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ARTICLE

Mites, Mildew and Anheuser-Busch: How Pests, Big Beer, and Hops Shaped the Craft Brewing Industry

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The American craft beer industry's creation narrative is rooted in countercultural food politics. Popular stories describe how plucky brewers pioneered complex and hoppy beers that revolutionized a bland American beer industry dominated by industrial lagers. Hops are now the most celebrated ingredient in the craft beer industry and serve as visual representations of the artisanal and revolutionary values of small brewers that contrasts with the industrial and bland products of the nation's massive lager brewers. The history of hops and brewing presented here, however, demonstrates the connections between big and small brewers and the environmental impacts of craft brewers' hoppy beers otherwise obscured by their preferred dichotomous narrative. Craft beer grew in tandem with the modern hop industry and became enmeshed with big business and industrial agricultural practices to access their signature commodity, hops. By integrating environmental and business history, this article explores how brewers, scientists, farmers, and nonhumans influenced each other to create the modern craft brewing industry. This approach demonstrates the often-obscured connections between big and small firms by examining the environments, organisms, and supply chains they depend upon.

Keywords: environment; agriculture; beverage industries; chemicals

Introduction

In 1975, San Francisco's Anchor Steam Brewing Company debuted Liberty Ale, a beer unlike any other. Several qualities set Liberty, an India pale ale (IPA), apart from other American brews. First, Anchor brewed this all-malt ale using an English method called dry hopping, then a novel practice in American brewing. Brewers typically add hops (the inflorescences [flower clusters] of the hop plant) during the boiling stage of beer production to extract their bittering and preservative properties. To dry hop Liberty Ale, Anchor's brewers added hops directly to the fermentation tanks after boiling. This technique imparted the hop's flavorful

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aromas without adding bitterness, giving Liberty a distinct citrus and floral bouquet. Secondly, and more importantly, Liberty featured only one type of hop—Cascade.[1]

Cascade became the first American-bred hybrid hop used in commercial brewing and Liberty Ale was the first craft beer to utilize this new variety. As a result of Liberty's popularity, Cascade became a darling of the nascent craft brewing scene and a staple craft beer ingredient, lending its flavors to other iconic craft beers such as Sierra Nevada's Pale Ale.[2] Many craft brewers credit the Cascade for transforming hops into a celebrated agricultural commodity in the United States and for launching the craft beer movement.[3] The history of American-bred hops and their role in launching the craft beer movement, however, is even more complex than these botanicals' tasting notes.

The craft beer industry's prominent creation narrative is rooted in countercultural food politics. Popular stories describe how plucky brewers fought back against corporate stagnation and revolutionized a bland American brewing industry dominated by insipid industrial lagers.[4] This narrative is reinforced through craft beer marketing that glorifies the hop. Local taprooms and craft beer labels are often adorned with images of hops. For example, Deschutes Brewing Company's popular Fresh Squeezed IPA label features a hop squeezed by a press to extract its citrus-flavored oils. Because the hop is such an important aspect of what sets craft beer apart from industrial lagers, these visual representations celebrate hops' role in establishing craft beer's artisanal ethos while also communicating this message to patrons.

Themes of authenticity, localism, and uniqueness abound in craft beer imagery and narratives. These themes present an industry identity that resonates with consumers and marks craft breweries as the antithesis of the nation's large industrial lager brewers.[5] For example, the Boston Beer Company—producer of Sam Adams Boston Lager—boasted in an advertisement in the *New York Times* from the early 1990s that their beer came from a family recipe utilizing "all-natural" ingredients and was produced using traditional brewing processes abandoned by industrial brewers. The ad claimed these two differences allowed Boston Beer to produce a better, more authentic product than the industrial brewers.[6] This small versus big rhetoric runs

1. Anchor Brewing, "A Revolutionary Label for a Revolutionary Beer," June 27, 2012, accessed August 25, 2022, https://www.anchorbrewing.com/blog/a-revolutionary-label-for-a-revolutionary-beer/; "Cascade (US)," Hoplist, accessed August 25, 2022, https://www.hopslist.com/hops/dual-purpose-hops/cascade-us/.

2. Ken Grossman, *Beyond the Pale: The Story of the Sierra Nevada Brewing Company* (Hoboken: Wiley, 2014).

3. Tom Acitelli, *The Audacity of Hops: The History of America's Craft Beer Revolution* (Chicago: Chicago Review Press, 2013); Nick Carr, "Cascade Hops: The Variety that Launched a Craft Beer Revolution," October 21, 2015, Kegerator.com, accessed August 25, 2022, https://learn.kegerator.com/cascade-hops/.

4. Steve Hindy, *The Craft Beer Revolution: How a Band of Microbrewers is Transforming the World's Favorite Drink,* (New York: Palgrave-MacMillian, 2014); Warren Belasco, *Appetite for Change: How the Counterculture Took on the Food Industry*, 2nd ed., (Ithaca: Cornell University Press, 2007); This essay also draws on the work of communication scholars analyzing the inherent political messages in food marketing, including the craft beer industry, that obscure connections between production, consumption, health, and environmental impacts. Sam Boerboom, ed. *The Political Language of Food* (Lanham, MD: Lexington Books, 2015); Jeff Rice, "Professional Purity: Revolutionary Writing in the Craft Beer Industry," *Journal of Business and Technical Communication* 30, no. 2 (2016): 236-261.

5. Jeff Rice, "Professional Purity," 236-261.

6. *The New York Times,* November 20, 1994.

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throughout the industry's history. In his reflection on the craft beer industry *The Craft Beer Revolution* (2015), Brooklyn Brewery cofounder Steve Hindy wrote that craft brewers "are restoring beer to its rightful place as a local business and a product that says something about its hometown and region," and that "at its heart the craft beer movement is a quest by a band of Davids to bring down the Goliaths."[7] Yet the preferred historical narrative of the industry is more complicated than a simple binary of small versus big. When viewed through the lens of hops, the research presented here demonstrates the historically obscured connections between big and small brewers and the environmental impacts of craft brewers' hoppy beers.

This article challenges the narrative put forward by Hindy and other boosters of the craft beer industry. It utilizes the history of modern hop development in the United States to argue that the hops craft beer brewers and connoisseurs crave—and the global hop markets they depend on—would not exist without the efforts of both the US government and big brewers to combat pests and diseases that threatened hops during the twentieth century. Craft brewers certainly deserve credit for revolutionizing a stagnant and consolidated industry in the 1980s and 1990s. Yet, craft brewers, who often tout their small size and authentic ethos, grew in tandem with the modern hop industry and became dependent on research funded by big brewers and environmentally harmful industrial agricultural practices to access their signature commodity—the hop. This paper argues that when viewed from an agricultural and environmental perspective, the upstart craft brewers depended on the industry they critiqued for their success and are embedded in the environmental problems associated with industrial hop production.

Food historian Jeffrey M. Pilcher recently argued the craft beer industry, rather than being "independent," is embedded in broad "knowledge networks and circuits of mobility" that would not exist if it were not for "Big Beer."[8] This essay bolsters Pilcher's findings and joins a growing group of scholars challenging the countercultural and exceptionalist narrative of craft beer.[9] This essay extends this analysis further by adopting an environmental history perspective to argue that craft brewers are not only embedded in the knowledge networks of Big Beer, but they are also complicit in perpetuating environmentally harmful industrial agricultural practices—particularly pesticide use—often not associated with small and artisanal producers.

The only commercial use for hops is brewing. The hops used in craft beer, and all beer, require large quantities of pesticides to produce. Even though it only accounted for roughly 12 percent of the American beer market in 2020, the craft beer segment used over one-third of the nation's hop crop that year.[10] The US (the world's largest hop producer) grew 101 million pounds of hops in 2022. Only 1.2 million pounds were produced organically, or 1.25 percent of the total crop.[11] Furthermore, pesticide exposure not only presents risks to applicators, soil,

7. Hindy, *The Craft Beer Revolution,* 1.

8. Jeffrey M. Pilcher, "Hop Movements: The Global Invention of Craft Beer," in *Food Mobilities: Making World Cuisine,* eds. Daniel E. Bender and Simone Cinotto (Toronto: University of Toronto Press, 2023): 325.

9. For other works on this theme, see Rice, "Professional Purity," 236-261; J. Nikol Becham, "Entrepreneurial Leisure and the Microbrew Revolution: The Neoliberal Origins of the Craft Beer Movement," in *Untapped: Exploring the Cultural Dimension of Craft Beer,* ed. Nathaniel G. Chapman, J. Slade Lellock, Cameron D. Lippard (Morgantown: West Virginia University Press, 2017): 99-100; Pilcher, "Hop Movement," 325-344.

10. Brewers Association, "Small and Independent U.S. Craft Brewer Annual Report," accessed September 14, 2023, https://www.brewersassociation.org/press-releases/2020-craft-brewing-industry-production-report/; Christopher Solomon, "How Hops Became the Star of American Brewing," *Outside Magazine,* October 7, 2020.

11. USDA, National Hop Report 2022 (Washington, D.C.: National Agricultural Statistics Service, 2022): 5.

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water, and other living organisms, but the use of these chemicals and fertilizers also accounted for 22 percent of the hop industry's greenhouse gas emissions—the second largest category behind energy consumption—in 2022.[12] Pesticides are essential to the hop industry and therefore, the brewing industry.

Crucially, this research merges previous scholarship on hops and brewing by integrating these two topics into a succinct narrative.[13] By integrating environmental and business history, this article provides a picture of how industry, agriculture, and nonhumans influenced each other to create the modern hop industry, and how that, in turn, influenced the development of today's billion-dollar craft beer industry.[14] This approach illuminates the often-obscured connections between big and small firms by exploring the environments, organisms, and supply chains they mutually depend upon.

Origins of Hopped Beer

The definitive origins of humans' entanglements with hops are unknown. Humans have been drinking beer for about 10,000 years, but only in the last thousand years did hops become a standard brewing ingredient. Beer (hopped and unhopped) is brewed by boiling malted grains to extract their sugars, producing a sugar-infused fluid called wort. Brewers then add yeast to the wort, which produces carbon dioxide and alcohol as byproducts of fermenting the grain sugars. Various botanicals and spices, including hops, can be added to the brew either during the boiling or fermentation stages to impact the flavor of the final product.

The hop (*Humulus lupulus*) is a fascinating vine that produces flower clusters that look like leafy green pinecones.[15] Hops likely originated in Mongolia about six million years ago. From

12. Hop Growers of America, *Good Bines Biannual* Issue 3, (March 17, 2022): 4.

13. For histories of the American brewing industry that focus on the production side of brewing, see Stanley Baron, *Brewed in America: A History of Beer and Ale in the United States* (Boston: Little, Brown and Company, 1962); Thomas C. Cochran, *The Pabst Brewing Company: The History of an American Business* (New York: New York University Press, 1944); A.M. McGahan, "The Emergence of the National Brewing Oligopoly: Competition in the American Market, 1933-1958," *The Business History Review* vol. 65, no. 2 (1991): 229-84; Maureen Ogle, *Ambitious Brew: The Story of American Beer* (Orlando: Harcourt Inc., 2006); Martin Stack, "Local and Regional Breweries in America's Brewing Industry, 1865 to 1920," *The Business History Review,* vol. 74, no. 3 (2000): 435-63; Martin Stack, "Was Big Beautiful? The Rise of National Breweries in America's Pre-Prohibition Brewing Industry," *Journal of Macromarketing* vol.30, no 1 (2010): 50-60.

14. This approach draws from recent neomaterialist scholarship that focuses on the entanglements between humans and agentic nonhumans. Excellent examples include Ian Hodder, *Entangled: An Archeology of the Relationship Between Humans and Things* (Oxford: Wiley-Blackwell, 2012); Timothy J. LeCain, *The Matter of History: How Things Create the Past* (New York: Cambridge University Press, 2017). For more on the importance of collaboration between business and environmental historians, see Christine Meisner Rosen and Christopher Sellers, "The Nature of the Firm: Towards an Ecocultural History of Business," *Business History Review* 73 (Winter, 1999): 577-600; Christine Meisner Rosen, "The Business-Environment Connection," *Environmental History* 10, no. 1 (2005): 77-79; *Green Capitalism?: Business and the Environment in the Twentieth Century*, eds. Hartmut Berghoff and Adam Rome (Philadelphia: University of Pennsylvania Press, 2017).

15. For more on the history of hop growing, see Heinrich Joh. Barth, Christiane Kline, Claus Schmidt, *The Hop Atlas: The History and Geography of the Cultivated Plant,* (Nuremberg: Joh. Barth & Sohn, 1994); Richard W. Unger, *Beer in the Middle Ages and Renaissance* (Philadelphia: University of Pennsylvania Press, 2004); For works on the history of American hops, see Michael A. Tomlan, *Tinged with Gold: Hop Culture in the United States* (Athens, GA: University of Georgia Press, 1992); Peter A. Kopp, *Hoptopia: A World of Agriculture and*

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there, wild hop bines, with their seeds dispersed on the wind and carried by animals, began spreading across Asia and Europe before reaching North America about 500,000 years ago.[16] Hops are members of the Cannabaceae, a plant family that includes hemp and cannabis as close relatives. While hops do not feature the psychoactive properties of their cousin cannabis, they contain a unique and celebrated set of chemicals, including bitter alpha acids and complex essential oils, that flavor and preserve beer and explain the botanical's rise to prominence in global brewing.

Hops' inherent biological traits and chemical makeup made the plant incredibly useful to brewers. Hop flowers contain lupulin-producing glands that contain flavorful and pungent acids and oils. Alpha acids provide beer with bitterness and antiseptic properties (extending the product's shelf life), and essential oils provide floral, pine, citrus, fruity, dank, grassy, and other unique flavors.[17] Some of the earliest instances of hopped beer come from Bavaria in the 850s CE.[18] Before adopting hops, brewers flavored their beverages with a mixture of fruit and herbs known as gruit. European gruit beers declined as hopped beer gained popularity from the twelfth century onward.[19] Even English brewers—who distinguished between ale (a fermented beverage *without* hops) and beer (a fermented beverage *with* hops) until at least the 1570s—eventually made hops a standard addition to their brews because of the taste and preservative benefits they provided to their product.[20]

Hopped beer spread beyond Europe as beer-swilling nations like England and the Netherlands began colonizing the Americas. In North America, Dutch brewers in New Amsterdam (present-day New York City) observed that wild hops suitable for brewing could be found in the nearby woods as early as 1626.[21] North America provided ideal growing conditions for *H. lupulus.* This geographic and ecological luck benefited the domestic brewing industry. According to agricultural historian Peter Kopp, colonial hop growers in New England typically grew the Farnham Pale hop, which was introduced from England, for use in home brewing. Starting in the 1800s, however, the nation's first commercial hop growers in New York and New England began to grow the Cluster, a cross between an introduced English hop and a wild North American variety.[22]

Cluster—the closest thing to a North American landrace and a useful bittering hop—at one point accounted for 90 percent of all hops grown in the United States.[23] Bittering hops like Cluster were grown for their alpha acids that brewers used to bitter and preserve their beer.

Beer in Oregon's Willamette Valley *(Oakland: University of California Press, 2016); Dennis M. Larsen,* Hop King: Ezra Meeker's Boom Years *(Pullman: Washington State University, 2016).*

16. Hieronymus, *For the Love of Hops* (Boulder: Brewers Press, 2012): 45-46; A. Murakami, P. Darby, B. Javornik, M.S.S. Pais, E. Seigner, A. Lutz, and P. Svoboda, "Molecular Phylogeny of Wild Hops, Humulus lupulus L." *Hereditary* 97 (2006): 66-74.

17. The Hop Growers of America currently identifies eleven hop aromas that include fruity, citrus, tobacco/earthy, pine, stone fruit, floral, cedar, grassy, tropical fruit, spicy, and herbal. Hop Growers of America, Aroma Selector, usahops.org, accessed January 30, 2023, https://www.usahops.org/hop-finder/.

18. DeSalle and Tattersall, *A Natural History of Beer* (New Haven: Yale University Press, 2019):113; Unger, *Beer in the Middle Ages and Renaissance,* 54.

19. Unger, 54.

20. Unger, 97-103.

21. Baron, *Brewed in America,* 20.

22. Kopp, *Hoptopia,* 16-18.

23. DiSorbo, *The Book of Hops* (New York: 10 Speed Press, 2022): 94; Hieronymus, *For the Love of Hops,* 145.

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Other hop varieties fall into the aroma category. Aroma hops, such as the classic European noble cultivars of Saaz, Tettnang, Spalt, and Hallertauer Mittelfrüh, were used in brewing for their mild bitterness and pleasant floral-tasting essential oils.[24] Both lagers and ales use bittering hops, but American lager brewers of the nineteenth century and beyond often used locally grown Clusters to bitter their beers and finished them with milder imported hops from Europe. The growth of lager beer consumption in the United States following the Civil War increased the domestic demand for Clusters and transformed hops into a major regional cash crop.

New York growers would be the first group to benefit and suffer, from hop fever. Upstate New York, centered around Ostego County, became the first significant region to produce American hops, growing 21 million pounds, or 80 percent of the country's crop, in 1880 alone.[25] The region's dominance, however, would not last.

Hops are typically cultivated in a monoculture. Each yard contains one clonally reproduced hop variety grown from the rhizomes of the parent plant. This practice makes commercially grown hops extremely susceptible to pests and disease.[26] Downy mildew—a fungal disease that thrives in humid conditions and leaves the hop plant yellow, wilted, and unusable in the brewery—devastated the global hop crop, including New York's, in 1882.[27] The region never fully recovered from the outbreak. American hop production shifted to the Pacific Northwest by 1890.

Hops grew exceptionally well in the relative disease and pest-free Willamette, Puyallup, and Yakima valleys of Oregon and Washington. The absence of critical hop enemies, like downy mildew, and a favorable climate allowed Pacific Northwest hop growers to cash in just as the world's brewers were reeling from the horrendous harvest of 1882. That year, some West Coast growers reported selling their hops for $1.00 a pound when the same amount typically sold for twenty-five cents.[28] The region dominated the American hop industry for the next century. Oregon's Willamette Valley became *the* center of global hop production from the 1890s until the 1940s.[29]

By 1905, Oregon usurped New York to become the nation's leading hop producer. Oregon growers produced enough hops to make one out of every ten beers globally that year.[30] The small farming community of Independence, Oregon, located along the banks of the Willamette River near the state capital of Salem, became the self-proclaimed "Hop Capital of the World" from the 1890s until the 1940s.[31] Downy mildew, however, eventually made its

24. DiSorbo, *The Book of Hops,* 24-25.

25. Tomlan, *Tinged with Gold,* 6, 19, 22.

26. Samuel F. Turner *et al*, "Challenges and Opportunities for Organic Hop Production in the United States," *Agronomy Journal* 103, no. 6 (2011): 1647.

27. Kopp, *Hoptopia,* 101; "Decline of British Agriculture," *The Brooklyn Daily Eagle* December 22, 1882 pg. 1; "The Hop Crop" *Buffalo Morning Express,* August 15, 1882 pg. 1.

28. Larsen, *Hop King,* 71.

29. For an excellent history of the Willamette Valley's rise and fall as the country's leading hop region, see Kopp, *Hoptopia.*

30. Kopp, *Hoptopia,* 74.

31. Kopp, 100-101.

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way to the Willamette Valley in the 1930s, and once again, this fungus drastically reoriented the American hop industry and would have important implications for the nation's brewers.

Downy Mildew in the Willamette Valley

On April 10, 1930, growers confirmed that hop shoots growing in Mt. Angel, Oregon, were infected with the dreaded downy mildew.[32] The fungus responsible for downy mildew, *Pseudoperonospora humuli*, traveled on the wind and reproduced quickly in the Willamette Valley.[33] Within a decade, downy mildew spores spread to every hop-growing region in western Oregon, ending the region's freedom from the dreaded fungus.[34] Downy mildew devastated the region's Cluster hops, causing young hop plants to develop dark masses of spores, turn brown, and shrivel up, making them useless for brewing.[35]

In 1932, G.R. Hoerner, a plant biologist at the Oregon Agricultural College (OAC) and leading hop researcher, reported that the fungus constituted "an annual menace to profitable production. There are no commercial hop varieties that are immune. Under favorable conditions, the disease spreads extremely rapidly, and actual crop losses range … as high as 100 percent."[36] Oregon hop growers and scientists were alarmed.

In response, the Oregon Agricultural College (now Oregon State University) Agricultural Experiment Station and the United States Department of Agriculture (USDA) formed a partnership in 1931 to research ways to combat downy mildew and other hop pests. The USDA hired Earl N. Bressman—an agronomist known for his work with Henry Wallace in developing hybrid corn—to lead the collaborative hop research program in Corvallis.[37] The OAC research program focused on two fronts: the long-term goal of breeding new resistant hop varieties and finding short-term means to combat downy mildew, such as quarantines, culling infected plants, and using synthetic agricultural chemicals.

Bressman hoped to develop hybrid hops from the downy mildew-resistant Fuggle (a British hop) and the high-yielding Cluster. In an early report of his efforts, however, Bressman noted that resistance could not be the only trait breeders sought. A desirable hybrid must have a yield rate suitable to growers *and* a flavor profile desired by brewers.[38] Producing a product that consumers wanted to enjoy was vitally crucial for brewers; in some instances, brewing with resistant but less flavorful hop varieties has resulted in unpalatable beer.[39] However, developing a hop

32. G.R. Hoerner, "The Relation of the Climatology of Western Oregon to the Incidence and Control of Downy Mildew of Hops," *The Plant Disease Reporter* 23, no. 22 (December 1, 1939): 361.

33. Hoerner, "The Relation of the Climatology," 362.

34. Hoerner, "The Relation of the Climatology" 361.

35. G.R. Hoerner, "Downy Mildew of Hops," *Extension Bulletin* no. 440 (March 1932): 5.

36. G.R. Hoerner, "Comparison of Spray Nozzles for Effective Spraying of Hops for Downy Mildew" (Corvallis: Agricultural Experiment Station, 1937): 2; Agricultural Experiment Station Records, 1889-2002 (RG 025), Oregon Hops and Brewing Archives (OHBA), Oregon State University, Corvallis, Oregon. Hereafter referred to as OHBA.

37. Kopp, 154.

38. E.N. Bressman, "Report of Hop Breeding" (Corvallis: Oregon State University Extension Service, 1931): 6.

39. To give a contemporary example, in 2021 the brewer New Belgium released a beer brewed with hops and grains resistant to the effects of the climate crisis called Torched Earth. The resulting beer was universally

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variety meeting growers' and brewers' needs proved challenging.[40] Even today, with advanced knowledge of hop breeding, developing a new variety can take more than ten years.[41] Breeding the first commercially viable American hybrid hops took four decades.

Bressman began his work at the OAC in 1931, but his successors would not release the program's first commercial hybrid, the Cascade, until 1972. Hop breeding takes time, and growers in the 1930s needed immediate solutions to the problems posed by mildew and other hop pests like the red spider mite, an arachnid that consumes hops and reduces their ability to photosynthesize. In response, they turned to toxic chemicals.

In 1932, researchers at the OAC began experimenting with chemical sprays to combat downy mildew and other pests. They used Bordeaux spray—a mix of copper sulfate and hydrated lime first used to control fungal infections in nineteenth-century French vineyards—to kill the fungus responsible for downy mildew. It did not work.

Bordeaux applications proved costly, time-consuming, and largely ineffective for hop growers. The copper spray burned the foliage of the hops. Brewers also complained that the copper residue found its way into their beer. Furthermore, the spray provided no meaningful protection to the crops. G.R. Hoerner concluded that "it is very difficult to prove the value of spraying…growers who have not sprayed at all have secured as good a crop as those who have attempted to spray several times during the season at considerable added expense to the cost of production."[42] After the failure of the Bordeaux spray, hop researchers turned to other chemical compounds to combat hop diseases and pests. Hop growers and researchers, along with every other agricultural producer in the nation, gained access to a vastly expanded arsenal of potent chemicals following World War II.[43]

In 1946, *The Hopper,* a trade journal for hop growers, issued glowing reports for the pesticide dichlorodiphenyltrichloroethane (DDT). The USDA released DDT for public use in 1945 after the chemical proved a valuable tool for controlling malaria outbreaks among US marines during the war. The magazine told growers, "The new miracle insecticide DDT has been used successfully against aphis as well as against many other insect pests."[44] Growers

reviled by beer critics. Brew Bound, "New Belgium Launches Fat Tire: Torched Earth Beer from a Climate-Raved Future-and it Tastes Awful," *Brew Bound*, accessed September 26, 2022, https://www.brewbound.com/news/new-belgium-launches-fat-tire-torched-earth-beer-from-a-climate-ravaged-future-and-it-tastes-awful/.

40. Ernest S. Salmon, a professor at Wye College in Kent, England, pioneered many of the early techniques in hybrid hop breeding in the 1910s. Hieronymus, *For the Love of Hops,* 15-18; Kopp, 155.

41. For a more in-depth discussion of hop breeding, see DiSorbo, *The Book of Hops,* 20-23.

42. G.R. Hoerner, "Second Progress Report on Hop Disease Investigations, With Particular Reference to Downy Mildew," December 31, 1932: 35, (RG 025), OHBA.

43. For the classic history of the connection between war and pesticides, see Edmund Russel, *War and Nature: Fighting Humans and Insects with Chemicals from World War I to Silent Spring* (New York: Cambridge University, 2006); For the best historical account of how American farms transformed into industrial enterprises, see Deborah Kay Fitzgerald, *Every Farm a Factory: The Industrial Ideal in American Agriculture* (Yale University Press: New Haven, 2003); For more works on the history of pesticides in the United States, see Pete Daniel, *Toxic Drift: Pesticides and Health in the Post-World War II South* (Baton Rouge: Louisiana State University Press, 2005); Frederick Rowe Davis, *Banned: A History of Pesticides and the Science of Toxicology* (New Haven: Yale University Press, 2014); Michelle Mart, *Pesticides, A Love Story: America's Enduring Embrace of Dangerous Chemicals* (Lawrence: University Press of Kansas, 2015).

44. *The Hopper* (January 1946): 9.

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soon had an expanding list of endorsed chemicals to control hop pests.[45] By 1948 hop farmers began using potent broad-spectrum organophosphates—first synthesized in the nineteenth century but released for commercial use shortly after World War II—like tetraethyl pyrophosphate (TEPP) and parathion to control downy mildew.[46] *The Hopper* described TEPP as a "nasty material to handle but gives very good results."[47] The National Institute of Health has since identified TEPP as both acutely toxic to humans and an environmental hazard.[48] And while the "miracle" chemicals killed hop pests, they came with unexpected costs.

DDT and parathion were of particular concern for growers. While the chemicals effectively killed mites and mildew, they created many new problems. In April 1961, *The Hop Press,* produced by the OAC–USDA Agricultural Extension Service, cautioned growers about the overuse of DDT and other pesticides. The editors republished one study from 1950 that warned, "the disadvantages of DDT, BHC, and parathion is their non-selective action…resistant strains of insects may be bred."[49] As more knowledge of pesticides became available and widespread, especially after the publication of Rachel Carson's *Silent Spring* in 1962, brewers' and researchers' enthusiastic embrace of these chemicals began to change.

The Cascade: America's First Hybrid Hop

Stanley Brooks, head of the hop research program at Oregon State in the 1960s, focused on developing hops with disease resistance in response to the publication of *Silent Spring.* Brooks believed that growing mildew-resistant varieties would help the industry reduce its reliance on chemicals and prevent the harm from pesticide overuse described in *Silent Spring.* His successor, Al Haunold, would finish his work.

Alfred Haunold was born in Retz, Austria, in 1929. After growing up in a war-torn Europe, Haunold came to the US on a Fulbright and earned his Ph.D. in agricultural science from the University of Nebraska in 1954. Haunold then landed a job in hop breeding at Oregon State in 1965, despite having no prior experience working with hops. Upon taking the job at Oregon State, Haunold continued Brooks's work with a mildew-resistant hop labeled #56013, which eventually became the Cascade.[50]

On January 3, 1972, the hop program officially released Cascade for commercial brewing. Breeders, growers, and brewers hoped the Cascade would serve as a domestic alternative to expensive imported European hops. Furthermore, the release announcement noted that the

45. *The Hopper* (January 1947): 14.

46. E.C. Klostermeyer, "Hop Aphid Insurance," *The Hopper* (February 1949): 6; Lucio G. Cost, "Organophosphorus Compounds at 80: Some Old and New Issues," *Toxicological Sciences,* 162 no. 1 (2018): 24-35.

47. Klostermeyer, "Hop Aphid Insurance," 6.

48. National Library of Medicine, "Compound Summary: Tetraethyl Pyrophosphate," accessed October 20, 2022, https://pubchem.ncbi.nlm.nih.gov/compound/tetraethyl%20pyrophosphate#section=RCRA-Requirements.

49. *The Hop Press* (April 1951): 7.

50. Al Haunold Oral History Interview #1, November 18, 2014 with Tiah Edumson-Morton and Shaun Townsend, OHBA Oral History Collection, accessed October 19, 2022, http://scarc.library.oregonstate.edu/omeka/exhibits/show/brewingvoices/item/30406.

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Cascade had "good resistance to systemic downy mildew crown infection… and to downy mildew cone infection."[51] The hop program's forty years of research was finally bearing fruit.

Coors, the nation's fourth largest brewer at the time, became the first in the United States to use the Cascade in 1972.[52] Coors thought the Cascade could replace its use of the expensive hops it imported from Germany and promised American growers a dollar per pound for Cascades when other domestic varieties, like Cluster and Fuggle, were generally selling for $0.65 to $0.75 per pound.[53] One commentator at the time described Coors's use of the Cascade as "the most significant development ever in the U.S. hop industry."[54] The Cascade's initial moment of promise with the big brewers, however, would be short-lived.

Soon after Coors switched to Cascade, they lost sales. The potent acids and oils of the Cascade made Coors beer less sessionable. The term "session beers" refers to mild, low ABV (alcohol by volume), and refreshing brews that encourage the consumption of multiple pints per drinking session. Alfred Haunold reported that the Cascade was not an exact substitute for the European hops Coors typically used. The Cascade contained a chemical called geraniol, which was not present in European varieties. This chemical resulted in a consumer's first can of Coors tasting good, but with subsequent cans an unfamiliar flavor would "come up through the nose" of the drinker, which was off-putting to Americans raised on bland and standardized lagers.[55] In essence, Coors's business model depended on a consumer being able to consume multiple cans of its relatively inexpensive beer in one sitting. A beer brewed with milder hops easily achieved this goal, whereas the flavor-packed Cascade lent itself to complex, but less sessionable, beers. As a result of its unique flavors, Coors subsequently reduced their use of the Cascade.[56]

Even though the Cascade did not suit Coors as well as the firm would have liked, its initial support proved instrumental. Other big brewers, like Anheuser-Busch and Schlitz, showed little interest in the new hybrid variety and were content with Oregon-grown Fuggles, Clusters, and imported European hops.[57] Al Haunold admitted, "It's a good thing Coors took the lead on the Cascade when they did…We were at the end of our rope" and were going to toss the Cascade into the germplasm library and move on to the next variety.[58] Coors's use of the Cascade bolstered both growers' and big brewers' hopes that subsequent varieties of

51. Chester E. Horner, et. al., "1971 Annual Report of Hop and Mint Investigations: Breeding, Genetics, Chemistry, Pathology and Culture of Hops and Mint (Work Reporting Unit 10670 OAES Projects 36 and 120)," 1971, pg. 39, Agricultural Experiment Station Records (RG 025) OHBA.

52. Kopp, 165-166.

53. Al Haunold Oral History Interview #1, November 18, 2014.

54. Bill Harris, "Major Brewer Switches to New Northwest Hop," *Tri-City Herald* (Pasco, Washington), October 10, 1972, pg. 1.

55. Alfred Haunold interview with Shaun Townsend and Tiah Edumnson-Morton, November 18, 2014, Corvallis, Oregon, OHBA.

56. Coors Company Meeting with Hop Dealers, Hop Growers, and Research People, February 28, 1980, HRC records, series III, box 2, folder 7.

57. Alfred Haunold interview with Shaun Townsend and Tiah Edumnson-Morton, November 18, 2014, Corvallis, Oregon, OHBA.

58. Roger Worthington, "Cascade: How Adolph Coors helped launch the most popular US Aroma Hop and the craft beer revolution, Hop History with Dr. Al Haunold, Part II," Indie Hops: In Hop Pursuit Blog, January 25, 2010, accessed October 19, 2022, http://inhoppursuit.blogspot.com/2010/01/cascade-how-adolph-coors-helped-launch.html.

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American-bred hops that met their needs could be developed. Coors's dalliance with the Cascade also extended its life long enough for the nascent craft brewing scene to fall in love with the hop.[59]

Craft Beer and the Cascade

Craft beer emerged during a countercultural revolution in American cuisine. As the historian Warren Belasco has observed, many activists in the 1960s and 1970s saw food as a political tool. Those weary of hegemonic American culture and a homogenized American food system that harmed both the planet and undernourished human bodies saw alternative foods and tastes as means to protest the status quo, protect the planet, and promote their bodily health.[60] The "counter-cuisine" embraced locally produced food, cuisine with unique flavors, and anything brown, especially homemade whole wheat bread or dark craft beer.[61] Because of the attitude of those involved in the countercuisine, drinking local craft beer, much like eating whole wheat bread, was an act of rebellion. This type of rhetoric was readily adopted by craft beer boosters, who, as Steve Hindy put it, were Davids fighting the Goliaths.[62] Craft brewers also loved the Cascade because their business model revolved around selling fewer, but more complex and flavorful beers, at a premium price to smaller, local markets.[63] This model contrasted with the big brewers who made money by selling massive quantities of a bland, but relatively inexpensive, product. Furthermore, a niche group of people simply enjoyed the taste of new hops like the Cascade lent to these novel brews.[64] Nascent craft brewers were ready to capitalize on the changing American food scene, and the Cascade became one of their key ingredients.

Under brewer Fritz Maytag's direction, Anchor Steam Brewing Company's Liberty Ale became the first craft beer to utilize the Cascade in 1975. Maytag, the heir to the Maytag washing machine fortune, purchased Anchor Steam Brewing Company in 1965 after developing an infatuation with the company's flagship brew, Anchor Steam. Under Maytag, Anchor Steam Brewing would become one of the first commercially successful craft breweries in the United States and their Liberty Ale helped popularize the Cascade among other upstart brewers.[65]

59. Worthington, "Cascade."

60. Warren Belasco, *Appetite for Change: How the Counterculture Took on the Food Industry,* 2nd ed. (Ithaca: Cornell University Press, 2007): 46; Francis Moore Lappe, *Diet for a Small Planet,* 20th anniversary ed. (New York: Ballantine Books, 1991).

61. Belasco, *Appetite for Change,* 48-49. For more on the cultural meanings of white and brown bread in the United States, see Aaron Bobrow-Strain, *White Bread: A Social History of the Store-Bought Loaf* (Boston: Beacon Press, 2012).

62. Hindy, *Craft Beer Revolution,* 1.

63. Grossman, *Beyond the Pale,* 42-48.

64. This essay also engages with Philip Scranton's research on novelty product development by not only showing that novelty allows big and small firms to coexist in competitive markets, but that both rely on each other for different aspects of innovation and product development, such as supply chain stabilization and new product innovation. Phil Scranton, *Endless Novelty: Specialty Production and American Industrialization, 1865-1925* (Princeton: Princeton University Press, 1997).

65. Ogle, *Ambitious Brew,* 258-265.

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Ken Grossman, an avid tinkerer, homebrewer, and founder of the Sierra Nevada Brewing Company, wanted to offer a uniquely American beer for his company's flagship brew. He looked to the Cascade to make this happen when Sierra Nevada launched their now iconic Pale Ale in 1980. Sierra Nevada Pale Ale soon became a classic within the craft brewing industry thanks to its refreshing notes of citrus and hoppy bitterness imparted from the Cascade.[66]

Beer critics in the US raved about the unique taste and novelty of Maytag's Liberty and Grossman's Pale Ale. Writing for the *Boston Globe* in 1984, one critic specifically recalled how his friend Joseph Owades, head of the Center for Brewing Studies in San Francisco, was so struck by the robust flavor of Liberty that after taking a sip, he exclaimed, "I just tasted Liberty Ale. It's the best ale I have ever tasted. It's better than any ale anywhere!" The critic described the beer as one "for those who prefer a bitter brew, and it so overwhelmed our taste buds we could barely detect the normally full flavor of Bass [pale ale]," in a taste comparison.[67] Liberty Ale became a truly novel American brew.

Sierra Nevada's Pale Ale was similarly received. The *Oakland Tribune,* in an article titled "The Superstars in the World of Beer," praised Grossman's product, stating that Sierra Nevada "makes a pale ale that rivals the Bass you can drink on draught in England. It is a medium golden color with a satisfying hoppyness [sic]… Easily a world classic."[68] Writing for the *New York Times* in 1988, beer critic Frank J. Prial praised both Anchor Steam's Liberty and Sierra Nevada's Pale Ale exclaiming, "Of the Anchor products, I prefer the Liberty Ale—it's more vigorous and more aggressive than the Steam Beer. But I would choose Sierra Nevada Pale Ale over the Liberty. Despite its name, it is a really gutsy brew."[69] These brews' distinctive flavors, derived from their use of the Cascade, attracted a growing segment of the US beer market not satisfied with domestic industrial lager and European imports. Both Liberty and Sierra Nevada Pale Ale became iconic beers among craft beer enthusiasts. They helped elevate the popularity of the Cascade and subsequent hybrid hops in other craft beers, and as a result, Cascade has consistently been one of the top grown aroma varieties in the United States since the 1990s.[70]

Craft beers' success in the 1990s and early 2000s was largely built on the back of pale ales' more intensely hoppy cousins, IPAs brewed with American hybrid hops (an IPA is simply a more hop-forward version of a pale ale). Their success would ultimately be full of irony.[71] Because of their incessant demand for hops used in new pungent IPAs like Stone Brewing Company's iconic Arrogant Bastard (1997) and Russian River Brewing Company's celebrated Pliny the Elder (2000), craft brewers would come to rely on the hop varieties and industrial

66. Grossman, *Beyond the Pale,* 76.

67. Bob MacDonald, "The Beer Facts," *The Boston Globe* January 26, 1984, pg. 73.

68. William Brand, "The Superstars in the World of Beer," *The Oakland Tribune,* July 22, 1984.

69. Frank J. Prial, "America's New Regional Brewers," *The New York Times,* May 15, 1988.

70. Hop Growers of America, "U.S. Hop Acreage Trends Alpha & Aroma Varieties 1996-2000," *2000 Statistical Report* (Seattle: HGA, 2001): 8; Grossman, *Beyond the Pale,* 77; DiSorbo, *The Book of Hops,* 70, 86; Jamie Bogner, "Infographic: Top Hops Going into 2022," *Craft Beer and Brewing,* accessed November 9, 2022, https://beerandbrewing.com/infographic-top-hops-going-into-2022/.

71. For more on the popularity of the IPA, see Hindy, *Craft Beer Revolution,* 128-135; Pilcher, "Hop Movements," 327, 332-336.

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agricultural practices financed by the big brewers through their partnerships with research universities. This entanglement of big brewers, the USDA, hop growers, and craft beer further blurred the line between big and small brewers and countercultural and industrial foods.

The Hop Research Council and Big Beer's Funding

The USDA began to cut funding for hybrid hop research in the 1970s and 1980s. As a result, big brewers and trade organizations like the Oregon Hop Growers Association and the Hop Research Council (HRC) stepped in to support the continued development of American hop hybrids and research on the pesticides essential to growing hops.[72] Private funds from the largest brewers would provide valuable support for hop research just as craft brewing began to take off.

On March 1, 1979, fifteen representatives from the hop industry, including growers, dealers, processors, and brewing companies (notably Anheuser-Busch, Pabst, Coors, and Stroh), met at the Stauffer Inn in Denver, Colorado.[73] With growing alarm, the group assembled to discuss the dwindling financial support for hop research in the United States. In 1978 the Brewers Association, for unclear reasons, cut back on its support for hop research. The assembled group also expressed concerns about the future of USDA funding, which would begin to dry up in the 1980s.[74] Therefore, the assembled parties established the Hop Research Council and pledged to financially support further hop research.

In its first year, the HRC distributed nearly $65,000 (about $260,000 in 2022 dollars) in research funds to hop scientists at Washington State University and Oregon State University. Since the Yakima Valley became the center of American hop production following the introduction of downy mildew in the Willamette Valley, Washington State received $33,000, and the HRC awarded Oregon State $29,000. The big brewers paid the lion's share of this sum. Anheuser-Busch (hereafter AB) provided $20,700, Coors contributed $12,700, Pabst provided $8,000, and Stroh donated $7,500. In contrast, the largest donation from a nonbrewer was $3,500 from John I. Hass, Inc., a hop dealer.[75]

HRC funds proved crucial to sustaining the work of Al Haunold, the nation's most successful hop breeder at the time. In a letter sent to Morten Meilgaard, second in command of Detroit's Stroh Brewing, on September 21, 1983, Haunold mentioned that he would only spend 40 percent of his time working on hops starting that October, and that given the dismal funding trajectory, he anticipated being out of hop research entirely by spring of 1986. Furthermore, he hoped that "the HR[C] has all intentions to keep hop research going without

72. Hop Research Council "History of the Hop Research Council," MSS Hop Research Council, series III, box 2, folder 1, OHBA; David W. Hyrest, "Review of the Hop Research Council," *Brewers Digest* (September 1993): 18-21, MSS Hop Research Council, Series III, Box 2, Folder 1, OHBA.

73. Hop Research Council "Financial Statements, 1981-1990," MSS Hop Research Council, series III, box 1, folder 7, OHBA.

74. Hop Research Council "History of the Hop Research Council," MSS Hop Research Council, series III, box 2, folder 1, OHBA; Kopp, *Hoptopia,* 168.

75. Hop Research Council "1979 Financial Report," MSS Hop Research Council, series III, box 1, folder 7, OHBA.

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any great slowdown. For [him] that means that Gail Nickerson and my State technician (both now 100% on industry funds) will be paid a living wage, and that I can count on sufficient operating funds."[76] Without HRC money, Haunold could not have continued his research.

During the fiscal year of 1984–1985, the HRC increased its research pool to $209,000 (with AB alone contributing $86,400).[77] That same year, the federal government's appropriation bill diverted $200,000 to the USDA Agricultural Research Service for hop research. One individual at the Coors Brewing Company was pleasantly surprised that hop researchers received any money at all from the government that year.[78] The HRC continued to provide substantial funds to Haunold and other researchers throughout the 1980s. By 1990, AB was the largest contributor to the HRC, having donated over $600,000 to hop researchers since 1979. Stroh and Coors, the second-highest donors, paid about $170,000 each over the same period.[79] Big brewers stepped in at a crucial moment to further the development of the American hop industry just as government funding was proving scarce. The HRC demonstrated that brewers, hop dealers, and researchers fostered a collegial and cooperative effort. Everyone was dedicated to the agricultural improvement of hops, a botanical on which all their livelihoods depended.

HRC-funded researchers achieved significant success during this period. Important hops were bred and released, including the Nugget (1984) and Chinook (1985). Together with Galena (1978), these three varieties accounted for 41 percent of all US hop acreage in 1992.[80] These incredibly bitter hops were not grown for their nuanced flavors but instead had their alpha acids processed into hop extract. This shelf-stable, molasses-like syrup appealed to industrial-scale brewers because it allowed them to add hoppy bitterness to their brews while avoiding the costs of storing perishable hops.[81] The high-alpha hops offered a price advantage for domestic brewers and made the "U.S. the most stable supplier of alpha to the world market."[82] In addition to breeding high-alpha hops, breeders were also interested in continuing their work in producing new aroma and pest-resistant hops.

Stephen Kenny and Charles Zimmerman received HRC funds to breed high-yielding pest and mildew-resistant hops at Washington State University's Prosser Research Station. They successfully bred Olympic, released in 1984, and more importantly, Centennial.[83] Centennial, first produced in 1974 and released for commercial use in 1990, is often described as a super

76. Alfred Haunold to Morten Meilgaard, September 21, 1983, MSS Hop Research Council, box 1, folder 13, OHBA.

77. Hop Research Council "Financial Statements, 1981-1990," MSS Hop Research Council, series III, box 1, folder 7, OHBA.

78. Sam Liken to Darwin Davidson, November 19, 1984, MSS Hops Research Council, series III box 1, folder 13, OHBA.

79. Hop Research Council "Financial Statements, 1981-1990," MSS Hop Research Council, series III, box 1, folder 7, OHBA.

80. David W. Hyrest, "Review of the Hop Research Council," *Brewers Digest* (September 1993): 18-21, MSS Hop Research Council, series III, box 2, folder 1, OHBA.

81. Hieronymus, *For the Love of Hops,* 132-135.

82. David W. Hyrest, "Review of the Hop Research Council," *Brewers Digest* (September 1993): 18-21, MSS Hop Research Council, Series III, box 2, folder 1, OHBA; Emma Janzen, "Craft Brewers Embrace Hop Extracts," *Imbibe Magazine,* November 13, 2017, accessed November 11, 2022, https://imbibemagazine.com/hop-extracts/. The "world market" for alpha acid is primarily brewers.

83. David W. Hyrest, "Review of the Hop Research Council," *Brewers Digest* (September 1993): 18-21, MSS Hop Research Council, Series III, box 2, folder 1, OHBA.

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Cascade due to its intense bitterness and tasting notes of lemon, vanilla, orange blossom, and dankness, along with good resistance to downy mildew. In 1997, the Centennial variety would become the only hop used in the widely celebrated Two Hearted Ale from Bell's Brewery in Kalamazoo, Michigan, and is now incorporated into other craft IPAs across the country.[84] While HRC research continued efforts to improve hops and provide brewers and growers with a product that met their needs, pests, and pesticides remained a problem.

Even with new pest-resistant varieties, disease and insects still posed significant threats to hop growers and, by extension, brewers. Because insects, weeds, and fungi constantly evolve to counter efforts to control them, resistance in hops remains transient. For example, Ann George, head of the US Hop Industry Plant Protection Committee (USHIPPC), reported that Cascade's resistance to downy mildew only lasted about twenty years.[85] Hop growers, researchers, and brewers found themselves in an agricultural arms race, trying to release new breeds and find effective pesticides to stay one step ahead of hop pests. The HRC, therefore, also directed significant funds toward research and registration of pesticides in addition to hybrid hop development. HRC dollars funded the expanding arsenal of synthetic chemicals used by growers to combat mites, mildews, aphids, and weeds during the 1980s and 1990s.[86] However, no one chemical proved effective in controlling pests while posing limited environmental harm and not impacting beer flavor.[87]

The hop industry became reliant on chemicals. Resistant hybrids failed to solve the industry's pesticide problem. Furthermore, even if new types showed strong resistance to common diseases, like downy mildew infection, there was no guarantee how long the resistance would last or if brewers would even be interested in brewing with that variety. Historically, the most prominent brewers were apprehensive about experimenting with new hops, such as Coors's tentative use of the Cascade. The hop industry's reliance on toxic chemicals soon became a headache for the nation's largest brewer as a patchwork of international pesticide regulations threatened to upend the global flow of hops across national borders.

84. William Brand, "Bavaria too Far? Try these Oktoberfest Beers," *Oakland Tribune,* October 14, 1992, pg. 44; DiSorbo, *The Book of Hops,* 80; Greg Hargreaves, "Interview with Ryan Maloney," December 29, 2015, Beer and Craft Brewing Oral History Interviews, The Hagley Museum, accessed November 8, 2022, https://digital.hagley.org/Ryan_Maloney_12_29_15; Bell's Brewery, "Explore our History," accessed January 30, 2024, https://bellsbeer.com/history/#:~:text=The%20first%20version%20of%20Two,1997%20as%20a%20winter%20seasonal.

85. Author interview with Ann George.

86. Researchers experimented with chemicals such as Orthene, Temik, and Ridomil to control downy mildew, but these chemicals had little success and proved to be acutely toxic to humans. Ralph E. Berry, "Research Proposal Submitted to Oregon Hop Commission," 1980, MSS Hop Research Council, Series III, box 2, folder 17, OHBA; HRC, "Meeting Minutes," February 8-9, 1982, MSS Hop Research Council, Series III, box 1, folder 17, OHBA; HRC, "Meeting Minutes," August 11, 1983, MSS Hop Research Council, Series III, box 1, folder 17, OHBA; United States Environmental Protection Agency, "Temik brand 15g Aldicarb label," October 1, 2009; C.E. Horner, "Research Plan for Ridomil Testing and Residue Analyses," 1980, MSS Hop Research Council, Series III, box 2, folder 7, OHBA; C.E. Horner, "Registration and Monitoring of Metalazyl (Ridomil, Subdue) for Hop Downy Mildew Control Annual Report to the Oregon Hop Commission for 1981-1982 Fiscal Year," MSS Hop Research Council, Series III, box 2, folder 7, OHBA.

87. This process is still ongoing as of August 2022. The hop industry uses over 120 different pesticides to control mites, fungi, weeds, and rodents. U.S. Hop Industry Plant Protection Committee, "2022 08-03 USHIPPC MRL [Maximum Residue Level] Chart," Hop Growers of America, August 2022.

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Anheuser-Busch and Pesticides

Anheuser-Busch ran into a major problem importing European hops doused in pesticides during the 1980s. In 1986 and 1987, the Food and Drug Administration (FDA) flagged substantial quantities of German and Czechoslovakian hops, which AB and other big brewers imported, for containing excessive residues of the pesticide folpet, a carcinogenic fungicide, and other chemicals banned in the United States. The FDA determined that the beer made from these hops was safe but warned European growers that they would be barred from importing their crops if they did not adhere to US standards.[88] Unfortunately for AB, the FDA flagged and banned a shipment of their European hops for illegal pesticides in 1989.[89] This sent AB into a panic.

In response to the banned hops, AB funded a conference in Washington, D.C., on May 12, 1989. The brewer flew in hop experts, growers, and dealers from the Pacific Northwest, including Ann George and Norm Batt of the Hop Growers of America (HGA). AB also invited representatives from European hop firms and their fellow brewers to the event. The purpose of the meeting was to "harmonize" the pesticide registration process in hop-growing nations. AB believed that if all the nations had the same chemical regulations for hops, it would eliminate brewers' and growers' fears that one nation's pesticide regulatory policies would impact the ability of another to import or export its hops.[90] Work on implementing such a system would begin that October, with another hop pesticide conference hosted by Anheuser-Busch.

On October 10, 1989, brewers and hop growers once again found themselves at an AB-funded hop pesticide conference in Washington, DC. This time, over 100 individuals attended, including government representatives from West Germany, Belgium, France, the UK, the European Economic Council, US congressional staffers, and members of the EPA, FDA, and USDA, in addition to chemical company representatives and hop growers, dealers, and researchers. Notably, only AB and Coors represented the brewers at the gathering, leading Norm Batt to comment, "you think that more breweries would be interested in the pesticide problems of one of their major ingredients!"[91]

The goal of this gathering was to synchronize the registration of hop pesticides in West Germany and the United States and convince chemical companies like Monsanto, Dow, and Bayer to work towards regulatory approval in both nations simultaneously. As a result of this conference, significant steps were taken toward harmonizing global hop pesticide regulation. According to Norm Batt, the attendees were "extremely complimentary of the lead that

88. Dean Miller, "U.S. Hop Farmers Gaining on Europeans," *The Spokesman-Review* (Spokane, WA), September 3, 1989, pg. 30.

89. Author interview with Ann George.

90. Norm Batt, "Synopsis of Hop Pesticides Working Group Meeting," May 12, 1989, MSS Hop Research Council, Series III, box 1, folder 14, OHBA.

91. Craft brewers would not have received an invitation to this gathering because in the 1980s, they were so small that hop dealers would not enter futures contracts with them. For example, Ken Grossman had to spot-purchase hops (buying what was left over after the big brewers' contracts were met) during the 1980s because his brewery was so small. This of course, would change, as craft brewers became a leading consumer of hops by the 2000s. Grossman, *Beyond the Pale, 76-78;* Norm Batt, "Pesticide Harmonization Meeting, Washington, D.C.," October 10-11, 1989, MSS Hop Growers of America, Series I, box 1, folder 3, OHBA.

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the US Hop Industry has taken" on the pesticide issue.[92] As a result of Anheuser-Busch's efforts to organize key players in the global hop industry, Ann George and the United States Hop Industry Plant Protection Committee (USHIPPC) of the HGA took the lead on hop pesticide use in the US and harmonizing pesticide regulations among all the major hop-growing nations.

In the 1990s, the USHIPPC capitalized on its influence to lead the charge in registering and maintaining the use of pesticides for the US hop industry. The USHIPPC became a leader in coordinating hop pesticide use and registration across national borders. As of 2022, their efforts have been incredibly successful, maintaining compatible maximum residue limits (MRL) of over 100 pesticides in over 11 different hop-growing countries and the European Union.[93] In addition to coordinating international hop pesticide allowances, the committee also worked to keep pesticides legal for American growers.

Throughout the 1990s, the USHIPPC petitioned the EPA and FDA to classify dried hops as raw agricultural commodities, even though they had undergone a form of processing. This change in distinction would help growers and brewers avoid the enforcement of the Delaney Clause of the Federal Food, Drug, and Cosmetic Act.[94] The Delaney Clause prohibited the presence of *any* carcinogenic chemicals in processed food commodities. If processed (i.e., dried) hops were considered the raw agricultural commodity, they would not fall under the purview of the Delaney Clause, and therefore, new pesticides and higher MRLs would become available to hop growers.

For example, in the early 1980s, the fungicide Aliette (fosetyl A1) produced by the French chemical company Rhone-Poulenc, was anticipated to become the leading chemical for controlling downy mildew in the hop industry. However, the EPA found that Aliette exposure caused cancerous tumors in mice and concentrated on dried hops at 15 ppm, which violated the Delaney Clause.[95] As a result, petitions for EPA approval of the fungicide were denied in the 1980s.

The USHIPPC enlisted brewers to justify their arguments that dried hops should be considered raw, not processed, commodities. Several leading brewers wrote to the EPA, testifying that no brewer used raw, undried hops in their beer. Therefore, since brewers did not use fresh hops at the time—although fresh hop beers have been popular among craft brewers since Sierra Nevada released Harvest Ale in 1996—they argued that the dried hops were technically the raw commodity used by brewers.[96] Ultimately, the USHIPCC and the brewers were

92. Norm Batt, "Pesticide Harmonization Meeting, Washington, D.C.," October 10-11, 1989, MSS Hop Growers of America, Series I, box 1, folder 3.

93. U.S. Hop Industry Plant Protection Committee, "2022 08-03 USHIPPC MRL [Maximum Residue Level] Chart," provided to the author by Ann George, president of the Hop Growers of America, August 2022.

94. Norm Batt, "Pesticide Harmonization Meeting, Washington, D.C.," October 10-11, 1989, MSS Hop Growers of America, Series I, Box 1, Folder 3, OHBA; John R. Wessel to Ann George, February 11, 1991, MSS Hop Growers of America, Series I, box 1, folder 7, OHBA.

95. Richard Wiles, "Case Studies of the EPA's Application of the Delaney Clause in Tolerance-Setting Process," in *Regulating Pesticides in Food: the Delaney Paradox* (Washington D.C.: National Academies Press, 1987).

96. Morten Meilgaard to Hoyt L. Jamerson, February 27, 1987, MSS Hop Growers of America, Series I, box 1, folder 7, OHBA. Those interested in trying Sierra Nevada's current iteration of a fresh hop ale can keep their eyes out for the firm's seasonal Celebration IPA.

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successful, and in 1993, the EPA and FDA decided to list dried hops as raw agricultural commodities and no longer required pesticide residue data for green (undried) hops.[97] This allowed hop growers and brewers to avoid the Delaney Clause's total ban on any carcinogenic residues in processed foods. Aliette has since become a common pesticide used to control downy mildew, although as of 2021, the fungus responsible for downy mildew has developed resistance to the chemical in some regions.[98]

This is just one example of how the USHIPCC worked to ensure that hop growers maintained access to pesticides. However, it is important to note that the USHIPCC and hop growers did not support the continued use, registration, and harmonization of pesticides because they enjoyed using toxic chemicals that posed threats to the health of growers and the environment. Instead, growers, trade organizations, and brewers came to rely on pesticides because they saw no other viable alternative to producing the quantity and quality of hops desired by the beer industry, whose demand for hops continued to grow year after year, particularly in the craft beer segment.[99]

Craft brewers developed a voracious hunger for hops as craft beer continued to gain in popularity. As the number of firms increased from 284 in 1990 to 1,566 by 2000, brewers also began brewing more hop-intensive beer styles, such as the American IPA, which uses more hops per gallon of beer than industrial lagers. By the 1990s, the IPA spread across the country, with craft brewers from California to Delaware experimenting with hybrid hops and new hopping techniques, such as Sam Calagione's continuous hopping method used at Dogfish Head Brewing Company and Sierra Nevada's hop torpedo.[100]

Yet the reliance on pesticides to produce hops contrasts strongly with craft beer's imagery and marketing, which in addition to hops also frequently uses nature and outdoor recreation images to promote the industry's natural, artisan, and craft ethos. This trend stretches from coast to coast and is used by brewers big and small. While there are countless examples to draw from, two that illustrate this point include the Uintah Brewing Company of Utah, which markets its products using images of skiing, fishing, and camping, and the small Nocterra Brewing Company located in Powell, Ohio, that exclaims its beer is best enjoyed outside in nature.[101] Hops funded by big brewers and grown using environmentally harmful chemicals are out of place in these narratives and marketing campaigns.

97. EPA, "PR Notice 193-12, Notice to Producers, Formulators, and Registrants of Pesticide Products" (December 23, 1993) MSS Hop Growers of America, Series I, Box 1, Folder 7, OHBA.

98. Douglas S. Higgins, Timothy D. Miles, and Mary K. Hausbeck, "Fungicide Efficacy Against *Pseudoperonospora humuli* and Point Mutations Linked to Carboxylic Acid Amide Resistance in Michigan," *Plant Diseases* 105, no. 7 (2021): 1880-1889.

99. Author interview with Ann George.

100. Alworth, *The Beer Bible,* 108-113. The continuous hopping method at Dogfish Head uses a vibrating machine to constantly shake hops into a brew for 60, 90, or 120 minutes. The Sierra Nevada torpedo is a cylindrical tube filled with hops that brewers continuously pump fermenting beer through. Both methods help further extract the acids and oils from the hops.

101. Nocterra Brewing Company, "Our Values," accessed January 30, 2023, https://nocterrabrewing.com/beer-outside/; Uintah Brewing Company, "Committed to Craft" accessed January 30, 2023, https://www.uintabrewing.com/all-beer.

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Hops, Pesticide Residues, and Beer

As of 2023, the primary hop diseases of downy and now powdery mildew (which affects hops in Washington's Yakima Valley) cannot be effectively controlled without pesticides. In 2015, the *Field Guide for Integrated Pest Management in Hops* noted that "no single management tactic provides satisfactory control of downy mildew" and that the disease can still result in 100 percent crop loss if not controlled. The guide recommended that growers select the most resistant varieties when possible. However, timely fungicide applications are needed to prevent the disease when the weather favors the pathogen's spread. Yet, the guide also cautions that the fungus has a high potential for developing fungicide resistance.[102] Downy mildew remains a headache and a significant financial threat for hop growers and brewers, just as it did in the 1880s and 1930s. Pesticides remain the only effective method for control. However, these chemicals come with steep costs and raise potential concerns. Not only is pesticide use in industrial agriculture associated with an acute loss of biodiversity, resulting in the deaths of birds, insects, and key pollinators in agricultural landscapes, but recent studies have shown that pesticide residues from hops frequently carry over into a consumer's pint glass.[103]

In 2016, a study published by the *Journal of the American Society of Brewing Chemists* found that statistically significant amounts of two-hop pesticides could be found in beers brewed with hops added to the fermentation tanks after the boiling stage. After testing both whole cone and pelletized hops, researchers from Washington State, the Washington Hop Commission, and the University of California detected meaningful quantities of two chemicals, boscalid (a fungicide) and bifenazate (a miticide). Beers brewed using fresh, whole cone or "wet" hops, exhibited the highest concentration of the chemicals, and while they receive much hype, beers made using this method are not very common. The report also noted that the pesticide residues fell below the legal limits established by US regulatory agencies.[104]

In 2018, a group of Czech researchers found that hops can carry over as many as 58 different pesticide residues into a beer. Their study included the sixteen most common hop pesticides. The Czech study focused on reproducing industrial lager beer and determined that 33 of the 58 tested pesticides had a residue transfer rate of 50 percent or greater into the final beer.[105] While this study mirrored the findings of the 2016 experiment—demonstrating that even chemicals with high carry-over rates only have very limited concentrations in the final beer

102. David H. Gent, Dennis A. Johnson, Amanda J. Gevens, and Mary K. Hausbeck, "Downy Mildew," in *Field Guide for Integrated Pest Management in Hops,* ed. S.D. O'Neal, Douglas B. Walsh, and David H. Gent, eds., 3rd edition (Pullman, WA:P U.S. Hop Industry Plant Protection Committee, 2015): 15-21.

103. Carsten A. Bruhl and Johann G. Zaller, "Biodiversity Decline as a Consequence of an Inappropriate Environmental Risk Assessment of Pesticides," *Frontiers in Environmental Science* 7 (October 2019): 1-4.

104. Douglas B. Walsh, Sally D. O'Neal, Ann E. George, Daniel P. Groenendale, Ruth E. Henderson, Geoffrey M. Groenendale, and Matt J. Hengel, "Evaluation of Pesticide Residues from Conventional, Organic, and Nontreated Hops Conventionally Hopped, Late Hopped, and Wet-Hopped Beers," *Journal of the American Society of Brewing Chemists* 74 no. 1 (2016): 53-56.

105. Martin Dušek, Vladimíra Jandovská, Jana Olšovská, "Tracking, Behavior and Fate of 58 Pesticides Originated from Hops During Beer Brewing," *Journal of Agricultural Food Chemistry* 66, no. 38 (September 2018): 10113-10121.

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—neither of these studies determines the impacts of pesticides on the people who apply the chemicals nor how these chemicals impact consumer health over decades of small, but repeated exposure.[106]

While many food products, ranging from produce, ice cream, and beer, contain pesticide residues below governmental limits, it is unknown how the buildup of these chemicals in the body over decades of consumption or when passed from mother to offspring across generations impacts human health.[107] Rachel Carson raised concern over chronic exposure to pesticides in *Silent Spring,* yet the issue remains highly controversial. While studies show that beer brewed with conventionally grown hops does not exceed legal tolerances, the long-term impact of repeated consumer exposure to hop pesticides and other synthetic chemicals in our food is largely unknown. Studies of chronic pesticide exposure in lab animals are linked to birth defects, cancerous tumors, blood disorders, nerve disorders, and reproductive effects.[108] Yet, due to a host of variables, it is difficult to prove a particular chemical's chronic toxicity (versus acute toxicity), even in lab animals. Given this information, a more cautious approach to pesticides than the current regulatory structure and the brewing industry's reliance on pesticides is warranted.

The hopyard cannot be the only site of innovation. Advances in the brew house and changing customer palate are also significant in overcoming these agricultural challenges. As this history, and others, have shown, monoculture farming for industrial production—for hops, coffee, bananas, wheat, and more—results in agriculture being susceptible to disease and other issues of soil erosion and biodiversity loss.[109] Even though craft brewers' demand for vast quantities of hops does not exempt them from contributing to the current pesticide-heavy hop growing regime—indeed, hybrid hops have not eased the industry's reliance on pesticides—their willingness to experiment with new hops and new flavors presents a valuable tool for addressing monocrop agriculture and perhaps offers a more sustainable way forward for the hop and brewing industries.

One of the most significant innovations in craft brewing is the embrace of novel and unique flavors. Historically, big brewers have been reticent to embrace hop cultivars that significantly change the taste of their signature beers, such as Coors's brief dalliance with the Cascade. Nevertheless, by being willing to experiment with new flavors and embrace flavor diversity across their products, craft brewers helped usher in consumer acceptance of new hops, many with resistance to mildews like the Cascade and Centennial.

106. Michael C. R. Alavanja, Jane A. Hoppin, and Freya Kamel, "Health Effects of Chronic Pesticide Exposure: Cancer and Neurotoxicity," *Annual Review of Public Health* 25 (2004): 155-97; Sara Mostafalou, Mohammad Abdollahi, "Pesticides and Human Chronic Diseases: Evidence, Mechanisms, and Perspectives," *Toxicology and Appplied Pharmacology* 268 (2013): 157-177.

107. Stephanie Strom, "Trace Amounts of Controversial Herbicide are Found in Ben and Jerry's Ice Cream," *New York Times,* July 25, 2017; Environmental Working Group, "Dirty Dozen: Shopper's guide to Pesticides in Produce," accessed January 31, 2023, https://www.ewg.org/foodnews/dirty-dozen.php.

108. Michael C. R. Alavanja, Jane A. Hoppin, and Freya Kamel, "Health Effects of Chronic Pesticide Exposure: Cancer and Neurotoxicity," *Annual Review of Public Health* 25 (2004): 155-97; Sara Mostafalou, Mohammad Abdollahi, "Pesticides and Human Chronic Diseases: Evidence, Mechanisms, and Perspectives," *Toxicology and Applied Pharmacology* 268 (2013): 157-177.

109. John Soluri, *Banana Cultures: Agriculture, Consumption, and Environmental Change in Honduras and the United States* (Austin: University of Texas Press, 2005); Stuart McCook, *Coffee is Not Forever: A Global History of Coffee Leaf Rust* (Athens: OH: Ohio University Press, 2019).

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As a result of craft beer's popularity in the United States and around the globe, many of the top ten hop varieties grown in the US are newer hybrids that exhibit some level of resistance to significant hop diseases. This includes new proprietary aroma varieties (hops bred by corporations such as the Hop Breeding Company) like Citra, Mosaic, Simcoe, and Amarillo, demonstrating moderate to good resistance to downy and powdery mildew.[110] Together, these four varieties, primarily used to craft IPAs, accounted for nearly 40 percent of all US hop acreage in 2020.[111]

Planting such high quantities of resistant varieties is important for growers seeking to control mildew outbreaks in their hop yards without using exorbitant amounts of chemicals.[112] Other popular legacy varieties with resistance, like Chinook, Centennial, and Cascade, are also frequently among the top ten varieties grown in the US. However, the Cascade is now threatened by new strains of fungal diseases that have evolved to overcome its resistance.[113] Innovation in breeding and a willingness to use new hops are essential to reducing the hop and brewing industry's reliance on pesticides. This only works, however, if brewers are interested in using new hop varieties, an area where craft brewers excel. Furthermore, and perhaps more radically, brewers could begin to experiment with new or even historical beer varieties that do not incorporate hops at all.

A growing interest among brewers to use locally-grown hops and distance themselves from the massive hop monocultures in Yakima Valley has led plant scientists to research wild hops in collaboration with craft brewers.[114] As Dr. James LaMondia of the Connecticut Agricultural Experiment Station remarked, "If [wild hops] have been growing out in the woods for a hundred years on their own, they probably have hardy characteristics that would be useful [to commercial growers and brewers]."[115] This approach not only opens new avenues for brewer creativity but could also result in the breeding and growing of hardy cultivars that also imbue beers with a sense of local terroir.[116] For example, brewers have partnered with researchers at the University of Maryland to cultivate the Monocacy hop, which is native to Maryland and exhibits resistance to the region's hop diseases and pests.[117] So, while the

110. Garret Oliver, "*The Oxford Companion to Beer* definition of Citra," Craft Beer and Brewing, accessed November 11, 2022, https://beerandbrewing.com/dictionary/uyq5PqpvWJ/; Matty Brynildson, "*The Oxford Companion to Beer* definition of Amarillo," Craft Beer and Brewing, accessed November 11, 2022, https://beerandbrewing.com/dictionary/9UD3hRcRx2/; "Mosaic Hop," Beer Maverick, accessed November 11, 2022, https://beermaverick.com/hop/mosaic/.

111. Ann George, "2020 Statistical Report," (Pullman, WA: Hop Grower of America, 2021): 7.

112. Melanie L. Lewis Ivey and Sally A. Miller, "Hops Downy Mildew," *Agriculture and Natural Resources* (June 2018), accessed November 22, 2022, https://ohioline.osu.edu/factsheet/plpath-fru-49.

113. D.H. Gent, B.J. Claassen, M.S. Wiseman, and S.N. Wolfenbarger, "Temperature Influences on Powdery Mildew Susceptibility and Development in the Hop Cultivar Cascade," *Plant Dis*eases 106, no. 6 (2022):1681-1689.

114. "Evolution of CT Hops Industry on Display at Growers' Annual Meeting," January 17, 2018, Connecticut Grown; Natasha Geiling, "The East Coast May Be on the Brink of a Hop Renaissance," May 21, 2018, *Smithsonian Magazine.*

115. "Evolution of CT Hops Industry on Display at Growers' Annual Meeting," January 17, 2018, Connecticut Grown.

116. Michael Féchir, Garrett Weaver, Curtis Roy & Thomas H. Shellhammer, "Exploring the Regional Identity of Cascade and Mosaic® Hops Grown at Different Locations in Oregon and Washington," *Journal of the American Society of Brewing Chemists* 81, no. 3 (2023): 480-492.

117. Brewers Association of Maryland, "The Monocacy Hops," n.d. accessed September 26, 2023, https://marylandbeer.org/the-monocacy-hop/.

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history of American hops since the outbreak of downy mildew in Oregon in the 1930s has led to the current pesticide-dependent growing regime, a willingness to experiment with novel cultivars in new growing regions offers the potential to foster an industry less reliant on toxic synthetic chemicals.

Conclusion

American craft beer was built on hops. The distinctive flavors of American hybrids helped nascent brewers establish a novel product and carve out a niche market among American beer drinkers tired of homogenized American lagers. However, craft beer would not be where it is today without the impact of pests, efforts to control them, and the funding of craft beer's narrative foil—brewers of homogenized lagers. Funding from big brewers contributed to creating the modern hop industry that craft brewers rely upon. Furthermore, not only did craft brewers rely on the funding of big brewing firms to develop some of their key hops, but their insatiable appetite for bitter green botanicals further supported an industrial agriculture model in hop growing to meet the quantity and quality standards demanded by their boutique brews. The use of industrial agricultural methods, particularly the reliance on pesticides, undermines much of the small, local, natural, artisanal, and craft ethos that craft brewers rely upon to market their brands.

This history challenges craft brewers' use of hops in their marketing to support a more "authentic" or "natural" product. By exploring the history of craft brewing through the development of hybrid hops and the control of pests, the connections between craft beer and its self-proclaimed antithesis, Big Beer, emerge from the dichotomous marketing narratives constructed by craft brewers. Moreover, the combination of hops, pests, and chemicals illustrates the ironic conclusion that an artesian industry like craft beer sustains itself through industrial, chemical-heavy agriculture. Nevertheless, despite this glaring irony, craft brewers' innovation and willingness to embrace new hop varieties and experiment with new flavors offer both the hop and brewing industries the opportunity to reduce their historical reliance on pesticides and hopefully develop a more environmentally friendly future.

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Bibliography of Works Cited

Books

Acitelli, Tom. *The Audacity of Hops: The History of America's Craft Beer Revolution*. Chicago: Chicago Review Press, 2013.

Alworth, Jeff. *The Beer Bible*. New York: Workman Publishing, 2015.

https://doi.org/10.1017/eso.2024.12 Published online by Cambridge University Press

Baron, Stanley. *Brewed in America: A History of Beer and Ale in the United States*. Boston: Little, Brown and Company, 1962.
Barth, Heinrich Joh., Christiane Kline, and Claus Schmidt. *The Hop Atlas: The History and Geography of the Cultivated Plant*. Nuremberg: Joh. Barth & Sohn, 1994.
Belasco, Warren. *Appetite for Change: How the Counterculture Took on the Food Industry*. 2nd ed. Ithaca: Cornell University Press, 2007.
Berghoff, Hartmut, and Adam Rome, eds. *Green Capitalism?: Business and the Environment in the Twentieth Century*. Philadelphia: University of Pennsylvania Press, 2017.
Bobrow-Strain, Aaron. *White Bread: A Social History of the Store-Bought Loaf*. Boston: Beacon Press, 2012.
Boerboom, Sam, ed. *The Political Language of Food*. Lanham, MD: Lexington Books, 2015.
Cochran, Thomas C. *The Pabst Brewing Company: The History of an American Business*. New York: New York University Press, 1944.
Daniel, Pete. *Toxic Drift: Pesticides and Health in the Post-World War II South*. Baton Rouge: Louisiana State University Press, 2005.
Davis, Frederick Rowe. *Banned: A History of Pesticides and the Science of Toxicology*. New Haven: Yale University Press, 2014.
DeSalle, Rob, and Ian Tattersall. *A Natural History of Beer*. New Haven: Yale University Press, 2019.
DiSorbo, Dan. *The Book of Hops*. New York: 10 Speed Press, 2022.
Fitzgerald, Deborah Kay. *Every Farm a Factory: The Industrial Ideal in American Agriculture*. New Haven: Yale University Press, 2003.
Grossman, Ken. *Beyond the Pale: The Story of the Sierra Nevada Brewing Company*. Hoboken: Wiley, 2014.
Hieronymus, Stan. *For the Love of Hops: The Practical Guide to Aroma, Bitterness and the Culture of Hops*. Boulder, CO: Brewers Press, 2012.
Hindy, Steve. *The Craft Beer Revolution: How a Band of Microbrewers is Transforming the World's Favorite Drink*. New York: Palgrave-MacMillian, 2014.
Hodder, Ian. *Entangled: An Archeology of the Relationship Between Humans and Things*. Oxford: Wiley-Blackwell, 2012.
Kopp, Peter A. *Hoptopia: A World of Agriculture and Beer in Oregon's Willamette Valley*. Oakland: University of California Press, 2016.
Larsen, Dennis M. *Hop King: Ezra Meeker's Boom Years*. Pullman: Washington State University, 2016.
LeCain, Timothy J. *The Matter of History: How Things Create the Past*. New York: Cambridge University Press, 2017.
Mart, Michelle. *Pesticides, A Love Story: America's Enduring Embrace of Dangerous Chemicals*. Lawrence: University Press of Kansas, 2015.
McCook, Stuart. *Coffee is Not Forever: A Global History of Coffee Leaf Rust*. Athens, OH: Ohio University Press, 2019.
Ogle, Maureen. *Ambitious Brew: The Story of American Beer*. Orlando: Harcourt Inc., 2006.
Russel, Edmund. *War and Nature: Fighting Humans and Insects with Chemicals from World War I to Silent Spring*. New York: Cambridge University, 2006.
Scranton, Phil. *Endless Novelty: Specialty Production and American Industrialization, 1865–1925*. Princeton: Princeton University Press, 1997.
Soluri, John. *Banana Cultures: Agriculture, Consumption, and Environmental Change in Honduras and the United States*. Austin: University of Texas Press, 2005.
Tomlan, Michael A. *Tinged with Gold: Hop Culture in the United States*. Athens, GA: University of Georgia Press, 1992.
Unger, Richard W. *Beer in the Middle Ages and Renaissance*. Philadelphia: University of Pennsylvania Press, 2004.

https://doi.org/10.1017/eso.2024.12 Published online by Cambridge University Press

Articles, Chapters in Books, Dissertations, Papers, Reports

Alavanja, Michael C.R., Jane A. Hoppin, and Freya Kamel. "Health Effects of Chronic Pesticide Exposure: Cancer and Neurotoxicity." *Annual Review of Public Health* 25 (2004): 155–197.

Becham, Nikol. "Entrepreneurial Leisure and the Microbrew Revolution: The Neoliberal Origins of the Craft Beer Movement." In *Untapped: Exploring the Cultural Dimension of Craft Beer*, edited by Nathaniel G. Chapman, J. Slade Lellock, and Cameron D. Lippard. Morgantown: West Virginia University Press, 2017.

Bruhl, Carsten A., and Johann G. Zaller. "Biodiversity Decline as a Consequence of an Inappropriate Environmental Risk Assessment of Pesticides." *Frontiers in Environmental Science* 7 (October 2019): 1–4.

Bressman, E.N. "*Report of Hop Breeding*." Corvallis: Oregon State University Extension Service, 1931.

Cost, Lucio G. "Organophosphorus Compounds at 80: Some Old and New Issues." *Toxicological Sciences* 162, no. 1 (2018): 24–35.

Dušek, Martin, Vladimíra Jandovská, and Jana Olšovská. "Tracking, Behavior and Fate of 58 Pesticides Originated from Hops During Beer Brewing." *Journal of Agricultural Food Chemistry* 66, no. 38 (September 2018): 10113–10121.

Féchir, Michael, Garrett Weaver, Curtis Roy, and Thomas H. Shellhammer. "Exploring the Regional Identity of Cascade and Mosaic® Hops Grown at Different Locations in Oregon and Washington." *Journal of the American Society of Brewing Chemists* 81, no. 3 (2023): 480–492.

Gent, D.H., B.J. Claassen, M.S. Wiseman, and S.N. Wolfenbarger. "Temperature Influences on Powdery Mildew Susceptibility and Development in the Hop Cultivar Cascade." *Plant Diseases* 106, no. 6 (2022): 1681–1689.

George, Ann. "U.S. Hop Acreage Trends Alpha & Aroma Varieties 1996-2000." 2000 Statistical Report. Seattle: Hop Growers of America, 2001.

Hoerner, G.R. "Comparison of Spray Nozzles for Effective Spraying of Hops for Downy Mildew." Corvallis: Agricultural Experiment Station, 1937.

Hoerner, G.R. "Downy Mildew of Hops." Extension Bulletin no. 440. March 1932.

Hoerner, G.R. "The Relation of the Climatology of Western Oregon to the Incidence and Control of Downy Mildew of Hops." *The Plant Disease Reporter* 23, no. 22 (December 1, 1939).

Hop Growers of America. Good Bines Biannual Issue 3, March 17, 2022.

Hop Growers of America. "U.S. Hop Acreage Trends Alpha & Aroma Varieties 1996-2000." 2000 Statistical Report. Seattle: HGA, 2001.

Hop Growers of America. "2020 Statistical Report." Pullman, WA: Hop Grower of America, 2021.

Hop Growers of America. "2022 08-03 USHIPPC MRL [Maximum Residue Level] Chart." *Hop Growers of America*, August 2022.

Higgins, Douglas S., Timothy D. Miles, and Mary K. Hausbeck. "Fungicide Efficacy Against Pseudoperonospora humuli and Point Mutations Linked to Carboxylic Acid Amide Resistance in Michigan." *Plant Diseases* 105, no. 7 (2021): 1880–1889.

Ivey, Melanie L. Lewis, and Sally A. Miller. "Hops Downy Mildew." *Agriculture and Natural Resources*, June 2018.

McGahan, A.M. "The Emergence of the National Brewing Oligopoly: Competition in the American Market, 1933-1958." *The Business History Review* 65, no. 2 (1991): 229–284.

Mostafalou, Sara, and Mohammad Abdollahi. "Pesticides and Human Chronic Diseases: Evidence, Mechanisms, and Perspectives." *Toxicology and Applied Pharmacology* 268 (2013): 157–177.

Murakami, A., P. Darby, B. Javornik, M.S.S. Pais, E. Seigner, A. Lutz, and P. Svoboda. "Molecular Phylogeny of Wild Hops, Humulus lupulus L" *Hereditary* 97 (2006): 66–74.

https://doi.org/10.1017/eso.2024.12 Published online by Cambridge University Press

Pilcher, Jeffrey M. "Hop Movements: The Global Invention of Craft Beer." In *Food Mobilities: Making World Cuisine*, edited by Daniel E. Bender and Simone Cinotto. Toronto: University of Toronto Press, 2023.

Rice, Jeff. "Professional Purity: Revolutionary Writing in the Craft Beer Industry." *Journal of Business and Technical Communication* 30, no. 2 (2016): 236–261.

Rosen, Christine Meisner, and Christopher Sellers. "The Nature of the Firm: Towards an Ecocultural History of Business." *Business History Review* 73 (Winter, 1999): 577–600.

Rosen, Christine Meisner. "The Business-Environment Connection." *Environmental History* 10, no. 1 (2005): 77–79.

Stack, Martin. "Local and Regional Breweries in America's Brewing Industry, 1865 to 1920." *The Business History Review* 74, no. 3 (2000): 435–463.

Stack, Martin. "Was Big Beautiful? The Rise of National Breweries in America's Pre-Prohibition Brewing Industry." *Journal of Macromarketing* 30, no. 1 (2010): 50–60.

Turner, Samuel F., *et al.* "Challenges and Opportunities for Organic Hop Production in the United States." *Agronomy Journal* 103, no. 6 (2011): 1645–1654.

USDA, *National Hop Report 2022*. Washington, D.C.: National Agricultural Statistics Service, 2022.

Walsh, Douglas B., Sally D. O'Neal, Ann E. George, Daniel P. Groenendale, Ruth E. Henderson, Geoffrey M. Groenendale, and Matt J. Hengel. "Evaluation of Pesticide Residues from Conventional, Organic, and Nontreated Hops: Conventionally Hopped, Late Hopped, and Wet-Hopped Beers." *Journal of the American Society of Brewing Chemists* 74, no. 1 (2016): 53–56.

Wiles, Richard. "Case Studies of the EPA's Application of the Delaney Clause in Tolerance-Setting Process." In *Regulating Pesticides in Food: the Delaney Paradox*, Washington D.C.: National Academies Press, 1987.

Newspapers and Magazines

Boston Globe
Brew Bound
Brewers Digest
Brooklyn Daily Eagle
Craft Beer and Brewing
Hopper
Hop Press
Imbibe Magazine
Indie Hops: In Hop Pursuit Blog
New York Times
Oakland Tribune
Outside Magazine
Smithsonian Magazine
Spokesman-Review (Spokane, Washington)
Tri-City Herald (Pasco, Washington)

Primary Sources

Agricultural Experiment Station Records, 1889-2002 (RG 025), Oregon Hops and Brewing Archives (OHBA), Oregon State University, Corvallis, Oregon.

Beer and Craft Brewing Oral History Interviews, The Hagley Museum, Wilmington, Delaware.

https://doi.org/10.1017/eso.2024.12 Published online by Cambridge University Press

Hop Growers of America Records, 1956-2011 (MSS HGA), Oregon Hops and Brewing Archives (OHBA), Oregon State University, Corvallis, Oregon.
Hop Research Council Records, 1943-2009 (MSS HRC), Oregon Hops and Brewing Archives (OHBA), Oregon State University, Corvallis, Oregon.
Oral History Collection, Oregon Hops and Brewing Archives (OHBA), Oregon State University, Corvallis, Oregon.

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