [Hops: The Latest Research](#)

THANK YOU!

STAN HIERONYMUS | stan@appellationbeer.com

HOP QUERIES (free newsletter)

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