The Industrialization of Milk in America During the Antebellum and Civil War Eras

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Abstract

At the beginning of the nineteenth century, most Americans harvested the milk they needed for food and medicine from their own or a neighbor's cow. By the end of the nineteenth century, most Americans purchased milk from peddlers or grocers, without ever seeing, much less feeding and caring for, the animals that furnished their favorite comfort food. During that same one-hundred-year period, Americans witnessed the transformation of milk from a variable and often dangerous fluid into a standardized, sanitized commodity that came packaged, and in some cases, dehydrated, in glass bottles, cans, and even boxes. This dissertation uses methodologies and models borrowed from a number of fields – among them environmental history, envirotech, social and cultural history, urban history, medical history, military history, animal studies, food history, agricultural history, and gender studies – to explain how and why these transformative processes occurred and with what consequences for consumers. It does so in three steps. First, it explains how and why Americans of the era inscribed cow's milk with culinary, medical, and symbolic value, even as they struggled to make large quantities of the fluid and move it over any distance. Second, it describes Antebellum Americans' (often disastrous) attempts to shrink the distance between rural cows and a growing urban milk market, culminating not only in the "swill milk" crisis of the 1840s and 1850s, but also in the commercial success of less-perishable milk products, among them Gail Borden Jr.'s canned sweetened condensed milk. Third, it draws these narrative threads together during the Civil War years, noting that Borden's invention gave Union medical officials and civilian aid workers an unprecedented ability to move life-saving milk to hospitals, aid stations, and the very front lines of combat, reducing the time that sick and wounded soldiers had to wait for aid from days to hours to minutes. On returning to their homes, Union veterans and aid workers were more

inclined to trust milk harvested on distant farms, giving a crucial boost to the Borden Company, specifically, and the growing industrial milk industry more generally.

Acknowledgements

There are so many people deserving of my thanks that it may take me a few pages to acknowledge them all. And yet, I fully intend to do so, for without them, I could never have completed this dissertation.

It is customary to begin these acknowledgements by thanking advisors, graduate colleagues, and others in the academic world who have given their time and advice in guiding the completion of this dissertation. However, I would like to begin by offering my most heartfelt thanks to my wife, Cory Noel Davis, who has offered me her unwavering support over the last nine years. Cory moved from Texas to Kansas so that I could pursue my academic goals. She served as an editor and sounding board, reading more chapter drafts than I can count. She always listened when the stress and loneliness of graduate school threatened to overwhelm me. She took me out on bike rides and long walks to make sure I got some exercise. She took me out for chicken wings, karaoke, and Sunday brunch to help me separate myself -- if only for a moment -- from my studies. She never complained. She is my rock. As far as I am concerned, this dissertation is as much hers as it is mine.

I would next like to thank my mother, Linda Davis, and my father, Woody Davis, for their love and support. I am grateful for the time that my Mom spent teaching me to love reading all those years ago. Her patience and empathy have helped me through many a dark hour. I am likewise grateful to my Dad for his unwavering confidence in my abilities and his interest in my life and work. It is my sincere hope that someday, I will learn to believe in myself as much as he believes in me. I am grateful to them both in ways that cannot be expressed in mere words. I love you both with all my heart!

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It is also necessary that I thank Dr. Gregory Cushman, who taught me to speak with an authoritative voice, Dr. Beth Bailey, who listened to my research problems and offered useful advice (even before she joined my committee), and Dr. Marie Grace Brown, who introduced me to methodologies that forced me out of my comfort zone. Dr. Sheyda Jahanbani always fought for me. Dr. Jonathan Hagel did as much as anyone to help me secure my current position as a high school history and civics teacher. My graduate colleagues read drafts, made me laugh, and found ways to distract me from the stress and strain of graduate work. I want to offer them all my sincerest thanks and gratitude.

Finally, I would like to thank all of my colleagues at Pinewood Preparatory School. Working with you has been, and continues to be, one of the greatest joys in my life.

If I have overlooked anyone, please forgive me. Know that I am grateful to you, and that I will make a point of thanking you in person.

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Introduction:

The American Civil War transformed Gail Borden Jr.'s patented "Eagle Brand" canned sweetened condensed milk from a poorly regarded product, beloved by no one, into one of America's most well-known, most enduring -- and if the label affixed to modern Borden's Milk cans be believed, "most trusted" -- preserved-food products. The editors of *Scientific American* claimed as much in March 1871, noting that "large quantities were required for the Northern Armies," giving a sudden "impetus to the [condensed milk] trade." Two years later, in his a defense of Borden's patent rights, Borden's long-time friend and business partner, Secretary of the Maine Board of Agriculture, Stephen L. Goodale, concurred with *Scientific American* editors, writing, "The civil war made [Borden's condensed milk] quickly and extensively known, so that the demand rapidly increased until it exceeded the supply." Editors of the May 25, 1918, *Indiana Farmer's Guide* were even more explicit than Goodale in attributing the success of Borden's Sweetened Condensed Milk to the Union war effort, noting that "milk put up in concentrated form was not popular until the opening of the Civil War, when it was used for food for the soldiers, and then the business became firmly established." So too the journalist James H. Collins, whose 1922 history of condensed milk industry claimed that Union troops "learned to like" Borden's "Eagle Brand" milk while serving, thanks to the government's decision to commandeer the entire output of Borden's Wassaic, New York, condensing plant beginning in 1861 for use as both a soldiers' ration and a hospital store.[1]

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[1] "The Condensed Milk Manufacture," *Scientific American*, 25 March 1871; Stephen Lincoln Goodale, *A Brief Sketch of Gail Borden, and His Relations to Some Forms of Concentrated Food* (Portland, Maine: B. Thurston & Co., 1872), 9; "War Increases Importance of Condensed Milk Industry Export Demand Enlarged 1,000 Per Cent," *Indiana Farmer's Guide*, May 25, 1918; James H. Collins, *The Story of Condensed Milk* (New York: The Borden Company, 1922), 15.

To date, historians have seen no reason to challenge this tidy, cause-and-effect narrative. Indeed, it has enjoyed a durability to match that of Borden's signature "Eagle Brand" milk. In his 1951 Borden hagiography, the historian Joe B. Frantz argued that Borden's condensed milk was too "foreign," and the New York Condensed Milk Company's sales staff too small, to attract civilian consumers before the American Civil War. All of that changed in August 1861, Frantz insisted, when an agent of the United States Commissary purchased 500 lbs. of the sweet, syrupy substance for use in feeding Union troops – the first in a series of lucrative wartime contracts that would ensure Borden's and the New York Condensed Milk Company's long-term success.[2] Citing Frantz's findings, the acclaimed Civil War historian James McPherson argued that U.S. government contracts gave a "crucial boost" to preserved food manufacturers such as Gail Borden Jr. during the Civil War. So too the food historian Andrew F. Smith, who claimed that Union Commissary and United States Sanitary Commission purchases of sweetened condensed milk "assured the future of Borden's enterprise," which had struggled to find a market for its revolutionary new product.[3] The social historian Deborah Valenze followed a similar course in her 2011 study of milk production and consumption. Although she struggled to explain the product's wartime popularity, noting that "at least some of the stuff made its way to the front lines," where Union officers and soldiers used it to sweeten their coffee, she was certain that Union military purchases of condensed milk propelled Borden and his New York Condensed Milk Company into the "front ranks of American business."[4]

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[2] Joe B. Frantz, *Gail Borden: Dairyman to a Nation* (Norman, Oklahoma: University of Oklahoma Press, 1951), 254-258.

[3] James M. McPherson, *Ordeal by Fire: The Civil War and Reconstruction*, 3rd ed. (Boston: McGraw-Hill, 2001), 400; Andrew F. Smith, *Starving the South: How the North Won the Civil War* (New York: St. Martin's Press, 2011), 81.

[4] Deborah Valenze, *Milk: A Local and Global History* (New Haven: Yale University Press, 2011), 178-187.

To be sure, there is much to recommend this narrative. Between 1861 and 1865, Borden's New York Condensed Milk Company did sell literal tons of canned sweetened condensed milk to civilian aid workers and Union Commissary agents, who took advantage of the product's portability and durability to ship canned milk to Union military hospitals and camps scattered across the embattled South.[5] Civilian merchants (or "sutlers") sold plenty more to Union officers and soldiers, who derived nutritional and emotional satisfaction from adding a few spoonfuls of the sweet, syrupy substance to their daily ration of bitter black coffee, mixing it with whiskey or brandy to make milk punch (a popular toddy), or in some cases, using a spoon to eat it straight from the can.[6] It is also true that wartime demand for the product exceeded the New York Condensed Milk Company's productive capabilities (about 10,000 quarts per day), leading Gail Borden to authorize the construction of at least three new condensing plants during or immediately following the war while granting licenses to two additional independent condensing plants to make and market canned sweetened condensed milk under the Borden patent and trademarks. There is at least some evidence that Union veterans purchased the

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[5] In the two weeks following the Battle of Antietam, the United States Sanitary Commission dispensed 2,620 lbs. of sweetened condensed milk to Union military hospitals. Following the Battle of Gettysburg, the commission dispensed an additional 12,500 lbs. See Charles Janeway Stillé, *History of the United States Sanitary Commission, Being the General Report of Its Work During the War of the Rebellion* (Philadelphia: Lippincott, 1866), 266–67, 379; "Condensed Milk," *Friends' Review: A Religious, Literary and Miscellaneous Journal*, August 20, 1864; George M. More, *The Illustrated History of Milk* (Cooperstown, New York: Freeman's Journal Co., 1943), 7–12.

[6] For examples of sweetened condensed milk use by Union military personnel, see Charles E. Davis, *Three Years in the Army. The Story of the Thirteenth Massachusetts Volunteers from July 16, 1861, to August 1, 1864* (Boston: Estes and Lauriet, 1894), 378; Thomas D. Marbaker, *History of the Eleventh New Jersey Volunteers, from Its Organization to Appomattox; To Which Is Added Experiences of Prison Life and Sketches of Individual Members* (Trenton, New Jersey: MacCrellish & Quigley, 1898), 36; J. W. Muffly, ed., *The Story of Our Regiment: A History of the 148th Pennsylvania Vols* (Des Moines, Iowa: The Kenyon Printing & MFG. Co., 1904), 516; Cullen B. Aubrey, *Recollections of a Newsboy in the Army of the Potomac, 1861-1865. His Capture and Confinement in Libby Prison, After Being Paroled, Sharing the Fortunes of the Famous Iron Brigade.*, 1904, 105; Richard T. Van Wyck, *A War to Petrify the Heart: The Civil War Letters of a Dutchess County, N.Y. Volunteer*, ed. Virginia Hughes Kaminsky (Hensonville, New York: Black Dome Press, 1997), 46-47.

product on returning home, driving postwar sales. Among them, the Lockport, Illinois, native James Springer dubbed Borden's milk, "A 'real god-send' to us poor sick soldiers."[7]

Compelling though it may be, this retelling of Gail Borden's story fails to capture the chaos and contingency of history. While it is true that Union military purchases during the American Civil War infused Borden's milk condensing business with capital and likely contributed to the long-term, widespread popularity of his signature "Eagle Brand" sweetened condensed milk, it was neither preordained nor inevitable that the Americans who rushed to join the Union war effort beginning in 1861 would find the product desirable and/or nutritionally and medicinally useful. Indeed, the historiography of nineteenth-century food production and consumption would seem to preclude such a conclusion. Historians of canning generally agree that nineteenth-century Americans were suspicious of canned goods, which had the power, mysterious and inexplicable though it may have been for those who lacked knowledge of microorganisms, to sicken and kill human consumers, thanks to imperfect canning techniques and technologies.[8] Meanwhile, historians of dairy production and consumption have muddled the narrative of nineteenth-century American milk use, with some arguing that the humble fluid was a cornerstone of the American diet and others concluding that it was of no great importance. Indeed, among the latter group, one went so far as to claim, "Fluid milk drinking was an extremely minor aspect of the human diet until modern times." Exceptions were, in no particular order: coffee and tea drinkers, who added a dash of milk or cream to their cups; urban mothers who were unable, or unwilling, to breastfeed young children; temperance advocates, who saw milk as a worthy substitute for stimulating drinks; and those who relished fermented milk

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[7] "Condensed Milk," *Friends' Review: A Religious, Literary and Miscellaneous Journal*, August 20, 1864.

[8] Gabriella Petrick, "The Arbiters of Taste: Producers, Consumers and the Industrialization of Taste in America, 1900–1960" (Dissertation, Newark, Delaware, University of Delaware, 2006) and Anna Zeide, *Canned: The Rise and Fall of Consumer Confidence in the American Food Industry* (Berkeley: University of California Press, 2018).

products such as buttermilk and clabbard. Otherwise, Americans of the era used milk to make butter and cheese, which could be shipped long distances without spoiling, or to fatten hogs for slaughter (or so the argument goes).[9]

This raises a puzzling question: Why would Union medical officials, civilian relief agents, and individual Union officers and soldiers purchase thousands of quarts of Borden's milk at 40 cents per can -- about 13 dollars, adjusted for inflation -- if they feared canned goods and had no special fondness or use for cow's milk?[10] It would appear that something is missing from the story; indeed, that many somethings are missing. In 1987, the environmental historian Arthur McEvoy argued that the interaction of economic, cultural, and ecological factors, as opposed to one singular cause, are responsible for historical changes.[11]

McEvoy's model helps us understand the emergence of canned condensed milk as owing to more than the relationship between Gail Borden Jr. and the Union war effort. In treating Union military purchases of Borden's "Eagle Brand" condensed milk as the one meaningful agent of the product's short- and long-term success, historians have obscured a host of variables -- many of which predated the conflict by decades or centuries -- that contributed in some way to the process. These included, but were not limited to: the nutritional, medicinal, symbolic, and magical powers that nineteenth-century Americans attributed to cow's milk and dairy cattle; the widespread distribution and use of popular medical manuals and almanacs; the persistence of lay healing; the folk knowledge, practices, and prejudices that farmers applied to the selection and

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[9] For two works that treat milk as an American dietary cornerstone, see Valenze, *Milk* and Sarah Sutton, "Milk: A New England History" (Dissertation, Waltham, Massachusetts, Brandeis University, 2016). For a work that treats milk as marginal to the American diet, see E. Melanie DuPuis, *Nature's Perfect Food: How Milk Became America's Drink* (New York: New York University Press, 2002).

[10] In some cases, the price reached $0.75 per can. See Thomas D. Marbaker, *History of the Eleventh New Jersey Volunteers From Its Organization to Appomattox* (Trenton, New Jersey: McCrellish & Quigley, 1898), 36.

[11] Arthur F. McEvoy, "Toward an Interactive Theory of Nature and Culture: Ecology, Production, and Cognition in the California Fishing Industry," *Environmental Review*, 11 (Winter 1987), 289-305.

management of cattle; the emotional and physical fragility of dairy cows; the nutrients present in fodder crops (or lack thereof); the advent of widespread railroad travel during the 1840s; Borden's media prowess; the dung and manure that choked nineteenth-century urban streets; the nutritional needs of trans-oceanic and trans-continental travelers; the social, agricultural, and military chaos of the war zone; the human endocrinological and immunological response to stress and traumatic injury and illness; and the chemical processes by which human bodies convert sucrose and fat into energy-rich glucose; the (relative) portability and durability of canned foods; and the perceived usefulness of the product. Remove one these variables, and story would have looked different. *How* different, of course, is anyone's guess.

All of this is to say, Gail Borden Jr. and his contribution to the Union war effort may best be understood – indeed, indeed, may only be understood – when placed in the context of a larger historical process. Specifically, that process was the transformation of cow's milk from something that Americans produced on their own farms for their own use, into an industrialized consumer good used by people who lived or worked too far from the nearest dairy cow to enjoy easy access to their favorite comfort food. Borden's first, halting effort to mass produce clean, nonperishable (or to be more accurate, less perishable) milk beginning in 1856 had everything to do with his desire to furnish a growing population of urban Americans, to say nothing of those who traveled great distances or settled in sparsely populated areas, with clean milk – all while turning a handsome profit for himself and his business partners.[12] It had nothing at all to do with a desire to furnish Union soldiers, who would not take up arms for another five years, with a life-

[12] "Interview with Mr. Knight by Mr. Hall," Joe B. Frantz Papers, 1746, 1801-2010, Literary Productions, 1861-1865, box 3J245, Dolph Briscoe Center for American History, The University of Texas at Austin; Gail Borden Jr. to [Unknown], 25 January 1858, J. Gail Borden Jr. Papers, 1830-1910, 1932-1937, box 3C18, Dolph Briscoe Center for American History, The University of Texas at Austin.

saving source of nutrition.[13] In that, Borden was no different from the selective breeding advocates, veterinary scientists, social reformers, biologists, urban distillery dairy owners, and milk train operators, among myriad others, who were trying in their own way to meet that need. Had Americans avoided war in 1861, he would have continued his pursuit of civilian consumers in Northern cities and the milk-poor regions of the American South and Greater Caribbean Basin. In fact, he did so even as the conflict raged.[14]

The American Civil War did come, however, bringing with it the greatest military medical disaster, and hence, the greatest single demand for clean, nonperishable cow's milk, in United States history up until that moment.[15] Americans of the era had long assigned great scientific, symbolic, and even magical value to milk as food and medicine.[16] It was therefore inconceivable that Northern parents would have sent their sons off to fight without at least *trying* to furnish them with a supply of their favorite comfort food. And yet, trial and error had proven to those same parents that mass producing clean, chemically consistent milk and/or shipping it over any distance was so difficult, and so potentially dangerous to the consumer, as to preclude them from even making the attempt. So it was that Gail Borden Jr. emerged as a folk hero.[17] His original motives notwithstanding, the New York-born Texan (and fierce Unionist) had

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[13] The American Civil War began on April 12, 1861, when South Carolina secessionists attacked Fort Sumter in Charleston Harbor. See Isabella D. Martin and Myrta Lockett, eds., *A Diary From Dixie, as Written by Mary Boykin Chesnut* (New York: D. Appleton and Company, 1906), 35-39.

[14] In March 1864, Borden traveled to Havana, Cuba, hoping to cultivate a market for sweetened condensed milk. See Gail Borden Jr. to New York Condensed Milk Company, 16 March 1864; Gail Borden Jr. to Mr. Milbank, 16 March 1864, J. Gail Borden Jr. Papers, 1830-1910, 1932-1937, box 3C19, Dolph Briscoe Center for American History, University of Texas at Austin.

[15] Margaret Humphreys, *Marrow of Tragedy: The Health Crisis of the American Civil War* (Baltimore: Johns Hopkins University Press, 2013), 3.

[16] For more on the social and symbolic significance of milk in Western societies, see DuPuis, *Nature's Perfect Food*, Hannah Velten, *Milk: A Global History* (London: Reaktion Books, 2010), Valenze, *Milk*, Kendra Smith-Howard, *Pure and Modern Milk: An Environmental History since 1900* (Oxford: Oxford University Press, 2014), and Andrea S. Wiley, *Cultures of Milk: The Biology and Meaning of Dairy Products in the United States and India* (Cambridge: Harvard University Press, 2014).

[17] Goodale, *Brief Sketch*, 9-10.

discovered a reliable means to extend the shelf life of milk, and convinced investors to build the physical plant needed to can and preserve millions of cans of the humble fluid, at the exact moment that Union soldiers and caregivers needed it the most. That canned condensed milk did a tangible service beyond anything that Borden imagined – in this case, making it possible to transport life-saving medicinal milk to the very front lines of combat, where no cow could be expected to travel – served only to augment the product's perceived usefulness and mystique.[18]

Looking back, it is clear that the American Civil War catalyzed or sped the process by which American farmers and consumers embraced the industrialization of milk production. On the one hand, camp and hospital life exposed hundreds of thousands of Union soldiers, surgeons, hospital stewards, and civilian caregivers to canned milk, furnished by cows that they never saw, on farms that they never visited, at a moment when hunger, fear, desperation, or some combination of the three, blunted any distrust of canned goods that would have motivated them to seek alternative sources or consign themselves to doing without. On the other hand, Borden and the New York Condensed Milk Company emerged from the conflict flush with capital and possessed of one of the first well-known, well-regarded, and above all, trusted national brands: Borden's "Eagle Brand" Sweetened Condensed Milk. Borden's son John Gail took advantage of his father's success, and the development of Pasteurization, to move beyond the canning of milk to furnish American urban and suburban consumers with bottled, fluid milk that required no evaporation or dilution. In doing so, the Borden Company, as it came to be known, did much to pioneer the modern – and profoundly local – milk trade, which sees producers contract with bottlers to furnish nearby communities with milk.[19]

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[18] Goodale, *Brief Sketch*, 3-4; A. N. Read, "The Western Department. In the Field," *The Sanitary Commission Bulletin*, 1 September 1864.

[19] Zella Armstrong, *Notable Southern Families, Volume II* (Chattanooga, Tennessee: The Lookout Publishing Company, 1922), 30. For more on the Borden Company as a pioneer of local milk production, see Alan I Marcus,

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Historiographically speaking, it is not altogether surprising that the story of Gail Borden and the industrialization of milk have been subsumed by that of the Union war effort. The American Civil War has a way of bending time, and with it, the stories that scholars tell about the United States and its peoples. To understand how and why this happens, it is helpful to borrow a model used by physicists to visualize the law of gravity. In this model, one places a heavy sphere -- representing a dense celestial body, such as a star or planet -- in the center of a blanket -- representing space and time -- that has been pulled taut at all four corners. The dense object creates a deep depression in the blanket, which simulates the distorting effect of gravity. By virtue of having less weight or mass than the central object, other, smaller objects placed on the blanket will roll or slide, almost inevitably, down into the depression. The American Civil War has had a similar effect on history and historiography. Much like the aforementioned sphere, the conflict rests near the temporal center of the nineteenth century, creating a deep depression in the fabric of time, into which all other events tumble or fall. Indeed, it is only those events that occurred near the beginning and end of the century, where the grade produced by the Civil War is less steep, that escape its pull.[20]

It is easy to spot the American Civil War's distorting effects. Generally speaking, historians organize U.S. history textbooks, as well as the U.S. history survey courses taught on high school and college campuses, in such a way that the conflict serves as a line of demarcation, separating all that came before it from all that has come after.[21] In doing so, they create the

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The Land of Milk and Money: The Creation of the Southern Dairy Industry (Baton Rouge: Louisiana State University Press, 2021).

[20] "Curved Space Time and Geometric Gravitation," *Britannica*, https://www.britannica.com/science/relativity/Experimental-evidence-for-general-relativity

[21] Brittany Adams, "Lecture Topics for First Half of American History Survey," American Historical Association, 2016, https://www.historians.org/teaching-and-learning/teaching-resources-for-historians/resources-for-globalizing-

impression that most everything that happened from September 3, 1783, the date that American colonists achieved their formal independence from Great Britain, until April 12, 1861, the day that South Carolina secessionists opened fire on Fort Sumter in Charleston Harbor, plunging the nation into civil war, led purposefully and inexorably towards the great bloodletting of 1861-1865.[22] This has served in turn to shape historians' interpretation of events. The Constitutional Convention of 1787 becomes a missed opportunity to destroy American slavery in its cradle and avert civil war.[23] The Market and Industrial Revolutions, which unleashed tremendous social, economic, legal, and political changes, become the twin engines of the sectional crisis of the 1830s-1850s.[24] Euroamerican acquisitiveness, which manifested in the rush to settle and exploit Western landscapes, becomes the literal flash point for an antagonistic sectional politics that would split the Democratic Party and send the Republican, Abraham Lincoln, to the White House.[25]

Historians have likewise cast the American Civil War as a transformative agent in American life that resonated long after the guns fell silent, and for good reason. The conflict destroyed a Southern slave society built on the violent exploitation of African American bodies

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the-us-history-survey/american-history-survey-lecture-topics-(irvine-valley-coll). For textbooks that treat the Civil War and Reconstruction as the dividing line in American history, see See Richard N. Current, *American History: A Survey, Volume I: to 1877* (New York: McGraw-Hill, 1986) and Alan Brinkley, *American History: A Survey, Volume 2: Since 1865* (New York: McGraw-Hill Higher Education, 2006).

[22] John Ferling, *Almost a Miracle: The American Victory in the War of Independence* (Oxford: Oxford University Press, 2007), 22.

[23] Michael F. Conlin, *The Constitutional Origins of the American Civil War* (Cambridge: Cambridge University Press, 2019); William L. Barney, *Rebels in the Making: The Secession Crisis and the Birth of the Confederacy* (Oxford: Oxford University Press, 2020).

[24] Charles Sellers, *The Market Revolution: Jacksonian American, 1815-1846* (Oxford: Oxford University Press, 1994); John Lauritz Larson, *The Market Revolution in America: Liberty, Ambition, and the Eclipse of the Common Good* (Cambridge: Cambridge University Press, 2014).

[25] Eric Foner, *Free Soil, Free Labor, Free Men* (Oxford: Oxford University Press, 1995); Leonard L. Richards, *The California Gold Rush and the Coming of the American Civil War* (New York: Vintage Books, 2008); James Oakes, *Freedom National: The Destruction of Slavery in the United States, 1861-1865* (New York: W. W. Norton, 2013); John Craig Hammond, *Slavery, Freedom, and Expansion in the Early American West* (Charlottesville: University of Virginia Press, 2020).

and freed approximately four million enslaved people.[26] The carnage provided physicians and scientists with an opportunity (and the motivation) to experiment with new treatment protocols and hospital designs, as well as new methods of collecting, cataloguing, and using bone and tissue samples for research.[27] It even gave rise to new funerary and mourning rituals, among them a decline in the cultural importance of Victorian Era "good death" and the widespread use of embalming to preserve corpses.[28] On the front lines, Union armies demonstrated the immense power of (relatively) new technologies such as the telegraph, the railroad, and the rifled musket to shape the outcome of military operations.[29] As the war dragged on and the body count soared, some Union commanders set aside Enlightenment-era prohibitions against making war on civilians, thereby normalizing "total war." On the Northern home front, farmers responded to wartime labor shortages by mechanizing their operations, while Northern capitalists set the grim precedent of partnering with federal officials and U.S. troops to suppress a growing labor movement. Even before the guns fell silent in April 1865, these same capitalists had commenced using the bureaucratic and logistical lessons of wartime resource mobilization to streamline their operations and consolidate their power.[30] This is but a small sample of the political, social,

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[26] For more on "slave societies," see Ira Berlin, *Many Thousands Gone: The First Two Centuries of Slavery in North America* (Cambridge, Mass.: Harvard University Press, 1998); Walter Johnson, *River of Dark Dreams: Slavery and Empire in the Cotton Kingdom* (Cambridge, Mass.: Belknap Press of Harvard University Press, 2013). For the wartime destruction of slavery see Oakes, *Freedom National*.

[27] Shauna Devine, *Learning from the Wounded: The Civil War and the Rise of American Medical Science* (Chapel Hill: University of North Carolina Press, 2014).

[28] Drew Gilpin Faust, *This Republic of Suffering: Death and the American Civil War* (New York: Knopf Doubleday Publishing, 2008).

[29] John E. Clark, Jr., *Railroads in the Civil War: The Impact of Management on Victory and Defeat* (Baton Rouge: Louisiana State University Press, 2001); William G. Thomas, *The Iron Way: Railroads, the Civil War, and the Making of Modern America* (New Haven: Yale University Press, 2011); Thomas F. Army, Jr. *Engineering Victory: How Technology Won the American Civil War* (Baltimore: The Johns Hopkins University Press, 2016).

[30] Grace Palladino, *Another Civil War: Labor, Capital, and the State in the Anthracite Regions of Pennsylvania, 1840-1868* (Urbana, Ill.: University of Illinois Press, 1990); Mark R. Wilson, *The Business of Civil War: Military Mobilization and the State, 1861-1865* (Baltimore: The Johns Hopkins University Press, 2006).

medical, and economic changes that may be attributed to the American Civil War. It stands to reason that the war had a similar impact on the nation's nascent preserved-food industry.

And yet, one thing is clear: If the success of nonperishable foods went hand in hand with conflict and crisis, Gail Borden would have succeeded long before the advent of the American Civil War. As the first customs collector for the Port of Galveston, Republic of Texas, Borden had ample exposure to shiploads of half-starved immigrants and scurvy-ridden sailors. Following U.S. victory in the Mexican War, he watched as "adventurers" arrived on the wind-swept island, seeking to purchase bulky, perishable foods before setting off toward California and other points in the Mexican Cession.[31] Borden also knew of the difficulties that the U.S. Army faced in feeding the soldiers who patrolled the Central Plains.[32] Never one to pass up an opportunity, he mixed flour with beef bouillon to create a lightweight, nonperishable "meat biscuit" for use by sailors, soldiers, and overland migrants. The 1851 London Crystal Palace Exposition awarded Borden a gold medal for the biscuit's "high nutritive properties."[33] From his base at Fort Leavenworth, Louisiana Territory (present-day Kansas), Colonel Edwin V. Sumner of the First U.S. Dragoons praised the biscuit for its portability and durability, urging the United States government to "commence using it . . . at once."[34] Borden had done everything right. Yet a single variable -- the biscuit's taste -- proved his undoing. Soldiers and sailors hated the product and refused it at mealtime. On trying a sample in 1856, the journalist Frederick Law Olmstead

[31] Frantz, *Gail Borden*, 131, 202–3.

[32] Gail Borden, Jr., *The Meat Biscuit, Invented, Patented, and Manufactured by Gail Borden, Jun.* (New York: D. Fanshaw, 1851), 13–15; For a study of American military operations on the Central Plains, see Elliott West, *The Contested Plains: Indians, Goldseekers, and the Rush to Colorado* (Lawrence, Kansas: University Press of Kansas, 1998).

[33] Frantz, *Gail Borden*, 203–4, 212.

[34] Gail Borden, Jr., *The Meat Biscuit, Invented, Patented, and Manufactured by Gail Borden, Jun.* (New York: D. Fenshaw, 1851), 13–15. Edwin V. "Bull" Sumner went on to lead the II Corps, Union Army of the Potomac, during the American Civil War. See McPherson, *Ordeal by Fire*, 265, 307–8, 328.

quipped, "I should decidedly undergo a very near approach to the travelers last bourne, before having recourse to it."[35]

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To understand how and why Borden's Milk emerged as a viable product before and during the American Civil War Era one is well served follow the advice given by Lewis Carroll's King of Hearts to the White Rabbit: "Begin at the beginning . . . and go on till you come to the end: then stop." In this case, the beginning comes with the eighteenth- and nineteenth-century Americans of all backgrounds -- old and young; rural and urban; indigenous and immigrant; enslaved and free; Northern, Southern, and Western -- who harvested and used new, sweet cow's milk, along with soured derivatives such as clabber and buttermilk, to feed mind, body, and spirit. Even a cursory survey of contemporary sources -- letters, diaries, travel narratives, and the advertisements that saloons published in newspapers, among myriad others -- reveals that new and soured milk were true and versatile cornerstones of the nineteenth-century-American diet. The humble fluid served as food, drink, and condiment for adults and children, as well as an irreplaceable ingredient in the soups, stews, breads, and toddies that adorned the family table. It was, to borrow a modern term, Americans' favorite "comfort food," and one that few were willing to do without for any great length of time. With respect to E. Melanie Dupuis's otherwise excellent study of nineteenth-century milk production and consumption, milk drinking did emerge on the "primeval farms" of Northern and Western Europe and North America, from which point it traveled *to* the nation's growing cities in the hearts and recipe books of rural-to-urban migrants.[36]

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[35] Frederick Law Olmsted, *A Journey Through Texas; Or a Saddle-Trip on the Southwestern Frontier* (New York: Dix, Edwards & Co., 1857), 81; Frantz, *Gail Borden*, 220.

[36]Lewis Carroll, *Alice's Adventures in Wonderland* (New York: Macmillan, 1920), ??; For an account of rural Americans using milk as a comfort food, see Daniel Drake, *Pioneer Life in Kentucky: A Series of Reminiscential*

If milk was nineteenth-century Americans' favorite comfort food, it was also their most important, most versatile medicine. To be sure, it lacked any of the specific antimicrobial properties common to modern medicines. Yet it did furnish the sick and injured with an ample dose of sugar and fat, both of which were vital to immune systems function and the repair of damaged bodily tissues. If nothing else, it did no harm, which is more than can be said for the blistering agents, toxic calomel (mercury), and other patent medicines prescribed by physicians of the era. Popular reliance on milk as medicine transcended the regional, ethnic, and class/social divisions that historians have long applied to study of the Civil War-era United States. With few exceptions, the women lay healers of rural New England and the Old Northwest turned to one of the many home medical manuals and almanacs, most all of which prescribed milk and milk-based remedies for a wide range of maladies, when treating those who fell sick and injured. So too the Euroamerican and African American lay healers of the South, to say nothing of the trained physicians who traveled the rural backcountry and/or treated patients in urban offices. In the nation's growing cities, middle- and upper-middle class women turned to an emerging selection of popular magazines – in particular *Godey's Ladies' Book* -- for advice on stocking the home "sick room." This included milk-based poultices and clysters (enemas), as well as milk-based foods and toddies that were believed to possess near-magical curative powers.[37]

Letters from Daniel Drake, M.D., to His Children (Cincinnati: Robert Clarke & Co., 1870), 11, 44; Robert Milham Hartley, *An Historical, Scientific, and Practical Essay on Milk, as an Article of Human Sustenance; with a Consideration of the Effects Consequent Upon the Present Unnatural Methods of Producing It for the Supply of Large Cities* (New York: Jay Leavitt, 1842), 173; William Bartram, *Travels through North and South Carolina, Georgia, East and West Florida* (Philadelphia: James & Johnson, 1791), 164; Baily, *Journal*, 372–73; Herbert C. Covey and Dwight Eisnach, *What the Slaves Ate: Recollections of African American Foods and Foodways from the Slave Narratives* (Santa Barbara, California: Greenwood Press, 2009), 136-138; "Late News from California," *Democratic Banner*, August 26, 1850; Dupuis, *Nature's Perfect Food*, 5.

[37] William Fields, "Scarlet Fever and Small Pox," *Glasgow Weekly Times*, January 22, 1857; For more on the relationship between vitamins, nutrients, and human health, see Frederick Gowland Hopkins, "Feeding Experiments Illustrating the Importance of Accessory Factors in Normal Dietaries," *The Journal of Physiology* 44, no. 5–6

Important though it was, nineteenth-century Americans struggled to make an abundance of the clean, chemically consistent milk needed for food and medicine. That is to say, they were unable to manage the three key variables that determine the quantity and quality of milk yielded by dairy cows -- the animals' genetic heritage; the animals' diet; and the animals' physical and emotional health and wellbeing -- with any consistency. This may be attributed, in part, to the scientific and technological limitations of the era. Where modern farmers use selective breeding programs, prepackaged foods, and climate-controlled barns to produce superior animals and harvest enormous quantities of clean, good-quality milk, nineteenth-century farmers relied on folk wisdom and intuition -- much of it mistaken, some of it harmful -- to select and care for dairy stock. The result was a scrawny, ill-bred race of "native" or "grade" stock that showed great variation in the amount and chemical composition of their milk. And yet, it may also be attributed to a callousness and carelessness on the part of the animals' human caretakers. Generally speaking, farmers of the era made little effort to provide their animals with good food, pure water, or clean, comfortable barns. Indeed, in the South and Old Northwest, it was customary to turn cattle out to fend for themselves, year-round, with the expectation that older, weaker animals would die of exposure and/or starvation. As the nineteenth century neared its midpoint, there was little to suggest that farmers would or even could increase production. The

(1912): 425–60; Wolfgang Herrmann and Rina Obeid, "History of the Vitamins: Discovery, Syntheses, Nobel Prizes, Modern Science," in *Vitamins in the Prevention of Human Diseases* (New York, New York: De Gruyter, 2011), 1–3; "Milk Facts," Milk Composition, n.d., http://www.milkfacts.info/Milk%20Composition/Milk%20Composition%20Page.htm; For more on nineteenth-century medicine and pharmaceuticals, see Humphreys, *Marrow of Tragedy*, 7, 27–29; For an overview of American pharmaceuticals on the eve of the Civil War, see Michael A. Flannery, *Civil War Pharmacy: A History*, Second (Carbondale, Illinois: Southern Illinois University Press, 2017), 25–40. For contemporary accounts of women lay healers using milk and milk-based remedies to treat the sick and injured, see An Amherst Subscriber, "Cure for the Bite of a Snake," *Southern Planter*, March 1847 and Herbert C. Covey, *African American Slave Medicine: Herbal and Non-Herbal Treatments* (New York: Lexington Books, 2007), 22–23, 51, 188. For a popular home medical manual that prescribed milk and milk-based remedies, see John C. Gunn, *Gunn's Domestic Medicine, or, Poor Man's Friend, in the Hours of Affliction, Pain, and Sickness* (New York: C.M. Saxton, Barker & Co., 1860); "Sick-Room and Nursery," *Goody's Lady's Book and Magazine*, August 1855.

cost of importing "blooded" or pure-bred cattle from Europe was enormous, ensuring that only the wealthiest stock raisers could afford to improve the quality of their herds.[38]

Had none of this been true, American farmers of the era would still have failed in producing large quantities of good-quality milk. Indeed, the more effort that farmers put into selecting good dairy stock and providing for their health and wellbeing, the more likely that the animals would fall victim to dangerous parasites, viruses, and bacteria. The first large-scale cattle plague to strike the United States, contagious bovine pleuropneumonia, arrived in 1859, via three blooded -- and very expensive -- Frisian (Holstein) cattle imported by the Massachusetts gentleman farmer Winthrop Chenery. Over the next year, a series of cattle exchanges carried the disease across the Commonwealth as far west as the Connecticut River, killing scores of animals and prompting mass culls in a (mostly) futile attempt to control the contagion. Yet bovine pleuropneumonia was only the most spectacular disease that took advantage of improved farming techniques to attack and destroy dairy cows. Absent knowledge of germ theory, and having only the most rudimentary -- and again, often mistaken -- knowledge

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[38] For more on modern cattle breeding techniques and technologies, see George Perry, "Detection of Standing Estrus in Cattle," FS921B (Brookings, South Dakota: College of Agriculture & Biological Sciences, South Dakota State University, February 2004); G. Robert Hagevoort and J. Armando Garcia, "When Should Dairy Cows Be Inseminated?," Guide B-117 (Las Cruces, New Mexico: College of Agricultural, Consumer and Environmental Sciences, New Mexico State University, August 2013); Wendy Short, "8-Step Guide to Artificially Inseminating a Dairy Cow," Farmers Weekly, November 5, 2015, https://www.fwi.co.uk/livestock/livestock-breeding/8-step-guide-artificially-inseminating-dairy-cow. For more on modern cattle feeding practices, see Jim Linn, "Feeding Total Mixed Rations," University of Minnesota Extension, n.d., https://extension.umn.edu/dairy-nutrition/feeding-total-mixed-rations; Judd Heinrichs and Alanna Kmicikewycz, "Total Mixed Ration for Dairy Cows," Penn State Extension, May 5, 2016, https://extension.psu.edu/total-mixed-rations-for-dairy-cows. For more on climate-control technologies used by modern dairy farmers, see "Heat Abatement and Ventilation of Adult Cow Facilities," Dairyland Initiative, University of Wisconsin-Madison, accessed June 10, 2020, https://thedairylandinitiative.vetmed.wisc.edu/home/housing-module/adult-cow-housing/ventilation-and-heat-abatement/; Pat Melgares, "Tips for Managing Livestock in Winter," Drovers: Driving the Beef Market, January 5, 2018, https://www.drovers.com/article/tips-managing-livestock-winter. For contemporary accounts of nineteenth-century cattle breeding practices, see "Color of Cattle," *Boston Cultivator*, April 3, 1841; "White Cows," *Maine Farmer and Mechanics Advocate*, June 18, 1842; odale, *The Principles of Breeding; or, Glimpses at the Physiological Laws Connected with the Reproduction of Domestic Animals* (Boston: A. Williams & Co., 1861), 10, 66, 107, 120. For a contemporary account of the enormous costs of importing European cattle, see "Sale of Short-Horns in England," *The Daily Union*, May 28, 1856.

of soil- and water-borne parasites, farmers who practiced "manuring," or the keeping and spreading of cattle dung to preserve soil fertility and improve crop yields, sowed the earth and water with microorganisms that sickened and even killed their animals. Until such time as American farmers possessed antibiotics and antiparasitic agents, the risk associated with improving the nation's herds and with it, the quality and quantity of the milk supply, would outweigh the benefits. So it would remain until the first half of the twentieth century, long after the medical crisis of the Civil War had passed.[39]

Attempts to mass produce milk by confining and feeding dairy cows year-round in the style of modern factory farms proved a spectacular failure. Known to agricultural reformers of the era as "soiling," the practice exposed cows to all of the bacteria, viruses, and parasites that plagued their free-ranging kin without offering them any chance to escape the deadly pathogens. This was especially true of the hapless beasts that lived out their short, miserable lives in the urban dairy sheds owned and operated by liquor distillers and beer brewers. Fed almost exclusively on a diet of wet distillers' and brewers' mash, the animals so confined excreted tons of semi-liquid feces each day. Workers failed to remove much of this waste, leaving the animals to stand hock-deep in their own feces and exposing them to all manner of parasites and necrotizing bacteria. To make matters worse, windowless barns trapped the animals' exhalations, aiding in the rapid spread of deadly diseases such as bovine pleuropneumonia. In rightly condemning these operations for animal abuse and the willful sale of innutritious and

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[39] For a contemporary account of the 1859-1860 Belmont, Massachusetts, contagious bovine pleuropneumonia outbreak, see Massachusetts General Court. Committee on Pleuropneumonia, *Evidence ... May 31, 1860* (n.p., 1860), 77. For more on mid-nineteenth-century debates surrounding the germ theory of disease, see Robert P. Gaynes, *Germ Theory: Medical Pioneers in Infectious Diseases* (Washington, DC: ASM Press, 2011), 143-172 and Kari Nixon, *Kept from All Contagion: Germ Theory, Disease, and the Dilemma of Human Contact in Late-Nineteenth Century Literature* (Albany: State University of New York Press, 2020). In noting the positive relationship between manuring and soil health, historians have ignored the microbes and parasites that took advantage of the practice to afflict cattle. See Steven Stoll, *Larding the Lean Earth: Soil and Society in Nineteenth-Century America* (New York: Hill and Wang, 2002).

tainted milk, contemporary observers and modern historians have implied that dairy operators could have done better, if only they had fed and cleaned up after their animals. In fact, a conscientious operator would have struggled to do better. American farmers of the era produced too little fodder to feed their own animals, much less a sufficient to feed urban dairy cows. Moreover, removing the animals' dung to a safe distance would have required an army of laborers and horse-drawn carts to accomplish, assuming that a disposal point could have been located. Both would have driven up costs without resolving one of the single greatest threats to the milk supply: the filth that urban milk peddlers traversed in moving unrefrigerated milk to urban buyers.[40]

The most obvious solution to the growing urban milk crisis -- moving milk from farm to city via trains and steamships -- may also be deemed a failure, if one places quality over quantity when judging success. From almost the moment that the first trains chuffed out of New York and into the rural hinterland, railroad workers set aside cargo space for cans of milk purchased from farmers. By the mid-1840s, the demand for "grass-fed country milk" was so great that railroad owners devoted entire trains to collecting and delivering rural (and presumably, clean and nutritious) milk to urban consumers. This included open cans of unsweetened condensed milk manufactured by Gail Borden Jr., who claimed that his patented evaporation process and rigorous sanitary standards created the most nutritious and durable milk product then available. Contemporary observers gave equal praise to the milk trains and Borden's milk condensing

[40] For two contemporary accounts of the urban swill milk crisis, see Robert Milham Hartley, *An Historical, Scientific, and Practical Essay on Milk, as an Article of Human Sustenance; with a Consideration of the Effects Consequent Upon the Present Unnatural Methods of Producing It for the Supply of Large Cities* (New York: Jay Leavitt, 1842) and John Mullaly, *The Milk Trade in New York City and Vicinity* (New York: Fowlers and Wells, 1853); United States Census Office, *The Seventh Census of the United States: 1850* (Ann Arbor, Michigan: University of Michigan Library, 2005); Joseph C.G. Kennedy, *Agriculture of the United States in 1860; Compiled from the Original Returns of the Eighth Census, under the Direction of the Secretary of the Interior* (Washington D.C.: Government Printing Office, 1864).

plants as the saviors of milk-starved New Yorkers. Yet neither was as successful as imagined. The farms of the era were too unsanitary, the trains too slow, the refrigeration too unreliable, and the urban landscape too filthy, to protect fluid milk deliveries against dangerous microbes. Borden's unsweetened condensed milk may have been *more* dangerous, for in addition to picking up contaminants *en route*, it required buyers to rehydrate the product with city -- and often polluted -- water. A sweetened variety that came sealed in tin cans proved more durable. However, Borden struggled to find a market for the product and treated it as an afterthought.[41]

When the American Civil War came in 1861, the conflict created the single greatest medical disaster, and hence, the single greatest demand for medicinal milk in United States history up until that point. Beginning in 1861, the rapid mobilization of recruits uprooted millions of young men -- most of whom hailed from isolated agricultural communities -- and muddled them together in crowded, unsanitary military camps. Smallpox, typhoid fever, influenza, and measles raced from tent to tent and person to person, scourging and killing those who lacked natural or acquired immunity. Adding to soldiers' misery were the mosquitoes and lice that swarmed over their bodies, transmitting malaria and typhus, to say nothing of the water- and fecal-borne bacteria that transmitted dysentery and/or transformed survivable cuts and scrapes into deadly secondary infections. Yet so did the prolonged absence from home, which denied them access to mundane domestic comforts that contributed to good humor and health. Campaign and garrison duty took Union soldiers even further afield and into the Southern and Western states while exposing them to extremes of heat and cold, hunger and thirst, and physical exhaustion. When it came time to confront the enemy, combat exposed Union soldiers to stress, terror, and traumatic injuries. All of this took a frightful toll on minds and bodies. All of this

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[41] Mullaly, *Milk Trade*, 89; "Medical Societies. Philadelphia County Medical Society," *Medical and Surgical Reporter*, March 2, 1878.

called for someone in a position of authority to furnish the sick, the injured, and the downtrodden with a steady supply of clean, good quality cows' milk -- assuming that such a thing was possible.[42]

In fact, during the first two years of the conflict, the demand for medicinal and culinary milk went almost entirely unmet. This comes as no surprise, for the variables that prevented farmers and urban dairy operators from making an abundance of clean, good quality milk and then moving it any distance also proved a barrier to those who would furnish sick and wounded soldiers with a supply in accordance with Union medical guidelines. To make matters worse, the warzone presented a host of new variables: the heat and humidity of the Southern landscape; the lack of space aboard trains and steamships for dairy cows and the fodder to feed them; the threat posed by Confederate raiders and hungry civilians; the sudden, unpredictable movement of armies on campaign duty; and the great crash and chaos of battle.[43] This is not to suggest that Union soldiers and caregivers did without milk during the first two years of the war. Individuals begged, purchased, or stole the occasional cupful from civilians or harvested it from free-roaming Southern cows.[44] Meanwhile, surgeons and nurses employed by Northern hospitals harvested milk from herds kept on the grounds and purchased the odd quart from local peddlers. On at least one occasion, a Union nurse arranged to have dairy cows shipped from Illinois to

[42] A robust literature describes the American Civil War as a profound medical crisis. The best book-length work available is Humphreys, *Marrow of Tragedy*. See also George Worthington Adams, *Doctors in Blue: The Medical History of the Union Army in the Civil War* (Baton Rouge: Louisiana State University Press, 1996) and Katherine, Shively-Meier, *Nature's Civil War: Common Soldiers and the Environment in 1862 Virginia* (Chapel Hill: University of North Carolina Press, 2013), Devine, *Learning from the Wounded*.

[43] For works that discuss the impact of weather and climate on Civil War military campaigns, see Theodore Steinberg, "The Great Food Fight," in *Down to Earth: Nature's Role in American History* (Oxford: Oxford University Press, 2002); Andrew McIlwane Bell, *Mosquito Soldiers: Malaria, Yellow Fever, and the Course of the Civil War* (Baton Rouge: Louisiana State University Press, 2010); Shively Meier, *Nature's Civil War*; Kenneth W. Noe, "Fateful Lightning: The Significance of Weather and Climate in Civil War History," in *The Blue, the Gray, and the Green: Toward an Environmental History of the Civil War* (Athens: University of Georgia Press, 2015).

[44] Davis, *Three Years in the Army*, 131-132; Covey and Eisnach, *What the Slaves Ate*, 162-164.

Memphis, Tennessee, for use by Union hospitals in the city. Yet she succeeded only because nearby President's Island in the Mississippi River was isolated enough to allow the cows to roam free and unmolested.[45]

Borden's Sweetened Condensed Milk solved all of these problems. The sugar and tin cans used manufacturing the product reduced (without altogether eliminating) the threat posed by dangerous microorganisms. For the first time in military history, it was possible to move milk hundreds, even thousands of miles from homefront to battlefront, and then store it indefinitely, without risk of its souring or spoiling. As Union armies moved deeper into Confederate territory, and casualties mounted, aid workers took advantage of the product's portability and durability to move boxes of Borden's Sweetened Condensed Milk ever closer to the front lines. By mid-1862, the product had appeared in Union encampments in the Eastern and Western Theaters of military operations, among the comfort foods that civilian merchants or "sutlers" peddled to homesick soldiers.[46] By mid-1863, the product was found at most every field hospital, aid station, railroad depot, and steamship landing used in treating and evacuating Union sick and wounded.[47] By the following summer, the product had traveled even to active battlefields, within sight and sound of combat. Each can furnished the sick, wounded, and injured with sugars and fats that fed the immune system, staved off shock, aided in the repair of damaged tissues, or gave emotional support to the downtrodden. Indeed, it served the same purpose as a modern IV (that is, an intravenous fluid bolus) to stave off shock and stabilize

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[45] Mary Ashton Rice Livermore, *My Story of the War" A Woman's Narrative of Four Years Personal Experience as Nurse in the Union Army, and in Public Relief Work at Home, in Hospitals, Camps, and the Front, During the War of the Rebellion* (Hartford, Conn.: A. D. Worthington and Company, 1896), 512-513.

[46] James L. McDonough, *War in Kentucky: From Shiloh to Perryville* (Knoxville: University of Tennessee Press, 1994), 508.

[47] Frederick Law Olmsted, *Hospital Transports. A Memoir of Embarkation of the Sick and Wounded from the Peninsula of Virginia in the Summer of 1862* (Boston: Ticknor and Fields, 1863), 99-114; The Sanitary Commission, *The Sanitary Commission Bulletin* (New York: The Sanitary Commission, 1866), 513.

patients before evacuation and emergency surgery. It also gave civilian aid workers the ability to take decisive, useful action in the face of terrible human suffering. It gave them hope. Had it done nothing more, it would still have served a useful purpose.[48]

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Borden's Sweetened Condensed Milk remained popular among American servicemembers and civilian aid workers for several decades following the Civil War. The cavalrymen who patrolled the Northern and Central Plains between the 1860s and 1880s, carried cans of the sweet, syrupy substance in their saddlebags. So too members of the First United States Cavalry -- the so-called "Rough Riders" -- who received cans purchased by the former Union nurse Clara Barton while serving in Cuba during the Spanish American War. Long before the United States committed troops to the First World War, the American Red Cross committed hundreds of thousands -- perhaps millions -- of cans of Borden's Milk to the relief shipments that went to Belgian refugees. There is also evidence that cans of the stuff traveled along with American "Doughboys," "Devil Dogs," and sailors as they confronted the Central Powers in France, Belgium, and the North Atlantic. On at least one occasion, European aid workers bought and used sweetened condensed milk manufactured by the Anglo-Swiss Condensed Milk Company (later Nestle) in a bid to stave off famine and medical disaster during the Franco-Prussian War of 1877. As Prussian forces moved to surround Paris, relief agents used balloons to airlift boxes of condensed milk to French soldiers trapped in the beleaguered city. Likely the recipients used the product in a manner similar to their American counterparts, to treat the sick and wounded, and with similar results.

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[48] Emily BLiss Thacher Souder, *Leaves from the Battlefield of Gettysburg: A Series of Letters from a Field Hospital: And National Poems* (Philadelphia: C. Sherman Son & Company, 1864), 24, 39, 47.

And yet, by the mid-twentieth century, Borden's Sweetened Condensed Milk had all but disappeared from the American military medical toolkit. Likely this had something to do with medical innovations that appeared to (and did) have near-miraculous curative powers of their own. Among these were the portable, durable fluid IV boluses that delivered life-saving fluids directly into to the bloodstream of sick and injured soldiers.[49] No less important were the antimicrobials, antiseptics, and vaccines that assisted that human immune system in locating, attacking, and killing the bacteria and viruses that caused disease.[50] To be sure, sweetened condensed milk retained all of the palliative and curative properties that Union caregivers relied on to reduce the death toll among their charges, just as the muzzle-loading rifles used by Union soldiers in combat retained their ability to kill and maim those unfortunate enough to be downrange. These new treatments did more, faster, and with more predictable results. To continue reliance on sweetened condensed milk under these circumstances would have been nonsensical -- as nonsensical as rolling a battery of Civil War-era howitzers out to confront a modern fighting force when mobile howitzers, machine guns, and jet-powered fighter planes were available. In the hands of experienced soldiers, the former might do enough damage to slow the enemy and stave off defeat, at least for a moment. However, the latter have the power to almost ensure victory. Indeed, the reduction in mortality among modern combat soldiers is proof enough that modern treatments have turned the tables against disease and traumatic injury to an extent that would have been impossible with Borden's Sweetened Condensed Mi

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[49] Steven R. Pierce, "Blood Transfusion in the First World War," University of Kansas Medical Center, n.d., https://www.kumc.edu/school-of-medicine/academics/departments/history-and-philosophy-of-medicine/archives/wwi/essays/medicine/blood-transfusion.html.

[50] John E. Lesch, *The First Miracle Drugs: How the Sulfa Drugs Transformed Medicine* (Oxford: Oxford University Press, 2007), 3, 249; Jonathan Wood, "Penicillin: The Oxford Story," University of Oxford, News and Events, 16 July 2010, https://www.ox.ac.uk/news/science-blog/penicillin-oxford-story.

At approximately the same time, a series of technological and scientific advances rendered Borden's Sweetened Condensed Milk nutritionally obsolete. Widespread acceptance of germ theory, to say nothing of the discovery that superheating foods killed dangerous microorganisms, made it possible for manufacturers to realize Gail Borden's true goal of canning and preserving unsweetened condensed milk for the use of American consumers, children and adults alike.[51] But then, the very same process, combined with chemical sanitizing agents (and the recognition of their usefulness) and mechanical refrigeration, obviated the need to use evaporation at all. It may be that this knowledge would have frustrated Gail Borden Jr., who had sacrificed his health and fortune to solving the nation's first great food purity and crisis. It is impossible to say. Borden died in 1874, twelve years before the German chemist Frans von Soxhelt first proposed using Pasteurization to preserve fluid milk. What is clear is that his son, the Union veteran John G. Borden, took advantage of these new technologies to build a fluid milk and ice cream empire that would come to dominate the American dairy trade by the dawn of the twentieth century. Indeed, the Borden Corporation far exceeded the elder Borden's wildest dream of capturing a *share* of the New York milk trade, which was modest by comparison.[52]

Borden's Sweetened Condensed Milk remains a popular and familiar product among American consumers. Though it no longer serves as a military medical supply, it has retained its value as a comfort food. Each year, Americans purchase millions of cans of the sweet, syrupy

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[51] Otto Frederick Hunziker, *Condensed Milk and Milk Powder* (La Grange: Ill.: Published by the Author, 1918), 46-47; Gail Borden first attempted to seal unsweetened evaporated milk in cans in 1856. See Gail Borden Jr. to Captain A. J. Fletcher, 19 February 1856, J. Gail Borden Jr. Papers, 1830-1910, 1932-1937, box 2N321, Dolph Briscoe Center for American History, the University of Texas at Austin.

[52] John Waller, *The Discovery of the Germ: Twenty Years that Transformed the Way We Think About Disease* (New York: Columbia University Press, 2002), 4; Armstrong, *Notable Southern Families*, 30; Gail Borden Jr. to [Unknown], 25 January 1858, J. Gail Borden Jr. Papers, 1830-1910, 1932-1937, box 3C18, Dolph Briscoe Center for American History, the University of Texas at Austin.

substance for use in the holiday recipes -- eggnog, rum balls, chocolate cookies, *tres leches* cakes, and fudge, among myriad others -- that bring comfort and joy to those who gather to celebrate with family and friends. Plenty more go to sweetening piping-hot cups of coffee and the ice cream dished out from the hand-cranked churns that are apt to appear at cookouts. Doubtless many would be surprised to learn that the humble product traces its origins to a dangerous, violent, and yet not-so-distant past, when Americans struggled to conquer -- or at least, tame -- the more destructive forces of nonhuman nature, even as they struggled to conquer -- or again, at least tame -- the more destructive forces of human nature. Doubtless they would be even more surprised to learn that those two forces were in such great tension during the bloodletting of 1861 to 1865, with victories against the former proving so vital to victory, however incomplete, over the latter. To be sure, it would be a stretch to suggest that Borden's Milk ensured Union victory (although on at least one occasion, Union sailors used empty cans as artillery projectiles).[53] However, it did save the lives of sick and wounded Union soldiers. At least some of these men rejoined their units, shouldered their rifles, and carried on the fight to abolish chattel slavery.

[53] United States Naval War Records Office, *Official Records of the Union and Confederate Navies in the War of the Rebellion*, vol. 16, 1 (Washington, District of Columbia, United States: Government Printing Office, 1903), 560.

Chapter 1:
"A Delicious Beverage":
Milk as Nineteenth-Century
Americans' Favorite Comfort Food

For two decades following the death of his wife, Harriett, in 1825, the Louisville physician Daniel Drake wrote letters to his children, describing childhood on the Kentucky frontier between 1788 and 1800. Published in 1870 as *Pioneer Life in Kentucky*, Drake's letters included tales of privation and hardship typical of American frontier narratives: the back-breaking labor of carving a farmstead from the forests and canebrakes of the Ohio River Valley; the loss of corn crops to unseasonal frosts; the perceived danger posed by Indigenous Peoples. However, they also included stories of abundance and ease, much of it derived from the family's free-roaming dairy cow, Brindle. Indeed, Drake spent many a morning wrestling bawling calves away from Brindle's udder, giving his mother a chance to "get ahead" with the milking before the young animals claimed their share. While much of the harvest went to make butter and cheese, plenty went to the family table. Drake's mother had a special fondness for buttermilk, the fluid by-product of butter making. He and his sister preferred bowls of new milk, still-warm from the udder -- "a delicious beverage," he recalled, "which [Brindle] distilled from the cane and luxuriant herbage in which she waded through the day." The entire family sat down to meals of mush-and-milk, a nineteenth-century dietary staple made by pouring new or buttermilk over boiled hominy.[54]

The Drake family's fondness for milk was altogether typical of Americans during the first half of the nineteenth century. As an agrarian people, most American families of the era owned at least one dairy cow, or lived close by someone who was willing to barter or trade milk

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[54] Daniel Drake, *Pioneer Life in Kentucky: A Series of Reminiscential Letters from Daniel Drake, M.D., to His Children* (Cincinnati: Robert Clarke & Co., 1870), 11, 44.

to friends and neighbors. Consequently, most everyone -- Northern and Southern (and Western), African American and Euroamerican (and some Indigenous Peoples), slave and free, rich and poor, adults and children -- derived nutrition and culinary satisfaction from sweet and fermented milk or milk-based foods. There were, of course, exceptions. Some Americans of the era disdained milk drinking as a childish or even repugnant habit.[55] Others lacked the gene mutation responsible for lactase persistence, preventing their digesting the lactose (milk sugar) present in unfermented milk.[56] Still others refused to drink milk or add it to food for fear of contracting one of several poorly understood, but often deadly diseases: milk sickness (tremetol poisoning), diarrhea, or dysentery.[57] Yet even they depended to some extent on milk. Absent baking powder and yeast, professional and lay cooks used sweet milk and buttermilk to give flavor and texture to breads.[58] It was a rare American indeed who took coffee or tea without a dash of sweet milk or fresh cream.[59]

In addition to providing nutrition, cow's milk also played what sociologists and food historians have described as a "performative function" in nineteenth-century Americans' social and cultural life. That is, the humble fluid served as a focal point of familiar eating rituals that gave physical and emotional comfort, reinforced social and gender hierarchies, cemented bonds

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[55] For a contemporary account of milk drinking as repugnant, see "An Essay on Cheese Making," *Ohio Cultivator*, February 1, 1851.

[56] For more on lactase persistence, see Andrew Curry, "Archaeology: The Milk Revolution," Nature: International Weekly Journal of Science, July 31, 2013, https://www.nature.com/news/archaeology-the-milk-revolution-1.13471.

[57] For more on milk sickness, see Marilyn K. Hunt, "White Snakeweed and 'Milk Sickness,'" *Countryside & Small Stock Journal* 86, no. 1 (January 1, 2002): 65; For more on nineteenth-century Americans' fear of milk-related illness, see E. Melanie DuPuis, *Nature's Perfect Food: How Milk Became America's Drink* (New York: New York University Press, 2002), 4–5.

[58] Ben Panko, "The Great Uprising: How a Powder Revolutionized Baking," Smithsonian.com, June 20, 2017, https://www.smithsonianmag.com/science-nature/great-uprising-how-powder-revolutionized-baking-180963772/.

[59] How to Make Good Coffee," *Southern Planter*, January 1842; "How to Make Good Coffee," *Farmer's Register; A Monthly Publication*, January 1843; "Domestic Department," *Valley Farmer*, April 1860; Jenny, "Farm-House Letters -- No. 6," *Christian Watchman and Reflector*, September 7, 1854.

of family and friendship, and even transmitted enduring (albeit problematic) narratives that presented the dairy and dairy products as the antithesis of wildness and the source of material abundance. When Daniel Drake's mother fed him milk for breakfast, it was nourishing, yes, but it also served as a tangible symbol of her motherly love and affection. When she spooned sweet milk or cream into her husband's morning coffee, it added flavor and calories, yes, but it also gave proof that she was a skilled homemaker. Indeed, the fact that she had cows to milk at all, to say nothing of a full milk pitcher on the table, was tangible proof that her family had beaten back the wilderness and rejoined the ranks of American civilization. None of this would have required any explanation. Nineteenth-century American learned and internalized these meanings as a consequence of their lived experience in a majority agrarian society. Hence their constant references to milk as a beloved food and condiment (and one lavished on guests), to say nothing of their habit of judging the worth of a farm based on the presence or absence of dairy cows and milk.[60]

For all of these reasons, cows' milk was a true cornerstone of the nineteenth-century American diet. Indeed, it may best be described as nineteenth-century Americans' favorite comfort food. This would seem to contradict the modern historiography of milk production and consumption, which holds that Americans of the era had no especial fondness for new, sweet milk and seldom used it for food and/or drink. To hear scholars tell it, farm families devoted most of the milk harvest to the cheese and butter manufacture while indulging only occasionally in clabbard, buttermilk, and other fermented milk by-products. These same historians depict the

[60] Tina M. Harris, "Deconstructing the Myth of the Dysfunctional Black Family in the Film *Soul Food*," in Lawrence C. Rubin, ed., *Food for Thought: Essays on Eating and Culture* (London: McFarland and Company, 2008): 213-214; Carol M. Counihan, *Food and Gender: Identity and Power* (New York: Routledge, 2004), 2-5, 7-8, 85; Virginia DeJohn Anderson, *Creatures of Empire: How Domestic Animals Transformed Early America* (Oxford: Oxford University Press, 2004), 89-90; Horace Greeley, *An Overland Journey, From New York to San Francisco in the Summer of 1859* (C.M. Saxton, Barker & Co., 1860), 67, 164-165.

drinking of new, sweet milk by adults as an urban habit that emerged during the late-nineteenth century, contemporary to the advent of refrigeration, which reduced the danger of milk drinking, and the ascendance of the temperance movement, which had long lauded milk as "nature's perfect food" and an alternative to alcohol. So long as one confines their retelling of the story to the commercial farms of the industrial Northeast, and their understanding of milk consumption to the specific act of quaffing a glass of new, sweet milk, there is some truth to this claim. However, if one takes a broader geographic view and expands the definition of milk drinking to include adding the fluid to coffee, pouring it over cereals, and pairing it with alcohol and spices to make toddies, the thesis is untenable.[61]

Historiographical wisdom notwithstanding, as the nineteenth century neared its midpoint, most Americans could have told at least one story of milk drinking and eating that would have resonated with the aforementioned Daniel Drake. Among them was the Pennsylvania native Harriett Cline West, who moved with her family to the vicinity of Wheeling, Virginia, and thence to Spring Creek, Virginia, during the late 1830s or early 1840s. Similar to Drake's beloved "Brindle," Cline West had her own family cow, "Bossie," that she described as "a great institution. . . . A fine milker, a family pet . . . and the most valued of our bovine stock." On one occasion, Bossie failed to return to the homestead for almost two days, thereby denying the Cline family access to new, sweet milk for food and drink. Unwilling to do without, Cline West's

[61] E. Melanie Dupuis, "The Body and the Country: A Political Ecology of Consumption," in Mark Golldiener, ed., *New Forms of Consumption* (New York: Rowman and Littlefield Publishers, 2000), 133; E. Melanie DuPuis, *Nature's Perfect Food: How Milk Became America's Drink* (New York: New York University Press, 2002), 30; Nina L. Etkin, *Foods of Association: Biocultural Perspectives on Foods and Beverages That Mediate Sociability* (Tucson: The University of Arizona Press, 2009), 43-44; Bill Conlogue, *Here and There: Reading Pennsylvania's Working Landscapes* (University Park, Pennsylvania: The Pennsylvania State University Press, 2013), 96; Andrew F. Smith, ed., *The Oxford Encyclopedia of Food and Drink in America* (Oxford: Oxford University Press, 2013), 595. Among the most recent works to tackle the subject, Kendra Smith-Howard's environmental history of American milk production and consumption focuses only on the twentieth century. See Kendra Smith-Howard, *Pure and Modern Milk: An Environmental History since 1900* (Oxford: Oxford University Press, 2014).

father and brothers set out to find the wayward beast and bring her back to the house. By the time Cline West heard Bossie "bawling along toward the house," she was "starving for milk." Driven by "the impetus of hunger," she sprinted "like a deer" down to meet the animal, crying out: "Here comes the Bell Cow, kicking up her heels, a rattle de dum, a rattle de dum, a doo!" On reaching Bossie, young Harriett seized a teat, aimed it toward her face, and squirted warm milk straight into their mouth, to which the startled animal responded by kicking her into a creek. Such was the price that nineteenth-century Americans were willing to pay for a taste of their favorite comfort food

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It is impossible to quantify the amount of milk and milk-based foods that Americans drank and ate during the first half of the nineteenth century. It was not until 1820 that United States Marshals first counted the number of Americans who self-identified as farmers. In doing so, they gave no indication of the type or amount of farm products produced by said farmers, fluid milk or otherwise, or the number and type of livestock present. The 1840 and 1850 iterations of the Census were more detailed, with census takers recording the amount of unimproved and improved acreage by states and counties, along with the number of "milch cows" present and the type and amount of vegetable and grain crops produced. However, they omitted fluid milk, along with butter and cheese, from the tabulations. Recognizing that cows of the era yielded between 2 and 10 quarts of milk per day, for about seven months beginning in January, one could use this data to make a rough estimate the amount of milk produced by the nation's dairy cows in 1840 and 1850. And yet, lacking any hard data about the production of dairy by-products, it is impossible to know how much of the fluid milk that farm families set aside for the table, devoted to butter and/or cheese making, or fed to market-bound hogs as a calorie-rich dietary supplement.[62]

Nevertheless, the historical record abounds with anecdotal evidence of milk use by rural Americans during the first half of the nineteenth century. Returning for a moment to *Pioneer Life in Kentucky*, the Louisville physician Daniel Drake recalled that his neighbors on the Kentucky frontier made regular use of milk at mealtime -- or did so whenever it was available. Among them was "Old Billy Johnson," one of the thousands of Euroamericans who streamed south and west through the Appalachians and Alleghenies in the aftermath of the American Revolution to purchase (or in Billy's case, squat on) land in the fertile Ohio River watershed. Each morning, before Old Billy and his sons set out for their fields, they gathered around a large bowl, carved from the wood of a buckeye tree, with spoons in hand. So soon as the bowl was filled with mush and milk, everyone reached into the bowl and claimed their share. This worked well enough unless Old Billy "happened to be in a hurry." Eager to "have them all in the field as soon as possible," Drake recalled, the family patriarch would "throw down his spoon, pick up the bowl with both hands, drink off the remainder, jump up, and saying they had all 'eat enough,' start away."[63]

Travel narratives compiled by English visitors to the United States reveal that Old Billy's milk-eating habits were typical of Euroamericans who settled west of the Appalachians. As he rambled about the rural backcountry near Nashville, Tennessee, in 1796, the English traveler

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[62] For census data, see *Census for 1820* (Washington, D.C.: Gales & Seaton, 1821); *Compendium of the Enumeration of the Inhabitants and Statistics of the United States* (Washington: Thomas Allen, 1841); J.D.B. DeBow, *Seventh Census of the United States: 1850* (Washington: Government Printing Office, 1853); Stephen L. Goodale, *The Principles of Breeding; or, Glimpses at the Physiological Laws Connected with the Reproduction of Domestic Animals* (Boston: A. Williams & Co., 1861), 70-73; "More of That Farmer Who Milks His Own Cows," *The Monthly Journal of Agriculture, Containing the Best Current Productions in Promotion of Agriculture* II (April 1847): 455.

[63] Drake, *Pioneer Life*, 212–13.

Francis Baily knocked at the doors of isolated farmhouses, asking to buy food and drink. Almost invariably, his hosts offered him "some Indian bread and butter, and some milk," which Baily dubbed "a standing dish in all these new countries." Another English traveler, Fortescue Cuming, stopped at a farm near Chickasaw Bluffs, on the Mississippi River, in 1809. There, he and his companions "obtained milk, sallad [sic], and eggs" from the Anthony family "and spent a pleasant night in a fine harbor," free from the pestering of mosquitoes. Still another Englishman, William Faux, had a similar experience as he traveled across rural Indiana in 1819, compiling information for use by would-be British immigrants. On reaching the town of Edmonstone, thirty miles west of Evansville, Faux stopped at a "little cold log hole" that passed for a cabin. Though his hosts had no coffee or tea, they did serve him a meal of "cold milk and pork, and corn cake." This satisfied Faux, for he thought milk a healthier drink than coffee or tea, and one that fortified the body against the fevers common to the young nation's "dangerous and debilitating climate."[64]

By all accounts, the habit of setting a bit of milk aside for domestic use or the use of guests persisted among rural Euroamericans into the 1850s. On crossing the Pedernales River near present-day Fredericksburg, Texas, in 1850, members of the U.S. Mexican Boundary Commission paid a family of Mormon settlers $3.00 for a filling meal that included "several pitchers of excellent milk." Five years later, a story published in the *Demoine Courier* told the humorous story of a visitor to rural Wisconsin who, spotting a cow grazing in front of a farmhouse, stopped to ask for a drink of milk. To his great dismay, the hostess tripped and spilled a basin of dirty dishwater into the milk pail, spoiling the libation before he could enjoy

[64] Francis Baily, *Journal of a Tour in Unsettled Parts of North America in 1796 and 1797* (London: Baily Brothers, 1856), 417; William Faux, *Memorable Days in America: Being a Journal of a Tour of the United States* (London: W. Simpkin, 1823), 333; Robert Rogers Hubach, ed., *Early Midwestern Travel Narratives: An Annotated Bibliography, 1634-1850* (Detroit: Wayne State University Press, 1961), 54.

even a sip. A correspondent of the Richmond *Daily Dispatch* fared no better in 1856, when he knocked at the door of a farmhouse in rural Doddridge County, asking to buy coffee with sugar. His hosts having plenty of the former but none of the latter, he settled for milk "so dark that I could not see *much* of the dirt at the bottom of the bowl." A correspondent of *The Winchester Home Journal* fared better in 1857, during a stop at the Thacher House, a hotel located in the farming hamlet of McMinnville, Tennessee. The proprietor, H.S. Thacher -- or more likely, his female kin (or perhaps even his slaves) -- treated the correspondent to a lovely dinner of "nice coffee, nice meats, nice hot biscuits, and *very* nice butter to spread between." Topping it off was a pitcher of "very nice milk to drink."[65]

Euromericans were hardly alone in drinking milk and eating milk-based foods. Prior to the Indian Removal Act of 1830, which began the forced resettlement of Indigenous Peoples from the East to U.S. Territories west of the Mississippi River, at least some members of the "Five Civilized Tribes" of the South had adopted the Euroamerican practice of milk drinking.[66] A witness to the practice, the naturalist William Bartram accepted an invitation to dine with a wealthy Creek family as he traversed South Carolina in 1791, on his way to Savannah. The meal, prepared by the family's Yamasee slaves, included venison stewed with bear's oil, corn cakes, hominy, and new, sweet milk drawn from the forty-odd cows that roamed nearby. A few

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[65] "From the Providence Journal. Mexican Boundary Commission," *The Southern Press*, November 22, 1850; "A Milk Story," *Demoine Courier*, April 5, 1855; "Correspondence of the Dispatch," *The Daily Dispatch*, November 28, 1856; "Hotels," *The Winchester Home Journal*, November 7, 1857; "Editorial Correspondence," *The Winchester Home Journal*, August 22, 1857.

[66] For a history of Indian removal in the Old Southwest, see Grant Foreman, *Indian Removal: Emigration of the Five Civilized Tribes of Indians* (Norman: University of Oklahoma Press, 1932). For the adoption of cattle by indigenous people, see Richard White, *The Roots of Dependency: Subsistence, Environment, and Social Change Among the Choctaws, Pawnees, and Navajos* (Lincoln: University of Nebraska Press, 1983), Timothy Silver, *A New Face on the Countryside: Indians, Colonists, and Slaves in South Atlantic Forests, 1500-1800* (Cambridge: Cambridge University Press, 1990), Terry G. Jordan-Bychkov, *North American Cattle-Ranching Frontiers: Origins, Diffusion, and Differentiation* (Albuquerque: University of New Mexico Press, 1993), and Virginia DeJohn Anderson, *Creatures of Empire: How Domestic Animals Transformed Early America* (Oxford: Oxford University Press, 2004).

years later, Francis Baily crossed paths with a "half-Indian" member of the Chickasaw People and several other "Indian chiefs" near Natchez, on the Mississippi River, who invited him to "alight [from his horse] and take some refreshment." The house, "a dirty hole of a place," failed to impress. Yet Baily could "not but smile" at the "homely repast" placed before him: an iron kettle filled with milk, which he and his new "party and kindred" ate with "all our spoons dipping into it alternately."[67]

Far to the west, centuries of contact and cultural exchange between Catholic missionaries, Spanish colonial officials, and the Indigenous Peoples of Southern California and New Mexico effected a similar culinary fusion. While traveling between Los Angeles and San Francisco during the mid-1830s, the journalist Edwin Bryant and his traveling companions ran out of food. To his great relief, a passing group of Indigenous *vaqueros* (cowboys) employed by one of the local *ranchos* offered Bryant some milk, fresh from a nearby cow, which he and his companions used to make two meals -- without meat, bread or vegetables -- over the next twenty-four hours. To be sure, it may be that the *vaqueros* were indulging a specific request by Bryant for milk. However, it may also be that they used milk in a manner similar to the Indigenous Peoples of New Mexico.[68] About ten years after Bryant traversed California, the American naturalist Josiah Gregg observed that Mexican families living in the Rio Grande Valley of New Mexico ate or drank *atole*, a thick beverage or porridge made by mixing cow's, or more often goat's milk with finely ground cornmeal, for breakfast, dinner, and supper. Gregg claimed that *atole*, paired with

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[67] William Bartram, *Travels through North and South Carolina, Georgia, East and West Florida* (Philadelphia: James & Johnson, 1791), 164; Baily, *Journal*, 372–73.

[68] For more on culinary fusion as a tool of empire, see Rachel Laudan, *Cuisine and Empire: Cooking in World History* (Berkeley: University of California Press, 2013); Edwin Bryant, *What I Saw in California: Being the Journal of a Tour, by the Emigrant Route and South Pass of the Rocky Mountains, Across the Continent of North America, the Great Desert Basin, and Through California, in the Years 1846, 1847* (New York: D. Appleton & Co., 1849), 417.

beans and chilis, represented New Mexicans' primary form of nutrition. Indeed, among the "lower classes of Mexicans," *atole* was a far more common drink than either coffee or tea.[69]

A similar culinary fusion occurred in the slaveholding South. There, the same processes that saw Euroamericans integrate okra, sorghum, sesame, black-eyed peas, and other food plants indigenous to West Africa into their diets saw African American slaves take up Euroamerican milk drinking and eating as a regular, even comforting practice. That slaves did so may come as something of a surprise. As a general rule, adults indigenous to West Africa are lactose intolerant, which is to say that they lack the gene mutation responsible for the production of lactase, the enzyme responsible for milk digestion, in the intestine. Those who drink milk may become violently ill with stomach cramps and diarrhea. And yet, it seems unlikely that lactose intolerance was a barrier to African American milk consumption. Recognizing that the African slave trade continued in the United States (albeit surreptitiously) into the mid-nineteenth century, the African American population had long-since reached the point of demographic stability and natural increase. Moreover, almost two centuries of (often forced) genetic exchange between Euroamericans and African Americans almost certainly passed lactase persistence along to members of the African American population. Lacking any systematic data, it is impossible to say for sure. However, anecdotal evidence would seem to point toward such a conclusion.[70]

A series of interviews compiled by agents of the United States Works Progress Administration during the 1920s reveal that former slaves relished sweet and fermented milk whenever it was made available to them. Among those who agreed to an interview, the former

[69] Josiah Gregg, *Commerce of the Prairies or the Journal of a Santa Fé Trader, During Eight Expeditions Across the Great Western Prairies, and a Residence of Nearly Nine Years in Northern Mexico* (New York: J. & H.G. Langley, 1845), 293.

[70] Kenneth F. Kiple, *The Caribbean Slave: A Biological History* (Cambridge: Cambridge University Press, 2002), 40-41; Herbert C. Covey and Dwight Eisnach, *What the Slaves Ate: Recollections of African American Foods and Foodways from the Slave Narratives* (Santa Barbara, California: Greenwood Press, 2009), 135-136.

slave Heard Griffin of Arkansas recalled that laborers on his master's plantation "drank one or two glasses of milk" and ate a piece of cornbread each morning before starting work. Griffin most likely referred to buttermilk or soured milk, both of which were relished by Southern whites and both of which were thought appropriate for inclusion in slaves' rations. The former slave Med Walker of South Carolina lent credence to this conclusion, remembering that slaves "got clabber and buttermilk," but never sweet milk. Yet some slaves did enjoy new, sweet milk. The former slave, Cicely Cawthon of Georgia, informed her interviewer that she, along with her fellow slave children, lined up outside her plantation's dairy house each morning, eager to fill and then drink quart and half-gallon cups of new, sweet milk. So too the former slave James Brittian of Mississippi, whose master gave the children on his plantation "all the sweet milk and buttermilk we could drink." Recalling the tasty treat, Brittian noted: "Us children liked milk better than anything."[71]

It may be that the rural, Euroamerican folk who persisted in New England and the Mid-Atlantic States -- at that time, the nation's most productive dairying region -- drank and ate less milk than their counterparts to the West and South. This may be attributed, in part, to an expanding local, regional, and global market demand for portable, nonperishable dairy products, which prompted Northeastern farmers to devote the lion's share of their fluid milk supply to making butter and cheese.[72] However, it may also be attributed to the demand for fluid milk originating in one of the region's growing urban centers. This proved especially true in the vicinity of New York. Roiled by the "swill milk" scandal of the 1840s and 1850s, which saw social reformers and journalists expose the unsanitary practices of urban, distillery-run dairy

[71] Herbert C. Covey and Dwight Eisnach, *What the Slaves Ate: Recollections of African American Foods and Foodways from the Slave Narratives* (Santa Barbara, California: Greenwood Press, 2009), 136–38.
[72] DuPuis, *Nature's Perfect Food*, 5; Sarah Sutton, "Milk: A New England History" (Dissertation, Waltham, Massachusetts, Brandeis University, 2016), 62, 68-74.

operators and milk peddlers, New Yorkers clamored for access to country milk. Beginning in 1842, the Erie Railroad responded by carrying fluid milk into New York City from rural Orange County, New York, aboard special trains. During its first year of operation, the railroad carried about 388,505 quarts into the city. By the late 1850s, that amount had increased to more than 5,000,000 quarts of milk each year.[73]

And yet, none of this precluded rural Northeasterners from indulging in nineteenth-century Americans' favorite comfort food. On traveling to Long Island, New York, in 1819, the English traveler, William Faux, stopped at the home of a certain farmer Miller, in search of a meal. It so happened that Miller, in keeping with the custom of the times, had enough new milk on hand to offer Faux a refreshing drink, along with his supper. Decades later, in his 1842 study of milk drinking in historical and contemporary context, the New York temperance advocate, Robert M. Hartley, recalled the story of an "eminent physician in New England" who had occasion to visit New York but "lived in the country." The good doctor was, by his own admission, "in the practice of securing, if possible, my accustomed glass of milk morning and evening." Indeed, when a "respectable house" on Broadway, in Manhattan, proved incapable of indulging his milk hunger, the doctor abandoned his lodgings and relocated to the Clinton House, which bought sweet milk direct from farmers in rural Harlem. Three years later, editors of the *Boston Cultivator* attributed the longevity of one John Bailes of Northampton, Massachusetts, to

[73] For a contemporary account of the New York swill milk crisis, see John Mullaly, *The Milk Trade in New York City and Vicinity* (New York: Fowlers and Wells, 1853); "Statistics of Agriculture, &c.," *The Merchants' Magazine and Commercial Review*, September 1, 1859; For a contemporary account the Boston milk trade, see "Milk in Boston," *The Farmers Cabinet and American Herdbook, Devoted to Agriculture, Horticulture, and Rural and Domestic Affairs*, January 15, 1848; Statistics of Agriculture, &c. Orange County Milk Trade," *The Merchants' Magazine and Commercial Review*, September 1, 1859.

his dairy-heavy diet -- brown bread with cheese to eat and milk diluted with water to drink -- and his avoidance of alcohol.[74]

More clear is the use of milk by the Euroamerican migrants, some of them accompanied by African American slaves, who followed one of the overland trails that connected the eastern United States to Santa Fe, Salt Lake City, California, and the Oregon Territory, beginning in the 1830s. Their motivations for undertaking the trip were, in the main, economic. Most were farmers looking to get away from the commercialized landscape of the East and go back to practicing the intergenerational subsistence farming that they'd grown up with, although some gold-seekers made the trek hoping to amass easy wealth and improve their fortunes. Others made the journey for spiritual reasons. Methodist Episcopal missionaries founded the Methodist Mission on the Willamette River, in the Oregon Territory, in 1834, while Mormon migrants hoping to escape religious persecution fled to and settled the Great Salt Lake Valley beginning in 1847. Whatever their specific motivations, those who traveled the overland trails faced a risky, if not necessarily unpleasant trek across the arid grasslands that separated the Missouri River Valley from the Rocky Mountain foothills. Arriving safely required determination and a fair bit of luck. It also required preparation, none more important than laying in a supply of portable, nonperishable food.[75]

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[74] Faux, *Memorable Days*, 12; Robert Milham Hartley, *An Historical, Scientific, and Practical Essay on Milk, as an Article of Human Sustenance; with a Consideration of the Effects Consequent Upon the Present Unnatural Methods of Producing It for the Supply of Large Cities* (New York: Jay Leavitt, 1842), 173; "Drink," *Boston Cultivator*, 10 May 1845.

[75] For more on the economic and spiritual motivations that prompted Americans to cross the Central Plains beginning in the 1840s, see John D. Unruh, *The Plains Across: The Overland Emigrants and the Trans-Mississippi West, 1840-1860* (Urbana: University of Illinois Press, 1993), Elliott West, *The Contested Plains: Indians, Goldseekers, and the Rush to Colorado* (Lawrence, University Press of Kansas, 1998), John Mack Faragher, *Women and Men on the Overland Trail* (New Haven: Yale University Press, 2008), and Judy Chapman, "Willamette Mission," *Oregon Encyclopedia*, 30 March 2022, https://www.oregonencyclopedia.org/articles/jason_lee_mission_willamette_mission/#.Y4Ets62ZNR0

What could be more useful, under the circumstances, than a few dairy cows? The animals were portable, in the sense that they followed along under their own power, and durable, in the sense that they were able to survive the long journey. Unlike the sacks of flour and barrels of hard crackers packed away in wagons, dairy cows were also a renewable resource. Given the opportunity to graze in the river valleys that paralleled the trails for much of their distance, and a modicum of safety, the animals could be expected to yield enough milk -- about 2-4 quarts, twice per day -- to nourish a party of migrants. This is not to suggest that dairy cows were ideal or dependable travel companions. For all of their size and strength, the animals were fragile, both physically and emotionally. A host of physical and environmental stressors, among them loud noises, heat and cold stress, insufficient food and water, strenuous exercise, and rough handling by caretakers, may startle or excite cows, prompting their immune systems to release somatic cells that may damage the quality of their milk. Indeed, these same stressors may cause their bodies to shunt energy away from milk synthesis, decreasing, and in some cases halting the flow of milk. But then, all of the migrants' supplies were subject to decomposition and exhaustion.[76]

Migrants were willing to take the risk, investing time and money in purchasing dairy cattle from St. Louis, Kansas City, and Omaha dealers before setting out for the West. On April 9, 1852, three years after the discovery of gold at Sutter's Fort, in California, the Missourian James Addison Bushnell "started for the new Eldorado" in the company of two aspiring

[76] Sumate Pratumsuwan, "Effect of Walking Extra Distances on the Performance of Grazing Dairy Cows in Early Lactation" (Master's Thesis, Massey University, 1994); Luisa Magrin et al., "Physiological and Productive Response of Lactating Dairy Cows to the Alpine Transhumance at the End of the Summer Grazing," *Italian Journal of Animal Science* 15, no. 1 (2016): 151–56; Catherine Bertenshaw and Peter Rowlinson, "Exploring Stock Managers' Perception of the Human-Animal Relationship on Dairy Farms and an Association with Milk Production," *Antrozoös* 22, no. 1 (March 1, 2009): 59–69; Valenze, *Milk*, 1, 293, n. 1; "Effects of Noise on Cattle Performance," Dairy Global, 23 November 2017, https://www.dairyglobal.net/health-and-nutrition/health/effects-of-noise-on-cattle-performance/#:~:text=Noise%20and%20milk%20production&text=This%20has%20resulted%20in%20an,following%20exposure%20to%20sudden%20noise.

prospectors. Joining them were one horse, three yoke of oxen (that is, six animals) to pull the wagon, and one yoke of cows (that is, two animals) to provide milk. That same year, Isaac Constant of Sangamon, Illinois, made similar preparations before leading his family across the Central Plains to the Oregon Territory. Reminiscing about the trip, Constant's then-eighteen-year-old daughter, Lavinia, noted that her father had the "[five] wagons, mules, horses, oxen and cows . . . shipped out ahead of us by water from St. Louis," as well as a four-seat, mule-drawn "hack" for his and his family's comfort. At approximately the same time, a party of forty-four men, women, and children left Saline, Missouri, bound for the San Jose Mission, located in present-day San Jose, California. A member of the party, Newton Finley recalled that the party's livestock herd numbered "about twenty mules and a few choice saddle horses," as well as "oxen and loose cattle, mostly cows."[77]

The uses to which overland migrants put milk depended on their individual tastes and needs. Some used it to make butter. Before setting out each morning, members of the Isaac Constant party hung a "special milk can" filled with new, sweet milk, fresh from the cow, from the back of a wagon. The "swinging and jolting" of the wagon churned the milk, leaving "a large ball of fresh butter," as well as "a good supply of delicious buttermilk," which could be drank or mixed with ground wheat or hominy to make mush-and-milk. The Newton Finley party also made fresh butter each day "simply by placing milk at morning in the churn, put[ting] it aboard the wagon," and harvesting the butter at the end of the day. Others preferred to drink new, sweet milk, still-warm from the cow's udder. In his memoir, *What I Saw in California*, the

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[77] James Addison Bushnell, *The Narrative of James Addison Bushnell* (Eugene, Oregon: Lane County Pioneer-Historical Association, 1959), n.p.; Kevin R. Biersdorff, "A Brief Review of the Life of Isaac Constant," *Oregon Pioneers*, http://www.oregonpioneers.com/constant.htm; Newton Gleaves Finley, "Memoirs of Travel [1852], Written 30 December 1922," Bancroft Library, 24 December 2005, http://lib-operations.sonoma.edu/fin/aaa-0709.html.

journalist and Louisville, Kentucky, native Edwin Bryant marveled at the milk hunger and appetite of migrant parties that stopped near his campsite in the Sweetwater Valley of Oregon to rest and graze their livestock. "In a thirsty state," he wrote, "milk is frequently drank in quarts, and sometimes gallons, in the course of a few hours." These same migrants, he wrote, drank milk instead of water or coffee when tucking into nightly meals of "fat middling of bacon and buffalo meat."[78]

Euroamericans used the relative presence or absence of domestic livestock among the people of a given society as an indicator of civilization -- or the lack thereof. Studies show that European colonists, as well as their Euroamerican descendants, who overspread the North American continent beginning in the late-fifteenth century, used the relative absence of stockraising among Indigenous Peoples as both a cultural and political pretext for purchasing, seizing, or simply squatting on what they deemed uncultivated or improperly cultivated lands.[79] Eighteenth- and nineteenth-century Americans applied a similar standard to their own kith and kin while adding an additional unit of measure: animal *products*. Those who produced an abundance of good-quality animal products had a greater claim to civilization than those who struggled for whatever reason to do so, or so the reasoning went. It comes as no surprise that cow's milk, Americans' favorite comfort food, served as an important litmus test for those passing judgment.

The New York newspaper publisher Horace Greeley applied such a standard to the settlements that he visited in the Kansas Territory in 1859. On passing through the most densely

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[78] Biersdorff, "Brief Review"; Finley, "Memoirs of Travel"; Edwin Bryant, *What I Saw in California: Being the Journal of a Tour by the Emigrant Route and South Pass of the Rocky Mountains, across the Continent of North America, the Great Basin, and through California, in the Years 1846, 1847* (New York: D. Appleton & Co., 1848), 128–29.

[79] Virginia DeJohn Anderson, *Creatures of Empire: How Domestic Animals Transformed Early America* (Oxford: Oxford University Press, 2004), 6-7.

populated (by Euroamericans) portion of the territory, between Osawatomie and Lawrence, Greeley encountered two types of settlers: poor men or squatters; and wealthy men "of liberal means." On reminiscing about his trip, Greeley heaped abuse on the former, noting that their inability (or unwillingness) to harvest an abundance of good-quality milk, among other shortcomings, indicated their laziness, wastefulness, and lack of ambition. By comparison, he praised the latter for insuring against present or future milk and butter shortages by purchasing a "cow in fresh milk," as well as "three heifers which will be cows next year," as a first step toward improving their claims. Greeley kept the milk standard in mind as he moved on to the frontier settlement of Denver, then boasting fewer than 5,000 residents. Rough and tumble though it was, Denver showed "signs of progress" -- among them a growing abundance of marketable milk, which had fallen in price from twenty-five cents to ten cents per quart in a week's time. Not so California, whose cows yielded less milk "than a like number kept for milk on any other portion of the globe." And yet, there was hope. Should farmers improve the land by planting fodder crops, Greeley mused, the state could become "one of the best dairy regions on earth."[80]

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Popular though it was, drinking sweet and fermented milks and/or pouring it over cooked grains to make mush and milk were but two of the uses to which that nation's rural, agrarian majority put fluid cow's milk during the first half of the nineteenth century. Prior to the invention of baking powder in 1856, lay and professional cooks combined soured milk or buttermilk with a bit of salt and baking soda (or sodium bicarbonate), invented in 1846, to leaven bread without yeast or potash. This technique worked because the butyric acid released by

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[80] Horace Greeley, *An Overland Journey, From New York to San Francisco in the Summer of 1859* (C.M. Saxton, Barker & Co., 1860), 67, 164-165.

lactose-metabolizing bacteria that infested milk from almost the moment it left the cow's teat reacted with salt to produce carbon dioxide bubbles that worked their way through the dough, causing it to expand. By no means foolproof, this technique required experience and luck. Absent any means to measure the acid content of the soured milk, the baker could never be sure how much to add to the flour and baking soda, how long to prove the dough, or how long to bake the bread.[81]

In addition to serving as a makeshift leavening agent, milk improved the texture and taste of the breads. Though poorly understood at the time, adding sweet milk to wheat flour in the mixing bowl started a useful chemical transformation, causing the protein (or gluten) strands in the flour to first unravel and then become entangled with one another, creating a dense, stretchy, often sticky matrix known as bread dough. At the same time, butterfat molecules caused some slippage between the individual gluten strands, imparting softness. Furthermore, when exposed to high heat during baking, the water content of the milk vaporized, expanding the air cells in the dough, increasing the volume of the bread, and imparting a light, fluffy texture. The baker could, of course, work a similar transformation using only water. However, sweet milk offered three additional advantages. First, it introduced lactose (milk sugar), giving an agreeable sweet taste to the finished bread. Second, it added a modest complement of nutrients to breads that were absent from water. Third, milk sugar reacted with heat to create the brown, crispy crust that was both aesthetically pleasing and beneficial to mouthfeel.[82]

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[81] Ben Panko, "The Great Uprising: How a Powder Revolutionized Baking," Smithsonian.com, June 20, 2017, https://www.smithsonianmag.com/science-nature/great-uprising-how-powder-revolutionized-baking-180963772/.

[82] Jillian Claire, "The Chemistry of Baking" (Senior Thesis, Columbia, South Carolina, United States, University of South Carolina, 2014), 14, 42, 73; Science Buddies, "The Scientific Secret of Stretchy Dough," Scientific American, September 1, 2016, https://www.scientificamerican.com/article/the-scientific-secret-of-stretchy-dough/.

It is difficult to overstate the importance of milk-based breads (or milk-breads, to use a period term) as a source of nutritional and emotional comfort for rural Americans during the first half of the nineteenth century. Editors of the February 15, 1843, *Michigan Farmer* noted a direct correlation between the "Young Housekeeper" skilled in the art of making milk-based breads and marital bliss. "To have pleasant husbands and happy homes," they wrote, "it is absolutely necessary to make good *bread*." In this case, good bread meant "milk emptings," a light, fluffy bread made with one cup of new milk, two cups of water, and enough flour to make a dough. So great was rural Americans' devotion to milk-breads that a declaration by the eminent German chemist, Justus Von Liebig, that such breads were liable to cause health problems in the aged invited mocking criticism from American editors. "We who were brought up in the country, and who have used milk as drink, and in bread," without suffering any ill effects, "have no patience for such science," noted the editors of *Plough, the Loom and the Anvil* in March 1855. Indeed, they "exhort[ed] . . . readers one and all . . . to get and eat as much milk-bread as they can."[83]

Perhaps no greater testimony to the importance of bread existed than the angst of those forced to do without. In addition to nourishing the body and satisfying the palate, leavened bread evoked many of the same symbolic meanings -- divinity, prosperity, and fertility -- as milk.[84] Indeed, good bread was seen to have built and sustained Western civilization. Editors of the London *Times* claimed as much in 1851, writing, "It is a very old remark that there is no point in which men will less consent to go back, and in which civilization makes its ground more firmly, than in the matter of bread." Whether or not he shared in these symbolic associations, the Louisville physician Daniel Drake recalled bread shortages as one of the greatest hardships of

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[83] E.M.S., "Young Housewives Department," *Michigan Farmer*, February 15, 1843; "Milk in Bread," *Plough, the Loom and the Anvil*, March 1855; For a biography of Justus von Liebig, see *Justus von Liebig: The Chemical* Gatekeeper (Cambridge: Cambridge University Press, 1997).
[84] Hans Welker, *Professional Bread Baking* (Hoboken, New Jersey: John Wiley & Sons, 2017), 4.

life on the Kentucky frontier. During the first fourteen months of their residence in May's Lick, Drake recalled in letters to his children, the Drakes had nothing to eat but wild game, and "almost loathed it, though of an excellent quality." What they wanted, what they needed, what their "hearts yearned for," was the nourishing, wheat-flour bread common to their native Plainfield, New Jersey. So stricken were the young Drake's parents when he, a toddler, would "cry and beg for bread," they excused themselves from the table "to cry themselves."[85]

If milk and milk-breads were indeed the staff of life for rural Americans during the first half of the nineteenth century, then milk-based desserts made that life more pleasurable. Periodicals of the era abounded with recipes for sweet treats that used milk as a key ingredient. Some were simple, requiring nothing more than the ingredients that farm families had on hand. The May 25, 1850, *New England Farmer* advised readers that baked, sweet apples, mixed with milk made a fine dessert, reminiscent of porridge. Others were more complex. The March 1, 1843, *Michigan Farmer* featured recipes for "Boiled Indian Pudding," a confection that called for sweet milk, salt, a "handful of dried whortle-berries," and some Indian meal, and "Indian Baked Pudding," which required that the cook supplement the milk and meal with three eggs, some molasses, and a teaspoonful of allspice. More complex still was *blanc mange*. A recipe that appeared in the December 1, 1849 *Ohio Cultivator* offered a three step recipe: first, boil and lightly salt a quart of sweet milk, to which six tablespoonfuls of sugar, along with a quantity of lemon peel, peach leaves, or some other flavoring agent had been added. Second, blend cornstarch with cold, sweet milk, to be added to the boiling milk. Third, pour the entire

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85 "Bread in England," *Littell's Living Age*, April 5, 1851; Drake, *Pioneer Life*, 4, 21–22.

concoction into a mold and cool, thereby creating a gelatin-like treat, best eaten with cream flavored with a bit of vanilla extract.[86]

These milk-based desserts and treats performed a number of overlapping culinary and social purposes. First, they tasted good and satiated the palate of those who consumed coarse, poor-tasting fare. Second, they provided isolated rural folk with an excuse to practice comforting social rituals. So it was with the Drakes of Kentucky. In his memoir, Daniel Drake noted that hog-killing and syrup making were family and community events, marked by days of difficult, messy labor. Thanks in part to sweet milk, however, these chores had their own rewards. The butchering complete, Drake and helpmates gorged on donuts, crullers, and other "dainties" made with milk, flour, and spices and fried up in a pan of the bubbling lard that was one of the most useful by-products of killing hogs and rendering their fat. Moreover, long, frigid days spent harvesting their sap of sugar maples were made bearable by the rich taste of spicewood tea, flavored with sweet milk.[87] Decades later, the New York author, Solomon Carvalho, who traveled with Col. John C. Frémont's 1856 expedition, surprised his fellow travelers -- then subsisting on horse-meat soup -- with six gallons of *blanc mange* made from tinned, powdered milk. "It is hardly necessary to say," Carvalho later wrote, "that is disappeared in double quick time. The whole camp had a share of it; and we were all sorry that there was 'no more left of the same sort'."[88]

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[86] "Apples," *The New England Farmer*, May 25, 1850; "Young Housewives' Department," *Michigan Farmer*, March 1, 1843; "Housewife's Department," *Ohio Cultivator*, December 1, 1849.

[87] Drake, *Pioneer Life*, 86, 96-97.

[88] Arlene B. Hirschfelder, *Photo Odyssey: Solomon Carvalho's Remarkable Western Adventure, 1853-1854* (New York: Clarion Books, 2000), 60. For more on Frémont's 1856 expedition, see Steve Inskeep, *Imperfect Union: How Jessie and John Frémont Mapped the West, Invented Celebrity, and Helped Cause the Civil War* (New York: Penguin Press, 2020).

No matter where they lived, no matter how far from urban centers, rural Americans drank great quantities of coffee, supplemented with milk or cream and sugar. Historians have traced this practice to the period of the American Revolution, when rebellious colonists in need of a stimulating drink exchanged tea, with all of its British cultural, economic, and political trappings, for coffee. The drink's popularity only increased during the first half of the nineteenth century. Between 1821 and 1836, the amount of coffee imported to the United States increased from 21,273,659 lbs. to 93,790,507 lbs. Though frowned on by medical and religious sectarians as a narcotic or poison, coffee performed a number of useful functions for the imbiber. The caffeine in coffee gave a burst of energy. It may also have stilled hunger pangs, offering what the historian Mark Pendergrast described as "an illusion of nutrition."[89] But then, supplemented with milk or cream and sugar, as it so often was, coffee nourished the body in actual fact. Two cups of coffee, each supplemented with an ounce of sweet cream, gave the drinker about 100 calories, most of the derived from butterfat, a slow-burning, and therefore long lasting energy source. Adding a teaspoonful of white sugar to each cup, as was custom, increased the calorie load to about 260. The drinker's body would have converted sugar (sucrose) into glucose, a fast-burning energy source that acted with caffeine to increase the drink's perceived stimulating effects.[90]

Beyond its stimulating and nourishing effects, coffee with milk or cream brought comfort and emotional satisfaction to rural Americans during the first half of the nineteenth century. Its

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[89] Mark Pendergrast, *Uncommon Grounds: The History of Coffee and How It Transformed Our World* (New York: Basic Books, 2010), 14–16.

[90] "Cream, Fluid, Heavy Whipping," U.S. Department of Agriculture, Agricultural Research Service, 1 April 2019, fdc.nal.usda.gov/fdc-app.html#/food-details/170859/nutrients; "Sugars, Granulated," U.S. Department of Agriculture, Agricultural Research Service, 1 April 2019, fdc.nal.usda.gov/fdc-app.html#/food-details/746784/nutrients; "Sucrose, Glucose and Fructose," Bralow Medical Group, 23 September 2017, bralowmedicalgroup.com/sucrose-glucose-fructose/.

power had much to do with its centrality to the feminine domestic sphere, presided over by a loving mother or wife. Agricultural journals of the era made clear that the competent, loving housewife worked hard to furnish her menfolk with "good coffee." This required, first, that she take great care in roasting and grinding the beans, so as not to damage their flavor and aroma. It required, second, that she dilute the boiling liquid with a quantity of boiling, sweet milk to suit the taste of drinkers. The September 7, 1854, *Christian Watchman* included a letter, written by a certain "Jenny," that testified to the power of good coffee, along with other culinary delights, to ensure domestic bliss. The subject of Jenny's missive, one Jemima Parker of Willoughby, Ohio, spent a long day helping her husband, Philo, with the farm chores. Exhausted though she may have been, Jemima did her duty, preparing a sumptuous repast of bacon, eggs, biscuits, and milk, topped off with a piping-hot pot of "fragrant coffee." On sitting down to the spread, Philo beamed with joy. Jemima, "delighted" by his response, beamed back.[91]

At least as popular as coffee with milk, though seldom if ever recognized as such by historians, was milk punch, a toddy beloved by rural and urban Americans during the first half of the nineteenth century. Recipes for milk punch varied in complexity. The 1849 *Knife and Fork* gave the following instructions: Fill a bottle with lemon peel, add "as much brandy as it will permit," and then let stand in the sun for two or three days; this done, pour the brandy out into a tub and add "two pounds of sugar, two quarts of water, four of brandy, two of boiling milk boiled with spice, and about a pint of lemon juice"; strain until clear and bottle. Editors concluded, "You will not be able to keep it long if anybody in the house as once tasted it." A less labor-intensive recipe, published in 1851 in *Gleason's Pictorial Drawing-Room Companion*,

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[91] "How to Make Good Coffee," *Southern Planter*, January 1842; See also "How to Make Good Coffee," *Farmer's Register; A Monthly Publication*, January 1843; "Domestic Department," *Valley Farmer*, April 1860; Jenny, "Farm-House Letters -- No. 6," *Christian Watchman and Reflector*, September 7, 1854.

advised readers to rub lump sugar on the skins of two lemons and then drop them into a bowl, squeeze the lemon juice onto the sugar lumps, and then "mix with boiling milk, hot as vengeance." The final two, tongue-in-cheek steps: "Pour in rum blindfolded, as you can't pour too much," and then serve over ice. In his 1861, the physician Ebenezer Neal proposed an even simpler recipe still: Four ounces of good brandy, mixed with eight ounces of sweet milk and served in a wineglass.[92]

However it was made, milk punch served an important social function for Americans during the first half of the nineteenth century. More than mere nourishment, it was a beverage of choice for those who gathered to practice secular and religious rituals. Among the members of the Scottish nobleman and military officer, Sir William Drummond Stewart's 1843 expedition to Fremont Lake, in the Rocky Mountains, a certain Mr. Field wrote to the New Orleans *Picayune* on July 8, 1843, describing events that had transpired during the trip. Notable was the party's celebration of Independence Day while encamped at Fort Platte, near present-day Laramie, Wyoming. The garrison must have had cows on hand, for the revelers washed down a meal of corn dodgers and choice cuts of bison meat with milk punch and wine. Fourteen years later, in 1857, celebrants gathered in rural Bellevue, Nebraska Territory, at the behest of one "Johnson," -- a "prince of good fellows," editors of the *Bellevue Gazette* wrote -- to ring in the Christmas holiday. Along with a sumptuous meal, Johnson offered his guests milk punch for use in sending up a series of warm toasts. Editors declared the libation and "excellent article," noting that it "met the approval of all."[93]

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[92] *The Knife and Fork for 1849* (London: H. Hurst, 1849), 38-39; "A Recipe for Milk Punch," *Gleason's Pictorial Drawing-Room Companion*, November 1, 1851; Ebenezer Neal, *Diet for the Sick and Convalescent* (Philadelphia: James Challen & Son, 1861), 44.

[93] "From the Rocky Mountain Expedition," *Richmond Palladium*, October 7, 1843; "Christmas," *Bellevue Gazette*, January 1, 1857.

Milk punch also served an economic function for rural Americans. Perhaps because it was so easy to make, requiring little more than the milk that farm families kept on hand, the drink served rural saloon and innkeepers as a reliable moneymaker. This proved especially true among those who lived near the nation's burgeoning urban/industrial centers. The June 22, 1837, New York *Morning Herald* indicated that a "very regular Dutch beauty" residing in the rural Flatbush community, south of Brooklyn, was happy to furnish carriage-bound excursioners in search of food and drink with a cooling draught of "choice" milk punch. Those who wished to avoid the ferry ride to Brooklyn, the *Morning Herald* wrote in July 1843, could head north in their carriages from Manhattan to rural Prospect Hill or Bloomingdale, to "swallow an ice cream or a glass of milk punch" in the "cool evening." Yet it also proved true in more out-of-the-way communities. Travelers passing through the picturesque Susquehannah Valley of eastern Pennsylvania in 1836 were apt to discover the "General Wayne," a country tavern owned by a New England migrant and Revolutionary War veteran, that served up milk punch to those in need of refreshment. Far to the south and west, those passing through Tuscaloosa, Alabama, in 1839 could whet their appetite for strong drink at a merchant house that advertised milk punch alongside "Millsaws, mouse traps, muslins, [and] mittens," perhaps as a means to lure road-weary customers. [94]

The inn and saloon keepers who catered to California gold seekers beginning in 1849 used the widespread popularity of milk punch to a similar economic advantage. On visiting the Oregon Bar mining camp on the North Fork of the American River in June 1850, a correspondent to the *Democratic Banner* wrote that a local saloon separated prospectors from

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[94] "A Drive to Bath," *Morning Herald*, June 22, 1837; "Watering Places and Drives About Town," *Morning Herald*, July 25, 1843; "The Red Box, or Scenes at the General Wayne," *Du Buque Visitor*, September 21, 1836; *Maumee City Express*, January 5, 1839.

their money, and their sobriety, with "milk punch concocted by fair hands." In March 1853, a certain Mrs. Smith invited those passing through Grass Valley, California, to drop by her Golden Gate Saloon for milk punch, "Tom and Jerry," hot whiskey, and other refreshments. The following year, the poet J.P. Anthony wrote a sketch for *The Sierra Citizen*, telling of his frequent visits to a roadside inn near Downieville, California. His "favorite resting place," the inn offered Anthony an opportunity to lounge in the shade of "picturesque" live oak trees that fronted the public road while visiting with the proprietors' young daughter, a charming "little sprite" who plied him for sugary treats. The only drawback was the inn's milk punch, which he considered "unexceptionable." Writing from Volcanoville on March 10, 1856, a correspondent to the *Georgetown News* noted that resident miners discovered "a vein of milk punch . . . a day or two ago, which prospected well.--Several got rich in a short time, and as a matter of course, got the 'swell head'."[95]

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As the nineteenth century neared its midpoint, a sustained rural-to-urban migration had taken hundreds of thousands -- perhaps millions -- of country folk away from the family farm and into one of the nation's growing cities. Historiographical wisdom notwithstanding, these newcomers, not a few of whom hailed from dairying cultures in Great Britain and Continental Europe, carried a love of sweet and fermented milk and milk-based foods with them to their new homes. [96] This proved something of a problem, for the cows that furnished them with their

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[95] "Late News from California," *Democratic Banner*, August 26, 1850; "San Francisco Advertisements," *The Nevada Journal*, March 11, 1853; J.P. Anthony, "A Sketch," *The Sierra Citizen*, October 14, 1854; "Volcanoville, March 10, 1856," *The Georgetown News*, March 20, 1856.

[96] Between 1800 and 1860, the population of Manhattan, alone, grew from 60,516 to 813,669 people, or a total of 753,153 people. See William C. Hunt, "Population of New York by Counties and Minor Civil Divisions," *Twelfth Census of the United States. Census Bulletin* no. 38 (22 January 1901), 2. During the 1840s, approximately 2 million Irish immigrants settled in New York City. See Lillian Hau, "A History of Irish Immigration in New York, City College of New York, 9 May 2009,

favorite comfort food often remained behind. So long as cities remained small, it was at least possible for newly minted urbanites to walk or take a short ride to their town's rural periphery and purchase some milk from local farmers. However, as urban expansion pushed that rural periphery further and further into the distance, it also pushed the milk frontier further and further away from the city center. Among those who noticed this change was the physician Daniel Drake, who moved from the Kentucky frontier to Cincinnati in 1800. By 1845, dairy cows were all but absent from the urban landscape, leading him to muse, "We think of the cow in connection with our tea and coffee, our butter, custards, and ice creams, but we never see her." The milk that Drake succeeded in buying from local peddlers struck him as inferior to the sweet, creamy beverage of his youth. Indeed, he compared the fluid to water drawn from an "impure and sluggish stream long after it has left the rocky fountain," and the people forced to use it -- himself included -- to "thirsty people" in need of a cooling draught. The problem that Drake faced as an urban consumer of milk in the early nineteenth century anticipated the problem that soldiers faced in the Civil War: how to consume one's favorite comfort food in a place with few (or no) cows?[97]

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https://macaulay.cuny.edu/seminars/drabik09/articles/a/_/h/A_History_of_Irish_Immigration_to_New_York_ab6b.html.

[97] Drake, *Pioneer Life*, x, 43-44, 158.

Chapter 2:
"A Most Important Article of Food for the Sick":
Milk as Nineteenth-Century Americans' Most Useful Medicine

In December 1856, "for the sake of humanity," the Wilmington, Delaware, physician, W. Fields, wrote up a short prescription for treating one of the most destructive, most feared diseases known to nineteenth century Americans: smallpox. Fields began by citing his long "experience" and success "in the cure of . . . smallpox of the most malignant type." He then moved to the specifics of the "recipe," which required nothing more than the supplies that rural American women -- the font of most antebellum medical knowledge and the givers of most practical medical care -- were apt to have had on hand. Step one called for dosing the patient with one teaspoonful of "good brewer's yeast," of the sort kept for bread making, mixed with three teaspoonfuls of sweetened water, three times per day. Step two called for feeding the patient a strict "milk diet" -- which is to say, cups of new, sweet milk, in lieu of meat, vegetables, and/or breads -- "throughout the entire disease." Fields assured readers that this remedy, "faithfully carried out," would "cure forty-five out of every fifty" smallpox patients "without calling on a physician." At least as important, the remedy worked in some way to prevent the disfiguring pock marks that gave the disease its name.[98]

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[98] William Fields, "Scarlet Fever and Small Pox," *Glasgow Weekly Times*, January 22, 1857; For more on nineteenth-century Americans' fear of smallpox, see Andrew C. Isenberg, "An Empire of Remedy: Vaccination, Natives, and Narratives in the North American West," *Pacific Historical Review* 86, no. 1 (2017): 84–113; Trained physicians were scarce in rural America during the first half of the nineteenth century. Consequently, and in keeping with age-old gendered tradition, women performed most medical care in the home. See Daniel Sutherland, *The Expansion of Everyday Life, 1860-1876* (Fayetteville, Arkansas: University of Arkansas Press, 2000), 121–22, 196–99, 201; See also Karen Buhler-Wilkerson, *No Place Like Home: A History of Nursing and Home Care in the United States* (Baltimore: The Johns Hopkins University Press, 2001); Margaret Humphreys, *Marrow of Tragedy: The Health Crisis of the American Civil War* (Baltimore: Johns Hopkins University Press, 2013), 6–7.

If the reprinting of Fields's smallpox remedy by rural newspaper editors is any indication, nineteenth-century Americans, Northern, Southern, and Western, believed that his suggestions were worthy of consideration and practical application. Beginning in January 1857, word-for-word reproductions of Fields's letter appeared in the *Glasgow Weekly Times*, published in Glasgow, Missouri, and the *Shepherdstown Register*, published in Shepherdstown, Pennsylvania. By March, it had appeared in the *Holmes County Republican*, published in Millersburg, Ohio, the *Oxford Democrat*, published in Paris, Maine, and the *Weekly Hawk-Eye and Telegraph*, published in Burlington, Iowa. April saw the letter appear in the Woodsfield, Ohio, *Spirit of Democracy*, the Greenville, South Carolina, *Southern Enterprise*, and the Charlotte, North Carolina, *Western Democrat*. By the end of summer, readers of the Richmond, Virginia, *Daily Dispatch*, the *Bedford Inquirer and Chronicle*, published in Bedford, Pennsylvania, and the *Opelousas Patriot*, published in Opelousas, Louisiana, had had the opportunity to read and apply Fields's advice.[99]

Viewed through the lens of modern medical science, it would be easy to dismiss Fields's smallpox remedy as quaint and ineffective. With due respect to his claims, there is no reason to believe that a diet of brewer's yeast and sweet cow's milk did much to cure those afflicted with what Fields termed "the most malignant strain" of smallpox, much less prevent the pock marks and disfiguring scars that gave the disease its name. Even now, in the twenty-first century, there is no specific cure for the disease. To be sure, modern physicians have long used a serum made

[99] Fields, "Scarlet Fever and Small Pox," January 22, 1857; William Fields, "Scarlet Fever and Small Pox," *Shepherdstown Register*, January 24, 1857; William Fields, "Scarlet Fever and Small Pox," *Holmes County Republican*, March 19, 1857; William Fields, "Weekly Summary of News," *Oxford Democrat*, May 15, 1857; William Fields, "Scarlet Fever and Small Pox," *Weekly Hawk-Eye and Telegraph*, March 25, 1857; William Fields, "Scarlet Fever and Small Pox," *The Spirit of Democracy*, April 1, 1857; William Fields, "Scarlet Fever and Small Pox," *The Southern Enterprise*, April 30, 1857; William Fields, "Scarlet Fever and Small Pox," *The Western Democrat*, April 28, 1857; "Scarlet Fever and Small Pox," *The Daily Dispatch*, July 7, 1857; "Scarlet Fever and Small Pox," *The Bedford Inquirer and Chronicle*, July 31, 1857; "Scarlet Fever and Small Pox," *Opelousas Patriot*, August 8, 1857.

of live vaccinia, a similar, but less-dangerous poxvirus, to vaccinate vulnerable populations against the variola virus that causes smallpox. The vaccine has even been shown to suppress some of the disease's worst symptoms if given soon -- that is, between 4 and 7 days -- after the variola infection has manifested as smallpox.[100] Otherwise, there is little that can be done for the afflicted, save keeping them well fed and hydrated and treating secondary infections with antibiotics.

Viewed through the lens of nineteenth-century medical science, however, Fields's prescription was altogether sensible. To understand how and why, it is first necessary to understand the culturally and environmentally informed processes by which nineteenth-century physicians made sense of the human organism and its response to disease and injury. Lacking any knowledge of microorganisms, most relied on humoral theory promulgated by the ancient Greeks, to explain the human body's succumbing to disease and infection. At the risk of oversimplification, humoral theory consisted of two main components: the attribution of sickness to an imbalance of bodily fluids or "humors," all of which were subject to outside influences such as climate, weather, sex, geographic location, miasmas (noxious vapors emanating from decaying organic matter), or in the case of smallpox, an unknown infectious agent; the belief that certain metals, chemical compounds, and foods were capable of restoring a sick person's humoral equilibrium, thereby restoring them to good health.[101] Assuming that Fields subscribed

[100] "Vaccine Basics," Centers for Disease Control and Prevention: CDC 24/7: Saving Lives, Protecting People, July 12, 2017, https://www.cdc.gov/smallpox/vaccine-basics/index.html; "Smallpox," Mayo Clinic, Patient Care & Health Information, Disease and Conditions, July 26, 2017, https://www.mayoclinic.org/diseases-conditions/smallpox/symptoms-causes/syc-20353027; Americans first used a crude smallpox vaccination in 1777, during the American Revolution. See Dan Liebowitz, "Smallpox Vaccination: An Early Start of Modern Medicine in America," *Journal of Community Hospital Internal Medicine Perspectives* 7, no. 1 (January 2017): 61–63; For more on the Great Smallpox Epidemic of 1775-1782, including early vaccination efforts, see Elizabeth A. Fenn, *Pox Americana: The Great Smallpox Epidemic of 1775-82* (New York, New York: Hill and Wang, 2001).

[101] William A. Jackson, "A Short Guide to Humoral Medicine," *TRENDS in Pharmacological Science* 22, no. 9 (September 2001): 487–89; Ajesh Kannadan, "History of the Miasma Theory of Disease," *ESSAI* 16 (Spring 2018): 41–43.

to humoral theory, it was reasonable for him to believe that yeast and milk were an effective treatment for smallpox.

And yet, there was something else at work, something so obvious to nineteenth-century Americans that it needed no special emphasis or explanation -- the presumed medicinal properties of milk. With few exceptions, trained physicians and lay healers of the era believed that new, sweet milk possessed tangible, even magical curative and palliative powers that were vital to the treatment of the sick and the injured.[102] This included even sectarian medical theorists, who rejected much of the Western medical canon as unnatural and therefore dangerous to human health.[103] That they did so may be attributed, in part, to a deep-seated European cultural inheritance, steeped in pagan and Christian symbolism, that inscribed milk with meaning and value. For Americans of the era, milk evoked images of motherhood -- the source of life and nourishment -- and the feminine domestic sphere -- site of most practical medical care. Add to this longstanding associations of milk with divinity, prosperity, and fertility, and the humble fluid appeared powerful indeed.[104]

Beyond the pseudoscientific and symbolic, Americans' faith in medicinal milk may be attributed to common sense and experience. Though they misunderstood the causes of disease and lacked knowledge of vitamins and nutrients, physicians and lay healers of the era recognized

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[102] Historians have long noted that Europeans and Euroamericans ascribed curative powers to milk. Yet in doing so, they have mostly confined their observations to Antiquity or the Early Modern Period. See Gabrielle Hatfield, *Encyclopedia of Folk Medicine: Old World and New World Traditions* (Santa Barbara, California: ABC-CLIO, 2004), 14, 112–15; Hannah Velten, *Milk: A Global History* (London: Reaktion Books, 2010); Deborah Valenze, *Milk: A Local and Global History* (New Haven, Conn.: Yale University Press, 2011), 105; Sarah Sutton, "Milk: A New England History" (Dissertation, Waltham, Mass., Brandeis University, 2016), 19–20, 26–27.

[103] For more on hydropaths, homeopaths, Thomsonians, and other medical sectarians, see Catherine Albanese, "Physic and Metaphysic in Nineteenth-Century America: Medical Sectarians and Religious Healing," *Church History* 55, no. 4 (December 1986): 489–502; For an example of medicinal milk advocacy by hydropaths, see "Coughs, Colds, and Their Cure," *Water-Cure Journal*, January 1, 1849.

[104] For more on dairy cows and milk in Celtic and Norse pagan tradition, see Cassandra Eason, *Fabulous Creatures, Mythical Monsters, and Animal Power Symbols* (Westport, Connecticut: Greenwood Press, 2008), 88–89; For more on dairy cows and milk in the Jewish and Christian traditions, see Valenze, *Milk*, 13–33.

that milk nourished and promoted the rapid growth of young mammals, humans included. From there, they reasoned that milk had the power to strengthen and restore those struck down by injury and illness. Likely, they were correct. Milk is high in fat, lactose (milk sugar), and vitamin A, all of which have been shown by modern researchers to boost the human immune system, promote bone and tissue repair, and ensure proper organ systems function.[105] Absent vaccines and antibiotics, milk was one of the best defenses against disease and secondary infections available to Americans of the era, short of exposure avoidance. If nothing else, medicinal milk gave lay healers a means to take decisive, and so far as they knew, medicinally effective action in the face of intense human suffering. When a mother fed milk to her feverish child, or a wife to her injured husband, she *believed* that it would work. Such confidence would have done much to stave off despair, making it possible for her to carry on the Quixotic work of treating those who sustained horrific injuries or succumbed to baffling diseases in the rural American backcountry.[106]

Medicinal milk differed from nutritional milk in one important sense: It had to be new and sweet if it was to be of any use in treating the sick and injured. Perhaps no nineteenth-century healer stated this more plainly than did the British nursing pioneer and social reformer, Florence Nightingale. In her 1859 *Notes on Nursing*, which enjoyed a widespread popularity among lay healers in both the United States and Europe, Nightingale claimed that "milk and the

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[105] British biochemist Frederick Gowland Hopkins first hypothesized that accessory "food factors" promoted human and animal growth while staving off nutritional disorders in 1912. Forty years would pass before researchers proved that Hopkins's factors -- dubbed "vitamins" by the Polish biochemist Cashmir Funk -- boosted the immune system, promoted the development and repair of soft tissues, and ensured proper organ systems function. See Frederick Gowland Hopkins, "Feeding Experiments Illustrating the Importance of Accessory Factors in Normal Dietaries," *The Journal of Physiology* 44, no. 5–6 (1912): 425–60; Wolfgang Herrmann and Rina Obeid, "History of the Vitamins: Discovery, Syntheses, Nobel Prizes, Modern Science," in *Vitamins in the Prevention of Human Diseases* (New York, New York: De Gruyter, 2011), 1–3; "Milk Facts," Milk Composition, n.d., http://www.milkfacts.info/Milk%20Composition/Milk%20Composition%20Page.htm.

[106] "The Power of the Placebo Effect," Harvard Health Publishing, Harvard Medical School, May 2017, https://www.health.harvard.edu/mental-health/the-power-of-the-placebo-effect.

preparations from milk, are a most important article of food for the sick." Indeed, she noted that one pint of milk had "nearly as much nourishment . . . as there is in a quarter of a lb. of meat." Yet Nightingale tempered her advocacy of medicinal milk with a caveat: "The least change or sourness in [milk], makes of all articles, perhaps, the most injurious; diarrhea is a common result of fresh milk allowed to become at all sour." She did make one exception for fermented milk products, noting that buttermilk -- "a totally different thing," indicating that Nightingale may have conflated "soured" with "spoiled" -- was useful for treating those suffering a fever. Otherwise, she insisted that the nurse "exercise her utmost care" in bringing only fresh, sweet milk into the sickroom.[107]

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To discover the exact geographic, temporal, and cultural origins of nineteenth-century Americans' faith in medicinal milk would be a feat worthy of many volumes. The human preoccupation with bovines extends back 40,000 years or more, as evinced by paintings of wild, horned cattle discovered in the caves of present-day Indonesia, France, and Somalia (and if one includes bison, India, Spain, and Romania). The first domesticated cattle appeared in the Near East in 8,500 BCE, after which time parallel domestication events placed them in the Indus Valley, China, Indochina, and Indonesia, around 6,000 BC, Africa around 4,000-5,000 BCE, the North Sea coasts of Europe around 3,000 years BCE, and the British Isles by 1,000-2,000 BCE.[108] Moreover, people have written about cows and milk from almost the moment that

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107 Florence Nightingale, *Notes on Nursing: What It Is, and What It Is Not* (London: Blackie & Son, Ltd., 1859), 40–42.

108 Brian Handwerk, "World's Oldest Known Figurative Paintings Found in Borneo Cave," Smithsonian Magazine, 7 November 2018, https://www.smithsonianmag.com/science-nature/worlds-oldest-known-figurative-paintings-discovered-borneo-cave-180970747/; N.K. Sandars, *Prehistoric Art in Europe* (New Haven: Yale University Press, 1985), 109, 114; Abdurahman Abdullahi (Baadiyow), *Making Sense of Somali History, Volume I* (London: Adonis and Abbey, 2017), 42; S.K. Tiwari, *Riddles of Indian Rockshelter Paintings* (New Delhi: Sarup & Sons, 2000), 158; Gheorghe M.L. Ponta, "Bihor Mountains" in Gheorghe M.L. Ponta and Bogdan P. Onac, eds., *Cave and Karst*

ancient Sumerians first touched stylus to clay, attributing divine and curative power to both the animals and their secretions.[109] The gene mutation responsible for lactase persistence -- that is, the ability of some adult humans to digest fresh milk -- is likewise an ancient event, dating to about 7,500 years ago in Europe.[110]

Better to begin with the common British and European folk who carried dairy cattle and milk-based remedies with them as they colonized the Greater Caribbean Basin and North America, beginning in the fifteenth century. The historian Gabrielle Hatfield noted that Scottish lay healers used the seeds of *Guilandina bonduc* (a plant native to the Caribbean basin), boiled in milk, to treat chronic diarrhea and dysentery. Across the Irish Sea, Irish lay healers treated jaundice with a draught made from urine mixed with cow's milk. Among the English, lay healers treated hydrophobia (or rabies) by soaking rock-like masses of hair and plant matter found in the stomach of ruminants, known as bezoars or "madstones," in milk and then applying the stones to bite wounds to draw out poisons. Scandinavian healers shared this belief in the medicinal and magical powers of milk. Norwegians applied clotted milk and bread to wounds and inflammations to promote healing. The eighteenth-century Sunnmore pastor Hans Strøm advised parishioners to treat fevers with one of two milk-based draughts: cooked cow manure in milk; or Ol-ost, a drink made by blending two parts milk and one part beer, heated separately.

Systems of Romania (New York: Springer, 2019), 316; Mario Melletti, "Cattle Domestication: From Aurochs to Cow," Fifteen Eighty Four: Academic Perspectives from Cambridge University Press, February 18, 2016, http://www.cambridgeblog.org/2016/02/cattle-domestication-from-aurochs-to-cow/.

109 A.R. George, *The Babylonian Gilgamesh Epic: Introduction, Critical Edition and Cuneiform Texts*, vol. II (Oxford: Oxford University Press, 2003), 823, 854–55.

110 Andrew Curry, "Archaeology: The Milk Revolution," Nature: International Weekly Journal of Science, July 31, 2013, https://www.nature.com/news/archaeology-the-milk-revolution-1.13471. Recent studies reveal that ancient Europeans drank and ate milk *despite* being lactose intolerant. See "Early Europeans Could Not Tolerate Milk but Drank It Anyway, Study Finds," *New York Times*, 27 July 2022.

For throat problems, he advised caregivers to anoint the afflicted with a poultice made from dog feces and milk.[111]

Anecdotal evidence reveals that at least some of these milk-based folk remedies, along with widespread faith in their efficacy, crossed the Atlantic and took root among rural Euroamericans. In 1847, the *Southern Planter* reported that a "lady of high standing" in Lynchburg, Virginia, proposed a milk-based remedy for those bitten by poisonous snakes: boil the root of a cockle-bur plant in new milk and then "drink freely" of the tonic. The following year, the *Massachusetts Ploughman and New England Journal of Agriculture* reported that "an elderly lady of intelligence and experience" had suffered for forty years from a paralyzing nervousness that left her weak and unable to stand. Always, she found that a glass of cold, new milk worked "as if by magic" to "banish" her nervousness and restore her vigor. Belief in the power of milk-soaked madstones persisted in rural America well into the 1850s. A correspondent to September 1869 *American Phrenological Journal* witnessed the use of a madstone by one Mr. Berry of Sullivan County, Missouri, in 1857. According to the story, a rabid dog bit Berry's horse, which then bit Berry on the hand. By applying a madstone soaked in new, sweet milk to the wound, Berry drew out the poison and recovered, or so the correspondent claimed. Denied similar treatment, the unfortunate horse, along with "a number of cows bitten by the same made dog," died of hydrophobia.[112]

Given sufficient time, milk-based remedies took root in African American slave communities in the South. In some cases, these remedies were imposed from the top down, as a

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[111] Hatfield, *Encyclopedia of Folk Medicine*, 118; Kathleen Stokker, *Remedies and Rituals: Folk Medicine in Norway and the New Lands* (St. Paul: Minnesota Historical Society Press, 2004), 14, 112–15.

[112] An Amherst Subscriber, "Cure for the Bite of a Snake," *Southern Planter*, March 1847; "Cure for Nervousness," *Massachusetts Ploughman and New England Journal of Agriculture*, March 18, 1848; "The Madstone," *American Phrenological Journal*, September 1869.

consequence of uneven power relationships. The historian Elizabeth Anderson has described this process as "cultural imposition," and it permeated all aspects of American slavery, from religion to social relationships to language. On speaking with an interviewer from the United States Works Progress Administration during the 1920s, the former slave Adeline Hodge of Alabama recalled that a Euroamerican doctor used cupping and bleeding, along with a dose of calomel (mercury) as a laxative, when treating her and other sick slaves. "De nex' mawnin," she noted, "[they] gib us a big bowl of gruel, made out ob meal and milk, an' den us w'uld be allright." However, it appears that the so-called "grannies" -- that is, older, more-experienced women -- who served as lay healers included milk-based remedies into their own folk treatments. When the former slave Sarah Wilson fell ill as a child, the local "granny" treated her with "clabber milk," a thick, fermented food, similar in taste and consistency to modern yogurt. Meanwhile, when the former slave, Annie Ware, of Texas contracted whooping cough, a granny treated her with a meal of horse milk and hog jaw.[113] The unstated implication in all of these testimonials was the milk proved an effective cure.

Beginning in the eighteenth century, British intellectuals set about codifying these traditional, milk-based folk remedies for public consumption. Among the first to do, the Scottish physician and mathematician, George Cheyne, spoke from personal experience. A cheerful, social fellow, given to indulging his love of rich food, strong drink, and good company in London taverns, Cheyne had developed an array of health problems by early middle age: obesity, shortness of breath, lethargy, listlessness, melancholy, and heart disease. Convinced that dietary changes gave him the best chance of losing weight and restoring his health, he swore off alcohol

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[113] Elizabeth Anderson, *The Imperative of Integration* (Princeton: Princeton University Press, 2010), 15, 17, 103; Herbert C. Covey, *African American Slave Medicine: Herbal and Non-Herbal Treatments* (New York: Lexington Books, 2007), 22–23, 51, 188.

and rich foods, adopted a strict milk diet supplemented with fruits, grains, breads, and root vegetables, and took up a regimen of vigorous exercise. By his own account, Cheyne lost 308 lbs., down from an original weight of 488 lbs., while regaining his good cheer and lust for life. Cheyne published his findings in two works: *The English Malady* in 1733, and *The Natural Method of Curing the Diseases of the Body and the Disorders of the Mind*, in 1742. Both prescribed a milk diet as the best remedy for curing the "nervous Distempers, Spleen, Vapours, and Lowness of Spirits" common to those who overindulged in food and drink. Indeed, Cheyne also believed a milk-and-vegetable diet capable of curing a range of specific diseases -- consumption, cancer, and hemiplegia (or palsy) caused by brain damage -- when used in tandem with bleeding and purging.[114]

Although written for the English "better classes," Cheyne's advice reached British and American lay healers via popular medical manuals that borrowed heavily from his work. Among the most widely read of these manuals, the British theologian John Wesley's 1764 *Primitive Physick* promised an "easy and natural method for curing most diseases" for the benefit of "plain, unlettered men." In some cases, this meant drinking new, sweet milk as a tonic. Those suffering chronic asthma or diabetes, Wesley noted, needed only to drink a pint of new milk each day to ease their suffering. So too those who contracted measles and smallpox, while a gill of milk, taken just before bed, prevented the discomfort of night sweats. Indeed, a few drops of warm milk were said to force parasitic worms from the human ear canal. In other cases, Wesley's recommendations called for blending sweet milk with other ingredients to make

[114] For more on George Cheyne, see Valenze, *Milk*, 105–13; "Temperance--Experience of Dr. Cheyne," *Journal of Health. Conducted by an Association of Physicians*, April 14, 1830; "Review 1 -- No Title," *Christian Watchman*, June 22, 1838; George Cheyne, *The English Malady: Or, a Treatise of Nervous Diseases of All Kinds, as Spleen, Vapours, Lowness of Spirits, Hypochondriacal, and Hysterical Distempers, &c.* (London: George Strahan, 1733), i, vii, 297; George Cheyne, *The Natural Method of Curing the Disease of the Body, and the Disorders of the Mind Depending on the Body* (London: George Strahan, 1742), 130, 140, 143.

medicinal draughts. Adding a nutmeg-sized helping of conserve of roses, a paste made of ground rose petals mixed with refined white sugar, to a pint of new milk, still warm from the cow, gave relief to children suffering from whooping cough. Liverwort and black pepper mixed with warm milk proved an effective remedy for the bite of a rabid dog, although Wesley cautioned, "It has sometimes failed."[115]

If publication data is any indication, Wesley's *Primitive Physick* enjoyed a wide readership in Europe and the Americas well into the nineteenth century. At the time of Wesley's death in 1791, the book was on its twenty-third London edition. The first American edition, a reprinting of the twelfth London edition, appeared in Philadelphia in 1764, followed by reprintings of the thirteenth, fourteenth, sixteenth, and twenty-second London editions by 1800. Yet the book's arrival in North America likely proceeded these domestic printings. At least some of the tens of thousands of British migrants who crossed the Atlantic between 1747 and 1764 packed a dog-eared, annotated copy of Wesley's prescriptions among their belongings before setting sail. Whatever their origin, copies of *Primitive Physick* soon diffused across the British colonial landscape. The historian Joseph Thacker attributed this to the religious and social ferment of the Second Great Awakening, which saw itinerant Methodist ministers carry the book with them in their saddlebags as they traversed the rural American backcountry, meeting with congregants.[116] The book enjoyed a following even into the mid-nineteenth century. In 1858, on the eve of the American Civil War, the Massachusetts pastor and physician,

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115 Valenze, *Milk*, 114; John Wesley, *Primitive Physic, or, an Easy and Natural Method for Curing Most Diseases* (Edinburgh, Scotland, United Kingdom: Thornton & Collie, 1846), 27, 36, 48, 74–75, 92–98.

116 Samuel J. Rogal, "Pills for the Poor: John Wesley's Primitive Physick," *The Yale Journal of Biology and Medicine* 51 (1978): 82–83; Elizabeth A. Georgian, "Medicine and Politics: The Primitive Physick and Early American Methodism," *Wesley and Methodist Studies* 8, no. 1 (2016): 35.

William Mason Cornell, published a "revised and enlarged" edition of Wesley's *Primitive Physick* in Boston.[117]

More popular even than *Primitive Physick* among British and American lay healers was the Scottish physician, William Buchan's, 1769 *Domestic Medicine*. Unlike Cheyne and Wesley before him, Buchan called on caregivers to make liberal use of prepared drugs such as calomel (or mercury) and opiates in treating the sick and injured. However, he shared their belief in the curative powers of milk and milk-based preparations. For those afflicted with lues (or venereal disease), Buchan prescribed a regimen of washing the genitals and other affected body parts with milk and water, sweet oil, or water and spirits, supplemented by a strict, restorative milk diet. For those suffering chronic diarrhea and dysentery, he prescribed a nutritious gruel made by mixing milk with flour. In keeping with the so-called heroic practices of cupping, purging, and bleeding common to physicians of the era, Buchan prescribed milk-and-water clysters (or enemas) to loosen the bowels of those suffering puerperal fever and large doses of milk, given orally, to promote vomiting. However, in keeping with more traditional folk practices, he advised healers to treat snakebites and swollen and inflamed tissues by topical application of milk-and-bread poultices.[118]

Once again, if publication data is any indication, Buchan's *Domestic Medicine* enjoyed a widespread readership on both sides of the Atlantic. Between 1769 and 1871, British and American printing presses produced one hundred and forty-two separate English-language editions. Writing in 1983, the medical historian Charles Rosenberg noted that copies of

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[117] John Wesley, *Primitive Physic: Or, an Easy and Natural Method of Curing Most Diseases*, ed. William M. Cornell (Boston: Cyrus Stone, 1858).

[118] William Buchan, *Domestic Medicine: Or, a Treatise on the Prevention and Cure of Diseases, by Regimen and Simple Medicines: With Observations on Sea-Bathing, and the Use of Mineral Waters: To Which Is Annexed, a Dispensatory for the Use of Private Practitioners* (Exeter, New Hampshire: J. & B. Williams, 1839), 267, 284, 345–49, 354, 379, 387, 400, 411, 427–28.

Buchan's *Domestic Medicine* were a "still ubiquitous" presence in American second-hand book stores. Indeed, citing the books' often ragged condition -- "covers loose, signatures shaky, hand-written recipes and newspaper clippings adorning end papers" -- Rosenberg reasoned, "In this case at least, the historian can be confident that he or she is dealing with a text that was widely and carefully read."[119]

British medical texts lost some favor with American readers following the American Revolution. Yet their advocacy of medicinal milk lived on in a series of American popular medical manuals that borrowed from -- plagiarized is a more accurate term -- their British forebears' work. According to the historian Norman Gevitz, American medical writers mimicked "the format of [English medical] books and their chapter headings, were imitative in their discussions of the non-naturals and the passions, and made outright copies or . . . paraphrases of their descriptions of diseases." None were more overt than the Philadelphia physicians Samuel Griffiths and Isaac Cathrall, who published Americanized versions of Buchan's *Domestic Medicine*. Save their "original discussions of their experience with the great yellow fever outbreak of 1793," Gavits noted, "these volumes were word for word renderings of Buchan's British editions."[120]

Of all the popular American medical manuals that circulated among lay healers in the fledgling United States, none proved more popular or more enduring than the Knoxville,

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[119] Charles E. Rosenberg, "Medical Text and Social Context: Explaining Buchan's Domestic Medicine," *Bulletin of the History of Medicine* 57, no. 1 (Spring 1983): 22–23; For evidence of a domestic reprinting of Buchan's work, see "New Publications," *The United States Literary Gazette*, December 1, 1825.

[120] Norman Gevits, "'But All Those Authors Are Foreigners': American Literary Nationalism and Domestic Medical Guides," in *The Popularization of Medicine, 1650-1850*, ed. Roy Porter (London: Routledge, 1992), 234, 242; For other relevant works, see James Ewell, *The Medical Companion, or Family Physician; Treating the Diseases of the United States, with Their Symptoms, Causes, Cure and Means of Prevention* (Washington D.C.: Printed for the Proprietors, 1827); Reynell Coates, *Popular Medicine; or Family Advisor* (Philadelphia: Carey, Lea & Blanchard, 1838).

Tennessee, physician John Gunn's 1830 work, *Gunn's Domestic Medicine*. Gunn himself remains an obscure figure, having left few written records behind -- aside, that is, from *Domestic Medicine* -- for the use of biographers and historians.[121] It is therefore impossible to say whether or not he drew direct inspiration from Cheyne's, Wesley's, or Buchan's work, one of the many copycat American medical manuals printed in the decades following the American Revolution, some combination of these sources, or none of them whatsoever. If nothing else, his advocacy of bleeding, cupping, prepared drugs, and other heroic remedies would seem to place him in the Buchan tradition. Yet one detects Wesley's spirit in Gunn's desire to provide isolated, unschooled lay healers with a plain-language guide to treating illness and injury without the benefit of trained physicians.[122]

Whatever the specific influences, Gunn peppered his text with references to the curative powers of milk. Like Buchan before him, he advocated the liberal use of milk-based clysters to purge the bowels of those afflicted with ailments ranging in severity from dyspepsia (indigestion) and kidney inflammation to consumption (or tuberculosis) and pleurisy (a painful, inflammatory condition marked by the adhesion of the one or both lungs to the surrounding tissues or pleura). Gunn likewise shared Buchan's faith in the power of milk-and-bread poultices, applied topically, to relieve the pain and swelling of toothaches, sore eyes (likely conjunctivitis or "pink eye"), ulcerations and buboes arising from syphilis and herpetic infections, testicular swelling that afflicted some adult male mumps patients, and even chordee, a painful deformation of the penis thought to be caused by excessive horseback riding. Though

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121 For more on John Gunn, see Carolyn Chambers Clark, ed., *Encyclopedia of Complementary Health Practice* (New York: Springer Publishing Company, 1999), 101–2; Ben Harris McClary, "Introducing a Classic: Gunn's Domestic Medicine," *Tennessee Historical Quarterly* 45, no. 3 (Fall 1986): 210–16.

122 John C. Gunn, *Gunn's Domestic Medicine, or, Poor Man's Friend, in the Hours of Affliction, Pain, and Sickness* (New York: C.M. Saxton, Barker & Co., 1860), xiv–xv, 212–13, 247, 268, 352.

less inclined than Cheyne or Wesley to prescribe oral doses of milk, Gunn did think the fluid effective when paired with indigenous American roots and herbs. For example, those afflicted with gout were said to derive medicinal benefit from quaffing a draught made from ginger root steeped in hot milk. Meanwhile, substituting Indian root proved an effective oral remedy for those with consumption.[123]

Though intended for rural lay healers in the Southern Appalachians and Old Southwest, *Gunn's Domestic Medicine* earned a nationwide following during the first half of the nineteenth century. Prior to the outbreak of the American Civil War in 1861, printing houses in Kentucky, Ohio, Pennsylvania, and New York sold editions of Gunn's *Domestic Medicine*. In 1857, Gunn himself authorized an expanded version of his work, which included a German-language edition for use by the nation's growing German immigrant population.[124] Perhaps no better evidence of the book's widespread popularity and persistence exists than its appearance in Mark Twain's American literary classic, *The Adventures of Huckleberry Finn*, published in 1884. Taken in by the feuding Grangerford family of Kentucky, the young Huck Finn marveled at his hosts' many and fantastic possessions. Among them was a table laden with important books: John Bunyan's *The Pilgrim's Progress*, a collection of speeches by the Kentucky orator and statesman Henry Clay, and a copy of "Dr. Gunn's *Family Medicine*, which told you all about what to do if a body was sick or dead."[125]

Popular though they were, medical manuals were only one means by which physicians and medical theorists disseminated ideas about medicinal milk to American lay healers. Rural

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[123] Gunn, *Domestic Medicine*, 183, 194, 232–33, 246–47, 280, 291, 314, 316, 500–501, 504.

[124] Gevits, "'But All Those Authors Are Foreigners,'" 245.

[125] McClary, "Introducing a Classic," 210; Ben Harris McClary, "Gunn's Domestic Medicine," Tennessee Encyclopedia, March 1, 2018, https://tennesseeencyclopedia.net/entries/gunns-domestic-medicine/; Mark Twain, *The Adventures of Huckleberry Finn* (New York: Harper & Brothers, 1912), 140.

and small-town newspapers also played a role. In some cases, editors reprinted excerpts of George Cheyne's work, in which he extolled the curative and preventative effects of the milk diet. Among them, editors of the January 13, 1824, *American Watchman and Delaware Advertiser* took a clear position, noting that Cheyne "gave some credence to his prescription . . . by making it the principle article of his consumption." In other cases, editors published prescriptions that could be traced to American physicians, such as the aforementioned W. Fields, whose milk- and yeast-based smallpox prescription reached lay healers across the nation. On November 18, 1859, editors of the *Orleans Independent Standard* noted that an unnamed "physician in Louisville has discovered how, by living principally on butter-milk, a human being may prolong his existence to the period of two hundred years." Though they stopped short of dismissing the physician's claim, which bore some resemblance to the milk diet, editors quipped, "Whether it were worth while [sic] to live two centuries on such a diet, our contemporary saith not."[126]

Of all the popular publications that codified and disseminated milk-based remedies, perhaps none was more influential than *Godey's Lady's Book*. One of the most-read periodicals of the era, copies of *Godey's* reached an estimated 150,000 American subscribers by 1860, in locales as far flung as Columbia, California, Bellevue, Nebraska Territory, Port Tobacco, Maryland, and Winchester, Tennessee.[127] On March 11, 1858, editors of the Okolona, Mississippi, *Prairie News*, praised the magazine as a "superb Monthly," comparable to

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[126] "Doctors Differ," *American Watchman and Delaware Advertiser*, January 13, 1824; "Two Centuries of Sour Milk," *Orleans Independent Standard*, November 18, 1859.

[127] Jan Pilditch, "'Fashionable Female Studies': The Popular Dissemination Of Science in Godey's Lady's Book, 1830-60," *Australasian Journal of American Studies* 24, no. 1 (July 2005): 22; "New Publications," *The Weekly Columbian*, May 9, 1857; *Bellevue Gazette*, December 11, 1856; "Godey's Lady's Book," *Port Tobacco Times, and Charles County Advertiser*, November 18, 1858; "Godey's Lady's Book," *Winchester Weekly Appeal*, December 5, 1856.

Petersen's and *Harper's Weekly*, with much to offer women readers in terms of fashion advice, "good stories," and instruction in matters of homemaking. "For the benefit of your wives and daughters," editors insisted, "take *Godey*."[128]

As early as 1850, *Godey's* editor Sarah Joseph Hale used a regular "Sick-Room and Nursery" column to offer readers instruction for preparing milk-based remedies for use in treating the sick and injured. Indeed, in July of that year, Hale advised readers to make three sick-room staples, barley water, cocoa, and arrowroot, more "nourishing" by replacing the water base with "an equal quantity of new milk." She offered similar advice to those who used white wine as a stimulant, noting that a bit of whey, the thin, protein-rich by-product of curdling and skimming whole milk, improved the already-useful drink by increasing its nutritive properties.[129] In keeping with popular medical manuals, Hale also cited milk-based remedies as relieving specific diseases. The August 1855 *Godey's* prescribed mustard whey, a drink made by boiling mustard seeds in new milk, straining off the curd, and then blending the remaining whey with hot water and loaf sugar, as a treatment for rheumatism and dropsy.[130] Later that December she recommended treating "troublesome" coughs by serving "a quarter pound of suet [boiled] in a pint of new milk."[131]

Other periodicals and agricultural journals joined *Godey's Lady's Book* in advising lay healers to keep the milk pitcher close at hand. The June 22, 1838, *Christian Watchman* included an excerpt from William A. Alcott's *Vegetable Diet: Sanctioned by Medical Men*, in which Alcott cited George Cheyne's milk diet as an effective remedy for obesity and related health

[128] "Our Table," *The Prairie News*, March 11, 1858.
[129] "Sick-Room and Nursery," *Goody's Lady's Book and Magazine*, July 1855; "Sick-Room and Nursery," *Goody's Lady's Book and Magazine*, August 1855.
[130] "Sick-Room and Nursery," *Goody's Lady's Book and Magazine*, August 1855.
[131] "Sick-Room and Nursery," *Goody's Lady's Book and Magazine*, December 1855.

problems. In concluding the excerpt, editors wrote: "We . . . have been entertained, and we think benefited in perusing the volume, and recommend it to all, who wish to gain information on the all-important subject of health."[132] The July 1856 *Peterson's Magazine* offered a recipe similar to *Godey's* for making arrowroot more nutritious by substituting hot, new milk for water during preparation. The same article offered a prescription for respiratory problems, noting, "Milk preparations are good when the lungs are weak."[133] The February 1860 *Valley Farmer* cited a medicinal draught made by mixing one pint of sweet milk with ground ginger, and then warming the concoction over the fire -- a recipe reminiscent, if not necessarily imitative of Gunn's ginger-and-milk consumption remedy -- as "the most accessible, the cheapest, the most efficacious and the most speedy remedy in the world" for the intermittent chills and fever associated with ague (or malaria).[134]

Indeed, American lay healers first discovered Florence Nightingale's influential *Notes on Nursing*, in the pages of popular periodicals. The book, which first appeared for sale in the United States in 1860, offered a wealth of practical knowledge amassed during Nightingale's tenure as a "resident lady superintendent" of a women's hospital located on London's Harley Street, and later as a volunteer nurse working to save the lives of sick and wounded British soldiers at Scutari Barracks (present-day Istanbul, Turkey) during the Crimean War. As a devotee of miasma theory, Nightingale believed that noxious odors arising from sewage, swamps, and human waste caused disease and infection. Consequently, she devoted much of *Notes on Nursing* to explaining how and why nurses should work to ensure proper ventilation in hospitals and sick rooms. Yet she also paid attention to the role that food -- in particular, milk --

[132] "Review 1 - No Title," *Christian Watchman*, 22 June 1838.
[133] "Sick-Room, Nursery, &c," *Peterson's Magazine*, July 1856.
[134] "Remedy for Chills, and Fever and Ague," *Valley Farmer*, February 1860.

played in restoring the sick and injured to good health. Nightingale thought milk superior in every way to beef tea, arrowroot, bread, and other common sickroom staples. The only drinks that she placed alongside milk -- tea and coffee -- were made *better* by milk, which added the only nutrition present in both beverages.[135]

American periodicals published excerpts from *Notes on Nursing* beginning in early 1860, even before the book went on sale in the United States. In doing so, they made clear that the book was practical and unimpeachable. In March of that year, *The Albion* lauded *Notes on Nursing* and expressed hope that "every woman . . . may read it, think about it, and live by it." That same month, the *Saturday Evening Post* serialized much of the work, including those sections that spoke to the medicinal properties and powers of milk. By May, excerpts had appeared in the Quaker publication, *The Friend*, and *Littell's Living Age*, both of which enjoyed broad readership. At least one agricultural journal followed a similar course. The December 13, 1860, *Maine Farmer* published "Diet for the Sick," in which Nightingale touted milk over beef tea, noting that the latter possessed but a teaspoonful of sold nutrition, and was "little to be depended on with the . . . convalescent where much nutrition is required." Doubtless the most significant endorsement, in terms of ensuring the book's popularity among American lay healers, came from that arbiter of nineteenth-century social and cultural norms, *Godey's Lady's Book*. From its pages, the editor Sarah Joseph Hale wrote in September 1861: "We hope to incite every lady who comes to our 'Table' for counsel, to study the work and practice its precepts."[136]

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135 For more on Florence Nightingale's work at Hadley Street in London, see Chad Hansen, "The Lady with the Lamp," Cholera and the Thames, n.d., http://www.choleraandthethames.co.uk/cholera-in-london/cholera-in-soho/florence-nightingale/; For more on Florence Nightingale's work at Scutari Barracks during the Crimean War, see Christopher J. Gill and Gillian C. Gill, "Nightingale in Scutari: Her Legacy Reexamined," *Clinical Infectious Diseases* 40, no. 12 (June 15, 2005): 1799–1805; Nightingale, *Notes on Nursing*, 1859, 40–43.

136 Humphreys, *Marrow of Tragedy*, 46; "New Books," *The Albion, a Journal of News, Politics and Literature*, March 3, 1860; Florence Nightingale, "Notes on Nursing: And the Best Means of Preserving Health," *Saturday Evening Post*, March 31, 1860; "Florence Nightingale and Her 'Notes on Nursing,'" *Chicago Medical Examiner*,

A final means by which medicinal milk advocacy diffused across the nineteenth-century United States were almanacs, which in rural communities, served alongside newspapers and word of mouth as a source of weather data, national news, humorous stories, and sick-room recipes.[137] Whether purposeful or coincidental, the medical advice published in almanacs conformed to the standards set by popular British and American medical manuals and/or endorsed by trained American physicians. The 1840 *American Medical Almanac* and 1848 *Poor Richard's Almanac* prescribed warm milk and aloe and warm milk and honey respectively for those afflicted with intestinal worms. Both were reminiscent of John Wesley's prescription of a few drops of warm milk for ridding the ears of parasitic worms. The 1851-1861 *Deseret Almanac* called for sickroom attendants to treat smallpox with hop yeast and water, supplemented by a diet of boiled milk and rice -- a remedy more-or-less identical to that proposed by the Delaware physician W. Fields and reprinted across the United States in newspapers. Meanwhile, the 1857 *Family Almanac and Guide to Health* echoed both George Cheyne's and John Gunn's call for feeding consumptives a diet of milk, while the 1858 *Cumberland Almanac* echoed Buchan's call for using large doses of milk as an emetic (that is, to induce vomiting).[138]

The great preponderance of written and anecdotal evidence notwithstanding, it is difficult to know how (or how often) rural Americans put any of this advice to use during the first half of

May 1860; Florence Nightingale, "Florence Nightingale on Noise in the Sick Chamber," *The Friend; a Religious and Literary Journal*, May 5, 1860; "From the Quarterly Review," *Littell's Living Age*, June 23, 1860; Florence Nightingale, "Diet for the Sick," *Maine Farmer*, December 13, 1860; "Editor's Table. Florence Nightingale's Book," *Goody's Lady's Book and Magazine*, September 1861.

137 Thomas A. Horrocks, *Popular Print and Popular Medicine: Almanacs and Health Advice in Early America* (Amherst: University of Massachusetts Press, 2008), 1.

138 *The American Medical Almanac* (Boston: Marsh, Capen, Lyon, & Webb, 1840), 141; *Poor Richard's Almanac* (Nashville: W.F. Bang & Co., 1847), n.p.; *Deseret Almanac for the Year 1865* (Great Salt Lake City, Utah: Deseret News, 1865), n.p.; *Family Almanac and Guide to Health* (New York: S.S. Fitch & Co., 1857), 4; *Cumberland Almanac, for the Year of Our Lord 1858* (Nashville: Bang, Walker & Co., 1857), n.p.

the nineteenth century. Certainly, a host of economic, cultural, and ecological variables would have encouraged or discouraged the use of medicinal milk across time and space. These were, in no particular order: the presence or absence of trained physicians schooled in the work of Cheyne, Wesley, Buchan, and Gunn; the availability and affordability of prepared drugs; the reading habits and/or folk prejudices peculiar to rural lay healers; the relative presence or absence of dairy cattle "in milk"; and the skill of individual farm families in making new, sweet milk and keeping it fresh long enough to be useful. Yet the fact remains that milk was a common, beloved, and versatile food, imbued by Americans of the era with symbolic meaning and even magical powers. It is reasonable to conclude that those who had milk -- which is to say, most everyone in the nation's rural, agrarian majority -- would have used it to nourish and heal the sick and injured.[139]

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It is one thing to recognize that nineteenth-century Americans used milk and milk-based foods as medicine; quite another to prove that it did them any practical good. Let us return for a moment to the Delaware physician W. Fields's milk-and-yeast-based prescription for smallpox, which diffused across the rural United States in 1857. In doing so, let us ask: Is it possible that the remedy helped those afflicted with the disease? Given the faith that Americans of the era placed in milk-based remedies, it would be easy enough to attribute milk's perceived medicinal powers to simple confirmation bias. That is to say, physicians and lay healers who used milk and milk-based remedies in the sick room did so with the expectation that those remedies would work. Assuming that the patient survived, and having no better explanation on hand, those same physicians and lay healers concluded that milk played some positive role in their recovery,

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[139] Hal S. Barron, *Those Who Stayed Behind: Rural Society in Nineteenth-Century New England* (Cambridge: Cambridge University Press, 1984), xi.

whether or not it did anything at all. This would go a long way toward explaining Fields's sincere belief that a milk diet, supplemented with "good brewer's yeast," saved "forty-five out of fifty" patients afflicted with smallpox, while also preventing their suffering disfiguring scars. More likely explanations -- that the patients were infected with a less-virulent strain of the variola virus, or that he misdiagnosed his patients -- would have been unknowable to Fields, or anyone else, at the time.[140]

In fact, it would be impossible to answer this question using only contemporary anecdotal and written sources. For even if rural physicians and lay healers of the era had kept systematic records of medicinal milk use and its perceived and/or practical effects, their ignorance of germ theory and nutritional science, and with it, their ability to explain how and why the human body used fats, proteins, and carbohydrates to fend off microbial invaders and repair damaged tissues with any real accuracy, would have prevented their drawing conclusions useful to modern researchers.[141] Recall that these same physicians and lay healers often interpreted the excessive salivation and diarrhea caused by calomel (mercury) poisoning, as well as the vomiting caused by tartarized antimony and the skin welts caused by blistering agents, as signs of healing. With all due respect to their sincere good intentions, one would be no less ill advised to trust nineteenth-century Americans' understanding of internal medicine than it would be to trust their

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[140] There are two major strains of smallpox, variola major and variola minor. The former is more virulent, with a thirty percent fatality rate. The mortality rate for the latter is less than one percent. See Brenda L. Tesini, "Smallpox," Merck Manual Professional Version, April 2019, https://www.merckmanuals.com/professional/infectious-diseases/pox-viruses/smallpox; For an account of contemporary physicians mistaking measles for smallpox, see "The Steamers," *Cheraw Gazette*, July 26, 1836.

[141] For more on mid-nineteenth-century debates surrounding the germ theory of disease, see Robert P. Gaynes, *Germ Theory: Medical Pioneers in Infectious Diseases* (Washington, DC: ASM Press, 2011), 143-172 and Kari Nixon, *Kept from All Contagion: Germ Theory, Disease, and the Dilemma of Human Contact in Late-Nineteenth Century Literature* (Albany: State University of New York Press, 2020).

belief that phrenology, a then-popular pseudoscience, could predict the relative intelligence of humans based on craniofacial features.[142]

Modern medical science suggests that milk did help the sick and injured, although not because it possessed any of the magical healing powers attributed to it by nineteenth-century physicians and lay healers. Rather, it performed three critical nutritional functions. First, the milk sugar and butterfat present in milk gave lay healers an effective means to treat hypermetabolism, the autonomic, adaptive, and left unchecked, deadly process by which the human body converts proteins, fats, and carbohydrates into high-energy glucose at an accelerated rate in response to traumatic injury or illness.[143] Second, the milk sugar, fat, and nutrients present in milk -- in particular, Vitamin A -- fed the immune system, increasing the likelihood that sick bodies could mount an effective defense against disease-causing microorganisms.[144] Absent modern antibiotics, cow's milk represented one of the best defenses against disease available to nineteenth-century Americans short of exposure avoidance.

Milk's usefulness in treating traumatic injury was of vital importance to rural Americans during the first half of the nineteenth century, for hazards abounded in the rural backcountry. Young children tumbled into open wells and burned or scalded themselves by touching or

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142 For more on the pseudoscience of phrenology, see James Poskett, *Materials of the Mind: Phrenology, Race, and the Global History of Science* (Chicago: University of Chicago Press, 2019).

143 H. B. Stoner, "Interpretation of the Metabolic Effects of Trauma and Sepsis," *Journal of Clinical Pathology* 40, no. 9 (September 1987): 1108–17; E. M. Breznock, "The Systemic Response of the Traumatized Patient," *The Veterinary Clinics of North America. Small Animal Practice* 10, no. 3 (August 1980): 523–32; Turgay Şimşek, Hayal Uzelli Şimşek, and Nuh Zafer Cantürk, "Response to Trauma and Metabolic Changes: Posttraumatic Metabolism," *Turkish Journal of Surgery* 30, no. 3 (September 1, 2014): 153–59.

144 Isabelle Wolowczuk et al., "Feeding Our Immune System: Impact on Metabolism," *Clinical and Development Immunology*, February 25, 2008, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2266987/; U.S. Department of Health and Human Services National Institutes of Health, *Understanding the Immune System*; Richard D. Semba, "Vitamin A as 'Anti-Infective' Therapy, 1920-1940," *The Journal of Nutrition* 129, no. 4 (April 1999): 783–91; "The Story of Vitamin A," Johns Hopkins Bloomberg School of Public Health: News, 2003, https://www.jhsph.edu/news/stories/2003/sommer-vita.html; Zhiyi Huang et al., "Role of Vitamin A in the Immune System," *Journal of Clinical Medicine* 7, no. 9 (September 2018): 258.

reaching into pots and pans placed over the cooking fire.[145] Older children and adults fell from moving wagons or were thrown from the backs of startled horses, cut themselves with axes and saws, and slipped beneath the wheels of carts loaded down with firewood, hay, and other heavy loads.[146] Everyone who came into contact with horses, mules, and cattle risked being kicked, trampled, or gored.[147] Indeed, everyone who spent time outdoors risked stepping on poisonous snakes or stumbling across rabid skunks, racoons, or dogs.[148] Inattentive hunters sustained life-threatening gunshot and knife wounds. So too belligerent property owners, gamblers, and imbibers of strong drink.[149]

From almost the moment a person sustained a life-threatening injury, their body initiated a biphasic metabolic and endocrinological response, known as the systemic inflammatory response to traumatic injury (or hypermetabolism), in an attempt to maintain life-sustaining homeostatic processes and repair damaged tissues. The first or "ebb" phase, which began moments after injury, preserved energy by slowing both the heart rate and respiration, constricting blood vessels, and suppressing the metabolism of glucose. The second or "flow" phase, which started between 24 to 72 hours after the ebb phase, saw the body make an "all or nothing" bid to preserve life by initiating the rapid metabolism of glucose stores, supplemented

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145 "Falling Into a Well," *Parley's Magazine*, January 1, 1837; "For Scalds and Burns," *The New England Farmer, and Horticultural Register*, February 9, 1827.

146 "Accident," *Boston Medical and Surgical Journal*, June 29, 1830; "Article VI. Case of Serious Injury of the Knee Joint, Terminating in the Almost Perfect Recovery of the Use of the Limb," *The American Journal of the Medical Sciences*, February 1840; "IV. Hospital Report. Fracture of the Knee-Joint," *The Boston Medical and Surgical Journal*, December 23, 1828.

147 "Excision of Part of the Brain," *The Boston Medical and Surgical Journal*, June 29, 1830; "Fatal Accident," *The Child's Newspaper*, July 8, 1834; Harriet Cline West, *The Life and Travels of Harriet C. West* (Kahoka, Missouri: Talbott Printing Co., 1910), 13.

148 "Snake Bites," *Prairie Farmer*, December 1848; George Russell, "Case of Hydrophobia from the Bite of a Raccoon," *The New-England Journal of Medicine and Surgery, and Collateral Branches of Science*, October 1823; "Weekly Summary," *The Gazetter*, June 21, 1824; "Hydrophobia and Dog-Laws," *Maine Farmer*, February 8, 1849.

149 "The Causes of Death," *Christian Observer*, November 12, 1841; "The Bloody and Oppressive South," *Liberator*, August 9, 1844.

by the catabolism (that is, the breaking down) of bone and muscle proteins and fats into compounds that could be converted into more glucose. Properly managed with aggressive nutrition and stress mitigation, this hypermetabolic phase lasts between two and three weeks and assists the body in healing. Left unchecked, it may lead to diminished muscle and bone mass, necrobiosis (irreversible shock resulting from insufficient oxygenation of cells), organ failure, and death. [150]

New, sweet milk offered physicians and lay healers with an effective means of treating hypermetabolic patients. One pint (or 488 ml) of whole-fat cow's milk contained about 314 calories, about the same as 3 to 4 chicken eggs.[151] A substantial portion of those calories came from lactose, or milk sugar. Assuming that the injured person's small intestine was intact and functioning, and that she had the gene mutation responsible for lactase persistence, her digestive system would have converted lactose into the simple sugar glucose, replacing some of that lost to hypermetabolism and providing her body with a sudden burst of energy.[152] No less important were the calories derived from fat, about 22 grams. Once more, assuming proper digestive function, the injured person's body would have converted this fat into fatty acids and glycerol, which not only served alongside glucose to restore energy lost to hypermetabolism, but also assisted the body in absorbing fat-soluble vitamins A, D, K, and E present in milk and other foods common to the sickroom.[153]

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[150] Stoner, "Interpretation of the Metabolic Effects of Trauma and Sepsis," 1108–17; Breznock, "The Systemic Response of the Traumatized Patient," 523–32; Şimşek, et. al, "Response to Trauma and Metabolic Changes: Posttraumatic Metabolism," 153–59.

[151] Clyde L. King, *The Price of Milk* (Philadelphia: The John C. Winston Company, 1920), 311.

[152] Mayo Clinic Staff, "Lactose Intolerance," Patient Care & Health Information, Diseases & Conditions, n.d., https://www.mayoclinic.org/diseases-conditions/lactose-intolerance/symptoms-causes/syc-20374232.

[153] "Glycerol," National Library of Medicine, National Center for Biotechnology Information, n.d., https://pubchem.ncbi.nlm.nih.gov/compound/Glycerol#section=Information-Sources; Matthew Brennan, "The Civil War Diet" (Master's Thesis, Blacksburg, Virginia, Virginia Polytechnic Institution, 2005), 112.

Pairing milk with other ingredients, per the advice of medical manuals and popular periodicals, would only have increased its usefulness in treating hypermetabolism. Consider the recommendation published in *Godey's* and *Petersen's*, that caregivers blend arrowroot starch with milk before serving the former to sick and injured patients. Assuming a ratio of one-half cup of arrowroot starch to one pint milk, the concoction would have offered convalescents approximately 400 calories, including 13.4 grams of carbohydrates.[154] The body would have converted these carbohydrates to energy-giving, life-sustaining glucose, albeit at a much slower rate than lactose. Those preparations that called for adding sucrose (or refined white sugar) to milk would have served a similar nutritional function to lactose. That is, the injured person's body would have converted sucrose to glucose in rapid fashion, restoring energy stores lost to hypermetabolism.[155]

Milk would have performed a similar service for those who endured medical procedures designed to stabilize wounds and promote healing. Whether or not a trained physician could be found in the backcountry, the injured person was apt to endure one or more painful and invasive procedures during recovery: the stitching of wounds; the amputation of a hand, foot, arm, or leg; the use of metal probes and forceps to locate and remove bullets, clothing fragments, and other foreign bodies from wounds; the excision of necrosed bone fragments; the insertion of catheters into damaged urethras and bladders; the removal of blood- and soil-encrusted dressings; the setting and splinting of simple and compound fractures.[156] Patients' bodies would have been

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[154] "Arrowroot, Raw," U.S. Department of Agriculture, Agricultural Research Service, April 1, 2019, fdc.nal.usda.gov/fdc-app.html#/food-details/168490/nutrients.

[155] "Carbohydrates and Blood Sugar," Harvard T.H. Chan School of Public Health: The Nutrition Source, n.d., https://www.hsph.harvard.edu/nutritionsource/carbohydrates/carbohydrates-and-blood-sugar/.

[156] J.D. McBrayer, "Wound of the Intestine, Treated by Suture -- Recovery," *The Boston Medical and Surgical Journal*, May 22, 1844; John Frederick May, "ART. II.--Cases of Amputation," *The American Journal of the Medical Sciences*, October 1851; "American Intelligence," *The American Journal of the Medical Sciences*, May 1830; T.B. Curling, "Clinical Lectures. Practical Clinical Remarks on Acute Periostitis," *Medical News*, November

unable to distinguish between the original traumatic injuries and this helpful (or at least, well-intentioned) intervention of surgeons and lay healers. Indeed, their sympathetic nervous systems would have responded to probing, cutting, stitching, and splinting by releasing yet another round of immune-suppressing, metabolism-accelerating epinephrine and cortisol into their bloodstreams.[157] The lactose, fat, and nutrients present in milk would have been just as helpful to post-operative patients.

The next greatest danger to those who suffered incisions, penetrating/puncture wounds, compound fractures, or severe burns came hours or even days after their initial injury, in the form of secondary infections. Though unknown to nineteenth-century physicians and lay healers, the bacteria that caused secondary infections were everywhere to be found in the rural backcountry. The most common of these pathogens, *Staphylococcus aureus*, often found in the human nose or on the skin, poses no immediate danger to healthy individuals. On gaining access to the bloodstream, lungs, or bone via open wounds or direct punctures, however, this otherwise harmless microorganism may cause a number of lethal complications: sepsis (blood poisoning); osteomyelitis (infection and necrosis of bone tissue); pneumonia; and endocarditis (inflammation of the heart valves, leading to heart failure or stroke). Also present in rural areas were the several strains of *Clostridium* bacteria, which traveled from soils and human and animal dung to open wounds via soiled clothing, bandages, and bedding, as well as direct fecal contact. Once

1859; Thomas Betton, "Laceration of the Urethra from a Fall on the Perineum, with Consequent Retention of Urine, for Which the Operation of Puncturing the Bladder Was Performed," *The American Journal of the Medical Sciences*, February 1837; Edward R. Squibb, "Art. II.--On the Advantages of Simple Dressings in Surgery," *The American Journal of the Medical Sciences*, January 1849; "Dr. Coale's Prize Dissertation on Fractures," *The Boston Medical and Surgical Journal*, September 10, 1845.

[157] Celeste C. Finnerty et al., "The Surgically-Induced Stress Response," *Journal of Parenteral and Enteral Nutrition* 37, no. 50 (September 2013): 21S-29S.

there, it caused gangrene, which manifested as tissue necrosis, high fever, vomiting, jaundice, sepsis, and in many cases, the death of the patient.[158]

To understand how milk may have helped those afflicted with secondary infections, it is first necessary to understand how the human body mobilizes resources to fend off invasive microorganisms. From almost the moment the immune system detects dangerous microorganisms (or antigens), it mobilizes an immune response to locate, attack, and destroy the invaders. It begins when the lymphoid organs -- the adenoids and tonsils, thymus, spleen, lymph nodes, Peyer's Patches (lymphatic tissue located in the small intestine), and appendix -- release millions of white blood cells into the bloodstream and lymphatic system. Some of these cells, known as B lymphocytes, specialize in the location and destruction of bacteria via the release of antibodies that direct phagocytes -- another specialized white blood cell -- to attack and devour the invaders. Others, known as T lymphocytes, bind themselves to cells that harbor viruses and deliver a lethal chemical attack. Aiding B and T lymphocytes and phagocytes in the offensive are a series of twenty-five inactive complement proteins that circulate through the bloodstream. On colliding with antibodies, these proteins start a chain reaction that punctures and kills infected cells. This process continues until all the invaders are destroyed (or the body succumbs to complications).[159]

All of this takes a great deal of energy. A sick person's B and T lymphocytes derive their energy from four sources: fatty acids or lipids stored in the adipose tissue (fat); glutamine, an amino acid that drives protein synthesis; ketone bodies, a group of three water-soluble molecules

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158 "Staphylococcus Aureus in Healthcare Settings," Centers for Disease Control and Prevention: CDC 24/7: Saving Lives, Protecting People, January 17, 2011, https://www.cdc.gov/hai/organisms/staph.html; Mayo Clinic Staff, "Gangrene," Mayo Clinic, Patient Care & Health Information, Disease and Conditions, n.d., https://www.mayoclinic.org/diseases-conditions/gangrene/symptoms-causes/syc-20352567.

159 U.S. Department of Health and Human Services National Institutes of Health, *Understanding the Immune System: How It Works*, 2003.

produced in the liver; and glucose, which is also produced and stored in the liver. Of these, glucose is the most important. This simple sugar provides T and B lymphocytes with most of the energy that they need, on encountering antigens, to expand in size, commence reproducing via a process known as proliferation, and attack and/or kill the invaders.[160] Given as medicine, milk delivers a substantial dose of glucose to the immune systems of those fighting secondary infections. Recall that one pint (or 480 ml) of whole-fat cow's milk contained about 314 calories, much of it derived from lactose (milk sugar). Assuming that a patient's small intestine is intact and functioning, and that they possess the gene mutation responsible for lactase persistence, their bodies convert lactose into glucose for immediate use by T and B lymphocytes. The butterfat content of milk also have helps, although it would have taken longer for the body to synthesize.[161]

The immune system also needs an abundance of vitamin A, a micronutrient common to milk, liver, eggs, kidneys, and green, leafy vegetables.[162] Indeed, vitamin A performs a variety of useful immunological functions: promoting the secretion of oral and intestinal mucus that bars the entry of antigens; regulating the growth and development of T and B lymphocytes, phagocytes, and other specialized white blood cells; inducing T lymphocytes to migrate from the bone marrow to the lymphoid organs; maintaining bone marrow homeostasis; and contributing to the synthesis of immunoglobulins -- that is, the antibodies that order T lymphocytes and phagocytes to attack and destroy antigens -- by B lymphocytes.[163] One pint of whole cow's milk

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[160] Wolowczuk et al., "Feeding Our Immune System"; U.S. Department of Health and Human Services National Institutes of Health, *Understanding the Immune System*.

[161] Adrienne Youdim, "Carbohydrates, Proteins, and Fats," Merck Manual Consumer Version, August 2019, https://www.merckmanuals.com/home/disorders-of-nutrition/overview-of-nutrition/carbohydrates,-proteins,-and-fats

[162] Brennan, "Civil War Diet," 108.

[163] Zhiyi Huang et al., "Role of Vitamin A in the Immune System," *Journal of Clinical Medicine* 7, no. 9 (September 2018): 258.

contains about 187 uµ (micrograms) of vitamin A, about half of that needed by a child aged 4 to 8 years, or between one-fourth to one-fifth of that needed by adults aged 18-plus, as recommended by modern nutritionists.[164] Recognizing that the rural American diet ran heavy on pork, breads, and maize, none of which offered vitamin A, cow's milk and milk-based foods would have been the best, and in lieu of fresh garden vegetables, only source of this vital nutrient available for the sick.[165]

None of this is to suggest that milk worked miracles for those who suffered from secondary infections related to traumatic injury. Recall that those who suffered serious injuries entered into a hypermetabolic state of two- to three-week's duration, during which time their bodies burned glucose, fatty acids, carbohydrates, and proteins, at an accelerated rate. The activation of glucose-hungry lymphocytes in an all-out immune system response to a *Staphylococcus* or *Clostridium* infection increased the nutritional burden placed on their already depleted bodies by several degrees of magnitude. It is difficult to know how an injured person's body would have apportioned the glucose derived from milk and milk-based foods under these circumstances. Two scenarios seem likely: It divided glucose among all systems in an attempt to repair damaged tissues, locate and eradicate invasive microorganisms, and restore/maintain homeostasis; it shunted glucose to the system or systems most in danger of failure, denying it to others that were no less in need. Either (or neither) being true, it is clear enough that hypermetabolism associated with traumatic injury, when coupled with the immune response to

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164 "Milk, Whole, 3.25% Milkfat, with Added Vitamin D," United States Department of Agriculture, Agricultural Research Service, April 1, 2019, fdc.nal.usda.gov/fdc-app.html#/food-details/171265/nutrients; "What's in Raw Milk," Raw-Milk Facts.com, June 21, 2012, http://www.raw-milk-facts.com/what_is_in_raw_milk.html; Brennan, "Civil War Diet," 39.

165 Harvey Levenstein, *Revolution at the Table: The Transformation of the American Diet* (Berkeley: University of California Press, 2003), 1–9, 26–29.

serious secondary infection, created an enormous energy drain that would have been difficult for medicinal milk to replace.

But then, milk was better than nothing, which in practical terms is what much of the nineteenth-century medicinal toolkit amounted to. Lacking antibiotics and antivirals, or any clear idea of what caused secondary infections, physicians of the era used prepared drugs such as toxic calomel (mercury), quinine, and opiates, along with the so-called heroic remedies of bleeding, cupping, blistering, and purging to treat infections. Such remedies were, to borrow a turn of phrase from the Civil War medical historian Margaret Humphreys, "ineffective or even harmful." Calomel and blistering agents caused visible side effects -- the former, salivation and loosening of the bowels, the latter red, irritated skin -- that physicians *interpreted* as helpful, though in fact, neither had any specific curative or palliative properties. The same may be said for bleeding and cupping, as well as purgatives such as tartarized antimony that caused vomiting. In addition to its anti-malarial properties, quinine may have offered some defense against *Staphylococcus* infections, although modern research is far from conclusive on the matter. Certainly, opiates dulled pain, yet in doing so, would have done nothing to boost the immune system or attack and destroy pathogens.[166] In any event, their use would have been contingent on finding a physician. This left nutritional and emotional support. Milk -- Americans' favorite comfort food -- offered both.

[166] Humphreys, *Marrow of Tragedy*, 1-2, 7, 27–29; Patrick Adams, "Meet the Woman Who Gave the World Antiviral Drugs," *National Geographic*, 31 August 2020, https://www.nationalgeographic.com/science/article/gertrude-elion-antivirals-coronavirus-remdesivir; For an overview of American pharmaceuticals on the eve of the Civil War, see Michael A. Flannery, *Civil War Pharmacy: A History*, Second (Carbondale, Illinois: Southern Illinois University Press, 2017), 25–40; R. Wolf et al., "Quinine Sulfate Inhibits Invasion of Some Bacterial Skin Pathogens," *International Journal of Dermatology* 45, no. 6 (June 2006): 661–63.

An even greater threat to the health of rural Americans during the first half of the nineteenth century were the many and baffling diseases that emerged as if from nowhere to strike down children and adults. It is well known to historians and medical researchers that disease took an especially heavy toll on the young. Writing for *Pediatric Research* in 2004, the physician Stanford Shulman noted, "From 1800 to about 1870, the major causes of death in children were tuberculosis, diarrhea of infancy, bacillary dysentery, typhoid fever, and the highly contagious diseases . . . scarlet fever, diphtheria, and lobar pneumonia."[167] Yet infectious disease made few distinctions based on age. Young and old alike, those who lacked natural or acquired immunity were at risk of contracting dangerous, even lethal pathogens. Between March and June, 1829, measles swept through Circleville, Ohio, and its environs, claiming the lives of children and adults. In the spring of 1835, smallpox reached the people of rural Marlborough County, South Carolina, killing an unspecified number. Cholera appeared in rural Madisonville, Tennessee, in August 1854, killing at least seven of its thirty known victims -- among them adults and children -- before subsiding. Malaria and yellow fever emerged seasonally to scourge those who lived in swampy, lowland areas.[168]

Milk, as well as the milk-based foods and tonics recommended by home medical manuals, popular periodicals, and almanacs, would have helped those who contracted infectious diseases for the same reasons that it helped those afflicted with secondary infections. That is to

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[167] Sylvia D. Hoffert, "'A Very Peculiar Sorrow': Attitudes Toward Infant Death in the Urban Northeast, 1800-1860," *American Quarterly* 39, no. 4 (Winter 1987): 601–16; Sutherland, *Expansion*, 126–27; Rebecca J. Fraser, *Gender, Race and Family in Nineteenth Century America: From Northern Woman to Plantation Mistress* (New York: Palgrave Macmillan, 2013), 88; Stanford T. Shulman, "The History of Pediatric Infectious Diseases," *Pediatric Research* 55 (2004): 163–76.

[168] John Cook Bennett, "Brief Notices of the Measles Which Prevailed at Circleville, O. in the Spring of 1829," *Western Journal of the Medical and Physical Sciences*, December 1829; "Steamers"; "Cholera at Madisonville," *The Athens Post*, September 22, 1854; Andrew McIlwane Bell, *Mosquito Soldiers: Malaria, Yellow Fever, and the Course of the Civil War* (Baton Rouge, Louisiana: Louisiana State University Press, 2010), 1–20.

say, the lactose (and in some cases, added sucrose), fat, and protein content of these remedies would have nourished the sick person's immune system, increasing the likelihood that T and B lymphocytes would succeed in detecting, attacking, and destroying invasive pathogens. Likely, the vitamin A content of milk had more specific curative effects. Vitamin A has been shown by modern studies to reduce morbidity and mortality among children afflicted with measles, malaria, and mumps, as well as three of the childhood diseases identified by Shulman: pneumonia, tuberculosis, and diarrhea.[169] Of course, any such claims must be weighed alongside the known negative consequences -- abdominal pain, diarrhea, and dehydration -- of feeding dairy to the lactose intolerant.

If it did nothing else, milk and milk-based foods gave comfort to caregivers and patients during periods of great physical and emotional distress. While it is true that nineteenth-century Americans were more familiar with sickness and death than their modern counterparts and hence, less inclined to be surprised by the sudden, untimely death of family and friends, it would be wrong to assume that they lacked empathy for those in need of medical attention.[170] The sight, sound, and smell of the sick and/or grievously injured caused them to experience physical anguish in the form of revulsion and nausea, as well as emotional anguish, in the form of sleeplessness, panic, and despair.[171] Milk, by virtue of its symbolic and perceived power, would have boosted caregivers' spirits, even as it provided them with a means to take decisive, effective

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169 Semba, "Vitamin A," 783–91; "The Story of Vitamin A"; Huang et al., "Role of Vitamin A"; Rene F. Najera, "Vitamin A and Measles," The History of Vaccines: An Educational Resource by the College of Physicians of Philadelphia, March 12, 2019, https://www.historyofvaccines.org/content/blog/vitamin-a-measles; K.Z. Long et al., "Supplementation With Vitamin A Reduces Watery Diarrhoea and Respiratory Infections in Mexican Children," *The British Journal of Nutrition* 97, no. 2 (February 2007): 337–43.

170 For more on death and dying in the antebellum United States, see "The Great Exaggeration: Death and the Civil War," *The Journal of the Civil War Era* 4, no. 1 (March 2014): 3–27.

171 Frederick Law Olmsted, *Hospital Transports. A Memoir of the Embarkation of the Sick and Wounded from the Peninsula of Virginia in the Summer of 1862* (Boston: Ticknor and Fields, 1863), 105-106.

action in the face of intense human suffering. This would only have helped their patients, who were no less certain that milk possessed magical, even miraculous powers. Indeed, medical researchers recognize that patient's and caregivers' *belief* in the medicinal efficacy of a given remedy may enhance said remedy's usefulness via a psychological process known as the placebo effect. This is true whether or not the remedy has any measurable preventative, curative, or palliative properties.[172]

Returning one final time to smallpox prescription proposed by the Delaware physician, W. Fields: Would milk and brewer's yeast have cured forty-five out of fifty patients afflicted with the most "malignant form of smallpox"? Certainly not in the sense that it coursed through the bodies of the afflicted in the manner of a modern antiviral agent, inhibiting the process by which the variola virus replicated and infected healthy cells and diminishing the severity of symptoms.[173] It would, however, have nourished their immune systems, giving their bodies an edge -- however slim it may have been -- in locating, attacking, and destroying the virus, as well as any bacteria that took attempted to invade the body via the open, weeping sores that characterized the disease. At the same time, it would have given emotional comfort to patient and caretaker in the face of baffling, terrifying circumstances. Given nineteenth-century Americans' belief in the efficacy of heroic remedies, it reasonable to assume that the pharmaceuticals, bleeding, and cupping prescribed and used by physicians and lay healers of the era to treat smallpox and other diseases would have instilled similar confidence. Yet none of these remedies would have done the patient any *material* good. In its own humble way,

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172 "Placebo Effect."

173 "What You Should Know About Antiviral Drugs," Harvard Health Publishing, Harvard Medical School, December 2015, https://www.health.harvard.edu/drugs-and-medications/what-you-should-know-about-antiviral-drugs.

medicinal milk was the best option available. Whether or not he made the correct diagnosis, Fields was right to prescribe milk.

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If it is true that milk and milk-based foods were a cornerstone of the nineteenth-century American diet, approaching universality, it is no less true that milk and milk-based foods were a cornerstone of nineteenth-century American medical care. Indeed, the two uses overlapped. Unlike modern physicians, who treat nutrition as important, yet ancillary to the pharmaceuticals, antimicrobials, surgical procedures, disinfectants, and other matters that constitute practical "medicine," Nineteenth-century physicians and lay healers drew no (or certainly, far fewer) fine distinctions.[174] Food was medicine and medicine was food. Of all the foods that occupied the liminal space between the two, none was more common, more beloved, more trusted, and more powerful in their application than milk.

To remove sweet milk and milk-based foods from rural nineteenth-century Americans' medicinal toolkit would have had real and disastrous consequences for the sick and injured. Save quinine and opiates, which have shown to possess anti-bacterial and pain-killing properties, respectively, sweet milk was the only medicine available to convalescents that would have made them feel better even as it worked with their bodies to nourish and boost the immune system, repair tissues damaged by injury and surgical procedures, and maintain proper organ systems function. That said, it would be analytical overreach to place milk alongside modern vaccines

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[174] As recently as February 2019, the Registered Dietitian Mary Russell noted that RDs were excluded from medical teams. See Mary Russell, "Registered Dietitian Nutritionists Should Be Included in Patient Health Care Teams," *American Family Physician* 99, no. 3 (February 1, 2019): 142–43; The Duke University School of Medicine offers no specific degree program in nutrition. See "Degree Programs and Admissions," Duke University School of Medicine, 2020, https://medschool.duke.edu/education/degree-programs-and-admissions; At present, the Duke University Dietetic Program is administered separate from the Medical School, as a part of the Department of Nutrition Services. See "Welcome to the Duke University Hospital Dietetic Internship Program Website," Duke University Hospital Dietetic Internship Program, 2020, https://dieteticinternship.duhs.duke.edu/home.

and antimicrobials, which are known by researchers and physicians to promote the creation of antibodies (blood proteins that help white blood cells identify specific pathogens), or inhibit the reproduction of microbial invaders once they enter the human body. Certainly, milk was no substitute for the stitches, dressings, splinting, and surgical procedures used by physicians and lay healers to stabilize cuts and fractures. Yet it did improve things, which was more than could be said for all of the heroic remedies -- purgatives, cupping, bleeding, and the like -- advocated by contemporary physicians. When physicians in the Civil War faced the challenge of dealing with the unprecedented number of sick and wounded, they drew on decades of medical and folk-medical knowledge in offering their patients milk.

Chapter 3:
More Art than Science:
Dairy Husbandry in the Antebellum United States

To borrow a term from modern chemists, new, whole milk, fresh from the cow, is an emulsion, made up of tiny, membrane-bound fat globules suspended in a protein, sugar, and water solution. The fat globules in milk provide neonatal animals and human consumers with concentrated caloric energy, as well as a complement of lipid-soluble (or fat-soluble) nutrients and essential fatty acids known by modern medical science to possess anti-inflammatory and immune-boosting properties while also promoting bone and tissue growth. The solution or serum -- known as whey -- delivers lactose (or milk sugar), a carbohydrate and additional source of energy, as well as two milk proteins, casein and albumen, which join nutrients and fatty acids in promoting bone and tissue growth and immune systems function. Generally speaking, the whole milk produced on twenty-first century dairy farms in the United States has a predictable chemical composition: 87.7 percent water; 4.9 percent lactose (milk sugar); 3.4 percent fat; 3.3 percent protein; and 0.7 percent minerals (referred to by dairy scientists as ash). Modern dairy science researchers at the describe any variation in these numbers from farm to farm or animal to animal as "minor."[175]

Such uniformity of composition is no given. Indeed, it takes a great deal of planning and precision on the part of dairy farmers. At the risk of oversimplifying a complex process, those who would make an abundance of chemically consistent milk must manage three key variables. The first of these is their animals' genetic heritage or breeding, which is the best predictor of a given animal's productive powers over the course of its life. The second of these is their

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[175] "Milk Composition," *Milk Facts*, http://milkfacts.info/Milk%20Composition/Milk%20Composition%20Page.htm.

animals' diet or feeding, which must offer the balance of the vitamins, nutrients, proteins, fats, carbohydrates, and fiber needed to keep cattle in peak physical condition throughout the entire year, including the dry period that separates one lactation cycle from the next. The third of these is their animals' comfort, which must be protected against physical and emotional stressors that may harm or upset the animals, reducing the abundance and quality of the milk harvest. Farmers in need of advice or training may draw on over a century's worth of data compiled by university-affiliated extension offices, government agencies, and private dairying associations. Up-and-coming farmers may earn dairy science degrees from one of hundreds of programs offered by private and state-funded universities.[176]

Assisting modern dairy operators are a host of technologies that demystify and simplify the management of the three key variables. Among them are mechanical and electronic estrus detectors, which assist operators in knowing when their animals are most apt to conceive, as well as artificial insemination guns, which allow farmers to deliver pre-harvested, pre-sexed sperm from the very best sires directly into the cervical canal of receptive cows and heifers.[177] No less useful are mechanical food mixers and blenders, which allow dairy operators to deliver a finely processed -- and therefore, easy-to-digest -- blend of carbohydrates, fats, proteins, and nutrients to their animals throughout the year, ensuring optimum nutrition while eliminating waste.[178] To

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[176] "Best Dairy Science Colleges in the U.S., Universities.com, 2022, universities.com/programs/dairy-science-degrees.

[177] George Perry, "Detection of Standing Estrus in Cattle," FS921B (Brookings, South Dakota: College of Agriculture & Biological Sciences, South Dakota State University, February 2004); G. Robert Hagevoort and J. Armando Garcia, "When Should Dairy Cows Be Inseminated?," Guide B-117 (Las Cruces, New Mexico: College of Agricultural, Consumer and Environmental Sciences, New Mexico State University, August 2013); Wendy Short, "8-Step Guide to Artificially Inseminating a Dairy Cow," Farmers Weekly, November 5, 2015, https://www.fwi.co.uk/livestock/livestock-breeding/8-step-guide-artificially-inseminating-dairy-cow.

[178] Jim Linn, "Feeding Total Mixed Rations," University of Minnesota Extension, n.d., https://extension.umn.edu/dairy-nutrition/feeding-total-mixed-rations; Judd Heinrichs and Alanna Kmicikewycz, "Total Mixed Ration for Dairy Cows," Penn State Extension, May 5, 2016, https://extension.psu.edu/total-mixed-rations-for-dairy-cows.

ensure animals' comfort during the summer, operators house animals in vast, shaded barns that are positioned to capture prevailing winds, or else equipped with fans that displace the animals' body heat via artificial breezes. During the winter, they protect animals against cold-weather stress by confining them in clean, dry stalls, lined with warm bedding and/or by erecting portable wind breaks in outdoor yards.[179]

Modern dairy operators take advantage of knowledge and technologies to harvest enormous quantities of chemically consistent milk. Specific amounts depend on the breed of animal housed in the dairy and the production goals of dairy operators. Those who are willing to sacrifice butterfat content for a high volume of milk -- that is, fluid milk sellers -- are apt to select members of the black-and-white spotted Holstein breed, which yield about 53 liters (or 14 U.S. gallons) of milk, with a 3.06 percent butterfat content, per day during peak lactation. Those who wish to maximize the butterfat content in milk -- that is, butter and cheese manufacturers -- are apt to choose animals from the smaller, fawn-colored Jersey breed, which yield about 19 liters (or 5 U.S. gallons) of milk, with a 3.65 percent butterfat content per day, during peak lactation. So long as they are milked on a regular, twice-daily schedule, stimulating the udder to continue production, cows may furnish milk for up to 305 days before entering the dry period. Recognizing that milk syntheses declines over the course of the lactation cycle, a single Holstein may produce 10,122 liters (or 2,674 U.S. gallons) per year, while a smaller Jersey yields about 7,775 liters (or about 2,054 U.S. gallons) per year.[180]

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[179] "Heat Abatement and Ventilation of Adult Cow Facilities," Dairyland Initiative, University of Wisconsin-Madison, accessed June 10, 2020, https://thedairylandinitiative.vetmed.wisc.edu/home/housing-module/adult-cow-housing/ventilation-and-heat-abatement/; Pat Melgares, "Tips for Managing Livestock in Winter," Drovers: Driving the Beef Market, January 5, 2018, https://www.drovers.com/article/tips-managing-livestock-winter.

[180] "Why Jerseys," *USJersey*, https://www.usjersey.com/Portals/0/AJCA/2_Docs/WhyJerseys2013.pdf; "Holstein 101: A Beginner's Guide to Holstein Cattle," *Holstein Association USA*, 2022, http://www.holsteininusa.com/holstein_breed/holstein101.html.

American farmers confronted the same three variables during the first half of the nineteenth century, albeit with far fewer tools at their disposal. To be sure, European and American stock raisers of the era had long dabbled in the selective breeding of cattle. Yet the fundamental building blocks of genetic science would remain a mystery until two researchers, the English naturalist, Charles Darwin, and the Austrian monk, Gregor Mendel, introduced natural and artificial selection, variation, and inherited traits to a wide audience in 1859 and 1866.[181] The same may be said for nutritional science, which remained incomplete until the discovery and documentation of gut microorganisms and vitamins beginning in the second half of the nineteenth century. Before that time, it was impossible to explain the processes by which human and animal bodies converted food into body tissue, bone, fat, energy, blood, and milk with any precision.[182] Regarding the physical and emotional comfort of livestock, farmers of the era recognized that cows were something more than the soulless organic machines described by the French philosopher René Descartes. Yet the impact that physical and emotional stress had on the real health of dairy cattle and by extension, the quality and quantity of their milk, remained unknown until the discovery of the stress hormones adrenaline and cortisol during the first half of the twentieth century.[183]

Absent this knowledge, farmers muddled along as best they could, using such tools as they did possess to make enough culinary and medicinal milk to meet the needs of family,

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[181] Charles Darwin, *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life* (London: John Murray, 1859); Gregor Mendel, "Experiments in Plant-Hybridisation," Cambridge: Harvard University Press, 1925).

[182] Janet Goins, "Microbiomes: An Origin Story," *American Society for Microbiology*, 8 March 2019, https://asm.org/Articles/2019/March/Microbiomes-An-Origin-Story; Hopkins, "Feeding Experiments," 425–60; Herrmann and Obeid, "History of the Vitamins," 1-3.

[183] Desmond M. Clarke, Descartes's Theory of the Mind (Oxford: Clarendon Press, 2003), 71, 174; Mary Ellen Bowden, Amt Beth Crow, and Tracy Sullivan, *Pharmaceutical Achievers: The Human Face of Pharmaceutical Research* (Philadelphia: Chemical Heritage Press, 2003), 49-50; Victor Cornelius Medvei, *A History of Endocrinology* (Lancaster, England, U.K.: M.T.P. Press Limited, 1982), 565; Hans Selye, *The Stress of Life* New York: McGraw-Hill, 1956).

friends, and neighbors. These were, in no particular order: practical experience; folk knowledge and intuition; and more-or-less useful advice gleaned from agricultural journals and selective breeding manuals. All three were helpful to American farmers in making milk. Practical experience derived from centuries of trial and error, along with folk wisdom and intuition, offered useful truisms, many of which would pass muster on modern dairy farms. Meanwhile, agricultural journals and breeding manuals featured the most up-to-date studies of breeding, feeding, and care published by European and American researchers. Yet all three suffered limitations. Practical experience, alone, was insufficient to discern complex organic processes that occurred on the cellular or molecular level, while folk knowledge and intuition strayed into the realm of superstition and magic, supporting practices that had no demonstrable positive impact and may even have damaged animals' health. Meanwhile reformers and breeding advocates struggled to convince skeptics that the costly, time consuming, often contradictory reforms that they advocated would lead to healthier animals and more and better milk. More problematic still, these same reformers promoted pseudoscience that was no more useful in practical terms than the folk practices they hoped to discourage.

Considering the circumstances, it should come as no surprise that American farmers during the first half of the nineteenth century struggled to make an abundance of chemically consistent milk. If any came close to matching modern dairy operators, it was the ethnic-Germans farmers of Pennsylvania who showed great care in breeding, feeding, and caring for their animals while also looking after the health of the soil that supported fodder crops. Contemporary observers reported that the *very best* animals yielded about 34 liters (or 9 U.S. gallons) of milk per day, slightly more than a modern Jersey.[184] Yet the "Pennsylvania Dutch"

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[184] "Agricultural Items," *Southern Cabinet of Agriculture, Horticulture, Rural and Domestic Economy*, September 1840.

were the exception rather than the rule. More common were the farmers of the New England and Mid-Atlantic States, who paid some attention to breeding, feeding, and animal care without committing their time, money, or energies to mastering any one task. Indeed, they took a lackadaisical approach to husbandry that frustrated reformers and crossed over into cruelty and neglect.[185] More common still were those of the Old Northwest and South, who turned dairy cattle out to find food, water, and mates on the open range, year round, without benefit of shelter or human supervision. Such farmers harvested a pittance of milk from their scrawny, ill-bred animals, most of it of a poor quality.[186]

As the nineteenth century reached and then passed its midpoint, there was no indication that American farmers were poised to make rapid advances in terms of the quantity or quality of milk produced. Notwithstanding the advice of agricultural reformers, the improvement of the nation's dairy herd via livestock importations and/or the selective breeding of native animals would take time and expense to complete. If the Secretary of the Board of Agriculture for the State of Maine, Stephen L. Goodale, be believed, the vast majority of American farmers had not embraced this process by 1861, much less achieved any positive results.[187] But then, doing so made little economic sense. Absent refrigeration, it was impossible to move fluid milk over any great distance or keep it for any great length of time. Any surplus milk harvested from better, more productive cows would thus go to waste, offering no return on the farmer's investment of

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[185] For examples of lackadaisical husbandry, see "From the Wool Grower. Winter Feeding," *Valley Farmer*, October 1850 and "Feeding Cattle," *The New England Farmer; a Monthly Journal*, April 1852.

[186] For more on the shortcomings of Northwestern and Southern free-range cattle husbandry, see D. Sanborn, "Prairie Hay -- Wintering Stock, &c.," *Prairie Farmer*, May 1843, Lewis F. Aiken, "Cattle Feeding in the Western States," *Ohio Farmer*, February 23, 1856, and "Making Forage and Wintering Stock," *Southern Cultivator*, January 1857.

[187] Goodale, *Principles*, 9.

time and resources.[188] To complicate matters further, farmers in the nation's so-called "Dairy Belt," here defined as Upstate New York and New England, were losing ground in the fight to extract higher yields of pasture grasses, legumes (clover), and grains from the region's soils, even as market demand for fluid milk emanating from nearby cities prompted them to intensify dairy production. Historians have attributed this reversal of fortune to a host of cultural and ecological variables: lack of attention to manuring, the over grazing of pastures, and the clearing of marginal, hillside lands for use in cultivating fodder crops, among others.[189] Whatever the specific cause, American dairy production looked to stagnate or even regress during the second half of the nineteenth century.

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When it comes to milk production, cattle genetics matter. Modern dairy farmers have long enjoyed the luxury of choosing dairy animals from established breeds, members of which possess a set of predictable and desirable genetic traits, the two most important being the relative abundance and butterfat content of their milk. In practical terms, those who are willing to sacrifice butterfat content for a high volume of milk production -- typically, those selling fluid milk at market -- are apt to select the enormous, black-and-white spotted Holsteins. Conversely, those who wish to maximize the butterfat content in milk -- typically, butter and cheese manufacturers -- are apt to choose animals from the smaller, fawn-colored Jersey breed, or even the Ayrshires, Brown Swiss, and Guernseys, which fall somewhere between the Holstein and Jersey in terms of the quantity and fat content of their milk. In much the same way, modern

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188 Unrefrigerated milk sours or spoils in about two-hours time. See Robert Robson Dinwiddie, *Milk: Its Decomposition and Preservation* (Fayetteville, Arkansas: Arkansas Agricultural Experiment Station, 1897), 49–55.

189 For a book-length study of soil fertility and manuring in nineteenth-century America, see Stoll, *Larding the Lean Earth*. See also Brian Donahue, *Reclaiming the Commons: Community Farms and Forests in a New England Town* (New Haven: Yale University Press, 1999), 129–30; Sutton, "Milk: A New England History," 62-63.

farmers and livestock breeders, select against animals with undesirable traits -- aggressive temperament, hereditary disorders, poor milk production, inability to accumulate fat stores -- by neutering or culling problem animals to remove them from the breeding pool.[190]

The cattle that roamed American pastures during the first half of the nineteenth century were less predictable, in terms of the abundance and chemical composition of their milk, than modern purebred animals. With few exceptions, these animals were descended from the bovine colonists carried to North America aboard Spanish, Portuguese, British, and Dutch ships between 1493, the year that the Genoese explorer Christopher Columbus introduced domestic cattle to the West Indies, and 1640, the date of the last large-scale, colonial-era European livestock importations. Turned out to fend for themselves in the continent's canebrakes, meadows, forests, swamps, and scrublands, American cattle mingled and interbred without much human supervision, creating a hardy race of animals known to nineteenth-century livestock breeders, pejoratively, as "native" or "grade" stock. Grade cattle varied in appearance, with some bearing the "deep red" coloration of English Devons, others the yellow tint of Danish breeds, and still others the long, curved horns and ill temperament of Iberian stock. These animals were much smaller than their modern descendants, weighing in between 750 and 900 pounds, or about half the size of a Holstein. They also showed great variability in terms of the quantity of milk produced during peak lactation. It was a rare American cow of the era that produced more than

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[190] Jud Heinrichs and Coleen M. Jones, "Milk Components: Understanding Milk Fat and Protein Variation in Your Dairy Herd," Penn State Extension, May 5, 2016, https://extension.psu.edu/milk-components-understanding-milk-fat-and-protein-variation-in-your-dairy-herd; For more on the intentional evolution via culling and selective breeding, see Edmund Russell, *Evolutionary History: Uniting History and Biology to Understand Life on Earth* (Cambridge: Cambridge University Press, 2011), 71–84.

four gallons of milk per day. More common by far were those that yielded between one and three U.S. gallons.[191]

It is difficult to pinpoint the exact date that American agricultural reformers first took up advocacy of selective breeding with an eye to improving grade stock. However, it does appear to have coincided with the farm improvement advocacy that emerged during the 1820s, in response to widespread soil exhaustion, farm abandonment, and chronic outmigration of people in the older, Eastern States.[192] As early as 1822, American agricultural journals published accounts of English livestock breeders' deliberate mixing of strains of so-called shorthorns in an attempt to create a hardier, more productive (in terms of meat and milk) race of animals. One such article, reprinted from the *London Farmer's Journal* by the August 16, 1822, *American Farmer*, confessed that this process as more "art" than science, noting that a Mr. Charles Colling had improved the so-called "Ketton Short Horns" via "the admixture of the blood of that stock with others," without then being able to explain just how, exactly, Colling's methods brought about these improvements. "Some will have it," editors noted, that "he made them no better than he found them." As early as September 1826, editors of the *New England Farmer* admonished readers to choose only "the best of our native stock, however small the number, *in every township*, and breed from them." That attention to the careful selection of breeding stock would

[191] For more on the introduction of domestic cattle to North America, see G. A. Bowling, "The Introduction of Cattle into Colonial North America," *Journal of Dairy Science* 25, no. 2 (February 1942): 129–54; Alfred Crosby, *Ecological Imperialism: The Biological Expansion of Europe, 900-1900* (Cambridge: Cambridge University Press, 1986), Terry G. Jordan-Bychkov, *North American Cattle-Ranching Frontiers: Origins, Diffusion, and Differentiation* (Albuquerque: University of New Mexico Press, 1993), and Virginia DeJohn Anderson, *Creatures of Empire: How Domestic Animals Transformed Early America* (Oxford: Oxford University Press, 2006); Robert Jennings, *Cattle and Their Diseases, Embracing Their History and Breeds, Crossing and Breeding, and Feeding and Management; with the Diseases to Which They Are Subject, and the Remedies Best Adapted to Their Cure* (Philadelphia: John E. Potter, 1863); Paul W. Gates, *The Farmer's Age: Agriculture, 1815-1860* (New York: Holt, Rinehart and Winston, 1960), 234.

[192] Stoll, *Larding the Lean Earth*, 9.

lead to improvement was "so obvious a principle, that it must be obvious to any farmer who thinks on the subject."[193]

An obvious principle, indeed, save one problem: Americans of the era disagreed about how to identify the best native stock. Nowhere was this more evident than in New England. To the great annoyance of selective breeding advocates, the region's farmers evinced a deep-seated cultural prejudice for the "deep red" -- that is, red-haired -- descendants of English Devons brought to North America by their English Puritan forebears, believing that the animals' hair color somehow gave their milk the distinctive yellowish tint preferred by American milk drinkers. Some farmers took this reasoning a step further, arguing that the color of an animal's milk could be traced to the color of its skin, with pale- or pink-skinned cows giving pale-white, less-desirable milk, and those with yellowish skins giving a rich, yellow product. A correspondent to the June 18, 1842, *Maine Farmer* explained how and why this natural process was presumed to work. "I had supposed," he wrote, "that hair was produced from the juice of the body; if such juice sends forth white hair, I had believed, that as milk was also produced from the juice of the system, it might have an effect to produce white or lighter colored milk." The letter writer granted that white oxen were superior to those of other hues, for "no color stands the heat so well." Yet, "Milk is another thing."[194]

Reformers, veterinary scientists, and progressive farmers did their best to convince husbandmen otherwise. One of them, a correspondent to the April 3, 1841, *Boston Cultivator*, dismissed farmers' reliance on hair and skin color when selecting milking and breeding stock as

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193 John Rooke, "On Improving the Breed of Horned Cattle," *The American Farmer, Containing Original Essays and Selections on Rural Economy and Internal Improvements, with Illustrartive Engravings and Prices Current of County Produce*, August 16, 1822; T. Pickering, "Colonel Pickering, on Improving the Native Breed of New England Cattle," *The New England Farmer, and Horticultural Register*, September 16, 1825.

194 "Color of Cattle," *Boston Cultivator*, April 3, 1841; "White Cows," *Maine Farmer and Mechanics Advocate*, June 18, 1842.

the patently "ridiculous" and outdated fancies of "persons older than myself." By his own admission, the correspondent made sport of challenging those who cited hair- and skin-color as evidence of a cow's productive powers to "explain the mystery" by which it worked. "I have not yet found one who was able to do so," he boasted, "although some do not hesitate even *now* to assert that it is the fact." The following year, a certain Dr. Bates issued a similar challenge to farmers gathered in Sangerville, Maine, with similar results. While observers were "friendly to his Ideas [sic]," Bates's assertion that white or light-colored cows were "as good for the dairy as any other color" struck them as problematic, even heretical in its deviation from accepted folk knowledge and practice.[195]

Those who professed to support agricultural reform were hardly immune to the pull of folk belief. Two years after Dr. Bates made his appeal to Maine farmers, editors of the *Massachusetts Ploughman and New England Journal of Agriculture* compiled a list of physical traits that farmers should look for in cattle if they wished to harvest "rich milk." Among them were a "yellow, or rather a mahogany color" skin, as well as "a red or yellow, or yellow brindle" coat, which was "as indicative as any, of a good rich milker." Agricultural journals and magazines reprinted this article for the benefit of dairy farmers North, South, and West, without offering any qualifying remarks. In November and December 1844, word-for-word copies appeared in the *Boston Recorder*, the New York-based *Spirit of the Times*, the Atlanta-based *Southern Cultivator*, the Baltimore-based *American Farmer*, and the Lansing-based *Michigan Farmer*.[196] Whether or not he read the article in question, the esteemed cattle breeder, Samuel

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[195] "Correspondence. Color of Cattle," *Boston Cultivator*, April 3, 1841; "White Cows."

[196] "The Best Cows," *Massachusetts Ploughman and New England Journal of Agriculture*, October 26, 1844; "Agricultural. The Best Cows," *Boston Recorder*, November 14, 1844; "Farmers and Breeders' Department," *Spirit of the Times; A Chronicle of the Turf, Agriculture, Field Sports, Literature and the Stage*, November 16, 1844; "The Best Cows," *Southern Cultivator*, November 27, 1844; "The Best Cows," *The American Farmer, and Spirit of the Agricultural Journals of the Day*, November 7, 1844; "The Best Cows," *Michigan Farmer*, December 15, 1844.

Jacques, of Charlestown, Massachusetts, used similar criteria in judging cow flesh. On describing his celebrated "cream pot" herd, Jacques made sure to note that the animals had "red or mahogany colored hair, yellow noses with mahogany colored teats," and "yellow skins, silky and elastic to the touch."[197]

It may be that nineteenth-century farmers' and reformers' reliance on skin and hair color to predict the productive powers of dairy cattle reflected the social preoccupations of the era. By the mid-nineteenth century, the racialist pseudoscience of phrenology, which held that human intelligence, character, and aggression could be determined by the shape of the skull, had emerged as a legitimate discipline, complete with best-selling works. Certainly, phrenologists used hair color and texture and skin color as markers when distinguishing between the (presumably) more civilized European racial groups and the (again, presumably) less civilized peoples of Africa and Asia.[198] Indeed, as late as 1882, the German dairy scientist Nicholas Gerber insisted that the breast milk yielded by women of different racial groups varied in terms of its smell, color, and chemical composition. Citing the work of the scientist, H.A. Mott, Gerber insisted that the breast milk of European women was white and almost devoid of odor. By comparison, the breast milk of "women of the African race" was yellowish in color, "resembling cows' milk," and gave off a "peculiar" and "distinct odor." At the risk of giving Gerber any credit, he dismissed the notion that hair color and texture were indicative of the composition and

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[197] "Stock Raising Department. [For the Valley Farmer]. Breeding In-and-In," *Valley Farmer* 11, no. 4 (n.d.): 115; For a contemporary account of Samuel Jacques's "Ten Hills Farm," see "Seven Days Journey in New Hampshire, Maine and Massachusetts," *Farmers Monthly Visitor* 2, no. 7 (July 31, 1840): 97–104.

[198] James Poskett, *Materials of the Mind: Phrenology, Race, and the Global History of Science* (Chicago: University of Chicago Press, 2019), 2.

abundance of a woman's milk. "A good healthy appearance and a happy disposition," he insisted, were "of far greater importance."[199]

At least some nineteenth-century Americans approached livestock breeding with the same pseudoscientific criteria in mind. Consider "The Unity of Man," which appeared in the May 1863 *American Phrenological Journal*. As humans moved toward a civilized or "mental stage of existence," the author insisted, their skin grew lighter. As evidence, he cited the physical differences between the presumably less-civilized sub-Saharan African, who possessed dark skin and "extreme woolly [sic] hair," and the presumably more-civilized African American, who was "becoming a *pale face* just as fast as the God of nature intended he should." The same principle, he argued, applied to domestic stock. On leaving the "forest" and taking up residence in a human "civilization," animals' coloration passed from black to red to gray to white. Yet this transformation came at a cost: The whiter the person or animal, the less robust and productive. This applied to the white cows disdained by American farmers, which were presumed "consumptive, nervous, without the health and physical prowess of the ancestry of [their] race." Reasoning from there, red animals with yellow or mahogany skins represented an intermediate stage of domestication, somewhere between the black "original ox" and the enfeebled white domestic cow.[200]

Of course, it may be that the explanation was more prosaic. Lacking any knowledge of genetic science, farmers of the era had no choice but to judge animals by what *Massachusetts*

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199 Nicholas Gerber, *Chemical and Physical Analysis of Milk, Condensed Milk, and Infants' Milk-Foods, with Special Regard to Hygiene and Sanitary Milk Inspection. A Laboratory Guide, Developed from Practical Experience, Intended for Chemists, Physicians, Sanitarians, Students, Etc*, trans. Hermann Endemann (New York: Lehmaier & Bro., 1882), 52–54, 58.

200 "The Unity of Man," *American Phrenological Journal*, May 1863; Scientists and historians now understand that white coloration in domestic animals is linked to artificial selection for desirable genetic traits by their human caretakers. See Edmund Russell, *Evolutionary History: Uniting History and Biology to Understand Life on Earth* (Cambridge: Cambridge University Press, 2011), 54–70.

Ploughman editors described as their "external marks." By this rationale, skin and hair color were no more or less indicative of a cow's milk producing potential than any of the other feature.[201] It may even be that these selection criteria satisfied a deep psychological need on the part of farmers to create order from chaos. Modern psychologists have long recognized that familiarity breeds comfort. The more often one comes into contact with a person, animal, food, song, or landscape, the more likely one is to develop positive feelings of attachment.[202] Assuming that they are correct, it stands to reason that nineteenth-century farmers used familiar, culturally derived short cuts, such as the hair and skin color of dairy cattle, to make sense of natural processes that were critical to their physical survival and economic prosperity, yet beyond their understanding. For the American farmer interested in making good milk, this meant selecting red-haired, yellow-skinned cattle.

Critical as they were of farmers' selection criteria, breeding advocates were no better equipped than farmers to judge the quality of cowflesh for the dairy. The selective breeding advocate, Stephen L. Goodale, urged American farmers to emulate those stock raisers of Europe, Great Britain, and the United States who had worked to improve their livestock via careful attention to breeding. However, he confessed to a lack of practical knowledge in the same breath, noting, "There has not been much published on the subject in any form within the reach of most. . . . Either among our own or the foreign agricultural literature." Although he dismissed superficial physical characteristics as poor indicators of an animal's health or suitability for the breeding pool, most of the advice that Goodale proceeded to offer readers centered on a given animal's physical characteristics, among them the "size, shape and position of the udder,"

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201 "Physiognomy of Animals," *Massachusetts Ploughman and New England Journal of Agriculture*, 11 April 1846.
202 Ryan Gunderson, *Making the Familiar Strange: Sociology Contra Reification* (London: Routledge, 2020), 105.

"thickness of skin," and "length of hair." Of these, modern stock breeders do acknowledge that the appearance and position of the udder may be indicative of a cow's fitness and capacity for synthesizing milk. Skin thickness and hair length, however, are not recognized as having any specific bearing on milk volume or quality.[203]

The dubious nature of Goodale's recommendations notwithstanding, he did offer some useful advice in the form of a simple, three-step process for improving the quality and productivity of one's dairy herd. The first, most important step for the would-be livestock breeder, Goodale noted, was to determine what he wanted to accomplish -- in this case, maximizing the quantity and quality of milk -- and then select cows or heifers of "the breed or race best adapted to fulfill the requirements demanded." The second step was to pair those cows and heifers with a robust male animal, descended from a proven line of good milking stock. The third step was to cull or sell off any animals that were poor milkers or showed signs of hereditary diseases, thereby preventing their tainting the herd. By repeating this process over several generations, Goodale insisted, it was possible to "retain and improve upon the [most desirable] points" of good animals. Indeed, he thought it possible to transform American grade stock into something that "will be as good as if thorough-bred." If only farmers would agree to share their best bulls with one another, or rent them at modest cost, the benefits of improvement "might be brought within the means of most persons."[204]

This was an important point, for the greatest barrier to livestock improvement during the first half of the nineteenth-century was economic. Though it was possible by the 1840s for American farmers to import purebred or "blooded" cattle from British and European herds, the

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[203] Goodale, *Principles*, 10; Jessica Stamschror, Tony Seykora, and Les Hansen, "Judging Dairy Cattle" (Minneapolis, Minnesota: University of Minnesota, July 2000).
[204] Goodale, *Principles*, 66, 107, 120.

animals were far too expensive for the typical farmer to afford. As evidence, one need only examine contemporary accounts of stock importations, which were rare enough, and costly enough, to attract national attention in the print media. On April 3, 1856, agents of the American cattle breeder Samuel Thorne purchased four blooded Durham cattle belonging to England's celebrated Fausley herd for shipment to his Thorndale Estate in Duchess County, New York. The agents paid $1,350 for a seven-year-old cow, "Amaranth," and one of her offspring, an unnamed yearling heifer. The agents also paid $400 and $500 respectively for two other heifers, "Blouzelind" and "Elgitha." Adjusted for inflation, these four animals cost Thorne the equivalent of $67,965.[205]

Purebred cattle were not only expensive, but also risky investments for American farmers. Moving the animals from British or European ports to American pastures required that they be driven aboard steamships and then ferried between 3,500 and 4,000 miles across the North Atlantic, a trip that took two weeks or longer to complete and exposed the clumsy, terrestrial animals to the pitching and rolling of rough seas. It did occur that purebred cattle sustained life-threatening or even mortal injuries during the crossing. One such incident took place in 1849, as an American purchasing agent returned from England with a cargo of shorthorn cattle. The agent later testified that a "continued hurricane" of twenty days' duration buffeted the ship, tossing people and livestock about and effecting great misery. When the vessel limped into New York Harbor, "the cattle were reduced and worn out," with one unfortunate heifer having been "knocked all to pieces." Five years later, in 1854, a shorthorn cow purchased by the Duchess County, New York, livestock breeder, Jonathan Thorne, for $1,500 -- about $45,849.82

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[205] Ulysses Prentiss Hedrick, *A History of Agriculture in the State of New York* (Albany, New York: New York State Agricultural Society, 1933), 367–69; The agricultural historian Paul W. Gates described American enthusiasm for Durham cattle as a "Shorthorn craze." See Gates, *Farmer's Age*, 232–33; "Sale of Short-Horns in England," *The Daily Union*, May 28, 1856.

adjusted for inflation -- suffered a similar fate while traveling from England to New York aboard the steamer *Hermann*. The ship's mast crashed down onto the deck during a severe storm, killing the cow, dubbed Thorne's "Duchess 68th," as well as a flock of blooded Southdown sheep confined in a makeshift pen.[206]

All of this served to ensure that the imported animals' American-born offspring commanded a premium at auction. The *Spirit of the Times* reported that an August 29, 1850, sale of blooded Durham cattle bred and raised on the estate of J.F. Sheafe of New Hamburg, New York, drew professional and amateur cattle breeders from as far afield as New Jersey, Long Island, western New York, and the counties of the Hudson River Valley between Manhattan and Albany. The cheapest animal in the lot, an imported cow aged fourteen years, and well past her prime in terms of breeding and milk or beef production, sold for $47.50, or about $1,563.60 adjusted for inflation. Two calves sold for $50.00 (about $1,645 apiece, adjusted for inflation), while two yearlings sold for $65.00 and $80.00 ($2,139 and $2,633 adjusted for inflation) respectively. Heifers of breeding age sold for an average of $117.50, or $3,867 adjusted for inflation. A number of cows between the ages of four- and seven-years old sold for an average of $136.87, or about $4,505 per animal, adjusted for inflation. The most expensive animal, the shorthorn bull "Exeter," sold to the livestock breeder L.F. Allen for $500.00, or $16,458 adjusted for inflation.[207]

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[206] "Importation of Shorthorn Cattle," *American Agriculturalist*, August 1849; "Notes for the Month. Arrival of Mr. Thorne's Stock," *The Cultivator*, December 1853; "Losses of Cattle at Sea," *Ohio Cultivator*, February 1, 1854.

[207] It is customary on modern dairy farms to cull cows at five years of age and replace them with younger, fitter animals. See Jud Heinrichs and Coleen M. Jones, "Milk Components: Understanding Milk Fat and Protein Variation in Your Dairy Herd," Penn State Extension, May 5, 2016, https://extension.psu.edu/milk-components-understanding-milk-fat-and-protein-variation-in-your-dairy-herd; "Sale of Durham Cattle," *Spirit of the Times; A Chronicle of the Turf, Agriculture, Field Sports, Literature and the Stage*, September 7, 1850.

Such prices would have exceeded the purchasing power of most American farmers during the first half of the nineteenth century. While it is difficult to know how much capital that Northern, Southern, or Western farm families had on hand at any given moment, it is possible to estimate how much profit they brought in from their yearly labors. In 1856, the same year that Samuel Thorne, paid $1,350 for two imported British cattle, common agricultural products commanded the following prices at market, on average: corn, about seventy-one cents per bushel; potatoes, between forty and eighty cents per bushel; cheese, about twelve cents per pound; and butter, about twenty-six cents per pound.[208] Using data derived from the 1860 United States Census (the closest in time to 1856), the average farm size in Thorne's New York was 106 acres, with the majority of farmers owning 99 acres or less.[209] That same year, the state's farms produced, on average, 102 bushels of corn (valued at $72), 246 lbs. of cheese (valued at $29), 523 lbs. of butter (valued at $135), and 134 bushels of potatoes (valued at between $53 and $107).[210] All told, this amounted to an annual profit of between $289 and $343. At least some of that money -- about $1.69 per day -- went to pay hired hands. Plenty more went to maintenance, manufactured goods, and other expenses. Assuming that they had money to invest in cattle, Thorne's neighbors would have done well to pay market price -- between $25 and $40 -- for the best grade animals.[211]

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[208] Carroll Wright, *Comparative Wages, Prices, and Cost of Living: [From the Sixteenth Annual Report of the Massachusetts Bureau of Statistics of Labor, for 1885]* (Boston: Wright & Potter Printing Co., 1888), 67, 70, 87–88, 163.

[209] W.I. Myers, "An Economic Study of Farm Layout," Memoir 34 (Ithaca, New York: Cornell University Agricultural Experiment Station, June 1930), 397.

[210] Of course, New York farmers derived similar modest profits from other market crops such as oats, barley, hay, and flax. See Joseph C.G. Kennedy, *Agriculture of the United States in 1860; Compiled from the Original Returns of the Eighth Census, under the Direction of the Secretary of the Interior* (Washington D.C.: Government Printing Office, 1864), 100–103.

[211] "New-York Cattle Market," *The Independent . . . Devoted to the Consideration of Politics, Social and Economic Tendencies, History, Literature and the Arts*, June 5, 1856; "New-York Cattle Market," *New York Evangelist*, December 11, 1856.

Even then, grade stock made for a risky investment. In his *Principles of Breeding*, Stephen L. Goodale described a problem peculiar to grade animals, which saw otherwise robust, well-formed native bulls sire calves with a blooded cow or heifer that were "all mongrels and showing mongrel origin more than he did." To be sure, a portion of the young animals showed some or all of the "good points" of their father and/or mother. Yet an equal portion grew into what Goodale described as "dull, mulish beasts" that gave little milk, dropped sickly, "round-breeched calves," and yielded "flesh of a very dark color, ill flavor and destitute of fat" when culled for beef. Indeed, those in the latter group were so common during the first half of the nineteenth century that Northeasterners gave them mock breed names: "Whitten" or "Peter Waldo" in Maine; "Yorkshire" or "Westminster" in Massachusetts; and "Pumpkin Buttocks" in New York. Absent knowledge of dominant and recessive alleles (that is, genes) or the laws of genetic inheritance, Goodale struggled to explain the great variation and defects that he witnessed in calves sired by the same animal. Drawing on a then-popular, pseudoscientific belief that sexual intercourse weakened human bodies, he concluded that the too early and excessive pairing of bulls with receptive cows robbed the animal, and by extension, some of his offspring, of their "vigor."[212]

Doubtless agricultural reformers in the Old Northwest would have welcomed an opportunity to debate the finer points of dairy improvement with interested, if skeptical and superstitious farmers, a la Stephen L. Goodale. As it happened, the region's stock raisers took almost no interest in selective breeding. In March 1841, the Chicago-based *Union Agriculturalist* criticized Illinois farmers for identifying and *selling off* their best cows and heifers for quick profits while keeping only the "Pharaoh's lean kine . . . for milk and raising

[212] Goodale, *Principles of Breeding*, 18–19.

calves." Editors implied that the repetition of this pattern over successive generations had diminished the state's herds, leaving farmers with "an ill-shaped worthless stock that none will buy and pay the expense of raising." Farmers in neighboring Indiana evinced similar tendencies, inviting similar criticism. In December 1846, editors of the Indianapolis-based *Western Farmer and Gardener* blasted Hoosiers for their lack of attention to cattle selection, insisting that the state "be regarded as altogether destitute of good stock; and seemingly, without ambition to procure any." There existed "here and there a neighborhood" populated by progressive-minded farmers. Yet the majority showed a "strange want of wise foresight" in selling off their best animals and retaining only "scrawny, bony, flabby cattle" of dubious bloodline and productive powers for themselves.[213]

Save a handful of wealthy planters who purchased blooded animals from Northern dealers, Southerners showed even less interest in long-term dairy improvement than did their Northwestern counterparts. Doing so would have required them to track the movement of cattle over the region's vast open range, anticipate cows' and heifers' estrus cycles, capture and confine receptive animals, and then pair them with proven bulls. More often than not, middling to poor farmers were fortunate to have even the vaguest notion of their animals' exact whereabouts from one moment to the next. Editors of the *Southern Planter* testified to this fact in December 1841, noting that the region's farm families often did without a "certain supply of good milk" for food and medicine, thanks to the "failure of the cow 'to come up'" to the house at milking time. A correspondent to the *Prairie Farmer*, W.D. Abernethy, told a similar story in 1846. As he passed near Memphis, Tennessee, on his way to Mississippi and Alabama, Abernethy noted a conspicuous absence of dairy cattle. A curious fellow, Abernathy asked

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[213] "Improvement of Stock," *Union Agriculturalist and Western Prairie Farmer*, March 1841; "Improved Cattle," *Western Farmer and Gardner*, 1 December 1846.

residents "where their cattle were." They responded with a shrug, followed by the rather vague explanation: "In the cyprus [sic] swamps."[214]

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Genetics notwithstanding, the very best cows are only as productive as they are well fed. To understand why, it is necessary to know something about the process by which ruminant digestive systems convert the protein, fat, and carbohydrate content of pasture grasses, clover, hay, grains, ensilage, straw, and vegetables into the new, sweet milk that human consumers favor. The process begins when a cow chews its food, introducing moisture in the form of saliva while also softening and breaking the food down into smaller, more digestible pieces. On passing through the esophagus and into the rumen, the largest chamber of the cow's four-chambered stomach, it is metabolized by billions of bacteria, protozoa, and fungi to create K and B vitamins, the ammonia and amino acids used in protein synthesis, as well as acetic, butyric, and propionic acid, otherwise known as volatile fatty acids. Contractions of the rumen ensure a good mix of microorganisms and food particles, while also moving partially digested food back through the esophagus and into the mouth in a ball or "cud" for further chewing. Indeed, cows spend about forty percent of their time chewing cud, which breaks their food down into smaller pieces, ensuring that the animal absorbs as many nutrients, amino acids, and volatile fatty acids as possible via the hair-like papillae that line the rumen (although the reticulum, true stomach, and intestines also help). Once absorbed, those used in synthesizing milk travel to the udder via the bloodstream.[215]

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[214] "The Cow," *Southern Planter*, December 1841; W.D. Abernethy, "Tennessee and Alabama," *Prairie Farmer*, May 1846.

[215] James Linn et al., "The Ruminant Digestive System," University of Minnesota Extension, 2018, https://extension.umn.edu/dairy-nutrition/ruminant-digestive-system.

Sudden changes in the type and abundance of food given to lactating cows may disrupt the interrelated processes of fermentation and absorption in the rumen, which may alter the chemical composition and amount of milk synthesized in the udder. This is especially true when carbohydrate-rich grains, starchy vegetables, and gas-producing legumes are fed in excess, or instead of, fibrous pasture grasses or hay. When converted to volatile fatty acids in the rumen, excess carbohydrates and starches may lower a cow's digestive pH, slowing the reproductive cycle of or even killing off the gut flora responsible for metabolizing the vitamin-A-rich cellulose and hemicellulose present in green pasture grasses and hay. This serves in turn to impair milk synthesis, which requires about 100,000 IUs (or International Units) of vitamin A per day to complete. To be sure, the legumes alfalfa and white and red clover are rich in protein and therefore beneficial for lactating cattle. However, they are also rich in galacto-oligosaccharides -- that is, small, unabsorbed fibrous carbohydrates -- that produce gas when fermented by a ruminant's gut flora. Animals fed an excess of legumes may experience rapid gas accumulation, a condition known as "bloat," that may damage the internal organs, inhibit lactation, and trigger spontaneous abortions in pregnant cows. In some cases, bloat may even kill otherwise healthy animals.[216]

Those wishing to produce an abundance of chemically consistent milk must also manage their animals' nutrition during the so-called "dry period," which separates one lactation cycle from another. Modern dairy scientists divide the dry period into two phases. The first or "far off" phase refers to the period 60 to 21 days out from calving, while the second or "close up" phase refers to the period 21 to 0 days out from calving. Both phases have their own nutritional

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[216] Heather Smith Thomas, *Storey's Guide to Raising Beef Cattle* (North Adams, Massachusetts: Storey Publishing, 2009), 95; "Legumes and Flatulence," Grains & Legumes Nutrition Council, 2019, https://www.glnc.org.au/legumes-2/legumes-and-health/legumes-and-flatulence/.

requirements. During the far off phase, cows must eat about 2.2 percent of their body weight per day in fodder (or about 13 lbs. for a 600-lb. animal), or enough to maintain body condition without putting on fat. During the close up phase, cows eat less food, amounting to 1.75 percent of their body weight (or about 10.5 lbs. for a 600 lb. animal). However, they need more protein, overall, to support fetal growth and udder-tissue development, which may be given in the form of distillers' or brewers' grains, legumes, cottonseed meal, and other high-protein foods. Inadequate nutrition during the dry period will put animals in ketosis (burning fat rather than carbohydrates for energy) and/or deplete protein stores. One or both of these conditions may leave them vulnerable to mastitis, an inflammation of the udder. Indeed, one or both may reduce the quantity and quality of the milk harvest.[217]

Whatever food is given to cattle, at whatever stage in the animals' gestational or lactational cycle, it must always be accompanied by an abundant supply of clean drinking water. Generally speaking, during both phases of the dry period, modern dairy cattle must drink about one gallon of water per hundred pounds of weight per day to remain hydrated. Lactating animals need twice that amount -- about two gallons per one hundred pounds of weight per day -- to maintain hydration while also synthesizing milk. Although the dairy scientist Rick Rasby described these numbers as a useful "rule of thumb," he insisted that cattle's real water needs vary depending on a host of climatic variables, in particular the ambient temperature, which may increase or decrease a cows' thirst. The dairy scientists Michael L. Cooper and Dan N. Waldner concurred with Rasby while citing additional variables -- humidity, water temperature, and the

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[217] "Dry Cow and Transition Cow Nutrition," Milkproduction.com, March 3, 2004, http://www.milkproduction.com/Library/Scientific-articles/Nutrition/Dry-cow-and-transition/; Anna Bradmeuller and Donna M. Amaral-Phillips, "Dry Period: An Important Phase for a Dairy Cow," Dairy Herd Management, November 26, 2018, https://www.dairyherd.com/article/dry-period-important-phase-dairy-cow; Mark L. Wahlberg, "Alternative Feeds for Beef Cattle," Virginia Cooperatve Extension, Publications and Educational Resources, May 1, 2009, https://www.pubs.ext.vt.edu/400/400-230/400-230.html.

moisture content of the animals' feed -- that have a direct impact on cattle's need to drink. So too the Australian dairy scientist John Moran, who noted that dairy cattle need an additional six to seven liters (about 1.5 to 1.8 gallons) of water per day for every four degree increase in temperature. All agree that dairy cattle should be provided with fresh water at all times, to be increased during periods of hot weather.[218]

European and Euroamerican researchers during the first half of the nineteenth century possessed an incomplete knowledge of cattle physiology and nutrition. It was not until the 1830s that the French scientist, Marie Jean Pierre Flourens undertook study of rumination by feeding vegetables, hay, and grains to sheep and then slaughtering and dissecting the animals with an eye to tracing the food's progress through the animals' four-chambered stomachs. Flourens made three discoveries: first, food entering the ruminant stomach following the first chewing was chopped into coarse particles by the teeth yet still recognizable; second, food re-entering the stomach after the second chewing was a less-recognizable paste, having been pulverized by the teeth and "attenuated" with bodily fluids; third, only fluid or "attenuated" foods could pass beyond the first two stomach chambers and into the third and fourth chambers for digestion. This appears to have satisfied British agricultural reformers. In 1837, the British *Quarterly Journal of Agriculture* declared Flourens's experiments "very cruel" yet successful in "clear[ing] up the whole mystery."[219]

[218] Rick Rasby, "Producer Question from 2016," Institute of Agriculture and Natural Resources: UNL Beef, July 19, 2016, https://beef.unl.edu/amountwatercowsdrink; Michael L. Looper and Dan N. Waldner, "Water for Dairy Cattle" (Las Cruces, New Mexico: New Mexico State University Cooperative Extension Service, February 2002); John Moran, *Tropical Dairy Farming: Feeding Management for Small Holder Dairy Farmers in the Humid Tropics* (Collingwood, Victoria, Australia: Landlinks Press, 2005).

[219] "From the Quarterly Journal of Agriculture. The Process of Rumination or Chewing the Cud in Cattle Explained upon the Experiments of M. Flourens," *New York Farmer and American Gardener's Magazine*, April 1837.

Even then, the practical conclusions that *Quarterly* editors drew from Flourens's research evinced a misunderstanding of rumination. Citing the work of a second French scientist, Louis Jean Marie Daubenton, they argued that the fluid attenuation of food during the second chewing robbed sheep and cattle of bodily fluids, disrupting their humoral equilibrium. This was especially true on hot days, when the animals perspired while grazing or ruminating. The results, editors noted, were four-fold and negative: "The body will be dried and the blood exhausted and heated by the loss, while thirst will supervene so as to make them drink till they are incommoded [discomforted], and their temperament altered." Editors' prescriptions were sensible, given the limitations of their knowledge. If rumination depleted the animal of fluids, best to avoid feeding "very dry food" such as hay. Far better to give them fodder that "abound[ed] in liquid, such as mangel wurtzel, a species of beet, or "distiller's wash" and "brewer's grains," the liquid by products of liquor distillation and beer brewing. This was especially true for dairy cattle. The fewer precious bodily fluids they devoted to rumination, the greater quantity devoted to making milk (or so the reasoning went).[220]

Researchers' knowledge of nutrition was likewise incomplete and marred by mistaken assumptions. In 1839, around the same time that Flourens undertook study of rumination, the Dutch scientist Garritt Mulder first recognized that casein, albumin, fibrin, and other so-called "animal substances" -- now known, collectively, as the proteins -- found in muscle tissue, eggs, hair, skin, and bone were organic compounds, composed of 16 percent nitrogen and quantities of Sulphur and phosphorous. From there, European scientists drew the logical, though incorrect conclusion that the only foods capable of giving energy and sustaining human and animal life were those high in nitrogen, such as legumes and meats. Indeed, the German organic chemist

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[220] Ibid.

Justus von Liebig proclaimed protein "the only true nutrient." In doing so, he dismissed the now well-known energy-giving potential of carbohydrates and fats, insisting that their purpose was to absorb excess oxygen taken into the body during periods of exertion, protecting bodily proteins against damage caused by oxidization. At the same time, having no knowledge of vitamins, he attributed nutritional disorders to protein deficiency. Both ideas enjoyed broad favor during the first half of the nineteenth century. At least one Scottish physician proposed that scurvy, a nutritional disorder caused by insufficient intake of vitamin C, could be cured with liberal doses of protein-rich cow's milk.[221]

Using these assumptions as a guideline, American agricultural reformers advised farmers to feed dairy cattle a diet of foods heavy in nitrogen. One sees this in the December 1844 *Cultivator*, which cited von Liebig when assuring readers, "The principal value of any food for the purpose of nutrition is depending on the . . . nitrogen it contains." By way of explanation, editors informed readers that nitrogen served as the basis for the formation of protein-rich body tissues and blood. One may infer that they also referred to milk, which nineteenth-century American researchers recognized as similar to blood in its chemical composition. As an aid to progressive-minded farmers, editors included a table compiled by the French chemist, Jean-Baptiste Boussingault, that showed the nitrogen content of different cattle feeds, with red clover hay standing at the top, "common hay" near the middle, and wheat straw near the bottom.[222] Almost two decades later, in *Cattle and their Diseases*, the veterinary scientist Robert Jennings

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[221] Kenneth J. Carpenter, "A Short History of Nutritional Science: Part I (1785-1885)," *The Journal of Nutrition* 133, no. 3 (March 1, 2003): 638–45; For more on Justus von Liebig, see John Alfred Heitmann, "Justus von Liebig," *History Faculty Publications*, no. 91 (1989).

[222] "Nature of Food, and the Relative Value of Vegetables as Food," *The Cultivator*, December 1844; "Milk and Its Preservation," *Scientific American*, July 2, 1860; For more on Jean-Baptiste Boussingault, see Richard P. Aulie, "Boussingault and the Nitrogen Cycle," *Proceedings of the American Philosophical Society* 114, no. 6 (December 18, 1970): 435–79.

offered near-identical advice. Though he never mentioned von Liebig by name, one detects the German chemist's influence. In calling for farmers to feed dairy cattle a well-balanced diet, Jennings divided foods into the "nitrogenized" (clover, peas, and other legumes), which built blood, bone, and cheesy substance in milk, and the "non-nitrogenized" (starches, sugars, and fats) that "aided respiration."[223]

The extent to which nineteenth-century American farmers knew about any of this, or applied it to dairying operations, would have depended on their access to and engagement with contemporary agricultural texts. Certainly, these texts were available. The historian Sally McMurry's 1989 study of the American agricultural press indicated that farm journals enjoyed a broad readership during the first half of the nineteenth century. The Albany-based *Cultivator*, alone, reached 20,000 subscribers by 1840, among them wealthy progressive farmers, unpropertied tradesmen, and those in between. But then, farmers or the era evinced an open and well-documented disdain for the "book farming" advocated by agricultural reformers and progressive farmers. It may be that farmers read the advice about livestock feeding that appeared in agricultural texts and followed it to the letter. It may also be that they read and ignored said advice. McMurry's research suggests that a middle ground existed between the two extremes, occupied by those who applied the tenets of book farming piecemeal, seeking modest improvement. Whatever the case, practical application of nutritional advice always depended on the whims of the individual.[224]

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223 Jennings, *Cattle and Their Diseases*, 104–10.

224 Sally McMurry, "Who Read the Agricultural Journals? Evidence from Chenango County, New York, 1839-1865," *Agricultural History* 63, no. 4 (Autumn 1989): 1–18; For more on supporters and opponents of "book farming" in nineteenth-century America, see Benjamin R. Cohen, *Notes from the Ground: Science, Soil, and Society in the American Countryside* (New Haven: Yale University Press, 2009), 49–80.

Generally speaking, farmers in the South and Old Northwest fell into the latter category, showing little or no attention to cattle feeding and nutrition. In both regions, fencing laws required farmers to fence crops rather than animals. This left cattle to roam at will, taking advantage of indigenous and invasive plant species to satisfy their hunger.[225] To be sure, some of these were nutritious and supportive of milk synthesis. The stands of giant river cane that flourished in river bottoms of the Eastern states furnished dairy cattle with phosphorous, calcium, and crude protein, all three of which were essential building blocks of the good, sweet milk that nineteenth-century Americans craved. Moreover, the invasive bluegrass that followed Euroamerican settlers and their livestock, replacing the canebrakes, was nutritious in its own right, especially when combined, either purposefully or on accident, with nitrogen-rich red or white clover. A mixture of seventy-three percent bluegrass to twenty-six percent clover is about twelve percent crude protein, and about fifty-six percent hemicellulose and cellulose (carbohydrates), both of which lactating cows needed to synthesize an abundance of good milk.[226] If the Louisville physician Daniel Drake's, memoir of Kentucky frontier life are any indication, free-range animals yielded enough milk during the summer and fall to satisfy family demand while also leaving a modest surplus for market production of cheese and butter.[227]

This feeding system, if it may be described as such, proved workable even during the dry period that separated lactational cycles. In his 2003 study of Creek Indian economy and ecology,

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[225] Such practices was not exclusive to the South and Northwest. See "Review of the May Number of the Agriculturalist," *American Agriculturalist*, July 1850; See also Charles J. Folger, *Letter from the Secretary of the Treasury, Transmitting in Response to Senate Resolution of February 10, 1882, the Report of the Treasury Cattle Commission on the Lung Plague of Cattle, or Contagious Pleuro-Pneumonia* (Washington, D.C.: Government Printing Office, 1882), 22.
[226] Robbie Ethridge, *Creek Country: The Creek Indians and Their World* (Chapel Hill: University of North Carolina Press, 2003), 49–50, 90, 165; Donald Worster, "Transformations of the Earth: Toward an Agroecological Perspective in History," *The Journal of American History* 76, no. 4 (March 1990): 1087–1106; Marvin H. Hall, "Kentucky Bluegrass," Agronomy Facts 50 (College Park, Pennsylvania: The Pennsylvania State University College of Agricultural Sciences, 1996).
[227] Drake, Pioneer Life, 11, 44.

the historian Robbie Ethridge noted that the giant river cane favored by cattle retained its nutritional value throughout the year. Indeed, the plant grew more soft and pliable during the fall and winter months, making it easier for foraging cattle to break apart and chew.[228] Wild pea vine (or *Amphicarpaea*), also known as the "hog peanut," served alongside giant river cane as the most important source of winter nutrition for free-range cattle. A nitrogen-fixing legume common to damp, shaded hillsides, wild pea vine flourished in the states of the South and the Old Northwest. In April 1857, a correspondent to the *New-York Tribune* identified only as "G.A.B." noted that free-range beef and dairy cattle in and about Fillmore, Missouri, "subsist[ed] during the Winter season entirely on the rushes and wild pea-vines which are found in abundance." He insisted, the animals suffered no ill effects, and appeared better off than those fed a winter diet of hay and corn.[229]

The correspondent G.A.B.'s comments notwithstanding, free-range dairy cattle almost certainly suffered from chronic malnutrition. Indeed, the historical record abounds with references to the "starved and miserable" cows, forced to scrounge in the woods and meadows of the South and the Old Northwest.[230] The animals' poor condition may be attributed to a simple energy imbalance. With every step that lactating, free-range cows took in search of the river cane, wild pea vine, meadow grasses, and other foods that sustained them, they expended caloric energy in excess of that needed for chewing, drinking, ruminating, grooming, and milk

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[228] Ethridge, *Creek Country*, 164; For more on giant river cane, see M. Kat Anderson and T. Oakes, "Plant Guide for Giant Cane *Arundinaria gigantea*" (Greensboro, North Carolina: United States Department of Agriculture Natural Resources Conservation Service, National Plant Data Team, February 2012).

[229] Asa Gray, "Notes of a Botanical Excursion to the Mountains of North Carolina, &c.; with Some Remarks on the Botany of the Higher Alleghany Mountains," *The American Journal of Science and Arts* 42, no. 1 (April 1842): 28; G.A.B., "Iowa. The Winter--Cattle Starved and Frozen--Free State Prospects," *New-York Daily Tribune*, May 14, 1857.

[230] O.P.Q., "Farm Stock," *Genesee Farmer and Gardener's Journal*, May 14, 1836; "Lieut. W.S. Hancock in Florida," *Southern Utonian*, December 2, 1887; Daniel Dupre, *Alabama's Frontiers and the Rise of the Old South* (Bloomington, Indiana: Indiana University Press, 2018), 180.

synthesis.[231] Modern studies show that moderate exercise, equivalent to a cow's traveling 7.5 km (or about 4.5 miles), will cause a two- to three-percent decrease in the fat content of their milk. More strenuous exercise, equivalent to a cow's traveling 40 km (about 25 miles) may reduce the length of the lactation cycle and the volume of milk produced by almost 50 percent.[232] The same rules applied to cows during the dry period. As winter forage dwindled, dry cows were apt to enter into metabolic ketosis.

Northeastern farmers took a more deliberate approach to feeding. Beginning in the second decade of the nineteenth century, a series of transportation improvements -- canals, steamships, and railroads -- made it easier and cheaper to ship staple crops grown in the rich, fertile prairie soils of the Great Lakes Region to eastern and international markets. Unable to coax a similar abundance from their region's rocky soils, and thus unable to compete with Western staple producers, Northeasterners had turned to a more mixed agriculture by the 1830s, centered on the cultivation of vegetable and fodder crops, livestock husbandry, and the production of fluid milk and milk by-products for market. Of these, butter and cheese production proved especially lucrative, thanks to a consumer demand for both products that originated in the milk-poor Southern states. Whether or not they paid much attention to Liebig's laws of nutrition, Northeasterners knew from practical experience that well-fed cattle yielded a greater abundance of high-fat, high-protein milk coveted by American milk, butter, and cheese consumers. This meant turning dairy cattle out to graze on cultivated grass and legume pastures

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[231] For evidence that nineteenth-century cattle roamed for days at a time, covering unknown distances, see Cline West, *Life and Travels*, 13.
[232] Pratumsuwan, "Effect"; Luisa Magrin et al., "Physiological and Productive Response," 151–56.

during the summer and fall, and then feeding the animals a diet of hay, root vegetables, and grains during the winter and spring dry period.[233]

This system worked well, at least for a few decades. Though ill-suited to the plow and the ox team, the rock-infested fields, steep hillsides, and swampy marshes that made up so much of the rural Northeastern landscape supported lush stands of pasture grasses, such as Timothy and red top, and legumes such as red and white clover and lucerne (alfalfa). Using the hay harvest as a unit of measure, the agricultural historian Homer L. Kerr noted that timothy pastures yielded between two and three tons of cattle feed per acre during the first half of the nineteenth century, while clover yielded between one-and-one-half to three tons.[234] Fed in tandem, and supplemented with salt that replenished sodium lost to perspiration, rumination, and milk synthesis, these grasses and legumes offered Northeastern dairy cows all of the carbohydrates and proteins needed to support abundant milk production, within the confines imposed by individual animals' physical condition and genetic makeup.[235] No less important, grasses and legumes emerged from cows' digestive tracts as nitrogen-rich dung, which could be spread over fields to restore soil nutrients and increase fodder and grain yields. Agricultural reformers North and South championed manuring, as the practice was known, as critical to the long-term health and productivity of American soils.[236]

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[233] For works that describe this transition, see John Donald Black, *The Rural Economy of New England: A Regional Study* (Cambridge: Harvard University Press, 1950), Percy Wells Bidwell and John Ironside Falconer, *History of Agriculture in the Northern United States, 1620-1860* (Boston: A. M. Kelly, 1973), and Sarah Sutton, "Milk: A New England History" (Dissertation, Waltham, Massachusetts, Brandeis University, 2016).

[234] Homer L. Kerr, "Introduction of Forage Plants Into Ante-Bellum United States," *Agricultural History* 38, no. 2 (April 1964): 89, 94; By way of comparison, U.S. farmers harvested between two and three tons of hay per acre, on average, in 2017. See Mike Rankin, "USDA: There's Less Hay," Hay and Forage Grower, January 16, 2018, https://www.hayandforage.com/article-1742-usda-there's-less-hay.html.

[235] "Added Sodium Essential to Keep Cows Healthy," NRM Feed to Succeed, November 6, 2017, https://nrm.co.nz/2017/11/06/added-sodium-essential-keep-cows-healthy/.

[236] Stoll, *Larding*, 122, 156.

Providing for cattle during the animals' dry period proved more challenging. Here again, the problem was both economic and ecological in origin. In taking up dairy production as a specialized trade, Northeastern farmers committed their bodies (along with those of their family and hired hands), their soils, their future profits, and their financial solvency to the long-term maintenance of bovine health. This included the winter and early spring months, when the animals took in food, took up time, and took up space without yielding enough milk to pay for their upkeep. Unlike Southerners, who enjoyed frost-free weather conditions for as many as 240 days of the year, followed by mild winters, Northeasterners faced short growing seasons, followed by long, bitter-cold winters. As a rule, farmers in New York and Massachusetts had 185 days to grow and harvest the hay, grain, and root vegetables needed for feeding cattle during the dry period. This left 180 days, give or take a late frost, to store up winter and spring fodder for their animals. The further north and east one moved, the shorter the growing season and with it, the greater the pressure to fill haylofts and root cellars with an abundance of fodder crops. Dairy farmers in Vermont, New Hampshire, and Maine had anywhere from 115 and 145 days to complete winter preparations. This left their animals to rely on stored fodder for 220 days, at best, and 250 days, at worst.[237]

Haying was an onerous task that required a large labor force and precise timing to do well. In a July 18, 1846, letter to the American Institute, the New York farmer R.L. Pell recounted the method by which he, along with seven men and one boy took seven days to transform a thirty-acre field of Timothy grass into seventy-five tons of hay for winter fodder. By

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[237] "Tennessee," Britannica, https://www.britannica.com/place/Tennessee/Climate; Steve LaPointe, "The Growing Season – When You're Safe to Plant This Spring," 6 News WRGB Albany, 30 March 2022, https://cbs6albany.com/weather/weather-extra/the-growing-season-when-youre-safe-to-plant-this-spring; Ryan Breton, "Maine's Climate: Growing Season," News Center Maine, 7 November 2019, https://www.newscentermaine.com/article/news/local/morning-report/maines-climate-growing-season/97-7bf0d6f3-92d9-416e-967b-62c8a0d0c36d.

Pell's account, the laborers began work each morning at 4:30 a.m. and worked until 3:00 pm. In doing so, they adhered to an orderly system. The first step saw workers cut the grass, most likely with hand scythes, and then spread it "as thin as possible over the field" to dry. The second step, completed before noon, saw laborers turn the cut grass with pitchforks to ensure that it dried evenly on both sides. Around one p.m., the laborers raked the cut grass into windrows and then gathered it into conical-shaped heaps or "cocks." Around two p.m., the men commenced loading the hay into wagons and then "drawing" it to the barn. Once there, they "packed and cured" the hay with "half a bushel to one bushel per ton of salt per ton" of hay, which "drew off water (about 14 percent total) in the same manner that it did with pork or beef," preventing decomposition. Editors of the October 15, 1846, *The Farmer's Cabinet* referred to Pell's efforts as "a very pretty specimen of rapid hay gathering." Indeed, his account appears to have captured the basic mechanics of haying.[238]

Orderly and efficient as farmer Pell made it sound, much could and did go wrong with the hay harvest. Farmers who cut and dried grasses, clover, or alfalfa too early in the season, before the plants reached full maturity, risked low yields. Those who waited too long in the season, after the plants became tall and "stemmy," to borrow a descriptive term used by modern agricultural extension agents, risked losing the proteins and carbohydrates vital to bovine nutrition and milk synthesis, which decreased after the plants reached maturity. Those who stored grass and legume hay too soon after cutting, before ultraviolet sunlight reduced the moisture content to about 30 percent, risked propagating molds that made the hay unpalatable and in some cases, dangerous for animals to eat. Those who left it in the sun too long risked bleaching, which left proteins and carbohydrates intact, but reduced the hay's carotene (that is,

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[238] "Hay Making," *The Farmers Cabinet and American Herd Book; Devoted to Agriculture, Horticulture, and Rural Economy*, 15 October 1846: 87.

vitamin A) content. The greatest risk to the harvest was also the least predictable: sudden storms that fell after the cutting, but before farmers could dry, gather, and store the hay. Falling water leached away the carbohydrates, vitamins, and nutrients while prolonging "respiration," a process that decreased the amount of dry matter. Both reduced the hay's nutritive value and in some cases, destroyed it altogether.[239]

Recognizing that grass and legume hay could and did vary in quality and quantity from farm to farm, it would appear that Northeasterners harvested more than enough of the stuff to keep their animals well fed during the winter/spring dry period. If the recommendations included in the January 28, 1863, *Zion's Herald* are any indication, dairy cattle of the era needed to eat about twenty pounds of hay per day to maintain condition during the winter.[240] Census data indicates that in 1850, farmers in Massachusetts harvested 651,807 tons (or 1,303,614,000 lbs.) of hay. Assuming a hay-feeding season of 180 days' duration, this would have been enough to give each of the commonwealth's 130,099 dairy cows 55 lbs. per day. The numbers were similar to the west, in neighboring New York State, with farmers harvesting 3,728,797 tons (7,457,594,000 lbs.) of hay, or enough to feed each of the state's dairy cows 44 lbs. per day for 180 days. To the south, in Connecticut, farmers harvested 516,131 tons (1,032,262,000 lbs.), enough to feed each of the state's 85,461 dairy cows an impressive 67 lbs. per day for 180 days.

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[239] Jimmy C. Henning and Howell N. Wheaton, "Making and Storing Quality Hay," University of Missouri Extension, October 1993, https://extension2.missouri.edu/g4575; Bruce Anderson, "Plan When to Cut Grass Hay," Institute of Agriculture and Natural Resources: UNL Beef, June 2015, https://beef.unl.edu/plan-when-to-cut-grass-hay; Brian Pugh, "What Is the Effect of Rain Damage on Hay?," Dairy Herd Management, June 29, 2017, https://www.dairyherd.com/article/what-effect-rain-damage-hay; S. Ray Smith, "Understanding and Reducing Mold Growth in Hay," University of Wisconsin-Madison, Team Forage Division of Extension, n.d., https://fyi.extension.wisc.edu/forage/understanding-and-reducing-mold-growth-in-hay/; Sid Bosworth and Dan Hudson, "Sensory Evaluation of Hay for Quality," University of Vermont Extension, Cultivating Healthy Communities, accessed June 2, 2020, https://pss.uvm.edu/vtcrops/articles/Sensory_Evaluation_Hay_UVM.pdf.

[240] "House and Farm," *Zion's Herald and Wesleyan Journal*, 28 January 1863, 16.

Supplemented with turnips, potatoes, and grain, as it would have been, this would have been more than enough to stave off ketosis.[241]

The problem, of course, was that demand for the region's hay crop extended beyond the dairy herds that roamed over Northeastern farms. Across the region, horses, mules, work oxen, beef cattle, and sheep ate their share of hay during the winter. Those that performed heavy winter labor -- for example, the ox teams that hauled timber down from the hillsides -- needed more than the 20 lbs. recommended by *Zion's Herald*.[242] Returning to Massachusetts, the 1850 hay crop, portioned out to all 490,898 of the Commonwealth's hay-dependent animals in equal shares, would have amounted to 14 lbs. per animal per day over a 180-day hay-feeding season. Over the same time period of time, Connecticut's 413,785 hay-dependent animals would have received 14 lbs. of hay per day, while in New York, the state's 5,778,857 animals would have received just 7 lbs. Likely they received less; the demand for fodder emanating from the region's urban centers absorbed a portion of the rural hay crop. Consider antebellum New York, which boasted about four work horses for every twenty-six people. In 1850, the human population of Manhattan Island was 515,547 persons, which placed the horse population around 79,312 animals. Assuming that each animal consumed 15 lbs. of fodder per day, they would have eaten about 434,233,200 lbs. (or 217,116 tons), about two-thirds of the state hay crop, for the year. Doubtless the horses of Boston, Hartford, New Haven, Albany, and other cities created a similar demand for hay.[243]

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[241] J.D.B. DeBow, *Seventh Census of the United States: 1850* (Washington: Government Printing Office, 1853), 60, 84, 124.

[242] Contemporary sources noted that a 1,500-lb. ox needed a minimum of 30 lbs. of hay per day when *not* working. See "House and Farm," 16.

[243] DeBow, *Seventh Census*, 58-59, 83, 121-122; Clay McShane and Joel Tarr, "The Horse as an Urban Technology," *Journal of Urban Technology* 15, no. 1 (2008): 5–17; "Total and Foreign-Born Population New York City 1790-2000," New York City Department of City Planning Population Division," n.d.,

The winter hay deficit was even more pronounced in northern New England, which had a shorter growing season. In 1850, New Hampshire farmers harvested 598,854 tons (1,197,708,000 lbs.) of hay. Based on a 250-day hay-feeding period, the state's hay harvest would have fed the recommended 20 lbs. of hay per day to 5,000 animals. And yet, in 1850, New Hampshire farmers claimed 686,918 horses, mules, milk cows, oxen, beef cattle, and sheep, all of which needed winter fodder. The numbers were more favorable in Vermont, with the state's 866,153 tons (1,732,306,000 lbs.) of hay being sufficient to give each of the state's 1,424,975 animals about 5 lbs. per day over a 20-day hay-feeding season, and Maine, with the state's 755,889 tons (1,511,778,000 lbs.) being sufficient to give each of that state's animals about 7 lbs. of hay per day over the same period of time. Nevertheless, assuming that farmers in both states sold hay to urban markets and timber-cutting crews that worked the region's forests, neither would have had enough hay on hand to meet dairy cows' most basic nutritional needs during the winter dry period, much less furnish the animals with enough food to recoup losses to lactation and maintain good condition.[244]

But then, even when Northeastern farmers had a good supply of fodder on hand, they evinced a lackadaisical attitude about feeding it to their animals. As late as 1850, editors of the New York-based *Wool Grower* complained that cattle owners strewed hay on the ground, rather than placing it in feeding troughs, to be trampled by hungry cattle. If editors' estimates be accurate, this resulted in the waste of one-quarter, if not more, of the fodder harvest. Editors of the April 1852 *New England Farmer* concurred. Indeed, they divided the region's farmers up into three groups, all problematic: those "who have no system whatever"; those who "having the

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https://www1.nyc.gov/assets/planning/download/pdf/data-maps/nyc-population/historical-population/1790-2000_nyc_total_foreign_birth.pdf.

[244] DeBow, *Seventh Census*, 12-13, 26-27, 41-42.

barn adjoining the wood-house, and quite handy, '*run out every once in a while and shake up a little*'"; and those who were inclined to "throw down a good stout foddering and let [cows] grind away upon it," without regard to the animals' actual needs. The editors of *Scientific American* offered a similar lament that October, noting that American farmers "badly managed" their animals' winter feeding. The problem as they saw it was two-fold. Farmers seldom kept to a regular feeding schedule, choosing instead to feed animals when it "suit[ed] the parties in charge." Cattle that endured long, indeterminate periods of hunger responded to the comings and goings of their handlers by rushing to them in hopes of obtaining food, preventing the animals' resting and ruminating.[245]

More troubling still, farmers showed little inclination to balance their animals' intake of carbohydrates and proteins, as prescribed by von Liebig and agricultural reformers. Rather, they fed whatever they had on hand, or were willing to retrieve from the barn, at any given moment. According to editors, some farmers fed hay "in large quantities at one time, with the injunction to let them have no more till they have finished what they have got," while others gorged their animals on turnips, causing the animals to experience gastrointestinal distress.[246] Such practices persisted into the 1860s. Writing in 1863, the veterinary scientist Robert Jennings complained of farmers' disregard of balanced nutrition, noting that some gave "hay alone, and oftentimes very poor hay at that," while others emptied the contents of their root cellars -- carrots, mangold wurtzel, and turnips -- into their cattle's troughs.[247]

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245 "From the Wool Grower. Winter Feeding," *Valley Farmer*, October 1850; "Feeding Cattle," *The New England Farmer; a Monthly Journal*, April 1852; "On Cattle Feeding," *Scientific American*, 9 October 1852, 30.
246 Ibid.
247 Jennings, *Cattle and Their Diseases*, 112.

Northeastern pastures yielded less and less of the verdant summer fodder and sweet-smelling hay that were the backbone of proper dairy nutrition with each passing year. The environmental historian Brian Donahue blamed this declension on emerging capitalist market demands, which changed Northeasterners relationship to the soil. in part, on poor soil stewardship -- specifically, Northeastern farmers failure to spread nitrogen-rich manure over their pastures. However, he also attributed it to mismanagement, noting that the region's pastures were "badly grazed." Where modern farmers now shift grazing cattle from pasture to pasture, giving grasses and legumes time to regrow, their counterparts in the nineteenth-century Northeast left the animals confined in one place for days, weeks, or months on end. Given no other choice, cattle stripped the ground bare, giving coarse grasses and weeds an opportunity to sprout and flourish. "Under this dispensation," Donahue noted, "the cows . . . returned to the sweet, palatable plants as fast as they could resprout and let the coarse stuff grow up unmolested all around." The result were scrubby, weed- and shrub-choked pastures that farmers had "actively unimproved."[248]

Dairy husbandry and soil stewardship were complementary. Done properly, the Colbyville, Kentucky, farmer noted in November 1840, the farmer need not worry himself and his hands with the tiresome, time-consuming task of carting manure from the barn and spreading it over pastures and fields. Rather, they should turn animals out to graze on "lands that will some day be ploughed." This allowed cow dung to drop "where it will be wanted to nourish the succeeding crops," so soon as the farmer chose to rotate acreage out of pasture and into corn, oats, rye, or some other grain crop.[249] Some described manuring as possessing almost magical

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[248] Brian Donahue, *Reclaiming the Commons: Community Farms and Forests in a New England Town* (New Haven: Yale University Press, 1999), 129–30.
[249] Samuel D. Martin, "Laying Down Open Lands in Grass--Kentucky Rotation--Stock Fodder, Manuring, and Grazing--Curing Clover Hay," *Farmer's Register; A Monthly Publication*, January 31, 1841.

powers. One George C. Gilmer wrote to *The American Farmer* in August or September 1857 to report success in using "stable manures" to revive "the poorer spots in my grass fields." Noting that he used this technique to produce "as heavy a crop of hay as I ever saw grow upon any high land," he advised, "There is no spot that cannot be made to produce well in grass thus liberally dealt with."[250]

As the nation neared the mid-point of the century, at least some farmers had embraced the cycling of manure, pasture grasses, and grains. In November 1857, the Philadelphia-based *Plough, the Loom and the Anvil* published a letter written by an unnamed Westerner (perhaps native to Missouri), following a tour of New England. The letter writer marveled at the fat, sleek, and generally large" cattle that roamed the region's well-tended pastures. He attributed the animals' good health to farmers' habit of spreading manure and feeding all of the hay and grain produced to their animals. He concluded with an admonition: "Let the western farmer take heed in season."[251]

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Beginning in 2000, the California Milk Advisory Board launched a new commercial tagline -- "Great milk comes from happy cows. Happy cows come from California" -- with the goal of attracting a broad national consumer base for the state's dairy products, in particular, cheese. Accompanying the tagline were humorous television ads, one of which featured a series of Holstein cows, all possessed of names, personalities, and human voices, auditioning for a spot as the "next happy California cow." The presumed *unhappiness* of four of the five contestants centered on the animals' dissatisfaction with their physical surroundings. An English cow,

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[250] George C. Gilmer, "Surface Manuring--Lime Experiment," *The American Farmer, a Monthly Magazine of Agriculture and Horticulture*, September 1857.

[251] "Spirit of the Agricultural Press," *Plough, the Loom and Anvil*, November 1857.

"Shelby," addressed viewers while standing, obscured, in a damp, roiling fog that she hoped to exchange for sunnier climes. So too a Canadian cow, "Kirsten," who stood shivering in a frozen, snow-covered pasture, her muzzle caked in ice, surrounded by howling wolves. A South Korean cow, "Soo," envisioned herself grazing in lush California pastures that she dubbed "never-ending fields of happiness and joy." A fourth cow hailing from Manhattan (or perhaps New Jersey), "Destiny," hoped to trade her crowded, urban surroundings for "exclusive grazing rights in her own field of alfalfa," as well as a promise that other cows would never look at, speak to, or approach her.[252]

Recognizing that the California "Happy Cows" campaign did much to conceal the abuses and exploitation of dairy cows by the modern, commercial dairy industry, the accompanying television advertisement carried more than a grain of truth. Happy cows *do* make more and better milk than unhappy cows. As indicated in the previous section, an abundant, well-balanced diet and clean drinking water go a long way toward ensuring that cows are happy -- or "content," to use a less anthropomorphic term -- and capable of synthesizing an abundance of chemically consistent milk, within certain genetic limits. Yet nutrition, alone, is insufficient to promote and maintain bovine contentment and with it, an abundant supply of good milk. For all of their size and strength, dairy cows are surprisingly fragile, both physically and emotionally. The animals do best when given access to clean, comfortable housing and well-shaded pastures, free from

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[252] RealCaliforniaMilk. "Auditions - Shelby." YouTube Video, 0:33. 19 December 2011. https://www.google.com/search?q=california+happy+cow+shelby+kirsten+soo+&client=safari&rls=en&ei=Nc2DY6WaOr6RwbkP3darmAQ&ved=0ahUKEwjliJKQns_7AhW-SDABHV3rCkMQ4dUDCA8&uact=5&oq=california+happy+cow+shelby+kirsten+soo+&gs_lcp=Cgxnd3Mtd2l6LXNlcnAQAzIFCCEQqwJKBAhBGAFKBAhGGABQgAJYgAJg9QRoAXAAeACAAWeIAWeSAQMwLjGYAQCgAQHAAQE&sclient=gws-wiz-serp#fpstate=ive&vld=cid:49f5e256,vid:Xij_FZO_WOs; RealCaliforniaMilk. "Auditions - Kirsten." YouTube Video, 0:32. 19 December 2011. https://www.youtube.com/watch?v=YxSASItLQY4; RealCaliforniaMilk. "Auditions - Soo." YouTube Video, 0:35. 19 December 2011. https://www.youtube.com/watch?v=kkqWt6n-1NY; RealCaliforniaMilk. "Auditions - Destynee." YouTube Video, 0:30. 19 December 2011. https://www.youtube.com/watch?v=aLLQeOrIf94.

sudden and chronic noises and physical abuse. Conversely, startling, frightening, or stressing the animals may inhibit milk synthesis in the udder while damaging the fluid's chemical structure, speeding decomposition. It does occur that stressed, agitated cows will flee from their human caretakers and/or hold up their milk. Under extreme physical and emotional duress, the animals may cease lactating or "dry up."[253]

Nineteenth-century Americans recognized that a correlation existed between dairy cattle's physical and emotional comfort and the quality and abundance of their milk. Indeed, agricultural reformers made repeated calls for farmers to approach their animals with a spirit of gentleness and efficiency, beginning each day at milking time. Among those who did so, editors of the July 8, 1852, *Maine Farmer* admonished farmers, "Milking should be performed gently, not harshly," lest the offended animal "bring into action her faculty of retaining her milk at pleasure." They recommended further that farmers view each of their cattle as unique individuals, some of which were bold, some of which were skittish, some of which were ticklish, and yet all of which enjoyed a brief massage of their udder and teats with lukewarm water before milking commenced. Seven years later, in November 1859, *Independent* editors offered similar advice, urging farmers to "approach the cow gently, to say a kind word as you seat yourself by her," and then "milk as fast as you conveniently can," always using a light touch. Recognizing that some animals were more apt to return the kindness than others, they added that it was always best to use a well-placed shoulder or arm to prevent belligerent or startled cows from kicking over and spilling the milk pail.[254]

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[253] Bertenshaw and Rowlinson, "Exploring Stock Managers' Perception of the Human-Animal Relationship," 59–69; Valenze, *Milk*, 1, 293, n. 1; "Milk Let-Down," *DairyNZ*, n.d., https://www.dairynz.co.nz/milking/dairy-stockmanship/milk-let-down/; "Effects of Noise on Cattle Performance."

[254] "Agricultural," *The Independent . . . Devoted to the Consideration of Politics, Social and Economic Tendencies, History, Literature, and the Arts*, November 24, 1859; "Farm Fences," *New York Observer and Chronicle*, June 12, 1856.

Modern studies suggest that nineteenth-century American agricultural reformers were correct in their recommendations. Citing records compiled by modern dairy operators in Switzerland, England, and Vermont, the social historian Deborah Valenze noted that "cows respond to sensitive, personalized handling; they're acutely aware of environmental factors, particularly so in the incongruous realm of modern milking machinery." Indeed, the annual milk yield of those treated by their human handlers with "respect and affection," which included the giving of names and the recognition of individual animals' very real emotions, "averaged slightly more than sixty-eight gallons higher than in less friendly settings."[255] Since then, the agricultural scientists Catherine Bertenshaw and Peter Rowlinson have confirmed that a correlation does exist between the productivity of dairy cattle and the behavior of the people who tend to their needs. Those who subjected their cattle to abuse of neglect, they argued, could expect to harvest less milk per cow over their course of the animals' productive years. Conversely, and in keeping Valenze's findings, "good, caring farmers" who placed "more importance on the individual, such as calling a cow by her name or interacting more with the animal as it grows up" improved the animals' lives and increased the milk harvest.[256]

The consequences of gentle or rough handling of cows by their human caretakers go beyond the volume of milk harvested. Though seldom acknowledged by historians, poor handling may alter the chemical composition of a given animal's milk. To understand why, it is necessary to know something of the bovine stress response. Dairy cows' bodies respond to physical and emotional stressors -- loud noises; slaps and punches delivered by impatient human handlers; butting and jostling by larger, more aggressive herd mates; and even sudden changes to

[255] Valenze, *Milk*, 1.
[256] Bertenshaw and Rowlinson, "Exploring Stock Managers' Perception of the Human-Animal Relationship," 59–69; Valenze, *Milk*, 1, 293, n. 1.

familiar daily routines -- by flooding the bloodstream with the stress hormones adrenaline and cortisol, initiating the so-called "fight or flight" response. Though useful in helping the animal evade danger, these hormones cause undesirable side effects. The release of adrenaline at milking time causes a tightening of the sphincter muscles that connect the mammary gland with the teats, preventing milk from entering the teat. Because the last milk to leave the animal is about 10 percent higher in fat than the rest, the harvest may be less nutritious and less suited to domestic and market uses. The stress hormone cortisol depresses the immune system, leaving animals vulnerable to mastitis (inflammation of the udder) and other diseases. At the same time, it increases incidence of somatic cells (white blood cells) in milk, altering the fluid's taste and aroma and increasing perishability.[257]

Perhaps because they were indifferent to the suffering of animals, perhaps because they took a Cartesian view of livestock as soulless, organic machines, perhaps both, nineteenth-century American farmers' inclination was to ignore such appeals. Indeed, they appear to have interpreted cows' holding up their milk as an act of rebellion, necessitating the use of force, up to and including the infliction of pain. A correspondent to the August 22, 1850, *Maine Farmer* revealed his technique for persuading a reluctant cow to give down her milk: using one's body weight and digging one's elbows into her back, forcing it down and (presumably) preventing her from tightening her sphincter muscles. A few repetitions, the writer noted, conditioned the cow, such that the mere placing of one's hand on her back caused her to "give way."[258] Another correspondent, this one in 1856, described his own technique: giving the teats of stubborn

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[257] "Stress - Health and Productivity," AHDB Dairy, 2020, https://dairy.ahdb.org.uk/technical-information/animal-health-welfare/mastitis/symptoms-of-mastitis/stress-health-and-productivity/#.Xtjs262ZNp8; D.N. Akam, Francis Dodd, and J. Quick Armand, "Milking, Milk Production Hygiene and Udder Health (FAO Animal Production and Health Paper)," 78 (Food and Agriculture Organization of the United Nations, 1989).
[258] "Cows Have the Power to Hold Up Their Milk," *Maine Farmer*, August 22, 1850.

animals a "good *yank*." This, he insisted, "either wearie[d] the muscles used in holding up the milk . . . or perhaps, the cow thinks . . . she had better give down her milk than have her dugs torn out by the roots." Still another noticed that cows flinched away from a sharp stick held over their backs, making it difficult for them to hold up their milk. With this in mind, he devised a sharpened board attached to a leather hinge that could be lowered over the backs of recalcitrant cows at milking. He dubbed the experiment a success, noting that it had "entirely cured" his animals of "the evil habit."[259]

The Louisville physician, Daniel Drake's, memoir of life on the Kentucky frontier suggests that the interaction between free-range dairy cows and their human caretakers was even more charged. Only one member of the family's dairy herd, the bell cow, Brindle, enjoyed a peaceful relationship with her human caretakers. Each morning, she stood just outside the cabin door, waiting for Drake's mother, Betsey, to draw off her milk, which the animal gave down without complaint. In return for the cow's cooperative behavior, Betsey rewarded her with a treat of kitchen "slop." The young Drake likewise used the promise of food to draw Brindle's semi-feral herd mates in from the surrounding meadows and forests at milking time. This failing, however, he used threats and physical abuse to force compliance. Under the watchful eye of his mother and sister, Drake used a stout stick to "drive [the animals] into a corner of the fence" and then hold them there, stress hormones cascading throughout their bodies, while one or both women drew off their milk.[260] This likely required some of the teat yanking, back gouging, or like techniques to force down the animals' milk. It almost certainly resulted in a less abundant, fat-poor milk harvest.

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[259] "Straighten Their Backs," *Maine Farmer*, 4 September 1856.
[260] Drake, *Pioneer Life in Kentucky*, 3, 44.

Looking back, it is clear that some nineteenth-century American farmers and their dairy cattle were locked in a negative feedback loop. The former used pain-based techniques to extract milk from cows. The latter came to fear and loath their human caretakers, prompting their bodies, via autonomic processes, to hold up their milk. This incited anger and impatience in their caretakers, leading to more mistreatment. So it went, around and around. To be fair, farmers of the era knew nothing of the bovine endocrine system, or its role in choking off the flow of milk from udder to teats. Yet, to excuse farmers' behavior as the product of mere ignorance would be to overlook agricultural reformers' economic and humanitarian appeal to kindness. It would also be to overlook the growing, well-publicized animal welfare movement, centered in the urban Northeast, that called for treating livestock with dignity and respect. Speaking from his Brooklyn, New York, pulpit in 1864, the Congregationalist minister, abolitionist, and farmer, Henry Ward Beecher, decried Americans' habit of exposing "the beasts of burden that minister to life and comfort" to "attention that distresses them." Though he referred to the abuse of urban draft animals, his sympathies extended to all beings, including even insects and spiders.[261]

Worse than physical abuse, at least in Beecher eyes, was the general neglect of livestock by American farmers, which he referred to as "cruel." This neglect took many forms, among them, the long-term exposure of dairy cows and calves to cold winter weather. Such was common in the Northwest and South, where farmers left cows to shift for themselves, free from human oversight. A correspondent to the May 1843 *Prairie Farmer* complained that Illinois

[261] "The Wanton Destruction of Insects (Henry Ward Beecher)," *Zion's Herald and Wesleyan Journal*, September 7, 1864; "Ward Beecher Farming," *Ballou's Pictorial Drawing-Room Companion*, July 9, 1859; For more on Henry Ward Beecher, see Debby Applegate, *The Most Famous Man in America: The Biography of Henry Ward Beecher* (New York: Doubleday, 2006); For more on the American animal welfare movement during the first half of the nineteenth century, see Diane L. Beers, *For the Prevention of Cruelty: The History and Legacy of Animal Rights Activism in the United States* (Athens, Ohio: Ohio University Press, 2006), 39–58.

cattle often endured the winter cold, snow, and winds without shelter. "Such management" they noted, was "enough to make [the animals] 'yield up their fair proportions and sometimes life itself'." Though Northeasterners placed more focus on building dairy barns and sheds, they were hardly immune to such behaviors. In December 1853, the New Hampshire-based *Granite Farmer* observed that state abounded with "calves, yearlings, and two-year-olds," left "shivering or shaking in the fields or yards . . . often into December." The growth of such animals, they warned, was liable to be "stunted," ensuring that they never reached their full potential as milk cows or work oxen.[262]

Dairy cattle also suffered neglect during hot summer weather, much of it centered on the relative scarcity of clean drinking water. As he passed through Albion, Illinois, in 1819, the English writer William Faux observed that farm families kept too little water on hand to complete their own washing, much less provide lactating dairy cows with the many gallons per day that they needed to remain hydrated while also synthesizing milk. Desperate with thirst, the dehydrated animals "strayed away for some days in search of water," leaving the locals, and Faux, without any milk to eat, drink, or use for medical care. Agricultural journals of the era abounded with such stories. The August 3, 1833 *Genesee Farmer* told of a good cow, quite capable of yielding five gallons of milk per day, that had been ruined by lack of clean drinking water. By way of explanation, editors noted: "She is supplied with water from a pump, *occasionally*, when her attendants conceive she wants it -- not when *she* thinks she wants it." In February 1857, the St. Louis-based *Valley Farmer*, noted that in Missouri, "farmers fail to make proper provision for a full and constant supply of water for their stock" during "dry summers," or

[262] "Take Care of Young Cattle," *Maine Farmer*, December 8, 1853.

furnished them only with water of "the most stagnant, unwholesome kind," resulting in "great suffering" among the animals.[263]

Contemporary agricultural reformers intuited, and modern scientists have shown, that prolonged exposure to heat and cold stress may deplete cows' energy stores and with it, their ability to synthesize milk. Animals forced to endure temperatures below their so-called "thermoneutral zone" -- between 15°C and -8°C (or 59° F to 17° F), depending on the humidity, the wind speed, and the thickness of a given animal's coat -- need extra food to maintain their core temperature. Otherwise, their bodies make up for the energy shortfall by metabolizing fats needed to insulate the body and depleting water needed to synthesize milk. The same is true of cattle forced to endure temperatures above their thermoneutral zone -- between 30° C and 35° C (or 86° F to 95° F). Indeed, cows' energy needs increase by up to ten percent during periods of heat-related stress. Yet heat stress presents the farmer with paradoxical problems beyond mere energy depletion. Cows' bodies respond to heat by depressing their appetite and hence, their willingness to eat the extra food that they needed to counteract the negative effects of heat stress. The August 2016 *International Journal of Dairy Science* notes that heat stress may also disrupt cattle's endocrine function by "altering levels of prolactin, thyroid hormones, glucocorticoid, growth hormone, estrogen, progesterone, and oxytocin which ultimately affects the milk production" by disrupting synthesis. Heat stress may even alter the chemical composition of milk by reducing the amount of fat and protein.[264]

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[263] William Faux, *Memorable Days in America: Being a Journal of a Tour of the United States* (London: W. Simpkin, 1823), 248–49; "Milch Cows," *The Genesee Farmer and Gardener's Journal*, August 3, 1833; "Water for Farm Animals," *Valley Farmer*, February 1857.

[264] "Managing Heat Stress in Dairy Cows," National Animal Disease Information Service," https://www.nadis.org.uk/disease-a-z/cattle/managing-heat-stress-in-dairy-cows/; Pragna Prathap et al., "Heat Stress and Dairy Cow: Impact on Both Milk Yield and Composition," *International Journal of Dairy Science*, 2016, 2–11; For a contemporary account of heat stress in dairy cows, see Arthur F. Bill, "Shade Trees in Pastures," *New Genesee*

Whether motivated by a humanitarian concern for dairy cows' suffering, a profit-minded desire to improve the quantity and quality of milk yields, or both, reformers urged farmers to manage their animals' comfort. Indeed, editors North, South, and West agreed on a few key points. Dairy cattle should be confined in clean, well-ventilated barns during the cold winter months, save short trips to an enclosed yard for fresh air and brief exercise.[265] During the hot summer months, farmers should give cows at pasture a few shady spots in which to relax and ruminate, be it sheds or a copse of trees. When members of the Ohio State Agricultural Society objected in 1859 that shade trees were a "nuisance" that attracted pestering flies while encouraging cattle to laze about, refusing to eat, a certain Dr. Townshend countered, "The instincts of animals may be trusted, and should be supplied."[266] Whatever the season, farmers should place troughs filled with clean water near enough to cows that they avoided walking long distances in search of a drink.

Some progressive reformers endorsed a more extreme practice, known as "soiling, which called for dairy cattle to be confined, fed, and watered in barns or feed yards throughout the entire year. The May 12, 1860, *Michigan Farmer* featured a short piece, written by an unnamed member of the Maine Board of Agriculture, that explained how and why soiling would benefit farmers and cattle alike. To begin with, confining cattle made possible the tilling and manuring of grass and legume crops, while preventing the animals' damaging young plants and compacting soils. English farmers reported much higher yields of green fodder and hay, with one acre of tilled land producing as much as seven that were grazed. Moreover, keeping cattle in

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Farmer and Gardeners' Journal, September 1840; For a contemporary account of cold stress in dairy cows, see Aiken, "Cattle Feeding."

[265] Hettie Hayfield, "The Dairy," *Southern Planter*, October 1857.

[266] Bill, "Shade Trees"; "Changing Pasture - Shade for Stock," *The Cultivator*, February 1860; For shade advocacy by Southern reformers, see "Art. XVIII.--On the Management of Cows, Calves, Sheep, and Pigs," *Southern Agriculturalist and Register of Rural Affairs*, March 1832.

one place made the collection, storage, and fermentation of nitrogen-rich dung and feces easier and less wasteful than allowing the animals ramble, and void bodily wastes, over tens or hundreds of acres. Both practices increased the food supply available to cows while preventing their expending energy in search of food and water. Soiling also served as check against heat and cold stress. The barns and sheds used in confining the animals kept them cool during the heat of summer, warm during the cold of winter, and dry during rain showers. If it accomplished nothing else, soiling freed the farmer of the need to build and maintain internal fences, saving time, energy, and costs.[267]

If a case study cited by the veterinary scientist Robert Jennings in 1863 be believed, soiling also served to increase milk yields. Jennings's study centered on a Massachusetts farmer, who confined seven or eight dairy cattle in a barn for the entire year. During the summer, he fed the animals "green fodder," most of it the leaves and stems of Indian corn, along with a quantity of alfalfa and fresh-cut grass. Throughout the year, he took pains to collect all of the animals' manure, including the liquid portion, for use in manuring his corn and grass crops. Because the farmer's cows never left the barn, they were "less vexed by flies" than those turned out to graze. He might have added that it prevented the animals walking great distances, expending energy that would otherwise have gone to milk synthesis. The results spoke for themselves. The soiled cows produced more milk than those turned out to pasture. Moreover, the practice saved him the trouble of driving the animals to and from pasture, a practice that likely stressed and tired the animals, while consuming time that was better spent in spreading manure over his fields and grass lots, nourishing the soil and contributing to higher fodder and hay yields. Indeed, he

[267] "Soiling," *Michigan Farmer*, May 12, 1860.

claimed that his "mowing land" was "every year growing more productive, without the expense of artificial manure."[268]

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The tenuous relationship between dairy cows' health and the chemical composition and quantity of their milk is matched only by the milk's fragility once harvested. New, whole milk, drawn fresh from the cow's udder, is an ideal medium for microbial growth. The humble fluid offers everything that microorganisms -- indeed, all living organisms -- need to survive and reproduce: abundant water, protein, carbohydrates, vitamins, and minerals.[269] It is also hot -- about 38 ° C (or 101° F) on leaving the teat -- and pH neutral -- about 6.8 -- making it an ideal breeding ground for a broad array of bacteria, fungi, and molds, many of which prefer temperatures above 18° to 21° (or 65° to 70° F), and most all of which are more-or-less sensitive to acidity. Cooling the milk slows without stopping microbial invaders. Four of the most common psychrotrophic bacteria known to cause milk spoilage, *Pseudomonas fluorescens, Pseudomonas gessardii, Pseudomonas fragi*, and *Pseudomonas lundensis*, reproduce at temperatures equal to or above 7° C (or about 45° F) and may survive at much colder temperatures. Holding the milk in vacuum is enough to kill molds, which are aerobic, meaning they require oxygen to survive. However, it is not enough to stop the depredations of bacteria that metabolize lactose (milk sugar) to create lactic acid, most all of which are microaerophilic, meaning that they need a bit of oxygen to survive, or aerobic, meaning that they require no oxygen whatsoever.[270]

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[268] Jennings, *Cattle and Their Diseases*, 118–20.

[269] "Seafood HACCP," Cornell Cooperative Extension, http://seafoodhaccp.cornell.edu/blackboard/module2/mod2-11.html.

[270] "Milk as a Growth Medium," University of Guelph Food Science, n.d., https://www.uoguelph.ca/foodscience/book-page/milk-growth-medium; Lu Meng et al., "Characterization of

The most familiar of these microorganisms to modern dairy farmers -- and even to nineteenth-century farmers, who could at least detect their presence -- are the bacteria that metabolize lactose or milk sugar to create lactic acid, for example, *Bacterium lactis acidi*. Indeed, these tiny lifeforms may transform a pail of new, sweet milk into a sour-smelling, sour-tasting, and for some human consumers, unpalatable substance, in less than two hours. A 1916 study by compiled by the dairy scientists Lucius L. Van Slyke and Alfred W. Bosworth of the New York Agricultural Experiment Station in Geneva, New York, described the interrelationship between new milk, warm temperatures, and the rapid growth of lactic acid-producing bacteria. Van Slyke and Bosworth based their findings on two experiments, the first of which monitored the growth of and chemical changes caused by *Bacterium lactis acidi* and *Bacterium lactis aerogenes* in two liters of whole milk held at 32° C (about 90° F) for a period of ninety-six hours, and the second of which introduced the same species of bacteria to a like amount of Pasteurized, skimmed milk, held under identical circumstances. In both cases, they discovered that the bacteria metabolized lactose at a steady rate until about the 10th hour, at which time the the rate -- and hence, souring -- accelerated until the 25th hour, at which time it slowed. By the 48th hour, the milk's acid content having reached a level (about .7 percent) inimical to microbial growth, metabolization ceased.[271]

Milk made sour by lactic-acid producing bacteria is safe enough for humans to drink and eat. Indeed, people have long taken advantage of microbial metabolism to preserve milk absent refrigeration. The buttermilk that nineteenth-century Americans drank as a beverage or used in

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Pseudomonas Spp. and Associated Proteolytic Properties in Raw Milk Stored at Low Temperatures," Frontiers in Microbiology: Food Microbiology, November 8, 2017, https://www.frontiersin.org/articles/10.3389/fmicb.2017.02158/full.

[271] Lucius L. Van Slyke and Alfred W. Bosworth, "Chemical Changes in the Souring of Milk," *Journal of Biological Chemistry* 24, no. 3 (1916): 191-202.

cooking was nothing more than the fluid by-product of butter manufacture that had been colonized by the lactic-acid producing bacteria that floated, undetected, in the atmosphere. So too clabbard, a yogurt-like food with roots in Scotland, that was made by leaving whole milk sitting out in warm temperatures, exposed to the air, and allowing lactic-acid producing bacteria to colonize and ferment the milk sugar. The acidity that gave fermented milk products their characteristic tangy taste -- and given enough time, killed off the lactic-acid producing bacteria that caused fermentation -- also served as a barrier to the survival and reproduction of dangerous pathogenic bacteria that may sicken and even kill human milk consumers. Fermented milk products could, therefore, be kept for extended periods with minimal or no refrigeration without fear of their becoming rancid.[272]

More problematic for farmers were the several species of microbes that altered the taste, aroma, and texture of cow's milk, rendering the fluid unpalatable to human milk drinkers. Among the most common of these are the so-called pseudomonads (or psychrotrophic bacteria) such as *Pseudomonas fluorescens* and *Pseudomonas fragi*. Unknown to nineteenth-century Americans, these tiny lifeforms, which preferred cool temperatures, swarmed over cattle's dirt- and feces-caked teats and udders, floated in fresh water, or drifted through the atmosphere aboard dirt and dust particles. On coming into contact with raw milk, pseudomonads attacked and metabolized the milk proteins casein and albumen and imparted a disagreeable fruity, bitter, or putrid taste while also speeding rancidity. Another common microbial contaminant, *Bacteria*

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[272] Needs Citation. George Lewis McKay and Christian Larsen, *Principles and Practice of Butter-Making* (New York: John Wiley & Sons, 1906), 213; R. L. Alsaker, *Maintaining Health* (New York: The Lowrey-Marden Corporation, 1920), 202-203; M. M. Drymon, *From Ulster to America: The Scotch-Irish Heritage of American English* (Belfast, Northern Ireland, United Kingdom: Ulster Historical Foundation, 2006), 37; Juan L. Arqués, Eva Rodríguez, Susana Langa, José María Landete, and Margarita Medina, "Antimicrobial Activity of Lactic Acid Bacteria in Dairy Products and Gut: Effect on Pathogens," *BioMed Research International*. 2015;2015:584183. Doi: 10.1155/2015/584183. Epub 2015 March 16. PMID: 25861634; PMCID: PMC4378328.

Viscosum, caused milk to develop a viscous, ropy texture. Much like the pseudomonads and other microbial invaders, *B. Viscosum* made its way into raw milk via soiled cow udders and flanks, dirty milking pails and pans, and dirty storage vats. Again like the pseudomonads, *B. viscosum* thrived at low temperatures. However, it was most common in milk that had been heated sufficient to kill the lactic-acid-producing bacteria that would otherwise have rendered the milk hostile to microbial life by lowering the pH. [273]

More troublesome still were pathogenic microorganisms that infested raw, fluid milk and had the power to sicken and kill human consumers. Unlike the lactic-acid-producing bacteria and the pseudomonads, these pathogens had no immediate impact on the milk's taste, smell, or aroma, and went undetected by consumers. Among them, the fecal coliform bacteria traveled from bovine and human digestive tracts to new milk via the swishing of cow tails caked with mud and feces, the unwashed hands of dairy farmers tending to the milk harvest, and the feet of flies as they flitted from dung piles to feed troughs to cattle teats to milking equipment. The most deadly of these, *Shigella dysenteriae*, was the leading cause of dysentery (or Shigellosis), a disease characterized by inflammation and ulceration of the colon, bloody diarrhea, fever, cramping, muscle aches, dehydration, and in extreme cases, death. *Shigella* was virulent, requiring no more than ten bacterium to sicken an otherwise healthy adult human. It was also resilient, capable of surviving for up to fifty days in room-temperature milk and up to twenty-one days in the acidic environment of fermented milk products. No less dangerous was *Escherichia*

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273 "Characterization of Flavour Defects - ADSA," University of Guelph Food Science, n.d., https://www.uoguelph.ca/foodscience/book-page/characterization-flavour-defects-adsa; D.M. Damas, J.T. Barach, and M.L. Speck, "Effect of Psychrotrophic Bacteria from Raw Milk on Milk Proteins and Stability of Milk Proteins to Ultrahigh Temperature Treatment," *Journal of Dairy Science* 59, no. 5 (May 1976): 823–27; Gislene B. de Oliveira et al., "Psychrotrophic Bacteria in Milk: How Much Do We Really Know?," *Brazilian Journal of Microbiology* 46, no. 2 (January 2015): 313–21; C.K. Mader, "Ropy Milk, Its Cause and Prevention," *Canadian Journal of Comparative Medicine* 4, no. 7 (July 1940): 203–5.

coli (or *E. Coli*) which entered milk by the same route(s) as *Shigella* and produced similar symptoms: vomiting, bloody diarrhea, and abdominal cramping. In mild cases, the symptoms of *E. Coli* infection lasted about five to ten days. In severe cases, it caused kidney failure and death, especially among the very young, the very old, and those suffering compromised immune systems.[274]

And yet, the fecal coliform bacteria were only one species of dangerous bacteria that infested raw, unpasteurized milk, endangering the lives of human consumers. Much like *Shigella* and *E. Coli*, the bacteria *Listeria monocytogenes*, traveled from bovine and human digestive systems to unpasteurized milk by one of several routes: the mud or dried soil adhering to cattle's tails, udders, teats, hooves, and flanks; the water used by farmers to fill drinking troughs or wash their animals' coats; the vegetable crops, hay, and ensilage used as forage; and the pails, pans, and other equipment used in harvesting and storing milk. It may also have reached milk via dust particles or bioaerosols -- fine droplets of bacteria-laden saliva or nasal mucous expelled by coughing or sneezing people or animals -- that floated through the air before coming to rest in milk. Again, much like *Shigella*, the bacteria was resilient -- capable of surviving freezing temperatures -- and virulent -- requiring no more than ten bacterium to sicken an otherwise healthy adult human. Ingested with milk, *L. monocytogenes* caused listeriosis, a life-threatening condition characterized by fever, muscle aches, nausea, and diarrhea, and in the case of the very young, the very old, and those with compromised immune systems, convulsions

[274] Rose Ann Gould Soloway, "Food Poisoning: Your Questions Answered," Poison Control: National Capital Poison Center, April 7, 2013, https://www.poison.org/articles/2013-apr/food-poisoning.

and death.[275] Also dangerous are the strains of bacteria responsible for salmonellosis, typhoid fever, and diptheria, all of which thrived in raw milk.[276]

Lacking access to modern chemical disinfectants, it would have been impossible for nineteenth-century farmers to prevent all microbial contamination of raw, unpasteurized milk, even if they had known that the organisms existed.[277] And yet, steps could be taken to minimize infestations and ensure sanitation. Washing and drying dairy cattle's udders and teats before every milking session to remove visible dirt and feces would also have removed invisible microorganisms that had the potential to taint the milk harvest. So too the pails, pans, and tanks used in collecting and storing milk, especially if one bothered to scrub those surfaces and joints/seams that came into direct contact with the fluid. All of this was made easier and more effective by washing and sweeping barns, removing dung, soiled bedding, and uneaten food, and killing/deterring pest species such as flies and rats that introduced harmful microorganisms to (relatively) sanitary surfaces.[278]

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275 Centers for Disease Control and Prevention, National Center for Emerging and Zoonotic Infectious Diseases (NCEZID), Division of Foodborne, Waterborne, and Environmental Diseases (DFWED), "Listeria (Listeriosis)," Centers for Disease Control and Prevention: CDC 24/7: Saving Lives, Protecting People, September 25, 2019, https://www.cdc.gov/listeria/index.html; J.S. Dickson, "Aerosol and Airborne Transmission of Listeria Monocytogenes: A Potential Source of Cross Contamination," United States Department of Agriculture: Research, Education & Economics Information System, August 14, 2011, https://portal.nifa.usda.gov/web/crisprojectpages/0207482-aerosol-and-airborne-transmission-of-listeria-monocytogenes-a-potential-source-of-cross-contamination.html; Anne-Laure Vivant, Dominique Garmyn, and Pascal Piveteau, "Listeria Monocytogenes: A Down to Earth Pathogen," Frontiers in Cellular and Infection Microbiology, November 3, 2013, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3842520/.

276 Chris Bell and Alec Kyriakides, *Salmonella: A Practical Approach to the Organism and Its Control in Foods* (Oxford: Blackwell Science, 2002), 61; George Lloyd Magruder, *The Solution of the Milk Problem* (Washington, D.C.: R. Beresford, 1913), 17; Milton Joseph Rosenau, *The Milk Question* (Boston: Houghton Mifflin Company, 1912), 120.

277 "Cleaning and Disinfection on the Dairy Farm," Cornell University College of Veterinary Medicine Animal Health Diagnostic Center, n.d., https://www.vet.cornell.edu/animal-health-diagnostic-center/programs/nyschap/modules-documents/disinfectionDairyFarm.

278 "Butter," *American Agriculturalist*, August 1845; *Michigan Farmer*, "Milk". Washing wooden pails and barrels offered an imperfect defense against pathogens. See G.L. Martin, "Making Butter on the Farm," *Montana Extension Service in Agriculture and Home Economics*, no. 57 (June 1922): 3. For a study of rats and flies as disease vectors, see Hans Zinsser, *Rats, Lice and History* (New York: Bantam Books, 1967).

All else failing, subjecting milk to hot or cold temperatures had the power to kill and/or retard the growth of the bacteria, fungi, and molds that soured or spoiled milk, leaving it unpalatable or dangerous for human consumption. Though they misunderstood the organic processes at work, nineteenth-century Americans recognized that boiling slowed the decomposition of milk, presumably by halting the incipient decay of milk's component parts. In fact, it killed the microorganisms outright. By contrast, cold temperatures reduced incidence of sourness and spoilage in raw and boiled milk products not by killing microorganisms, but rather by slowing the tiny lifeforms' reproductive cycle. And yet, neither heat nor cold were a failsafe against decomposition. Bacteria would have recommenced their mindless colonization of boiled milk almost as soon as the temperature fell below 74°C (or 165°F). Because the psychrotrophic bacteria that infest milk not only survive but also continue to reproduce at temperatures below 7°C (or 45°F), it is impossible to prevent spoilage using only refrigeration. Indeed, assuming that it is otherwise well handled, milk placed in continuous cold storage at or below 7°C (or 45°F) will spoil about two weeks after harvest.[279]

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As with most major changes in American history, widespread improvement of the nation's dairy herds awaited an economic catalyst. In this case, it came in the form of so-called milk trains, which commenced shipping highly perishable cow's milk from rural producers to urban consumers, beginning in 1842, with the opening of the Erie Railroad. For the first time,

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[279] Cornell University "Milk Facts," http://milkfacts.info/Milk%20Processing/Heat%20Treatments%20and%20Pasteurization.html/.; "Grade 'A' Pasteurized Milk Ordinance" (Washington, D.C.: United States Department of Health and Human Services Public Health Service Food and Drug Administration, 2017); E.H. Hoyle, Pamela Schmutz, and D.T. Vines, "Safe Handling of Milk and Dairy Products," Clemson Cooperative Extension, Home & Garden Information Center, Factsheet (Clemson, South Carolina: Clemson University, March 8, 2007), https://hgic.clemson.edu/factsheet/safe-handling-of-milk-dairy-products/.

farmers from Orange County, New York, could ship grass-fed milk as far as Jersey City, just across the Hudson River from Manhattan, and connected by ferry, with relative speed. The very first year, running one train per day, they sent 388,505 quarts into the city. The next year, railroad operators added a second, evening train, enabling farmers to ship 3,181,505 quarts of milk into the city. Still, it was insufficient to satisfy New Yorkers' hunger for grass-fed rural milk. In 1844, three years after beginning a milk route, the Erie Railroad shipped 5,095,762 quarts into the city. By 1856, the Erie brought milk in from as far afield as Otisville, New York, about eighty miles northwest of Jersey City. Other railroads soon joined in the enterprise. The New Jersey Railroad brought milk in from New Brunswick, and Elizabethtown (now Elizabeth), New Jersey; the Paterson and Ramapo Railroad from the rural communities between Paterson, New Jersey, and Suffern, New York. The extension of the New York and Harlem Railroad brought milk from Westchester and Dutchess Counties, New York, on the Connecticut border. Beginning in 1853, the Hudson River Railroad brought milk from Sing Sing, Peekskill, Croton, and other distant stations.[280]

Even then, the transition was slow. The milk trains touched a mere handful of Northeastern communities, and were accessible only to those farmers who lived no more than about three miles distant from a depot (or the furthest that one could move new milk by wagon with any hope of its remaining sweet while in transit). Moreover, lacking reliable refrigeration, it was impractical to ship fluid milk more than about eighty miles by train. This left most farmers of the era to do business with neighbors and local merchants. Historians have recognized that this lack of market access served to disincentivize fluid milk production beyond the bare minimum needed for family use or small-scale butter and cheese production without

[280] Mullaly, *Milk Trade*, 89.

necessarily recognizing that it also disincentivized farmers' taking steps to improve their animals and with it, the milk yield.[281] Notwithstanding reformers' and breeding advocates' advice, it made little sense for small-town or isolated stockmen to invest time, energy, and resources in buying (or creating) more productive dairy cows or working to extend the duration of the animals' lactation cycles via complex feeding regimens, the construction of expensive barns, and the careful management of the animals' emotional health, only to see the bulk of their milk harvest go to waste. There were, after all, only so many mouths to feed, only so many hands available to make butter and cheese, and only so many willing buyers. Far better to devote one's energy to durable grain and vegetable crops.

[281] Sutton, "Milk: A New England History," 20.

Chapter 4:
God or Luck or Fate:
The Limitations of Progressive Farming in the Antebellum United States

If any American embraced the tenets of progressive farming during the mid-nineteenth century, it was the Massachusetts businessman and stock raiser, Winthrop Chenery. In keeping with reformers' call to select the very best animals for breeding, Chenery purchased blooded cattle from Dutch and British breeders and had them shipped overseas to his Belmont, Massachusetts, estate, all at great personal cost. Indeed, many of the Frisian (that is, Holstein) cattle that populate modern American dairy farms trace their lineage to one of Chenery's imports.[282] Yet his efforts went beyond the purchase of superior breeding stock. During the summer and early fall months, Chenery's prized Frisians and Durhams ambled over lush pastures, feeding on grasses and clover, and then dozing in the shade of trees, chewing their cud. During the winter and early spring months, he confined the animals in clean, well-constructed barns and fed them a balanced diet of hay, vegetables, and grains. Where his contemporaries evinced skepticism of veterinary medicine, Chenery consulted trained veterinary scientists from Boston when his animals that fell sick or injured. Though he disagreed with their diagnoses on occasion, he did follow their advice.[283] Assuming that the scientists, agricultural reformers, and

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[282] William Richard Cutter, *Genealogical and Personal Memoirs Relating to the Families of Boston and Eastern Massachusetts Vol. III* (New York: Lewis Historical Publishing Company, 1908), 1367; Massachusetts General Court. Committee on Pleuropneumonia, *Evidence ... May 31, 1860* (n.p., 1860), 3, 6, 9, 76-77, 80; Winthrop W. Chenery, *Holstein Herd Book: Containing a Record of the Holstein Cattle in the United States. Also a Sketch of the Holstein Race of Cattle* (Boston: Association of Breeders of Thoroughbred Holstein Cattle, 1872), 19.

[283] For more on Chenery's devotion to progressive feeding and care, see "Dutch Cattle," *New England Farmer*, September 1868, George H. Dadd, *Dadd on the Nature and Treatment of the Diseases of Cattle* (Boston: John P. Jewett and Company, 1859), 297, 313-314, and "Highland Stock.-Imported Dutch Stock, &c.," *American Veterinary Journal*, 4, no. 1, January 1859: 25-26.

breeding advocates were correct, all of this should have ensured that Chenery's cattle were happy, healthy, and productive of milk and beef.

In fact, Chenery's devotion to reformist wisdom and progressive farming almost proved his undoing. Unknown to him, one of the Frisian cows that he purchased from a Dutch livestock breeder in 1859 harbored *Mycoplasma mycoides*, the bacteria responsible for contagious bovine pleuropneumonia, in its lungs. This insidious disease, which is most often passed from animal to animal via airborne droplets of saliva and mucus, but may also be passed via normal bovine behaviors such as nuzzling or licking other animals, killed up to, and in some cases exceeded, 50 percent of infected cattle. Survivors often suffered permanent physiological damage such as diminished lung capacity that rendered them unfit for milk or beef production or agricultural labor. Moreover, survivors were often asymptomatic carriers, capable of spreading the disease to immunologically naïve animals. Furthermore, the disease's lengthy incubation period -- three weeks to six months -- made it possible for unsuspecting livestock dealers and farmers to move seemingly healthy animals over great distances, exposing hundreds, even thousands of naïve hosts to *Mycoplasma mycoides* along the way.[284] When the disease raced through Chenery's herd, killing and maiming animals, he concluded that some mysterious and unknown infectious agent had manifested in his barn. Never did he suspect -- nor could he have -- that an Old World microorganism was to blame.[285]

Those among Chenery's neighbors in eastern and central Massachusetts who shared his interest in herd improvement and looked to him for assistance suffered a similar fate. Beginning in 1859, a series of cattle exchanges took infected cows, calves, and heifers -- some of them

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[284] "Contagious Bovine Pleuropneumonia," World Organization for Animal Health, https://www.woah.org/en/disease/contagious-bovine-pleuropneumonia/.
[285] Massachusetts General Court, *Evidence ... May 31, 1860*, 77.

originating on Chenery's estate, others that came into direct or indirect contact with the infected animals -- as far west as Brookfield, Massachusetts, about sixty miles west of Belmont, and as far south as Sturbridge, about fifteen miles south of Brookfield and about three miles north of the Connecticut border. As animals sickened and died, panic gripped Massachusetts farmers. Commonwealth officials responded by authorizing a team of cattle commissioners to visit farms suspected of harboring the disease and isolating and destroying infected animals. Notwithstanding the commissioners' good intentions, some farmers doubted that the disease was contagious and resisted efforts to cull their herds -- among them Chenery. Though he submitted to the destruction of his animals, he refused to believe that pleuropneumonia was anything more than a localized, environmentally induced malady. No sooner had he buried the dead than he replenished his herd with new, blooded Frisians, direct from Holland.[286] Though it is impossible to know for sure, it may be that Chenery reintroduced *Mycoplasma mycoides* to Massachusetts several times over before federal officials eradicated the disease in the 1890s.

Yet contagious bovine pleuropneumonia was only the most spectacular, in terms of its geographic scope and virulence, among the diseases that afflicted and killed domestic American cattle during the first half of the nineteenth century. Dangerous pathogens and parasites, many of them unknown to veterinary scientists and farmers of the era, lurked in the food that the animals ate, the dung and bodily fluids that the animals excreted, the soil that the animals walked over (and rolled in), the water that the animals drank (and waded through), the straw that the animals used for bedding, and the air that the animals breathed. These tiny lifeforms paid no mind to bovine bloodlines or human caregiving. Purebred or mongrel, fenced or free-range,

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[286] "Where Did Pleuro Pneumonia Originate?," *Prairie Farmer*, 5 March 1864; Winthrop Chenery, *Holstein Herd Book: Containing a Record of the Holstein Cattle in the United States. Also a Sketch of the Holstein Race of Cattle*, 19.

domestic cattle contracted a host of diseases and conditions that were as harmful to the animals' health as they were baffling to the animals' owners. Agricultural journals and veterinary manuals of the era abounded with tales of blackleg, red water, foot rot, lung worms, and hoose, among other scourges, along with advice for treating the afflicted. Always, the authors qualified their prescriptions, noting that remedies failed as often as they succeeded, and without clear reason. But then, animal diseases were no better understood than human diseases. Given the poor state of veterinary training among Americans of the era, they were perhaps less well understood.[287]

Clearer is the role that progressive farming methods played in exposing animals to dangerous pathogens and parasites. Of all the practices that agricultural reformers of the era advocated, none was more celebrated or useful than manuring. In collecting and spreading livestock dung over grain fields, gardens, and pastures, farmers returned nitrogen, phosphorous, and potassium to the soil, along with helpful bacteria that converted these nutrients into forms that may be absorbed by plant roots. Healthy soil and plants meant more and better fodder, which could be used in "soiling" (that is, confining and feeding) cattle year round in barns and outdoor pens. To be sure, these practices were an improvement over traditional American husbandry, which saw farmers neglect both cattle *and* the soil.[288] Yet they also placed milch cows and beeves in harm's way. Well-intended though it may have been, manuring sowed the soil and water with fecal-borne viruses, bacteria, and parasites that invaded cattle's digestive,

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[287] "Quarter-Ill in Cattle," *The Cultivator*, May 1854; George H. Dadd, "Black Leg in Cattle," *Prairie Farmer*, April 23, 1864; "Diseases of Domestic Animals and Their Cure," *The American Farmer, Containing Original Essays and Selections on Rural Economy and Internal Improvements, with Illustrartive Engravings and Prices Current of County Produce*, April 30, 1824; "Veterinary Department. Diseases of the Feet in Animals," *The Cultivator*, May 1842; William Youatt, *Cattle; Their Breeds, Management, and Diseases* (Philadelphia: Grigg & Elliot, 1836), 396-398; William B.E. Miller, *The Diseases of Live Stock and Their Most Efficient Remedies; Including Horses, Cattle, Cows, Sheep, Swine, Fowls, Dogs, Etc.* (Philadelphia: H.C. Watts & Co., 1885), 339–40.
[288] Stoll, *Larding*, ????.

circulatory, and respiratory systems, wreaking havoc.[289] Meanwhile, soiling increased the likelihood that air- and fecal-borne bacteria and viruses would leap from animal to animal, decimating entire herds in short order.[290] Absent knowledge of microorganisms, to say nothing of antibiotics and antivirals, there was little farmers could do to prevent or cure these diseases.[291] Here was a great irony, on par with Winthrop Chenery's accidental importation and widespread propagation of contagious bovine pleuropneumonia: The more conscientious the farmer, the more likely that his animals would sicken and die.

Historians have not recognized that a direct, cause-and-effect relationship existed between nineteenth-century progressive farming practices and the health and productivity of domestic cattle. A modest body of veterinary historians have noted that American stock breeders of the era introduced myriad Old World pathogens into the nation's herds. Their object in doing so, however, has been twofold: to trace the concomitant rise of veterinary science programs in Boston, Philadelphia, and other American cities; and to describe state and federal efforts to eradicate zoonotic diseases during the first half of the twentieth century. Otherwise, scholars

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[289] "Blue-Green Algae and Harmful Algal Blooms," Minnesota Pollution Control Agency, n.d., https://www.pca.state.mn.us/water/blue-green-algae-and-harmful-algal-blooms; Michelle Arnold et al., "Harmful Algal Blooms - Are My Cattle in Danger?," University of Kentucky College of Agriculture, Food and Environment, accessed February 28, 2020, https://afs.ca.uky.edu/dairy/harmful-algal-blooms-are-my-cattle-danger; Floron C. Fares, Jr., "Common Cattle Parasite," Texas A&M Agrilife Extension, October 2005, https://agrilifeextension.tamu.edu/library/ranching/common-cattle-parasite/; Control of Lungworm in Cattle, COWS Technical Manual, https://www.cattleparasites.org.uk/app/uploads/2018/04/Control-of-lungworm-in-cattle.pdf; "Liver Fluke in Cattle," Farm Health Online, accessed February 29, 2020, https://www.farmhealthonline.com/disease-management/cattle-diseases/liver-fluke/; Noel Campbell et al., "Liver Fluke: An Internal Parasite of Sheep and Cattle," Agriculture Victoria, February 2007, http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/pest-insects-and-mites/liver-fluke.

[290] Massachusetts General Court, *Evidence ... May 31, 1860*, 3.

[291] Margaret Humphreys, *Marrow of Tragedy: The Health Crisis of the American Civil War* (Baltimore: Johns Hopkins University Press, 2013), 1-2, 7, 27–29; Patrick Adams, "Meet the Woman Who Gave the World Antiviral Drugs," *National Geographic*, 31 August 2020, https://www.nationalgeographic.com/science/article/gertrude-elion-antivirals-coronavirus-remdesivir

have treated progressive farming as a positive good.[292] Agricultural historians, for example, have devoted many pages to tracing the evolution of American selective breeding programs during the second half of the nineteenth century and with them, the propagation of robust, purebred cattle that trace their ancestry to European herds.[293] Joining them are environmental historians, who depict progressive farmers as the heroic, though oft-ignored foil to those who neglected manuring and robbed the soil of health and productive power.[294] Together, they offer a not-so-subtle rebuke of nineteenth-century American farmers: Had they taken up selective breeding of cattle at an earlier date, had they shown more care in returning nutrients to the earth, they could have recreated the productive, ecologically sustainable farms of Great Britain and Holland.

This line of argumentation is problematic, however, for it overlooks the fact that pathogens and parasites lurked in the manure piles, pastures, and barns of the European and British farms that American agricultural reformers hoped to recreate in North America, afflicting and killing the blooded cattle that American stock raisers so coveted. This was certainly true of bovine pleuropneumonia. Between 1831 and 1887, the disease claimed the lives of approximately 250,000 Dutch cattle, among them the little group of Frisians sold to Winthrop Chenery in 1859. Across the English Channel, the disease killed approximately 10 million head of cattle in England and Scotland, a number that included those culled as a preventative measure. The rinderpest virus took an even greater toll. During the eighteenth century, alone, farmers on

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[292] Earl Guthrie, “History of Veterinary Medicine,” *Iowa State University Veterinarian* 2, no. 1 (1939): 6–10; Ann N. Green, "The Now-Opprobrius Title of 'Horse Doctor': Veterinarians and Professional Identity in Late-Nineteenth Century America," in Karen Brown and Daniel Gilfoyle, eds., *Healing the Herds: Disease, Livestock Economies, and the Globalization of Veterinary Medicine* (Athens, Ohio: Ohio University Press, 2010), 42-58.

[293] Ulysses Prentiss Hedrick, *A History of Agriculture in the State of New York* (Albany, New York: New York State Agricultural Society, 1933), 363, 366–80; Paul W. Gates, *The Farmer’s Age: Agriculture, 1815-1860* (New York: Holt, Rinehart and Winston, 1960), 232–33.

[294] Steven Stoll, *Larding*.

the European Continent lost an estimated 200 million head of cattle to the disease, while British farmers lost about 507,000 head between the years 1745 to 1758.[295] And yet, as in America, crowd diseases were only the most visible of the maladies that afflicted cattle. Pastures, ponds, and watercourses harbored necrotizing bacteria that colonized and devoured soft tissues, as well as parasitic worms that infested cattle's respiratory, digestive, and cardiovascular systems, killing the very young and crippling adults. Most benefited from farmers' careful keeping and spreading of manure, which returned them to the soil, water, and sunlight that they depended on to begin the next lifecycle.[296]

So long as farmers lacked knowledge of bacteria and viruses, and struggled to understand the lifecycles of known parasitic organisms, their attempts to keep large numbers of dairy and beef cattle confined together and in good health would fail as often as it succeeded. Indeed, it would take antibiotics, antivirals, and industrial disinfectants capable of sterilizing manure, barn floors, caretakers' hands, milk pails, and the animals' very hooves and hides before it would be practical, or indeed possible, to confine thousands of expensive, purebred cows in the style of modern dairy operators with the expectation that most would enjoy good health over eight-to-ten years of productive life. Such would have to wait for the twentieth century. Until then, the best

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[295] W. N. Masiga, J. Domenech, and R. S. Windsor, "Manifestation and Epidemiology of Contagious Bovine Pleuropneumonia in Africa," *Revue Scientifique et Technique (International Office of Epizootics)* 15, no. 4 (1996): 1–2; Massachusetts General Court. Committee on Pleuropneumonia, *Evidence*, 44–61; L. B. Bull, "Foreword," *Commonwealth of Australia Council for Scientific and Industrial Research, Bulletin No. 93*, 1936, v; A. D. Campbell and A. W. Turner, "Studies in Contagious Pleuro-Pneumonia of Cattle. II. A Complement-Fixation Reaction for the Diagnosis of Contagious Bovine Pleuro-Pneumonia. Its Use in Experimental Investigations and in the Control of Disease," *Commonwealth of Australia Council for Scientific and Industrial Research, Bulletin No. 97*, 1936, 11–12; *Department of Agriculture. Special Report – No. 12. Investigation of Diseases of Swine, and Infectious and Contagious Diseases Incident to Other Classes of Domesticated Animals* (Washington: Government Printing Office, 1878), 229–30, 237–38; Amanda Kay McVety, *The Rinderpest Campaigns: A Virus, Its Vaccines, and Global Development in the Twentieth Century* (Cambridge: Cambridge University Press, 2018), 17; John Broad, "Cattle Plague in Eighteenth-Century England," *The Agricultural History Review* 31, no. 2 (1983): 114.

[296] Floron C. Fares, Jr., "Common Cattle Parasite," Texas A&M Agrilife Extension, October 2005, https://agrilifeextension.tamu.edu/library/ranching/common-cattle-parasite/; Control of Lungworm in Cattle, COWS Technical Manual; Liver Fluke in Cattle," Farm Health Online; Campbell et al., "Liver Fluke".

that progressive American farmers could do was nourish the soil with manure, harvest an abundance of fodder, populate their farms with blooded cattle, and pray that God or luck or fate -- or some combination of the three -- took a kind view of their animals and their bottom line.

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As the nineteenth century neared its midpoint, agricultural reformers extolled the virtues of manuring from the pages of farm journals and newspapers. Among them, the December 1842 *American Agriculturalist* noted that energetic progressive farmers on the periphery of New York had taken to buying horse and cattle dung harvested from the streets and stables of Manhattan to spread over their fields and pastures. Three years later, and perhaps reasoning that all dung possessed soil-enriching properties, editors of *The Albion* blasted English farmers for neglecting to collect and use the "night soil" (human feces and urine) that accumulated in London's streets and privies, amounting to "3,800 tons of solid manure daily," and using it to restore fertility to the island nation's depleted pastures and heath lands. Citing the *American Farmer*, the April 15, 1850 *Port Tobacco Times* noted that the turnips, mangel wurzel, and other root crops known to improve milk yields in dairy cows were known to "delight in . . . manures" scraped from roads and/or taken from the barnyard and stable. Doubtless a correspondent to the August 1858 *New England Farmer* would have agreed, comparing the barnyard to a savings bank, with the most valuable deposits being the dung and urine of cows that could be sown in fields and pastures to increase crop and fodder yields.[297]

Though they misunderstood the exact process by which manuring preserved or restored soil fertility, progressive reformers were correct in calling on farmers to spread livestock dung

[297] "Raising Grapes and Strawberries," *American Agriculturalist*, December 1842; "Political Department and General Intelligence," *The Albion, A Journal of News, Politics and Literature*, 11 January 1845; "Work on the Farm," *Port Tobacco Times, and Charles County Advertiser*, 15 April 1850; "A Savings Bank," *New England Farmer*, August 1858.

over pastures and fields. In his 2002 study of early nineteenth century agricultural reform, the historian Steven Stoll noted that the fodder fed to cattle retains much of its nitrogen, phosphorous, and potassium content on passing through the animals' digestive tracts and falling to the earth as dung. In collecting and returning these nutrients to the soil via manuring, progressive farmers gave nourishment to the fodder crops and pasture grasses that they depended on to feed both their families and their livestock, leading to higher yields, while also giving the soil structure, promoting water drainage, and encouraging the growth of helpful soil microbes. In failing to do so, more lackadaisical farmers – the vast majority, to hear Stoll and nineteenth-century progressive farmers tell it -- robbed the soil of its fertility, leading to decreased yields and, given enough time, rendering their farms so unproductive as to cause financial hardship, followed by land abandonment.[298]

Manuring may have protected the soil, but it also had the potential to maim and kill the livestock that farmers depended on for milk and meat (and hence, profit). Indeed, the greater a farmer's attention to keeping and spreading manure over fields and pastures, the more likely it was that he seeded the soil with dangerous bacteria and parasites. This was true whether or not farmers carted manure to the fields or penned cattle on acreage that needed manuring and allowed the animals to defecate. Among the most insidious of these pathogens was *Clostridium chauvoei*, the bacteria responsible for "black leg" (also known as "quarter ill"). Scientists now know that *Clostridium chauvoei* may pass from ruminant digestive systems as spores into the manure piles cultivated by nineteenth century farmers. From there, they travel to the soils that sustained pasture grasses and other crops in the cart. Once they come into contact with the soil, the spores may survive for years until environmental conditions create conditions suitable for

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[298] Stoll, *Larding*, 19, 25, 51, 56, 133, 187.

their regeneration. Ingested by grazing ruminants, which pull grass and dirt into their mouths, the spores pass from the ruminoreticulum to the muscle tissue, spleen, and liver via the bloodstream, where they lie dormant until roused by exercise or tissue damage. Once active, the spores cause a range of symptoms -- depression, swollen muscle tissue, lameness, and fever -- followed by death in about 12 to 48 hours. Modern veterinarians treat black leg with the antibiotic, penicillin. Ridding pastures of *Clostridium* is more difficult, requiring farmers to burn the top layer of soil, killing the spores.[299]

Ignorant as they were of germ theory, nineteenth-century Americans were at a loss to explain or treat black leg. An anonymous letter published in the March 22, 1854, *Cultivator* reveals much about terrifying speed with which black leg struck down animals. The letter writer lost "four yearling calves within the last two weeks" from a disease that he was "wholly unacquainted with." Three of the animals showed symptoms consistent with black leg: sudden, pronounced stiffness in the joints, followed by tissue "mortification" (that is, necrosis) and sudden death. A fourth showed no outward signs of the disease, save loss of appetite, before collapsing and dying. However, a post-mortem revealed congealed blood trapped between the skin and muscle tissue, indicating the onset of mortification. Although they admitted to knowing of "no treatment offering . . . hope for a cure," *Cultivator* editors directed the letter writer to the work of the English veterinary surgeon William Youatt, who called for bleeding and purging afflicted animals. They also described a four-part treatment advocated by the Canadian veterinary scientist Dr. W.A. Cuming of New Brunswick: give diluted alcohol as a stimulant;

[299] "Basic Dairy Bacteriology," Cornell University Department of Food Science, 1 June 2010, https://foodsafety.foodscience.cornell.edu/sites/foodsafety.foodscience.cornell.edu/files/shared/documents/CU-DFScience-Notes-Bacteria-General-Dairy-Micro-06-10.pdf; J.J. Barrett, "Blackleg: A Preventable Disease of Cattle," West Virginia University Extension," March 2022, https://extension.wvu.edu/agriculture/livestock/beef-cattle/cattle-health/blackleg.

bathe the affected tissues with "sharp hot water"; rub the affected tissue with irritants such as mustard or turpentine; apply "the laundress' iron at a heat less than sufficient to injure the skin." Of these two treatments, editors noted, the latter "h[ad] been found to show the greatest appearance of being of use." Yet they hedged their bets, admitting, "The chance of recovery are so slender" as to be hardly worth the trouble.[300]

Ten years later, veterinary scientists were no closer to understanding the causes of black leg or offering any advice about prevention or treatment. Writing from Chicago in 1864, the veterinary pioneer, Dr. George H. Dadd, compared the disease to cholera, plague, and yellow fever, all diseases with "obscure" origins that appeared "independent of local causes, occur[red] at uncertain intervals, and sometimes seem[ed] to select its victims, without regard to their condition." A critic of Youatt and an early advocate of humane veterinary medicine, Dadd disavowed the use of bleeding, purging, blistering, hot irons, and other heroic remedies to treat black leg. He proposed instead that farmers give one-pint of tar water, supplemented by four ounces of tincture of gentian to afflicted animals by mouth "until a decided improvement has taken place." He also advised farmers to apply the "anti-putrescent" agents tar water and powdered charcoal to the necrotic tissues to halt decomposition and restore the animal's health. This advice notwithstanding, Dadd agreed with his contemporaries that the prognosis for animals afflicted with black leg was grim. Noting, "I have little faith in any kind of treatment," he advised farmers to take a common-sense approach to preventing the disease. More specifically, he advised them to pay "proper attention to breeding, feeding, rearing, housing, &c."[301] If

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[300] "Quarter-Ill in Cattle," *The Cultivator*, 22 March 1854.

[301] George H. Dadd, "Black Leg in Cattle," *Prairie Farmer*, April 23, 1864. In fact, Dadd was right to compare black leg to cholera, which was also caused by bacteria spread by feces entering the food or water supplies. See Charles E. Rosenberg, *The Cholera Years: The United States in 1832, 1849, and 1866* (Chicago: The University of Chicago Press, 1987).

“proper attention” included manuring, however, it would have only increased the spread of *Clostridium chauvoei*.

Although they knew nothing of *F. nocrophorum*, nineteenth-century Americans had at least some sense of what caused foot rot. As early as April 1824, editors of *The American Farmer* recognized that a correlation existed between cattle walking over hard, stony ground and the onset of foot rot. A certain Mr. Skerrett attributed foot rot to “gravel, or other hard bodies getting between the [hooves], and causing by their pressure and friction great pain and inflammation,” or else to some “morbid state of the system,” which may be interpreted to mean the spontaneous generation of the disease in an unhealthy animal. Eighteen years later, the farmer J. Lawrence of Jefferson County, Tennessee, offered a similar explanation of the causes of foot rot in cattle in a letter published in *The Cultivator*. Like Mr. Skerrett, Lawrence intuited that a relationship existed between cattle walking over “muck or litter” -- that is, damp, muddy, manure-covered soils -- and the onset of the disease. When this muck was particularly “offensive,” he reasoned, it discouraged cattle from licking and cleaning the debris from a small canal “just below the false hooves or hinder claws.” The result was the tissue necrosis, foul odor, and lameness that gave the disease its name. At least one writer proposed that foot rot was contagious. Again, noting the correlation between dampness, injury, and the onset of the disease, he proposed isolating afflicted animals in dry stalls or sheds “till the danger of communicating the disease is passed.”[302]

It may be that the remedies proposed by veterinary scientists and agricultural reformers did some good in preventing or curing foot rot. Those who took the time to pick the stones from

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[302] “Diseases of Domestic Animals and Their Cure,” *The American Farmer, Containing Original Essays and Selections on Rural Economy and Internal Improvements, with Illustrartive Engravings and Prices Current of County Produce*, April 30, 1824; “Veterinary Department. Diseases of the Feet in Animals,” *The Cultivator*, May 1842.

their animals' hooves decreased the likelihood of nicks, cuts, and abrasions that permitted entry of *F. necrophorum* into the soft tissues and bloodstream. So too those who mucked out barns and sheds, lined their animals' stalls with dry bedding, and barred their animals from wading through muddy and/or stubbly fields. Editors' suggestion that farmers trim their animals hooves and apply blue vitriol (crystalline copper sulfate) to the infected limbs may also have helped. Modern dairy and sheep farmers have enjoyed success using copper sulfate foot baths to prevent and cure foot rot. Editors of *The Cultivator* doubted that farmer Lawrence's hoof-cleaning regimen was an effective preventative, noting, "We were not aware that cattle possessed the excretory ducts spoken of by our correspondent." However, his suggestion that farmers drive their cattle to "dry, high and clean pastures" would have reduced incidence of the disease. The only sure means to prevent foot rot was to prevent cattle from walking over or through pastures and fields sown with dung and manure. Such a practice was no more possible on nineteenth-century American farms than it is now.[303]

Cattle dung and manure also contaminated the bovine water supply, giving rise to toxic algal blooms that sickened livestock. In much the same way that the nutrients present in fresh cow pats and cattle manure nourished grasses, vegetables, and grains when added to the soil, the nitrogen present in cattle feces nourished the approximately 2,000 species of blue-green algae -- in fact, cyanobacteria -- that occurred naturally in North American ponds, creeks, and slow-moving rivers, as well as in the troughs that the more conscientious nineteenth-century dairy farmers put out for livestock. During periods of warm weather, these tiny lifeforms flourished, creating great slicks, scums, or mats that turned the surface of the water a distinctive blue-green,

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[303] Michael Metzger, "Foot Rot and Foot Scald in Sheep and Goats," Michigan State University Extension, 21 December 2018, https://www.canr.msu.edu/news/foot-rot-and-foot-scald-in-goats-and-sheep;"Veterinary Department".

white, or brown color. Because dairy cattle were less discriminating in their choice of drinking water than people, they swallowed great mouthfuls of cyanobacteria, which were destroyed in the animal's digestive tract, releasing cyanotoxins. The symptoms of cytotoxin poisoning depended on the species of cyanobacteria, and ranged from bloody diarrhea, photosensitization (a condition that causes light or non-pigmented skin tissue to peel away), and excessive salivation to loss of motor control, convulsions, liver failure, and sudden death. Whether or not afflicted animals died, or their owners understood the exact cause of their illness, the physical symptoms of cytotoxin poisoning would have triggered physiological and endocrinological stress responses that reduced milk synthesis and altered the milk's chemical composition.[304]

It is unclear whether or not nineteenth-century agricultural reformers and farmers recognized cytotoxin poisoning by blue-green algal blooms as a distinct problem of the dairy farm. Contemporary sources referred to water as either dirty or clean, without making reference to its color or the presence of algal scums, mats, or filaments. Certainly, the conditions were right to support the growth of cyanobacteria. If contemporary sources are any indication, it was common for cattle to drink the runoff of dung heaps. The December 29, 1832, *Genesee Farmer* indicated that cattle developed "a relish for it and refused good water if offered them." In doing so, the beasts "la[id] the foundation of a train of disorders [that] will rarely if ever be eradicated," which likely included the problems associated with cyanotoxin poisoning. Editors of the September 1851 *Valley Farmer* recoiled at the "filthy compound which some cattle are allowed to drink" during periods of warm weather, noting that the beasts slaked their thirst from "dirty horse-pond[s] adjoining the farmyard, contaminated by the excrement of cattle and the drainage

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304 "Blue-Green Algae and Harmful Algal Blooms," Minnesota Pollution Control Agency, n.d., https://www.pca.state.mn.us/water/blue-green-algae-and-harmful-algal-blooms; Michelle Arnold et al., "Harmful Algal Blooms - Are My Cattle in Danger?," University of Kentucky College of Agriculture, Food and Environment, accessed February 28, 2020, https://afs.ca.uky.edu/dairy/harmful-algal-blooms-are-my-cattle-danger.

of dung heaps." Editors reasoned that such water caused "derangement of the stomach," damaging the animals' health and along with it, their ability to produce good milk.[305]

Toxic cyanobacteria need not have been present to render dung- and manure-tainted water harmful to nineteenth-century American cattle. Modern researchers recognize that high concentrations of nitrate in drinking water -- 1,000 ppm or higher -- may poison and kill cattle by preventing their blood hemoglobin from carrying oxygen to their body tissues. Afflicted animals quite literally suffocate to death while still drawing breath. And yet, smaller amounts of nitrate -- anywhere from 101 to 1,000 ppm -- have been shown to cause a host of health problems in cattle, among them spontaneous abortions, vitamin A deficiency, loss of appetite, slow growth, and reduced milk synthesis. Whether or not they understood the exact causes, nineteenth-century agricultural reformers understood that dung- and manure-tainted water had the power to sicken and kill livestock. Noting that "wholesome" drinking water was more important to cattle than "the public is aware of," the July 31, 1829, *New England Farmer* told readers of "three or four farmers" who "had sustained such loss from abortions in their cows that they were ruined or obliged to give it up." The "present occupier" of their land fenced the ponds and sank a deep well for use in filling cattle troughs with fresh water, after which time the "mischief" abated. Over twenty years later, in 1851, editors of the *Genesee Farmer* noted a similar correlation between cows drinking the runoff of dung heaps and the onset of disorders -- spontaneous abortions, reduced quality and quantity of milk, and scouring (diarrhea) -- that are indicative of nitrate poisoning.[306]

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305 "On Watering Neat Cattle," *Genesee Farmer*, December 29, 1832; "Improvement and Management of Cattle," *Valley Farmer*, September 1851.

306 Richard S. Adams, Thomas R. McCarty, and Lawrence J. Hutchinson, "Prevention and Control of Nitrate Toxicity in Cattle," Penn State Extension, February 19, 2016, https://extension.psu.edu/prevention-and-control-of-nitrate-toxicity-in-cattle; "On Watering"; Shane Gadberry and John Jennings, "Nitrate Poisoning in Cattle," Agriculture and Natural Resources (Fayetteville, Arkansas: University of Arkansas Division of Agriculture,

In addition to tainting the soil, water, and fodder crops with bacteria, cattle dung helped spread parasitic organisms over a broad area. Of particular concern to nineteenth-century American farmers were lung worms, a species of nematode (most likely *Dictyocaulus viviparous*) that infested the bronchial tubes of young cattle, causing a complex of symptoms known, collectively, as "husk" or "hoose." Much like the fecal coliform bacteria, lung worm eggs passed from cattle's digestive systems to the ground via cow pats. Given favorable environmental conditions -- temperatures between 55° F and 85° F, with abundant precipitation -- the eggs hatched into larvae, which then wriggled from the cow pats and into the grass under their own power, or else were washed free of their fecal nursery by rainfall and/or floodwater. Once introduced to a pasture, the larvae were resilient, capable of surviving the cold winter months in sufficient numbers to afflict cattle released to graze on spring grasses, when environmental conditions were more favorable. Infestation occurred when grazing cattle swallowed larvae that were clinging to pasture grasses. Once inside the animal, the larvae passed through the ruminoreticulum and into the intestine, and then burrowed through the intestinal mucosa to reach the lymphatic system. From there, they traveled to the alveoli in the lungs via blood and lymph, and thence to the trachea and bronchial tubes. It was at this stage that cattle showed overt signs of infection: mild or severe coughing; wheezing and labored breathing while at rest; and in some cases, severe tachypnea (increased rate of breathing) and dyspnea (labored breathing). Left untreated, lungworm may kill young calves. In older cattle that lacked exposure immunity, the parasite caused rapid weight loss and reduced the amount and chemical composition of milk synthesized in the udder.[307]

Research and Extension), accessed February 29, 2020, https://www.uaex.edu/publications/pdf/FSA-3024.pdf; "The Importance of Wholesome Water to Cattle," *The New England Farmer, and Horticultural Register*, July 31, 1829; *Genesee Farmer*, 1851.

[307] Fares, Jr., "Common Cattle Parasite,"; "Control of Lungworm in Cattle".

Contemporary veterinary manuals abounded with references to the coughing and wheezing of young cattle afflicted with "hoose" caused by lungworms.[308] The aforementioned English veterinary surgeon, William Youatt, described the condition as it existed among British and Jamaican livestock in his 1834 work, *Cattle: Their Breeds, Management, and Diseases*. According to Youatt, yearling cattle raised on "low, marshy, woody lands" were prone to developing a "peculiarly distressing" or "violent" cough, followed by sudden death. The veterinary scientist R. M'Clure of Philadelphia described a similar condition in the November 1860 *Cultivator*. M'Clure concurred with Youatt's findings, noting that hoose occurred when "minute filaria, (thread worms,)" invaded the trachea and bronchial tubes of calves during the autumn months, causing the afflicted animals to suffer bronchitis and "lose flesh very rapidly." Yet another veterinary manual, William B.E. Miller's 1885 *The Diseases of Live Stock and their Most Efficient Remedies* told a similar story, noting that "husk" or "hoose" afflicted "calves under one year old, and especially such as are pastured in low-lying lands, near rivers, and subject to flood." The worms were most prevalent in August and September, he noted, and killed young animals by congregating in their windpipe, "thus choking them to death." Treatment protocols varied, with Youatt calling for bleeding and purging, Miller prescribing an inhalation of burning sulfur, and Miller and M'Clure suggesting that a draught of turpentine and linseed oil. All agreed that bringing the sick in out of the elements provided some relief.[309]

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[308] Nineteenth-century veterinary scientists also used the term "hoose" to refer to non-parasitic bronchitis in livestock. See Robert Jennings, *Cattle and Their Diseases, Embracing Their History and Breeds, Crossing and Breeding, and Feeding and Management; with the Diseases to Which They Are Subject, and the Remedies Best Adapted to Their Cure* (Philadelphia: John E. Potter, 1863), 238–39.

[309] William Youatt, *Cattle: Their Breeds, Management, and Diseases* (London: Baldwin and Cradock, 1834), 397–98; "Hoose in Young Cattle," *The Cultivator*, November 1860; Likely R. M'Clure was the veterinary scientist Robert McClure, who was appointed a professor of the Veterinary College of Philadelphia in 1860. See J.H. Steel, "Veterinary Science in America," *The Veterinarian: A Monthly Journal of Veterinary Science*, Fourth, 53, no. 630 (June 1880): 387; William B.E. Miller, *The Diseases of Live Stock and Their Most Efficient Remedies; Including Horses, Cattle, Cows, Sheep, Swine, Fowls, Dogs, Etc.* (Philadelphia: H.C. Watts & Co., 1885), 339–40.

Though they recognized that a correlation existed between damp, muddy pastures and hoose, veterinary scientists struggled to explain how lung worms gained access to cattle or how to cure the animals, once infected. Youatt proposed that the parasites' eggs could be found "floating in the atmosphere" or "contained in the food or drink of the animal." He proposed further that the eggs then caused or took advantage of bronchial inflammation -- "these are questions," he wrote, "which will better be answered by-and-by" -- as they hatched into the worms that caused hoose. Writing in 1885, William B.E. Miller likewise alluded to the possibility that the eggs passed from animal to animal via the air, similar to other respiratory ailments, leading him to recommend that "affected calves . . . be separated from the rest of the flock, so that none of the eggs of the worm convey the disease to the remainder."[310] It is difficult to determine whether the proposed treatments did any good. Certainly, barring calves from low-lying pastures during the spring and fall months would have decreased incidence of infection. Confining them in warm, dry stalls would also have helped, if for no other reason that it assured the animals' physical comfort. As late as 1915, the Texas Department of Agriculture advocated the use of burning sulfur to treat lung worm, noting that inhalation of the vapors caused violent coughing fits and nasal discharge that expelled the worms from the trachea and bronchial tubes. Effective or not, such treatments were palliative rather than preventive. Absent modern vaccines, the only reliable means of control available to farmers of the era was the time-consuming and costly process of burning pastures and fodder suspected of harboring the worms, destroying the eggs and larvae.[311]

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[310] Youatt, *Cattle*, 398; Miller, *Disease of Live Stock*, 340.

[311] John McKinley Jones and J.E. Boog-Scott, "Sheep Production in Texas," Texas Department of Agriculture Bulletin (Austin, Texas: Texas Department of Agriculture, August 1915), 55; "Seventeenth Annual Report of the Bureau of Animal Industry for the Year 1900" (Washington D.C.: United States Department of Agriculture, 1901), 377.

Another parasite that benefited from widespread distribution of cattle dung was the liver fluke. Known by the scientific name Trematoda, these tiny flatworms propagated via a complex, multi-host lifecycle. The cycle began -- or ended, for it was a circular process -- when cattle dung laden with trematode eggs fell to the ground. Assuming that the temperature was optimal (about 70° F), and that the cow pats remained undisturbed, the eggs hatched in about 9-10 days, giving rise to a host of wriggling larva known as miracidium. At birth, these tiny lifeforms had about three hours to locate and burrow into one of several species of freshwater or mud snails that were common in damp, low-lying pastures, or in stagnant pools and ponds and slow-moving creeks and rivers. The direct threat to cattle began about six or seven weeks after this invasion, as the miracardium -- now a second larval stage, known as metacercariae -- swarmed from the infected snails and encysted themselves on the stems of pasture grasses. When unsuspecting cattle ate the cysts, the metacercariae erupted in their small intestine and burrowed into the peritoneal cavity in search of the bile duct and liver (a process that took about seven or eight weeks to complete). Once there, the metacercariae fed on the infested animals' blood until they matured and laid eggs, which traveled through the bile ducts and into the feces. Infested cattle suffered a host of health problems: weight loss, anemia, chronic diarrhea, and reduced milk production.[312]

Here again, nineteenth-century agricultural reformers labored under an incomplete understanding of the liver fluke and its propagation. One of the more thorough descriptions of the parasite and its lifecycle appeared in the February 15, 1856, *Ohio Farmer*. Citing the correspondent Robert H. Gilmore, editors explained to readers that a condition known as "bloody murrain" in cattle (that is, bloody diarrhea) could be traced to a species of leech that inhabited

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[312] "Liver Fluke in Cattle"; Campbell et al., "Liver Fluke".

pools of stagnant water. Moreover, they explained that the leeches, which they described as looking "much like a tadpole, with a long tail, a triangular head, and a large sucker in the middle of the body" (a description consistent with the metacercariae larval stage of liver flukes) survived for long periods by attaching themselves to, without necessarily feeding on, the bodies of water snails. From there, the account loses much of its coherence. Citing the biologist Louis Agassiz, it proposed that the leeches that attacked the snails emerged from a larger "nurse" worm, which served as their living incubator. The nurse worms were thought to emerge from another "grandnurse" worm, which emerged in turn from a *Distoma*, the worm known to infest the liver and gall bladder of cattle. All of this centered on stagnant puddles and snails, with no indication given that cattle dung played any role in spreading the parasites. Indeed, editors reasoned that infestation occurred quite by accident, when thirsty cattle lapped up *distoma* in mouthfuls of water.[313]

Even as farmers and veterinary scientists struggled (and failed) to discover the exact causes of cattle disease, a growing number of progressive agricultural reformers called on stock owners to maximize the collection of livestock dung by confining and feeding their cows year-round in barns and small fenced lots. Known as "soiling," this practice did offer advantages. First, it ensured that cattle voided feces and urine in a relatively small space, as opposed to scattering them over tens, hundreds, or even thousands of acres. Second, it made possible the tilling and manuring of grass and legume crops, increasing the fodder supply while also preventing the animals' damaging young plants and compacting soils. Indeed, English farmers reported higher yields of green fodder and hay, with one acre of tilled land producing as much as

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[313] "Naturalists' Department. The Fluke Worm. Distoma Hepaticum," *Ohio Farmer*, February 16, 1856. For more on Louis Agassiz, see Edward Lurie, *Louis Agassiz: A Life in Science* (Baltimore: Johns Hopkins University Press, 1988).

seven that were grazed. Third, it prevented dairy cows' expending energy in search of food and water, which improved the animals' health and by extension, the quality and quantity of the milk harvest. Fourth, it served as check against heat and cold stress, with the barns and sheds used in confining the animals keeping the animals cool during the summer, warm during the winter, and dry during rain showers. If nothing else, soiling freed the farmer of the need to build and maintain fences, saving time, energy, and costs.[314]

A case study of soiling published by the veterinary scientist Robert Jennings would seem to bear out the wisdom of the practice. Jennings's study centered on a Massachusetts farmer, who confined seven or eight dairy cattle in a barn for the entire year. During the summer, he fed the animals "green fodder," most of it the leaves and stems of Indian corn, along with a quantity of alfalfa and fresh-cut grass. Throughout the year, he took pains to collect all of the animals' manure, including the liquid portion, for use in manuring his corn and grass crops. Because the farmer's cows never left the barn, they were "less vexed by flies" than those turned out to graze. He might also have added that confinement prevented the animals walking great distances, expending energy that would otherwise have gone to milk synthesis. The results spoke for themselves. The soiled cows produced more milk than those turned out to pasture. Moreover, the practice saved him the trouble of driving the animals to and from pasture, a practice that likely stressed and tired the animals even as it consumed time that was better spent in spreading manure, nourishing the soil and contributing to higher fodder and hay yields. Indeed, he claimed that his "mowing land" was "every year growing more productive, without the expense of artificial manure."[315]

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[314] "Soiling," *Michigan Farmer*, May 12, 1860.
[315] Jennings, *Cattle and Their Diseases*, 118–20.

And yet, for any good that it did, soiling would only have increased the animals' exposure to disease-causing microorganisms. Absent modern disinfecting and sanitizing agents, no amount of mucking and sweeping would have eliminated the fecal-borne bacteria that caused foot rot, black leg, and other deadly infections. Absent knowledge of microbes and antibiotics, it would likewise have been impossible for farmers to prevent the bacteria and viruses that caused respiratory infections in cattle from killing and maiming animals that were crowded into barns and exercise lots. Regarding the latter, nineteenth-century observers used a number of catch-all terms such as "distemper" and "consumption" to explain the symptoms that they observed among dairy cattle.[316] It seems likely that *Mycobacterium bovis*, the bacteria responsible for bovine tuberculosis, appeared on nineteenth-century American farms. The common symptoms -- sluggishness, emaciation, coughing, and death -- match up well with those described by nineteenth-century farmers and veterinary scientists. Indeed, scientists agree that the virus arrived in North American prior to the Civil War. It may also be that the bovine virus diarrhea virus (or BVDV), a pathogen which causes a range of temporary or chronic symptoms such as diarrhea, dehydration, fever, and weight loss, also afflicted cattle of the era. Scientists generally agree that the disease emerged much earlier than 1946, the date that it was isolated and described in the United States.[317]

[316] "Domestic Summary," *The Independent . . . Devoted to the Consideration of Politics, Social and Economic Tendencies, History, Literature and the Arts*, 10 December 1857; Youatt, *Cattle*, 377.

[317] Scientists agree that the bacteria arrived in North America prior to the Civil War Era. Mitchell V. Palmer and W. Ray Waters, "Bovine Tuberculosis and the Establishment of an Eradication Program in the United States: Role of Veterinarians," *Veterinary Medicine International*, May 17, 2011, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3103864/; Hanspeter Stalder et al., "Traces of History Conserved Over 600 Years in the Geographic Distribution of Gentic Variants of an RNA Virus: Bovine Viral Diarrhea Virus in Switzerland" 13, no. 12 (December 5, 2018), https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0207604.

Such were the risks that conscientious nineteenth-century farmer faced in using progressive farming methods to manage two of the variables -- feeding and care -- that were vital to the raising of healthy, happy, and productive dairy cows. And yet, it was the third variable, breeding, that had the potential to do the most harm when done in accordance with the progressive (and very expensive) program of purchasing blooded animals from abroad and introducing them to American herds. Recall that mid-nineteenth-century American dairy cows had enjoyed no real contact with European stock for almost two centuries. Consequently, they lacked acquired immunity to the zoonotic diseases that killed millions of cattle and prompted European officials to quarantine and cull animals. Save rinderpest, none of these was more destructive to cattle than contagious bovine pleuropneumonia, a deadly respiratory infection that emerged in Europe in the late-seventeenth century and then raced across the continent and Central Asia, aided by the movement of armies and cattle drovers. Thanks to the well-intentioned efforts of a single Massachusetts farmer intent on improving his herds, the disease reached the United States on the eve of the American Civil War, with devastating consequences for the farmers of New England.[318]

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The Belmont, Massachusetts, gentleman farmer Winthrop Chenery had reason to be pleased as he made his way to the Boston wharf on May 23, 1859. A ship just arrived from Holland carried four blooded Frisian (or Holstein) cattle in its hold -- among the first of their kind in the Americas -- that would soon make the nine-mile trip west to Chenery's manicured

[318] "Contagious Bovine Pleuropneumonia"; Masiga et al, "Manifestation and Epidemiology of Contagious Bovine Pleuropneumonia in Africa," 1–2; Massachusetts General Court, *Evidence*, 44–61; Bull, "Foreword," v; Campbell and Turner, "Studies in Contagious Pleuro-Pneumonia of Cattle. II. A Complement-Fixation Reaction for the Diagnosis of Contagious Bovine Pleuro-Pneumonia,"11–12; *Department of Agriculture. Special Report*, 229–30, 237–38.

estate. If so, his pleasure soon gave way to concern. One of three cows in the lot had suffered extensive injuries during the weeks-long, trans-Atlantic voyage. Another was ill. The ship's crew reported that sick animal had been unable to stand for the final twenty-two days of the forty-seven-day trip. Chenery put the injured animal down the following Monday. The sick cow lingered on until Wednesday, on which day it died, surrounded by twenty to thirty animals confined in a barn. Although aware that Dutch cattle breeders had suffered terrible losses to contagious bovine pleuropneumonia, Chenery saw no reason to suspect its presence among his animals. The newcomers originated in northern Holland, an area that his purchasing agent assured him was free from the disease. And so, lacking any better explanation, Chenery blamed "ill treatment" on board ship for the losses and turned his stock, the surviving Dutch newcomers included, out to pasture for the summer.[319]

Unknown to Chenery, at least one of the cattle that spent the summer of 1859 ambling about the grounds of his Belmont estate carried *Mycoplasma mycoides*, the bacteria responsible for bovine pleuropneumonia, in its respiratory system. Perhaps by coughing, perhaps by engaging in normal bovine social behaviors -- for example, kneeling alongside herd mates to ruminate -- this animal passed the bacteria along to the rest of Chenery's cattle. Over the next five months, 30-40 head developed symptoms common to bovine pleuropneumonia: standing with front feet shoulder-width apart, necks fully extended; labored breathing; hair bristling; coughing; yellowish nasal discharge; lethargy; reduced milk production; loss of appetite; and rapid weight loss. The animals then died, gasping for air. Those that contracted and then recovered from the disease "look[ed] well generally" to Chenery, leading him to put an ox team back to work as beasts of burden. However, these animals continued to hack and cough,

[319] "Contagious Bovine Pleuropneumonia"; Massachusetts General Court, "Evidence," 75-80.

indicating that they suffered permanent physiological damage. In fact, they remained contagious and very much capable of transmitting the disease to uninfected animals.[320]

Had Chenery quarantined his cattle at the first sign of illness, the *Mycoplasma mycoides* that infested his estate might well have died out for lack of naïve hosts. In fact, he did the opposite. Chenery sold a mature cow to a certain Mr. Marsden who owned a farm eight miles from Belmont in Malden, Massachusetts. The animal sickened and died about two months later from a disease that resembled bovine pleuropneumonia. Chenery next sent a yoke of oxen to a neighboring farm to retrieve a wagonload of hay. The beasts showed no signs of illness, or at least, none that alarmed Chenery. Yet a calf tethered alone in the neighbor's hay barn sickened and died, suggesting that it contracted pleuropneumonia from Chenery's oxen. In turning his primary herd out to pasture for the summer, Chenery gave the animals ample opportunity to spread the infection to neighboring farms. By his own admission, nothing but a "common stone wall" bounded the estate -- insufficient to stop curious cattle on both sides of the barrier from greeting one another with probing noses, much less obstruct bacteria capable of traveling 100 meters through the air. It is impossible to know whether any of these cattle contributed to the outbreak. Suffice to say, none of Chenery's immediate neighbors reported having sick animals that summer.[321]

In late June, *Mycoplasma mycoides* traveled west seventy miles from Belmont to North Brookfield in the respiratory systems of three calves that Chenery sold to farmer Curtis Stoddard. Three days after arriving on Stoddard's farm, one of the calves "exhibited a very great illness," prompting Stoddard's father, Leonard, who thought himself a better nurse, to transfer the calf to

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[320] Massachusetts General Court, 9, 75–80.
[321] Ibid., 91-95.

his own farm. Unable to cure the young animal, the elder Stoddard returned it, although not before it passed the infection to eight of his work oxen. These animals transferred the bacteria, in turn, to a herd owned by Leonard Stoddard's neighbor, a Mr. Needham, who confined Stoddard's animals in his barn for the night after a day spent cutting and hauling timber. Around the same time, three other farmers -- a Mr. Olmstead, a Mr. Woods of New Braintree, and a Mr. Doane -- purchased cattle or borrowed oxen from Leonard Stoddard, introducing *Mycoplasma mycoides* to their herds. Although mortality figures are difficult to come by, contemporary sources reported that Olmstead and Woods suffered heavy losses. So too Doane, who used a yoke of oxen borrowed from Olmsted to assist in moving a building from Oakham to New Braintree, about five miles northwest of North Brookfield. In doing so, Doane passed the contagion to an additional twenty-two yoke of oxen belonging to eleven separate herds (or as many as thirteen herds, depending on the source). By year's end, fourteen of Leonard Stoddard's cattle and eighteen belonging to Needham -- his entire herd -- lay dead. Curtis Stoddard lost no animals save the sick calf that he purchased from Chenery. Unaware that his cattle harbored the bovine pleuropneumonia contagion, or so he later claimed, Curtis Stoddard sold eleven animals, mostly heifers, at auction on November 1, and then distributed the remainder of his herd -- four oxen and five young cows -- to his father, father-in-law, and uncle.[322]

The farmers who purchased the younger Stoddard's cattle at auction drove the infected animals -- none of which showed any outward signs of illness, or at least, nothing that aroused suspicion -- to points across south-central Massachusetts. Among them, a Mr. Tucker kept one of the infected heifers for a time before selling the animal to an unidentified North Brookfield farmer. Said farmer then passed the heifer to a Mr. Bowen, who drove the animal to Sturbridge,

[322] Massachusetts General Court. Committee on Pleuropneumonia, 3-4; "The Terrible Cattle Plague," *Michigan Farmer*, June 2, 1860.

three miles north of the Connecticut border, before selling it to a Mr. Gleason, who lived about thirteen miles northwest of Sturbridge in the Coy's Hill community. At about the same time, Bowen sold or exchanged eight head of cattle, all known to have come into contact with the infected heifer, to farmers residing in and about Sturbridge. By early February, approximately 200-300 cattle along the heifer's line of travel had contracted bovine pleuropneumonia and died. The heifer lived on into June, having never contracted the disease, until Gleason had it slaughtered. A postmortem exam revealed unmistakable signs of pleuropneumonia: lungs adhered to the diaphragm, pleura, and pericardium. Yet the inflamed organs and tissues also showed signs of healing, indicating that the animal could have survived for years, infecting even more naïve hosts.[323]

As news of the illness spread, farmers petitioned Massachusetts authorities to intervene. Responding to their constituents' pleas, the legislature convened an emergency session on November 1 -- incidentally, the same day that Curtis Stoddard auctioned off his remaining cattle -- during which it appointed a Joint Select Committee to meet on May 31, 1860, to discuss and organize a response to the crisis. Otherwise, authorities dithered. It was not until April 2, 1860, almost a year after Winthrop Chenery first introduced *Mycoplasma mycoides* to the commonwealth, and simultaneous to farmers' turning their cattle out to graze on spring pasturage, that the Massachusetts legislature passed a law authorizing cattle commissioners to "extirpate" the infection. The law sounded good on paper. It not only authorized the cattle commissioners to condemn and destroy animals that manifested symptoms of bovine pleuropneumonia, but also included an appropriation of $10,000 to compensate farmers for their

[323] "The Terrible Cattle Plague," *Michigan Farmer*, June 1860.

losses and cover the commissioners' incidental expenses.[324] Nevertheless, it proved insufficient to meet the crisis. "As soon as we began [culling animals in and about North Brookfield]," Cattle Commissioner Amasa Walker later recalled, "we found a second circle of infection, and another after that. . . . It assumed such proportions that it was very evident that the commissioners had not the funds to perform the operations required by the law." By June, the commission had slaughtered 842 cattle at a cost of $20,000. Cattle Commissioner, Dr. George B. Loring, insisted that an additional 1,000 head should be "isolated for such a length of time as should establish the fact that they had no disease about them."[325]

The wisdom of Loring's recommendation notwithstanding, neither he nor his colleagues knew enough about bovine pleuropneumonia to explain its epidemiology to Massachusetts legislators. Pressed by members of the Joint Select Committee to pinpoint the cause of the disease and/or specify its incubation period, Cattle Commissioner Amasa Walker demurred, stating, "The most alarming fact in regard to the disease, [is] that it don't seem to be understood at all in this country, or even in Europe, where they have had it for two hundred years." He insisted that bovine pleuropneumonia was contagious, citing as proof his ability to trace every known case back to the Winthrop Chenery farm, via the Stoddards. Yet skepticism abounded. Testifying before the Joint Select Committee, Dr. Jacob Bigelow chided the cattle commissioners for engaging in alarmist rhetoric. "In times of popular panic," he insisted, "widely spread epidemics are believed, by the populace at large, to be contagious." Dr. John B. S. Jackson of Boston fell back on miasma theory -- that is, the widely held belief that noxious vapors arising from filth and damp caused illness in people and animals -- to explain the

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324 *Act and Resolves Passed by the General Court of Massachusetts, in the Year 1860* (Boston: William White, 1860), 201-202; "Cattle Disease," 36th Congress, 1st Session, Report No. 651 (18 June 1860).
325 Jennings, *Cattle and Their Diseases*, 275, 279-281.

epidemic. Attributing bovine pleuropneumonia to an unidentified miasmatic "poison," Jackson insisted that "hygienic treatment" would halt the disease, which he considered "not in the slightest degree contagious."[326]

In the meantime, the Massachusetts legislature having imposed no limits on the movement or sale of cattle, farmers and drovers carried on as they always had, herding animals from farm to farm and across state borders. Already by June, as many as 300 Massachusetts cattle roamed over summer pastures in and about the towns of Lempster, Hillsboro, Washington, and Antrim, in New Hampshire, as well as Brattleboro, in Vermont. If contemporary sources be believed, bovine pleuropneumonia traveled north with the newcomers. On June 1, the Bellows Falls, Vermont, *Times* reported that two heifers from Lexington, Massachusetts, fell ill soon after reaching the farm of a Mr. Blanchard of Hillsboro. Summoned to the farm to investigate, a certain Dr. Cutter declared that the beasts showed symptoms identical to those seen in West Brookfield. The same report noted that two cattle summering on the farm of B.P. Whittemore of Antrim had been exposed to the contagion, with one having been earmarked for slaughter. Across the border in Vermont, editors of the *Brattleboro Phoenix* dismissed reports that pleuropneumonia had arrived in the state as "the natural apprehension incident to such a disastrous disease." Though editors cautioned against alarmism, they stopped short of criticizing farmers who, being "much exercised in the matter," were "anxious that some early legislative action should be had . . . to prevent if possible the introduction of this disease."[327]

[326] "Cattle Disease"; Massachusetts General Court. Committee on Pleuropneumonia, 7, 149, 151, 222, 225-226.
[327] "The Cattle Cholera.--Look Out for Your Herds," *Bellows Falls Times*, June 1, 1860; "The Cattle Disease," *Vermont Phoenix*, June 16, 1860.

Near midsummer, the disease having crossed state lines, Commonwealth officials at last took decisive action. On June 12, Governor Nathaniel Banks signed “An Act Concerning Contagious Diseases Among Cattle” granting power to the selectmen, mayor, and alderman of any city or town to seize cattle suspected of harboring bovine pleuropneumonia, or any other contagious disease, and isolate them in “some suitable place or places,” with expenses for their care to be paid for with local and Commonwealth funds. Moreover, the act empowered these same local officials to use city or town funds in condemning, destroying, and burying sick cattle, or if they preferred, branding infected animals with a “P” to prevent resale to unwitting buyers. Furthermore, the act gave local authorities the power to prohibit the movement of cattle to and from enclosures or along roads. By way of ensuring compliance from private citizens and local officials, the bill included punitive measures. Those among the former who sold branded cattle, drove suspect animals in violation of quarantines, or hid evidence of the disease’s presence faced fines of up to $500 and/or a prison term of up to one year. Those among the latter who neglected their duty faced fines amounting to $500 per day. The indemnities paid to farmers who lost cattle to culls would be determined in each case by “three competent and disinterested men, under oath.”[328]

Yet Massachusetts officials refused to grant full discretionary power to local authorities. The cattle law required that mayors, selectmen, and alderman abide by any and all regulations put in place by the duly appointed cattle commissioners, to include the seizure, isolation, destruction, and burial of animals suspected of harboring the disease, as well as the use of town or county funds to indemnify farmers against losses. Moreover, the law obliged local officials, under penalty of fine, to report suspect cattle to the cattle commissioners no more than twenty-

[328] *Act and Resolves*, 280-283.

four hours after said animals' discovery. Perhaps most important in terms of containing the disease, the new law placed geographic restrictions on the cattle trade. Unless authorized by the cattle commissioners to do so, private citizens were forbidden to drive cattle across the Connecticut River and into western Massachusetts, or from Massachusetts into neighboring states, until April 1, 1861. Here again, the bill imposed fines of up to $500 and a prison term of up to one year for violators.[329]

To the great relief of farmers and officials alike, the crisis soon appeared to abate. The Cattle Commissioners discovered no new or active cases of bovine pleuropneumonia as they traveled about the Commonwealth that summer. They did, however, keep busy. Hoping to "allay public alarm," beginning on June 16 the commissioners welcomed state and local agricultural officials from New Jersey, Indiana, Pennsylvania, and Ohio to Boston to discuss preventative measures. At the same time, the veterinary surgeon George Dadd traveled to New Hampshire to investigate rumors that bovine pleuropneumonia existed in that state. Later that summer, commissioners ordered the cull of 1,100 cattle suspected of harboring the contagion, lest in allowing them to live, they permit asymptomatic animals from mingling with the healthy and reigniting the epidemic at some later date. This included blooded cattle belonging to Winthrop Chenery of Belmont, who had by that time replenished his cattle herd by importing a second round of blooded Frisians from Holland. Chenery's risky, but altogether legal actions notwithstanding, the commissioners saw reason to be hopeful. Dadd's investigation turned up nothing, suggesting that pleuropneumonia had either run its course in the Granite State or never existed there to begin with. As 1860 drew to a close, Paoli Lathrop and Amasa Walker of the

[329] Ibid., 283-85.

Massachusetts Board of Agriculture went on record in stating that pleuropneumonia "has been exterminated."[330]

Walker's and Lathrop's confidence notwithstanding, both doubted that the states, alone, were capable of preventing the disease's reintroduction from abroad. Though they stopped short of advocating federal interference in state and local agricultural matters, Massachusetts legislators approved a resolution, calling on Congress to pass a national quarantine law, barring the entry of foreign, and possibly infected cattle into the United States. On June 11, however, Congress tabled the resolution without debate.[331] Undaunted, Walker and Lathrop wrote to state agricultural societies in December, asking them to petition Congress for a quarantine law.[332] There is no record, however, that Congress received or acted on any such petition. To be fair, the US government lacked the political will and the coercive apparatus necessary to enact quarantines, much less implement the draconian, European-style containment and eradication strategies summarized and advocated by the editors of the Cincinnati *Daily Times*: "killing all infected animals and burying them entire, cutting off all communication with suspected herds and farms, burning all hay and straw used about infected animals, and placing the movement of all animals under strict *surveillance*." For the moment, the safety of US dairy herds rested with state and local officials.[333]

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330 "Report on the Cattle Disease," *The New England Farmer; a Monthly Journal*, February 1861.

331 "XXXVIth Congress – First Session.," *Maine Farmer*, 21 June 1860.

332 "Quarantine for Imported Cattle," *Ohio Cultivator*, January 1, 1861; "Report on the Cattle Disease," *The New England Farmer; a Monthly Journal*, February 1861.

333 The United States adopted its first animal welfare law, intended to protect livestock while in transit, in 1873. See Janet M. Davis, *The Gospel of Kindness: Animal Welfare and the Making of Modern America* (Oxford: Oxford University Press, 2016), 169. The first United States federal law to prohibit the importation of animals and plants from abroad was passed by Congress in 1912. See Bailey DeSimone, "Plant and Animal Quarantining in United States Legal History," Library of Congress, 16 December 2020, https://blogs.loc.gov/law/2020/12/plant-and-animal-quarantining-in-united-states-legal-history/. "The Massachusetts Cattle Disease," *Cincinnati Daily Times*, 31 May 1860.

As it happened, state and federal officials had plenty else to worry about in the coming months. Just before dawn on April 12, 1861, South Carolina secessionists bombarded Fort Sumter in Charleston Harbor, igniting the American Civil War. In the months that followed, US authorities and Northern state governments scrambled to mobilize tens of thousands of men and horses, along with the food, arms, uniforms, tack, wagons, tents, and myriad other manufactured items needed to form and support large standing armies.[334] By early June, the Union war effort had its first martyr, Colonel Elmer E. Ellsworth of the 11th New York Volunteer Infantry, who was shot and killed while removing a secessionist flag from on top of the Marshall House Inn in Alexandria, Virginia.[335] It also had its first victory, a smallish affair at Philippi, Virginia, that propelled Major General George B. McClellan into the national spotlight as the wartime North's first bona fide hero.[336] Given all of this excitement, it is not surprising that contagious bovine pleuropneumonia faded from public consciousness. Editors of the *Prairie Farmer* thought so anyway, writing from Chicago on June 22, "Since all Massachusetts has gone volunteering, and the Legislature makes appropriations for war purposes, instead of paying for the wholesale slaughter of the finest herds of cattle within her borders, we have heard nothing" about bovine pleuropneumonia.[337]

Even as the *Prairie Farmer* went to press, however, *Mycoplasma mycoides* reemerged to afflict Massachusetts cattle herds. As war fever swept the North that April, the farmer C.C. Barnes of Squantum noticed that one of his cows looked ill. On or about May 12, the animal died. Perhaps because he doubted that his cattle had contracted the so-called "Massachusetts

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[334] James M. McPherson, *Battle Cry of Freedom: The Civil War Era* (New York, New York: Oxford University Press, 1988), 312–14, 322–27.
[335] Bruce Catton, *This Hallowed Ground* (New York: Pocket Books, 1956), 46.
[336] For an account of the Battle of Philippi, see McPherson, *Battle Cry*, 299–301.
[337] "Pleuro-Pneumonia," *Prairie Farmer* 7, no. 25 (June 20, 1861): 395.

Disease," perhaps because he feared losing his animals to a state-sanctioned cull, Barnes neglected to alert Commonwealth authorities in accordance with the June 12, 1860, cattle law. Instead, he cut open and examined the dead animal, discovering diseased lungs, surrounded by "considerable fluid," both symptoms of acute bovine pleuropneumonia. All seemed well enough until late November, when a second animal sickened and died. Once more, Barnes did his own post-mortem examination. Once more, the examination revealed diseased lung tissue consistent with pleuropneumonia. A butcher present during the procedure, who went on to kill and process a "fat cow" for beef, told Barnes that the latter animal's lungs showed unmistakable signs of pleuropneumonia, suggesting that it was an asymptomatic carrier, capable of spreading the disease. Still, Barnes kept the matter to himself. It was not until six weeks later, in January 1862, that a third outbreak drove Barnes to contact Secretary of the Massachusetts Board of Agriculture Charles Flint who traveled to Squantum with the veterinary surgeon Elisha F. Thayer to investigate the outbreak. On arriving, Flint and Taylor had three animals killed. Post-mortem examinations revealed solidified lung tissue and lesions consistent with pleuropneumonia.[338]

Though his failure to report the illness among his cattle violated the letter of the June 1860 Massachusetts cattle law, for which he may or may not have faced sanction, Barnes's actions deserved no special condemnation. Everyone involved in containing and eradicating pleuropneumonia, from the Massachusetts legislature to the Cattle Commissioners to individual farmers, agreed that the disease defied easy diagnosis, not only because its incubation period lasted days, weeks, or even months, but also because it mimicked other inflammatory lung ailments common to cattle. Moreover, there is evidence that Massachusetts farmers resented and even feared the commissioners' intrusion into their personal affairs, especially when it came to

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[338] "Pleuro-Pneumonia," *The New England Farmer; a Monthly Journal*, February 1862.

enforced culls, which claimed the lives of both sick and healthy animals, and in doing so, robbed farm families of a season's worth of manure, labor power, calves, and the revenue derived from milk, butter, cheese, beef, and veal sales. That veterinary surgeons such as Elisha F. Thayer and George Dadd advocated quarantines and culls would have added little legitimacy to the proceedings. American veterinarians had not yet earned professional cachet in 1861. Given the choice, most farmers -- likely Barnes among them -- relied on folk knowledge and a hodge-podge of remedies cadged from agricultural journals or farrier's manuals to treat sick animals.[339]

A similar case came to light in April, hundreds of miles southwest of the Massachusetts infection zone, in New York State. In an April 16 letter to the *New York Observer and Chronicle*, L.D. Clift of Carmel, a hamlet located about thirty miles due north of Manhattan Island, reported that a tenant farmer had introduced bovine pleuropneumonia to his cattle herd in October 1860, via a heifer driven onto the farm from "an adjoining town, below this." Much like farmer Barnes of Squantum, when the animal sickened and died three weeks later, Clift, who thought "her ailment . . . nothing more than ordinary," kept the matter to himself. It was not until a second animal died of a similar illness three weeks later that he "became quite alarmed." Clift's alarm was justified. Three more animals developed the disease near the end of the year, one of which died. Clift killed the two survivors and buried all three "without skinning, deep in the ground." And yet, the disease had not run its course. The last week of February 1861 saw two more animals sicken and die, bringing the tally to seven, with "three of them being fine Durhams." Believing that the disease manifested "from some local or unknown causes," Clift thought it preventable. Should it be necessary, he also proposed a remedy: fresh air and clean

[339] "The Cattle Disease," *Prairie Farmer*, 21 June 1860; "The Cattle Disease," *The New England Farmer; a Monthly Journal*, April 1862; "Agricultural. The Pleuro-Pneumonia," *Saturday Evening Post*, June 28, 1862.

barns, combined with a diet of dry mucilage, wood ashes, soot, conditioning powders, and brimstone.[340]

The Squantum and Carmel cases notwithstanding, summer and fall brought no repetition of the 1859 and 1860 bovine pleuropneumonia epidemics. It may be that state-sanctioned culls so depopulated central and eastern Massachusetts of cattle as to deny *Mycoplasma mycoides* access to immunologically naïve hosts. It may be that farmer Barnes was but one of many Massachusetts cattle owners who withheld evidence of the disease in violation of the June 1860 cattle law. It may be that war news, most notably, the Union military disaster at Manassas, Virginia, on July 21, which sent the Union Army of Northeastern Virginia to Washington in panicked flight so preoccupied Northerners as to diminish interest in the cattle plague.[341] Whatever the reason, the Massachusetts Cattle Commissioners interpreted the lack of new or active cases as proof that the disease had been "exterminated." Taking a lesson from Massachusetts, editors of the *Country Gentleman* wondered whether the quarantines and culls might also be effective in stamping out hog cholera, thereby saving "millions of dollars to the corn and pork raising farmers of the fertile west."[342]

Once again, the Massachusetts Cattle Commissioners had been too quick in declaring an end to the bovine pleuropneumonia crisis. No sooner had the Massachusetts Legislature approved a new cattle commission in February, consisting of Elisha F. Thayer, Henry L. Sabin, and James Ritchie, than the Milton Selectmen summoned the commissioners to investigate a suspected pleuropneumonia outbreak in the town's herds. On verifying the presence of the

340 "Cattle Disease," *New York Observer and Chronicle*, May 23, 1861.
341 For more on the Battle of First Manassas, see McPherson, *Battle Cry*, 339-350.
342 "Quarantine for Imported Cattle," *Ohio Cultivator*, 1 January 1861; "The Close of the Year," *The Country Gentleman*, 26 December 1861.

disease, the commissioners brought the full force of the June 1860 Massachusetts cattle law to bear. First, they ordered the immediate isolation of all cattle in Norfolk, Suffolk, Plymouth, and Worcester Counties, regardless of their condition, "which could, by any possibility, have come into contact with any of the infected animals." Second, they had all animals suspected of harboring the disease, regardless of whether they showed any symptoms of infection, killed and examined. Of the 154 animals that lay dead at the end of the investigation only seventy-seven were found to have been infected with bovine pleuropneumonia. In completing this quarantine and cull, the commissioners spent $5,700, exceeding the $5,000 appropriation.[343]

The year 1863 saw the Massachusetts Cattle Commissioners and their efforts to eradicate bovine pleuropneumonia suffer a reversal of fortune. Effective though they may have been in the short-term, the commissioners' reliance on quarantines and mass culls to isolate and destroy bovine pleuropneumonia had, by 1863, provoked more resentment among Massachusetts farmers as gratitude. If editors of the *Prairie Farmer* be believed, "The people manifested almost as much dread of the Commissioners as of the disease itself." Massachusetts politicians also took an increasingly dim view of the cattle commissioners, who made a habit of spending money in excess of their annual appropriation, while at the same time condemning the legislature for failing to provide sufficient resources. Doubtless ongoing debates surrounding the causes of bovine pleuropneumonia, with some insisting that the disease was contagious and others arguing that it manifested in poorly ventilated and/or dirty barns also weakened public resolve. Forced to choose between the will of the people and the state budget on the one hand and the imperatives

[343] "Pleuro-Pneumonia," *The New England Farmer; a Monthly Journal*, March 1863.

of the cattle commissioners on the other, Governor John A. Andrew and the Massachusetts legislature sided with the former and disbanded the commission.[344]

The results were altogether predictable. The June 1860 cattle law having expired, responsibility for containing, and eradicating bovine pleuropneumonia fell to local officials. Over the course of the year, *Mycoplasma mycoides* reemerged and raced across the Commonwealth, carried from farm to farm and from town to town -- and possibly across state borders -- in the lungs of infected cattle. Writing to Governor Andrew in February 1864, one-time cattle commissioner and Secretary of the Massachusetts Board of Agriculture Charles Flint lamented that pleuropneumonia, which had once been confined to a relatively small area in central and eastern Massachusetts, now infested herds in twelve to fifteen counties, costing farmers an estimated $10,000 per year in losses. He concluded his missive by citing grim statistics compiled during a recent trip to the London cattle market: $10,000,000 in annual losses to pleuropneumonia; over one million animals killed by the disease or culls between 1854-1860; over nineteen tons of meat sourced from diseased animals sold to London consumers in one week. The message was clear: act now, lest Massachusetts cattle, and those who depended on them, suffer a similar fate. Flint's appeal notwithstanding, the Commonwealth took no further action during the war years to contain or eradicate pleuropneumonia.[345]

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Beginning with the development of an anthrax vaccine by the French microbiologist and chemist Louis Pasteur in 1881, American farmers have inoculated animals against a host of microbial infections. The Pasteur Institute in Paris, France, sold the first anti-blackleg

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[344] "Dutch Cattle for the Dairy, Pleuro-Pneumonia," *New York Observer and Chronicle*, 25 February 1864.
[345] "Pleuro-Pneumonia in Massachusetts," *The Cultivator*, March 1864.

vaccination kits to American farmers beginning in 1895. At approximately the same time, the German bacteriologist Robert Koch isolated tuberculin, a substance that served as a vaccine against bovine tuberculosis, while also giving veterinarians an effective means to test for the tubercle bacillus, which may be present in asymptomatic cattle and people. Researchers have since developed vaccines for use in preventing Bovine Viral Diarrhea (or BVD), the Parainfluenza-3 virus (or PI-3), the bovine herpes virus 1 (or BHV-1) and other common microbial infections, as well as antibiotics, which may be used by veterinarians as therapeutics to treat sick animals. Researchers have likewise developed antiparasitic agents for use in killing intestinal and lung worms and liver flukes. Thanks to a series of federally mandated quarantines and culls -- the very action requested by Massachusetts veterinary scientists -- the United States Department of Agriculture declared victory over bovine pleuropneumonia in 1892. The disease rages on in Africa, although a vaccine developed in the 1980s and 1990s shows promise in controlling the spread.[346]

In the meantime, farmers who invested time and money in tending to the soil and improving their herds risked catastrophic losses. This was true of Winthrop Chenery and other wealthy stock raisers who imported blooded animals from Europe. However, it was also true of the middling and poor farmers who hoped to better their farms by keeping and spreading manure, by paying to drive their animals to a neighboring county or state to graze on improved pastures, or even by confining their animals in "tight" barns during periods of foul weather. It was, in a very real sense, gambling -- and the game favored the ultra-wealthy. Winthrop Chenery had

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[346] "The Antibody Initiative: Veterinary Vaccines and Serums," National Museum of American History, Behring Center, n.d., https://americanhistory.si.edu/collections/object-groups/antibody-initiative/veterinary; Campbell, "Viral Respiratory Tract Infections in Cattle"; Nandi et al., "Bovine Herpes Virus"; Burt Rutherford, "Tips for Controlling Flies on Cattle," Beef Magazine, April 1, 2007, https://www.beefmagazine.com/mag/beef_shoo_fly; William A. Geering and William Amanfu, *Preparation of Contagious Bovine Pleuropneumonia Contingency Plans* (Rome: Food and Agriculture Organization of the United Nations, 2002), 5.

enough resources to weather a series of bad hands and keep on playing. Indeed, he did just that, importing enough Frisian cattle, losses notwithstanding, that he succeeded in founding the modern American Holstein herd. For every Winthrop Chenery, however, there were many more farmers for whom the loss of one blooded animal, or several grade animals, would have caused losses amounting to bankruptcy. Some of them gambled and won. Plenty more lost, leaving them to take up work as hired hands, or else join the tens of thousands of rural-to-urban migrants (European immigrants included) who crowded into the nation's growing cities during the first half of the nineteenth century.

The diseases that afflicted cattle during the nineteenth century have long-since faded from the American consciousness. Doubtless this may be attributed to urbanization and the industrialization of milk and beef production, which took many thousands of Americans away from the farm during the second half of the nineteenth century even as it absolved the milk- and meat-hungry of any need to dirty their hands in tending to the animals' needs. The same could not be said for the Union medical officials and civilian caregivers who traveled south to care for Union soldiers who fell sick or injured (or both) during the Civil War. The diseases that appeared as if from nowhere to maim and kill dairy cattle were well-known to anyone of the era who lived on a farm and/or bothered reading newspapers and journals. Indeed, they were one of many variables that Union medical planners would have taken into account when weighing the pros and cons of buying and shipping dairy cattle to the Southern war zone for use in furnishing medicinal milk. Ultimately, Borden's Milk resolved the problem by shrinking the distance between the Northern dairy belt and front line Union military hospitals and aid stations. Indeed, it may be that the product helped contain the spread of contagious bovine pleuropneumonia beyond New England and the Mid-Atlantic by discouraging the wartime movement of infected animals into the Union-occupied South. This is a fascinating question and one that deserves further study in its own right.

Chapter 5:
"An Impure and Sluggish Stream":
America's First Factory Dairy Farms

It is common for twenty-first century dairy farmers to confine and feed their cows year-round in rambling, air-conditioned sheds or barns, with little or no access to pasture or exercise. Known to nineteenth-century Americans as "soiling," the practice now known as CAFOs (confined animal feeding operations) gives farmers the greatest amount of control possible over the three key variables -- breeding, feeding, and physical/emotional health – that determine the quantity and quality of the milk harvest. Restricting the animals' movement to a stall or small yard offers four advantages. First, it prevents the animals' burning energy looking for food, water, and shade that would otherwise go toward synthesizing milk in the udder. Second, it ensures that farmers may control of every stage of heifers' and cows' reproductive process, from the use of artificial insemination -- or in some circumstances, copulation with a bull -- to induce pregnancy, to the setting aside of quiet, straw-lined stalls as a bovine maternity ward. Third, the mechanical fans and heaters installed in dairy barns, aided by prevailing winds, serve to protect the animals against extremes of heat and cold that may cause discomfort and stress and inhibit milk synthesis. Fourth, trough-feeding allows for farmers to control the exact amount of fats, proteins, and carbohydrates, and water ingested by their animals, while also making it possible to include dietary supplements that free-range animals might otherwise miss or refuse to eat.[347]

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[347] Sumate Pratumsuwan, "Effect of Walking Extra Distances on the Performance of Grazing Dairy Cows in Early Lactation" (Master's Thesis, Palmerston, New Zealand, Massey University, 1994); Luisa Magrin et al., "Physiological and Productive Response of Lactating Dairy Cows to the Alpine Transhumance at the End of the Summer Grazing," *Italian Journal of Animal Science* 15, no. 1 (2016): 151–56; George Perry, "Detection of Standing Estrus in Cattle," FS921B (Brookings, South Dakota: College of Agriculture & Biological Sciences, South Dakota State University, February 2004); G. Robert Hagevoort and J. Armando Garcia, "When Should Dairy Cows Be Inseminated?," Guide B-117 (Las Cruces, New Mexico: College of Agricultural, Consumer and Environmental Sciences, New Mexico State University, August 2013); "Heat Abatement and Ventilation of Adult Cow Facilities," Dairyland Initiative, University of Wisconsin-Madison, accessed June 10, 2020, https://thedairylandinitiative.vetmed.wisc.edu/home/housing-module/adult-cow-housing/ventilation-and-heat-abatement/; Pat Melgares, "Tips for Managing Livestock in Winter," Drovers: Driving the Beef Market, January 5,

Per regulations and standards set by the United States Environmental Protection Agency, CAFOs must depend on outside sources, some of them hundreds or even thousands of miles distant from their front door, for all of the fodder that they feed to their dairy cattle. To meet that need, American farmers have devoted an incredible 780 million acres, or about 41 percent of the land mass of the contiguous United States, to raising the corn, soybeans, sorghum, hay, and other crops that go to feeding livestock, including the dairy and beef cattle, pigs, and chickens raised by CAFOs. Moving cattle fodder from field to trough requires a veritable army of human farm and transportation workers, assisted by fleets of combines, grain carts, train cars, and semi tractors hauling grain hoppers. So too processing the feed -- in this case, blending different grains to create feed pellets while adding nutritional supplements -- and packing it for shipment in sacks and hoppers. To keep the wheels turning, and the stream of grain and fodder flowing from farm to CAFOs, state and federal officials offer a web of tax breaks and subsidies to incentivize fodder production while keeping the prices well below the cost of their production and transportation.[348]

And yet, CAFOs are an imperfect system. Long-term confinement may damage dairy cattle's mental and physical health and by extension, their ability to synthesize milk. Indeed, modern dairy scientists employed by university extension agencies agree that dairy cattle suffer when denied the chance to engage in the "species-specific behaviors" of roaming, grazing and

2018, https://www.drovers.com/article/tips-managing-livestock-winter; Jim Linn, "Feeding Total Mixed Rations," University of Minnesota Extension, n.d., https://extension.umn.edu/dairy-nutrition/feeding-total-mixed-rations; Judd Heinrichs and Alanna Kmicikewycz, "Total Mixed Ration for Dairy Cows," Penn State Extension, May 5, 2016, https://extension.psu.edu/total-mixed-rations-for-dairy-cows.

[348] Carrie Hribar, "Understanding Concentrated Animal Feeding Operations and Their Impact on Communities" (National Association of Local Boards of Health, 2010), https://www.cdc.gov/nceh/ehs/docs/understanding_cafos_nalboh.pdf; Gerald May, "What Does It Take To Be a CAFO?," MSU Extension, October 8, 2013, https://www.canr.msu.edu/news/what_does_it_take_to_be_a_cafo; Adele Peters, "This Vertical Farm Is Growing Food - But It's For Cows," Agritecture, accessed July 16, 2021, https://www.agritecture.com/blog/2020/11/12/this-vertical-farm-is-growing-foodbut-its-for-cows; "Animal Feed," Food Print, 2021, https://foodprint.org/issues/animal-feed/.

resting/ruminating in open pastures. As evidence, they point to increased incidence of lameness among confined animals forced to stand on hard surfaces -- for example, the poured-concrete floors common to modern dairy barns -- for extended periods, to say nothing of increased incidence of nervous scratching, chewing, head butting, and goring among those held in overcrowded conditions.[349] The increased milk volume produced under such conditions may exacerbate health problems. Animal welfare advocates note that the weight of fluid milk synthesized in the udder of high-producing cows puts pressure on the animals' hip joints and back, while also increasing pressure on the hooves, forcing the toes to splay and damaging the soft tissues between. Soiling also places the animals at greater risk of contracting infectious diseases, especially viral respiratory infections, which are transmitted from animal to animal via aerosolized nasal and esophageal mucus. Controlling disease with antivirals and antibiotics is common, effective, and risky. In treating their animals, farmers contribute the evolution of resistant microbial strains that may sicken and kill cattle.[350]

Perhaps the greatest problem that CAFOs face, and the one most likely to attract negative attention from the public, is the removal, storage, and recycling of their animals' feces and urine. Modern dairy cows may excrete up to 150 lbs. of solid waste (or more) per day, along with 8 gallons of liquid waste (urine and the water content of feces), all of which must be removed from the sheds and barns. Modern farmers have long relied on farm machinery to complete this

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[349] Maria Papageorgiou and Panagiotis E. Simitzis, "Positive Welfare Indicators in Dairy Animals," *Dairy* 3, no. 4. https://doi.org/10.3390/dairy3040056; 814-841; J.K. Shearer and S.R. Van Amstel, "Effect of Flooring and Flooring Surfaces on Lameness Disorders in Dairy Cattle," DAIREXNET, 16 August 2019, https://dairy-cattle.extension.org/effect-of-flooring-and-flooring-surfaces-on-lameness-disorders-in-dairy-cattle/; J.A. Fregonesi, C.B. Tucker, and D.M. Weary, "Overstocking Reduces Lying Time in Dairy Cows," *Journal of Dairy Science*, 90 (July 2007): 3349-3354; American Society of Animal Science, *Guide for the Care and Use of Agricultural Animals in Research and Teaching* (Champaign, Illinois: American Dairy Science Association, American Society of Animal Science, and Poultry Science Association, 2020), 9, 23.

[350] Compassion in World Farming, "Welfare Sheet- Dairy," 9 January 2012, ciwf.org.uk/media/5235188/Welfare-sheet-Dairy-cows.pdf; Edmund Russell III, *Evolutionary History: Uniting History and Biology to Understand Life on Earth* (Cambridge: Cambridge University Press, 2011), 98.

onerous task. Some use automated scrapers to remove semi-liquid feces from the barn and milking parlor and then store the liquid in vast, concrete-lined lagoons. Others use tractors fitted with scoops to collect solid manure for storage in concrete bins that may be covered or uncovered, depending on the humidity and average rainfall. Conscientious farmers empty the lagoons and bins on a regular basis to make way for the never-ending stream of fresh dung and urine excreted by their animals. For this, they rely on diesel-powered tankers and trucks to move liquid and solid waste to other farmers, who use spreaders and sprayers to cover their fields and pastures with the smelly (but useful) substance. Otherwise, they risk the manure's escaping containment via flooding or leeching and polluting the soil and groundwater.[351]

Though the term CAFOs is new, the milk-harvesting operations that they describe first appeared in the cities of the U.S. Northeast over two centuries ago. Before, during, and after the War of 1812, the US government prohibited the importation of European alcohol, prompting American liquor distillers and beer brewers to take up the trade in Eastern cities. Distillers and brewers saw an opportunity to dispose of waste product – the semi-liquid mixture of water and fermented and unfermented grains known to nineteenth-century Americans by the pejoratives "swill," "slop," or "mash," and to modern farmers as wet distillers' grains -- by feeding it to cows confined in urban pens. These same distillers and brewers turned an extra profit by peddling the milk harvested from said animals to the (often poor) rural migrants and immigrants who were then crowding into cities by the thousands. To save money, operators crowded the animals together, paid their employees a pittance, and forwent the feeding of nutritious (and

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[351] Gary Kleppel, *The Emergent Agriculture: Farming, Sustainability and the Return of the Local Economy* (Gabriola Island, British Columbia, Canada: New Society, 2014), 42; Anna Balas et al., "A Look at Concentrated Feeding Operations in North Carolina: The Problems With Animal Waste & A Framework to Solve Them," Bass Connections Animal Waste Management & Global Health, Fall 2016, https://bassconnections.duke.edu/sites/bassconnections.duke.edu/files/documents/animal-waste-management-global-health-final-paper.pdf;

expensive) green grasses, legumes, hay, and root vegetables. To stretch profits, they used rotten eggs, calves' brains, chalk, and water, among other vile adulterants, to amend the fluid's color, texture, and odor. To hide their trespasses, they bribed city officials and threatened reformers with bodily harm. The milk so produced was innutritious and swarmed with dangerous pathogens.[352]

Americans of the era were sure that the poor, even toxic quality of milk sold by distillery-run dairies had something to do with the swill fed to the cattle in lieu of (or in addition to) other, more nutritious fodder. They were no less sure that the poor quality of city milk had something to do with the physical suffering endured by the dairy cows confined in distillery-run dairies, to say nothing of the milk sheds' pervasive filth. Beginning with the publication of Robert N. Hartley's, "An Historical, Scientific, and Practical Essay on Milk, as an Article of Human Sustenance," in 1842, urban social reformers and temperance advocates published a series of damning exposés of the urban dairy trade that shocked readers with narratives of sick cattle and dirty, innutritious milk. In addition to calling their attention to the dairies' habit of feeding distillers' and brewers' mash to cows, said reformers also confronted readers with a series of revolting images: diseased, emaciated cattle, tethered in rows and forced to stand hock-deep in their own urine and feces; cattle troughs swarming with rats and flies; shirtless, sweating, dirt- and feces-encrusted "milk maids" beating cows that were too weak to stand; sick and injured animals turned out to die in the streets; great heaps of dung piled outside the sheds that swarmed with vermin. Little wonder that the urban dairy trade prompted Americans to petition local and

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352 Deborah Valenze, *Milk: A Local and Global History* (New Haven, Conn.: Yale University Press, 2011), 165-167; E. Melanie DuPuis, *Nature's Perfect Food: How Milk Became America's Drink* (New York: New York University Press, 2002), 18-19.

state authorities to intervene even as they cast about for some practical means to move rural -- and presumably, clean -- milk to urban consumers.[353]

Historians have joined nineteenth-century reformers in condemning the actions of distillery-run dairies and the local governments that tolerated their existence, most often by framing said dairies as the monstrous offspring of a depraved American capitalism. In doing so, they have blamed the innutritious brewers' and distillers' mash fed to the animals, along with dairy operators' inattention to sanitation, for the poor, even toxic milk peddled to urban consumers.[354] This criticism is well-founded. The capitalist profit motive *did* shape urban dairy operators' most reprehensible practices, to say nothing of state and local officials' willingness to forego taking corrective action.[355] The milk yielded by cows fed on nothing but distillers' and brewers' mash *did* lack much of the nutritional value of the new, sweet milk furnished by rural dairy cows fed a more balanced diet.[356] Dangerous viral and bacterial diseases *did* take advantage of crowding and filth to sweep the milk sheds, killing and maiming many thousands of

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[353] Robert Milham Hartley, *An Historical, Scientific, and Practical Essay on Milk, as an Article of Human Sustenance; with a Consideration of the Effects Consequent Upon the Present Unnatural Methods of Producing It for the Supply of Large Cities* (New York: Jay Leavitt, 1842); John Mullaly, *The Milk Trade in New York City and Vicinity* (New York: Fowlers and Wells, 1853), 66-67; Samuel R. Percy, *On the Food of Cities* (New York, 1864); Samuel R. Percy, *What Effect Has the Meat or Milk From Diseased Animals Upon the Public Health?* (New York: John Medole, 1866).

[354] Valenze, *Milk*; Joy Holland, "Distilling in Brooklyn -- Whiskey Wars and Swill Milk in the 1860s," Brooklyn Public Library, January 20, 2010, https://www.bklynlibrary.org/blog/2010/01/20/distilling-brooklyn; Michael Obladen, "From Swill Milk to Certified Milk: Progress in Cow's Milk Quality in the 19th Century," *Annals of Nutrition and Metabolism* 64, no. 1 (2014): 80–87; Mark Kurlansky, *Milk: A 10,000-Year Food Fracas* (New York: Bloomsbury Publishing, 2018); Daniel Fernandez, "The Surprisingly Intolerant History of Milk," Smithsonian Magazine, May 11, 2018; E. Melanie DuPuis, *Nature's Perfect Food: How Milk Became America's Drink* (New York: New York University Press, 2002).

[355] For more on the capitalist ethos, see Donald Worster, *Dust Bowl: The Southern Plains in the 1930s* (Oxford: Oxford University Press, 2004).

[356] Distiller's and brewer's mash is high in protein yet lacks non-fiber carbohydrates (sugars and starches) that are essential to bovine digestion. See Charles C. Stallings, "Rumen Degradable Protein (RDP)," Virginia Cooperative Extension, January 2002, https://www.sites.ext.vt.edu/newsletter-archive/dairy/2002-01/rumen.html; Dupuis, *Nature's Perfect Food*, 18.

animals.[357] The unsanitary practices of dairy operators *did* ensure that the milk sold to urban consumers contained unsafe levels of dangerous bacteria.[358] Always, the implication is that urban dairy operators could have done better, if only they had placed human and animal dignity above greed.

In fact, the most conscientious urban dairy operator would have struggled to produce better results. At the time Robert Hartley published his 1842 exposé of the urban dairy trade, general knowledge and widespread acceptance of germ theory was about fifty years distant in the future. Meanwhile, antibiotics were about one hundred years distant, leaving dairy operators mostly defenseless against the bacteria and viruses that maimed and killed cattle.[359] This was problem enough on its own. However, the internal combustion engines and electric motors that assist modern CAFOs in moving fodder from farm to trough, as well as collecting, storing, and recycling feces and urine, would not appear until the 1870s (with trucks and tractors coming during the 1890s).[360] This left nineteenth-century dairy operators to rely on hand tools and literal

[357] "Quarter-Ill in Cattle," *The Cultivator*, May 1854; George H. Dadd, "Black Leg in Cattle," *Prairie Farmer*, April 23, 1864; "Diseases of Domestic Animals and Their Cure," *The American Farmer, Containing Original Essays and Selections on Rural Economy and Internal Improvements, with Illustrartive Engravings and Prices Current of County Produce*, April 30, 1824; "Veterinary Department. Diseases of the Feet in Animals," *The Cultivator*, May 1842; William Youatt, *Cattle; Their Breeds, Management, and Diseases* (Philadelphia: Grigg & Elliot, 1836), 396-398; William B.E. Miller, *The Diseases of Live Stock and Their Most Efficient Remedies; Including Horses, Cattle, Cows, Sheep, Swine, Fowls, Dogs, Etc.* (Philadelphia: H.C. Watts & Co., 1885), 339-40. Among the respiratory diseases that took advantage of overcrowding in urban dairies was contagious bovine pleuropneumonia. See C harles J. Folger, *Letter from the Secretary of the Treasury, Transmitting in Response to Senate Resolution of February 10, 1882, the Report of the Treasury Cattle Commission on the Lung Plague of Cattle, or Contagious Pleuro-Pneumonia* (Washington, D.C.: Government Printing Office, 1882), 22–25, 31.

[358] Mullaly, *Milk Trade*, 47, 62, 66.

[359] Robert P. Gaynes, *Germ Theory: Medical Pioneers in Infectious Diseases* (Washington, DC: ASM Press, 2011), 143-172; Kari Nixon, *Kept from All Contagion: Germ Theory, Disease, and the Dilemma of Human Contact in Late-Nineteenth Century Literature* (Albany: State University of New York Press, 2020); Humphreys, *Marrow of Tragedy*, 1-2, 7, 27–29; Patrick Adams, "Meet the Woman Who Gave the World Antiviral Drugs," *National Geographic*, 31 August 2020, https://www.nationalgeographic.com/science/article/gertrude-elion-antivirals-coronavirus-remdesivir.

[360] For more on the invention of internal combustion and electric engines and their early use, see Vaclav Smil, *Creating the Twentieth Century: Technical Innovations of 1874-1914 and Their Lasting Impact* (Oxford: Oxford University Press, 2005).

horse power to move dung and fodder to railheads or steamship landings, home to the only vehicles able to move more than about two tons of cargo over any great distance.[361] Regarding fodder, there were no subsidies or tax breaks to encourage production, leaving the urban dairy operator who would purchase hay, grain, and vegetables to supplement the distillers' and brewers' mash fed to animals at the mercy of farmers who seldom raised enough to feed their own cattle, much less sell off a surplus. Lastly, urban dairy operators lacked the chemical sanitizers, vacuum harvesters, storage tanks, and refrigerated trucks and train cars that give modern farmers a decisive edge in protecting the harvest against contamination and spoilage.[362]

In his own 1853 exposé of the New York milk trade, the reformer John Mullaly urged Americans to replace the distillery dairy business with a fleet of trains, whose job it would be to ferry new, sweet (and presumably, clean and nutritious) milk from farm to city. Mulally's faith in the "agency of steam" notwithstanding, the so-called "milk trains" were no better able to furnish urban consumers with clean, chemically consistent milk.[363] Recall that the best farmers of the era struggled to protect milk against dangerous microbial contaminants, not only because they lacked knowledge of bacteria and viruses, but also because the well-meaning steps they took to improve livestock feeding programs via improved crop yields increased the likelihood of contamination. Recall further that the majority of farmers took a lax approach to feeding and caring for their animals, to say nothing of mucking out barns and stables and washing the pans,

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[361] Clay McShane and Joel A. Tarr, *The Horse in the City: Living Machines in the Nineteenth Century* (Baltimore: The Johns Hopkins University Press, 2007), 33, 37, 41, 173.

[362] The first farm subsidy bill passed by the United States Congress came in 1933 and was designed to reduce, rather than promote, production. See Sidonie Devarenne and Bailey DeSimone, "History of the United States Farm Bill," Library of Congress, https://www.loc.gov/ghe/cascade/index.html?appid=1821e70c01de48ae899a7ff708d6ad8b&bookmark=What%20is%20the%20Farm%20Bil; Robert G. Spinney, *City of Big Shoulders: A History of Chicago* (Ithaca, New York: Cornell University Press, 2020), 53; "Frederick McKinley Jones," National Inventors Hall of Fame, n.d., https://www.invent.org/inductees/frederick-mckinley-jones.

[363] Mullaly, *Milk Trade*, 30.

pails, and buckets used in harvesting milk. Assuming that the milk handed over for shipment arrived at depots unscathed, the many hours that it sat unrefrigerated on a siding awaiting shipment, to say nothing of the dirt, dust, animal dung, spoiled milk, and other contaminants that covered the walls and floors of the rail cars, almost ensured that dangerous microorganisms would colonize the fluid during transit.[364] Were this somehow not the case, the final trip from depot to consumers, across an urban landscape awash in human and animal waste and swarms of flies, would have delivered the *coup-de-grace*.[365]

Knowing -- or at least suspecting -- that the milk furnished by distillery-run dairies or ferried into cities by train had the power to poison and kill human consumers, nineteenth-century Americans nonetheless purchased millions and millions of quarts of the stuff.[366] Such was the conundrum that they faced: Drinking the vile milk furnished by urban peddlers was almost unthinkable; but then, so was doing without. Adaptable as people are, nineteenth-century Americans developed a taste for the thin, bluish milk furnished by urban peddlers. As late as 1871, New York consumers rejected “large shipments” of rural, grass-fed milk furnished by a certain Mr. Crosby, citing the fluid’s “mysterious thickness” and “slimy, greasy” texture. Discerning that the grease was merely the cream that accumulated on the surface of new, sweet milk, Crosby resolved to furnish only skimmed, watered-down milk moving forward, to the great delight of his customers.[367] Yet the majority longed for access to the a cleaner, more nutritious source of the milk that they not only craved but also needed for the sickroom. So long as urban

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[364] Ivan C. Weld, “Pasteurization of Milk,” *Pennsylvania Health Bulletin*, no. 91, March 1917, 214; “Medical Societies. Philadelphia County Medical Society,” *Medical and Surgical Reporter*, 2 March 1878.

[365] Martin V. Melosi, *The Sanitary City: Environmental Services in Urban America from Colonial Times to the Present* (Pittsburgh: The University of Pittsburgh Press, 2008), 11-12.

[366] The New York reformer John Mullaly estimated that New York residents purchased 200,000 quarts (or more) of distillery milk per day in 1853. See Mullaly, *Milk Trade*, xi.

[367] “Skim-Milk Vs. Cream-Milk,” *The Independent . . . Devoted to the Consideration of Politics, Social and Economic Tendencies, History, Literature and the Arts*, 16 February 1871.

Americans depended on distillery dairies and unrefrigerated rail cars to furnish milk, that need would go unfulfilled. So long as that need went unfulfilled, the very young, the very old, and the very sick would risk life and limb drinking what the geographer Peter .J. Atkins has dubbed "the white poison."[368]

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In his book-length 1842 study of milk consumption and the New York distillery-dairy trade, the temperance advocate Robert M. Hartley offered two interrelated observations. First, and keeping with American cultural norms, he praised cow's milk as "a model of what a nutritious substance ought to be, and the most perfect of all elementary aliments." Second, and reflecting his contemporaries' incomplete knowledge of human and animal nutrition, he proposed that the distillers' and brewers' mash fed to the cows confined in urban milk sheds poisoned the animals and their milk. As evidence of the harm done to dairy cows "condemned to subsist chiefly on the dregs of distillation," he pointed to the many and obvious health problems that afflicted the animals tethered in Manhattan and Brooklyn milk sheds: tooth decay, hair loss, "flaccid" flesh, running sores that covered the animals' bodies, and a bewildered expression on their faces that resembled drunkenness in people. As evidence that distillers' mash tainted cows' milk, making it unfit for human consumption, Hartley pointed to the high mortality among New York children under the age of five, for "whom this impure milk was a staple article of diet." Lest readers doubt his findings, he recalled the horror of watching his own youngest child "rapidly sinking under the effects of this pernicious aliment."[369]

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[368] Daniel Drake, *Pioneer Life in Kentucky: A Series of Reminiscential Letters from Daniel Drake, M.D., to His Children* (Cincinnati: Robert Clarke & Co., 1870), 44; Peter J. Atkins, "White Poison?: The Social Consequences of Milk Consumption, 1850-1930," *Social History of Medicine* 5, no. 2 (August 1992): 207-227.

[369] Hartley, *An Historical, Scientific, and Practical Essay*, 19–21.

Hartley was hardly alone in believing that distillers' mash poisoned cattle and their milk. On traveling to New York on business, a gentleman farmer identified only as "H." was shocked by the "unnatural" quality of the distillery-dairy milk served to him by the owners of "a respectable house near Broadway" in Manhattan. Accustomed to drinking the milk of his own cows, "H." held his nose and downed two glasses of the "loathsome" substance each day. Yet he paid a steep price for his indiscretion. By the end of the week, H. felt "enfeebled, with loss of appetite, a feverish heat of the hands, and a slightly furred tongue," all symptoms that he blamed on the swill fed to the city's dairy cow. His health failing, his milk cravings unsatisfied, H. moved to the Clinton Hotel, which claimed to serve new, sweet milk harvested from cows that grazed in nearby (and at that time, largely rural) Harlem. Three days later, his body fortified by "a well-flavored glass of milk morning and night," H. enjoyed a full recovery.[370] John Mullaly shared H.'s belief that distillers' mash harmed urban cattle. "Who would believe, if not informed of the fact," he asked in 1853, "that of the twelve or thirteen thousand cows fed on swill, over two thousand die annually from diseases produced by their peculiar diet and cruel treatment?" So too the author of an exposé of the urban milk trade published in 1866, who went so far as to label distillers' mash, "The Distillery Poison."[371]

The belief that wet distillers' grains harmed urban cattle and tainted their milk continues to inform twenty-first century scholarship. Similar to Hartley, the author of a 2010 study published by the Brooklyn Public Library attributed a litany of sins to the feeding of distillers' mash to cattle. "This diet," she wrote, "caused the unfortunate animals to become 'tail-less, red-eyed and dropsical' and to develop weeping sores." An article published four years later in the

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[370] Ibid., 173-174.

[371] Mullaly, *Milk Trade*, 60; Samuel R. Percy, *What Effect Has the Meat or Milk From Diseased Animals Upon the Public Health?* (New York: John Medole, 1866), 34.

Annals of Nutrition argued that the wet distillers' grains fed to urban dairy cattle produced "thin and *contaminated* swill milk" [emphasis mine]. More recently, in 2018, a review of Mark Kurlansky's popular history *Milk: A 10,000-Year Food Fracas*, which appeared in *Smithsonian Magazine*, informed readers that dairy cattle fed on distillers' mash yielded a "sickly, bluish milk" of a "ghastly color" (loaded terms, to be certain), without explaining how or why the diet produced such poor results. Among the few dissenting voices, the historian E. Melanie Dupuis noted that the distillers' mash fed to New York cattle was "quite nutritious," as evinced by its continued use as a bovine dietary supplement by twenty-first-dairy farmers. But then she confounds the issue by pointing to the "shortcomings" of the milk synthesized by cattle fed on distillers' mash, without explaining how or why this supposedly "nutritious" food produced "a thin, bluish fluid, ridden with bacteria," that proved so repellent to Hartley and other New York social reformers.[372]

To clarify DuPuis's point, the distillers' and brewers' mash fed to urban dairy cattle was not poor nutrition so much as it was incomplete nutrition. The substance known to modern CAFOs as wet distillers' grains are nothing more than the semi-liquid by-product of liquor distillation or beer brewing, composed of seventy-percent water and thirty percent unfermented grains, yeasts, and soluble nutrients. Though they lack the starch and sugar content of whole grains, both of which are broken down during distillation, wet distillers grains retain their fiber content, which aids in ruminant digestion. More important, wet distillers' grains offer a high concentration of ruminally undegradable protein -- that is, protein that passes through the

[372] Joy Holland, "Distilling in Brooklyn -- Whiskey Wars and Swill Milk in the 1860s," Brooklyn Public Library, January 20, 2010, https://www.bklynlibrary.org/blog/2010/01/20/distilling-brooklyn; Michael Obladen, "From Swill Milk to Certified Milk: Progress in Cow's Milk Quality in the 19th Century," *Annals of Nutrition and Metabolism* 64, no. 1 (2014): 80–87; Daniel Fernandez, "The Surprisingly Intolerant History of Milk," Smithsonian Magazine, May 11, 2018; E. Melanie DuPuis, *Nature's Perfect Food: How Milk Became America's Drink* (New York: New York University Press, 2002), 18.

ruminoreticulum without being metabolized or degraded by the animals' gut flora, and then into the small intestine, to be absorbed by the animal. Indeed, in a 2002 article published by the Virginia Cooperative Extension, the dairy scientist Charles C. Stallings noted that high-producing dairy cattle need ruminally undegradable protein in their diet to produce the large quantities of chemically consistent milk demanded by twentieth-century milk drinkers. This would have been no less true of nineteenth-century American dairy cattle, whether or not they were confined in urban milk sheds. Likely, the Harlem farmers that "H." praised likely supplemented their animals' diets with a portion of wet distillers grains purchased from New York distillers and brewers.[373]

There is no evidence that wet distillers' grains, by virtue of any innate toxic properties, caused the sensational health problems reported among urban dairy cattle by nineteenth-century social reformers, and repeated by modern scholars. Certainly, there was no scientific basis for Robert Hartley's oft-repeated claim that cattle fed on wet distillers grains not only appeared drunk but also yielded milk capable of producing intoxication in human consumers.[374] Indeed, one of Hartley's contemporaries, the Professor of Chemistry to the New York College of Pharmacy, Lawrence Reid, debunked this claim in 1848, using a test capable of detecting 1 part alcohol to 50,000 parts of fluid to conclude that six samples of distillery-fed milk were free from contamination by spiritous liquors. No less dubious was Hartley's (again, oft-repeated) attribution of the myriad physical ailments then common to urban dairy cattle -- hair loss, rotting tails, and open, running skin lesions -- to the presumed toxic properties of wet distillers' grains.

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[373] J.W. Schroeder, "Distillers' Grains as a Protein and Energy Supplement for Dairy Cattle," North Dakota State University Extension Service, February 2003, https://biofuelscoproducts.umn.edu/sites/biofuelscoproducts.umn.edu/files/2021-09/cfans_asset_418646.pdf; Stallings, Rumen Degradable Protein (RDP)"; Mulally, *Milk Trade*, 42.
[374] Hartley, *An Historical, Scientific, and Practical Essay*, 302–3.

All would have been caused by viruses or pathogens that lurked in the animals digestive and respiratory tracts.[375]

That said, dairy cows fed nothing but distillers' and brewers' grains did suffer from chronic malnutrition. Recall that lactating ruminants need a balanced diet, rich in protein, fats, carbohydrates, and nutrients, and supplemented by an abundance of clean water, to maintain their own physical health while also synthesizing an abundance of chemically consistent milk. Although a handful of smaller urban dairies located in Brooklyn, Wallabout, and Bloomingdale are known to have supplemented their animals' diet of distillers' grains with root vegetables, grains, and hay, the larger, the more well-known (and more infamous) milk sheds located south of fortieth street in Manhattan relied almost exclusively on distillers' grains to nourish their animals. Six years after Hartley published his exposé, a committee appointed by the New York Academy of Medicine to investigate the city's milk trade observed that the proprietors of Johnson's Stables, located at the corner of 16th Street and 10th Avenue, gave their animals only a "pittance of hay, oil cake, or bran" to supplement their diet of distillers' grains. As for clean water, there is no evidence that urban dairy operators made an effort to furnish animals with a ready supply. They appear instead to have relied on the high water content of the wet distillers' grains to satisfy cattle's thirst, a not-ineffective method for hydrating animals, given the enormous quantities of the slurry consumed each day -- between 30 and 60 gallons, depending on the size of the animal.[376]

Contemporary observers reported that the milk yielded by cows fed on nothing but distillers' and brewers' grains was thin, with a bluish color. This may be attributed to the fluid's

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[375] Augustus K. Gardner, *Report of a Committee Appointed by the Academy of Medicine, Upon the Comparative Value of Milk, Formed from the Slop of Distilleries and Other Food, with Chemical and Microscopical Analysis* (New York: R. Craighead, 1851), 12–13.
[376] Gardner, Report, 4; Samuel R. Percy, *Food of Cities*, 6.

low fat content. In a 2017 article, Joe Schwarcz of the McGill University Office of Science and Society explained that whole-fat milk appears white to the human eye because of the fat globules suspended in solution, which scatter rather than absorb light. The higher the fat content, the whiter the milk appears. The distillers' and brewers' grains fed to urban dairy cows during the nineteenth century was high in crude protein and giving of energy. However, it lacked the dense, fibrous material needed to promote rumination and with it, the production of acetic and butyric acid, both of which are vital to the synthesis of milk fat. The milk given by urban dairy cows fed on nothing but distillers' and brewers' grains had far fewer of the suspended milk-fat globules than did the milk synthesized by rural cows fed a diet of hay, grain, and vegetables. Moreover, dairy operators' and milk peddlers' habit of diluting and stretching the milk with water to increase profits served to create more physical space between the suspended fat globules. The result was milk that scattered less light, giving it the blue tint described by nineteenth-century Americans.[377]

It would have been possible -- at least theoretically -- for dairy operators to improve their animals' diet by purchasing hay carried into New York, Brooklyn, and Jersey City from those cities' rural hinterlands. By 1845, three years after Hartley went public with his findings, horse-drawn rakes and mowers were appearing on Northeastern farms with greater frequency, making possible the greater and more efficient harvesting of hay. Indeed, these new machines increased

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[377] Joe Schwarcz, "Why is Milk White and Not Green Like Grass?," McGill University Office for Science and Society, 20 March 2017, https://www.mcgill.ca/oss/article/general-science-you-asked/why-milk-white-and-not-green-grass; J. G. Linn, "Factors Affecting the Composition of Milk from Dairy Cows," in *Designing Foods: Animal Product Options in the Marketplace* (Washington, D. C.: National Academies Press, 1988), https://www.ncbi.nlm.nih.gov/books/NBK218193/; Alvaro Garcia and Fernando Diaz Royon, "Distillers' Grains & Milk Fat Depression," Engormix, 26 June 2012, https://en.engormix.com/dairy-cattle/articles/distillers-grains-milk-fat-t35333.htm; Alvaro Garcia, "Feeding Distillers Grains: Mathematics Vs. Biology," South Dakota State University Extension," 19 August 2020, https://extension.sdstate.edu/feeding-distillers-grains-mathematics-vs-biology; Jud Heinrichs and Geoff Zanton, "Opportunities and Challenges of Feeding Distillers Grains," Penn State Extension, 4 May 2016, https://extension.psu.edu/opportunities-and-challenges-of-feeding-distillers-grains; "Skim-Milk Vs. Cream-Milk."

the amount of hay produced, in some cases between seven and ten times the amount. At the same time, fixed and portable hay presses were an equally common enough sight on Northeastern farms. These simple machines used animal power to lower a half-ton counterweight onto hay tossed into a twenty- or thirty-foot high, chimney-like baling compartment, pressing it into bales. Once tied, these bales, each weighing about 300 lbs., could be loaded onto wagons, steamships, barges, or railcars for transport to urban hay markets. There, they sold for between 36 and 45 cents per 2,000 lbs. weight. Although less efficient to ship, loose hay also found its way into New York and other cities. The December 3, 1846 *Mechanic's Advocate* noted that loose hay was available for purchase from open wagons in the New York Cattle Market. The following August, the *Mechanic's Advocate* indicated that loose hay was selling for 63 to 75 cents per hundred pounds.[378]

And yet, it was impractical -- perhaps impossible -- to furnish New York's dairy cattle with enough hay to make any difference in their health. To understand why, it is necessary to know, first, how many animals lived in the milk sheds. Although the United States first counted the number of livestock present on American farms in 1840, and did so every ten years thereafter, the data included only those animals that lived on farms. How else to explain the small number of animals counted in New York County (that is, Manhattan) in 1850 -- a mere 2,228 cattle -- or the sharp decline in their numbers by 1860 -- down to 495 animals.[379] The social reformer John Mulally noted that the real number was much higher. In 1853, he estimated

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[378] Kimball Webster, *History of Hudson, N.H.* (Manchester, New Hampshire: Granite State Publishing, 1913), 360; "About Hay Presses," *The Plow: A Monthly Journal of Rural Affairs* 1, no. 7, 208; New York Market: New York Cattle Market," *Mechanic's Advocate*, December 3, 1846; "Market," *Mechanic's Advocate*, August 14, 1847; For evidence that Kings and Queens County farmers shipped hay into New York, see Ted Steinberg, *Down to Earth: Nature's Role in American History* (Oxford: Oxford University Press, 2002), 163.

[379] J.D.B. DeBow, *Seventh Census of the United States: 1850* (Washington: Government Printing Office, 1853), 121; Joseph C.G. Kennedy, *Agriculture of the United States in 1860* (Washington: Government Printing Office, 1864), 100.

that there were between 1,500 and 1,600 animals housed at a single milk shed, owned by Crane, Coggswell, and Company, on 1st Street, near the Williamsburgh Ferry, on the southeastern tip of Manhattan Island. Meanwhile, a smaller dairy owned by Johnson's Distillery, and located at the corner of 16th Street and 10th Avenue, housed about 100 animals. Across the East River, dairies scattered about Williamsburgh hosted an estimated 6,000 animals; Brooklyn's Skillman Street dairy, owned by Woods, Underhill and Wilson, housed about 2,000 animals; and an additional 300-400 cattle lived in Wallabout, south of Brooklyn on the southwestern tip of Long Island. Another 1,000 animals lived in milk sheds in Jersey City, across the North River from Manhattan. All told, Mullaly believed that there were about 12,000-13,000 dairy cattle confined in New York's distillery-run dairies.[380]

This done, it is next necessary to discover how much hay the dairy cows confined in urban milk sheds would have needed each day to maintain their health while synthesizing an abundance of chemically consistent milk. Modern dairy cattle need about thirty to thirty-five pounds of pasture grasses or hay and about twenty-five pounds of mixed grain per day to maintain their health while synthesizing milk.[381] Nineteenth-century dairy cattle were smaller than their modern bovine counterparts and synthesized less milk. Consequently, they needed less food per day. If the recommendations included in the January 28, 1863, *Zion's Herald and Wesleyan Journal* are any indication, cattle of the period did best when fed twenty pounds or more of fibrous matter such as pasture grasses or hay per day, supplemented with about five pounds of turnips per one pound of hay -- one hundred pounds per animal, per day -- or about 8

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[380] Mullaly, *Milk Trade*, 60-61, 65-69, 73.

[381] "Breeds of Livestock - Jersey Cattle," Breeds of Livestock, Department of Animal Science, Oklahoma State University, December 12, 1997, http://afs.okstate.edu/breeds/cattle/jersey; "Breeds of Livestock - Holstein Cattle," Breeds of Livestock, Department of Animal Science, Oklahoma State University, February 23, 2000, http://afs.okstate.edu/breeds/cattle/holstein/index-2.html.

½ pounds of corn meal per animal per day. Taking John Mulally's smaller number of 12,000 dairy cattle confined in New York for argument's sake, dairy operators would have needed 240,000 pounds, or about 120 to 130 tons of hay per day to maintain the weight and health of their animals while synthesizing milk. Extended out to a period of one year, the amount would have come to 87,600,000 lbs., or about 43,800 tons.[382]

The problem was one of availability. The farmers who persisted on the near periphery of New York's urban core, here defined as New York, Kings, and Richmond Counties, New York, and Hudson County, New Jersey, produced far too little hay, on their own, to feed the animals confined in urban dairy sheds. The United States Census indicates that New York County farmers harvested about 948 tons (or 1,896,000 lbs.) of hay in 1850. Ten years later, and reflecting population growth and urban expansion, hay production in New York County had dropped by over two-thirds, to a mere 305 tons (or 610,000). The farmers who persisted in Hudson County, New Jersey (Jersey City and its environs), saw a similar decline in hay production, from 4,161 tons (or 8,322,000 lbs.) in 1850, down to 3,917 tons (or 7,834,000 lbs.) in 1860. Elsewhere on the near periphery, hay production did increase. Farmers who persisted in Kings County (Brooklyn) harvested and stored 6,804 tons (or 13,608,000 lbs.) in 1850, and 7,806 tons (or 15,612,000 lbs.) in 1860. Meanwhile, farmers who persisted in Richmond County (Staten Island) harvested 5,642 tons (11,284,000 lbs.) in 1850 and 7,515 tons (or 15,030,000 lbs.) in 1860. All told, that amounts to 17,555 tons (or 35,110,000 lbs.) of hay in 1850, increasing to 19,543 tons (or 39,086,000 lbs.) by 1860. However, assuming that Mullaly was correct in placing about 12,000 animals in the urban milk sheds, the urban hay crop would have provided

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382 "House and Farm," *Zion's Herald and Wesleyan Journal*, January 28, 1863.

each animal only 2,925 lbs. of hay per year -- or 8 lbs. per day -- in 1850, and 3,257 lbs. of hay per year -- or about 9 lbs. per day -- in 1860.[383]

This assumes, of course, that farmers of the near periphery would have committed their hay crop to feeding urban cattle. In fact, they had their own livestock to feed. In 1850, census takers counted 21,390 farm animals -- a number that included horses, asses and mules, along with the "milch cows," working oxen, and "other cattle" -- owned by farmers of the near periphery. Assuming that each of these animals needed a minimum of 20 lbs. of hay per day to thrive, and that farmers doled the hay out in equal shares, each one would have received about 1,641 lbs. (or about 4.5 lbs.) per day. In fact, some would have received more and others less, depending on their size and/or the amount of farm labor required of them. Working oxen that weighed 2,000-plus pounds and pulled plows and wagons, for example, would have eaten more than a 500-lb. cow. By 1860, the number of farm animals had decreased to 8,001, and the hay crop was larger. However, it made little statistical difference in terms of the availability of hay. That year, each of the animals present would have consumed about 4,885 lbs. of the year's hay crop, or about 13 lbs. per day, given in equal shares. This amounted to less than the recommended twenty pounds per day. If one accounts for all of the farm animals plus urban dairy cows present in 1850 and 1860 -- 33,390 and 20,001 respectively -- the 1850 hay crop would have furnished 1,051 lbs., or about 3 lbs. per day, per animal. In 1860, each animal would have received about 1,954 lbs. (about 5 lbs.) per day.[384]

To be sure, the farmers who lived in the rural counties located beyond the near periphery produced a greater abundance of hay. Across the Hudson in New Jersey, the farmers of

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383 DeBow, *Seventh Census*, 124, 148; Kennedy, *Agriculture of the United States*, 98, 102.
384 DeBow, *Seventh Census*, 121, 147; Kennedy, *Agriculture of the United States*, 98, 100.

Middlesex, Bergen, Passaic, and Essex Counties harvested 79,161 tons (or 158,322,000 lbs.) of hay in 1850, and 92,474 tons (184,948,000 lbs.) in 1860. In the Hudson River Valley and on Long Island, the farmers of Orange, Putnam, Westchester, Dutchess, and Queens Counties harvested and stored 347,238 tons (or 694,476,000 lbs.) of hay in 1850, and increased production to about 368,773 tons (or 737,546,000 lbs.) in 1860. Combining these totals, the farmers in what may be termed New York's mid-periphery harvested 426,399 tons (or 852,798,000 lbs.) of hay in 1850, and 461,247 tons (or 922,494,000 lbs.) in 1860, more than enough to feed the 12,000 dairy cows confined in Manhattan, Brooklyn, and Jersey City. Indeed, the 1850 harvest alone furnished enough hay to furnish 71,066 lbs. per animal, per year, which amounted to just over 194 lbs. of hay per animal per day.[385]

Similar to those of the near periphery, however, the farmers of the mid-periphery had their own livestock to feed. In 1850, census takers counted 45,842 horses, mules, donkeys, "milch" cows, working oxen, and "other cattle" in Middlesex, Passaic, Bergen, and Essex Counties, New Jersey. By 1860, that number had increased to 53,412 assorted animals. Assuming that the hay-feeding season lasted about 180 days, each of these animals would have received about 19 lbs. of hay per day in 1850 and 1860. This would have been adequate to keep up the animals' health while still falling short of the twenty pounds per day standard set by nineteenth-century agricultural reformers and veterinary scientists (and leaving no real surplus for use in feeding the dairy cows confined in Brooklyn, Manhattan, and Jersey City). To the north and east, in Orange, Putnam, Westchester, Dutchess, and Queens Counties, New York, census takers counted 192,565 assorted livestock in 1850, and 185,599 in 1860. Again, assuming that the hay-feeding season lasted 180 days, the animals in these five counties would

[385] DeBow, *Seventh Census*, 124, 148; Kennedy, *Agriculture of the United States*, 98, 102.

have received 20 lbs. of hay per day in 1850, and a bit over 26 lbs. per day in 1860.[386] Of course, none of this accounts for the greater nutritional needs of work oxen, which were used during the winter months to haul timber.[387]

These figures exclude the greatest drain on the metropolitan New York hay crop: the horses and mules that served as the work engines of nineteenth-century American commerce and industry. Though omitted from census data, the equines that lived and worked in Manhattan, Brooklyn, and Jersey City numbered in the tens of the thousands. Indeed, the historians Clay McShane and Joel Tarr estimate that nineteenth-century American cities averaged about one horse for every fifteen people, with New York exceeding that average, boasting one horse for every 6.5 people. In 1850, the population of Manhattan Island south of 86th[th] Street was 515,547. By 1860, the population had increased to 805,658. Using McShane's and Tarr's calculations, the horse population of Manhattan Island reached about 79,312 animals in 1850, and about 123,944 animals in 1860. Regarding the animals' nutritional needs, the equine specialist Jennie Ivey estimates that a 1,000 lb. horse needs to eat about 15-20 lbs. of forage per day, be it pasture grasses, grains, hay, or some combination of the three. Extrapolating from the lower figure of 15 lbs., the work horses that populated Manhattan Island in 1850 were capable of eating about 1,189,680 lbs. (or about 594 tons) of hay each day, and about 434,233,200 lbs. (or about 217,116 tons) per year. By 1860, hay consumption by Manhattan work horses may have reached 1,859,160 lbs. (or about 929 tons) of hay per day, and 678,593,400 lbs. (or about 339,296 tons) per year.[388]

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386 DeBow, *Seventh Census*, 121, 147; Kennedy, *Agriculture of the United States*, 98, 100.
387 For contemporary accounts of oxen hauling timber, see "Art. V. -- The Lumber Business and the State of Maine," *The Merchants' Magazine and Commercial Review*, 1 September 1856: 314 and Massachusetts General Court. Committee on Pleuropneumonia, *Evidence ... May 31, 1860* (n.p., 1860), 4.
388 Clay McShane and Joel Tarr, "The Horse as an Urban Technology," *Journal of Urban Technology* 15, no. 1 (2008): 5–6; For more on horses as nineteenth-century biotechnology, see Anne Norton Greene, *Horses at Work:*

The equine drain on the hay crop only increased if one includes the horses and mules that lived and worked across the East River, in Brooklyn. Census data indicates that the human population of Brooklyn numbered 139,000 in 1850. Ten years later, the population had more than doubled, reaching 279,000.[389] Again, using McShane's and Tarr's humans-to-horses estimate, Brooklyn would have boasted a population of about 42,920 horses. These animals could have eaten about 643,800 lbs. (or about 321 tons) of hay or other forage per day, and about 234,987,000 lbs. (or 117,493 tons) per year. Likely they ate much less. Recall that nineteenth-century Americans inclined to underfeed their cattle, horses, mules, and oxen, a fact borne out by contemporary accunts. In 1856, the journalist John Mullaly noted that carts that delivered barrels of distillers' mash to dairies beyond the city limits were pulled by old, emaciated horses. And yet, the animals did eat, with every forkful of hay given them taking away from the amount available for dairy cows.[390]

None of this excuses distillery-run dairy operators for their callous, and indeed cruel disregard for their animals' nutrition. By the time Robert M. Hartley published his indictment of the New York milk trade, a robust literature penned by European and American agricultural reformers and veterinary scientists described the correlation between happy, healthy, productive cows and a balanced diet. Around the same time, a small but growing number of Christian sectarians and abolitionists had commenced calling on Americans to take a more compassionate, less utilitarian view of animals -- in particular those that did some useful work for people, among

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Harnessing Power in Industrial America (Cambridge, Massachusetts: Harvard University Press, 2008); Demographia, "New York (Manhattan) Sectors: Population and Density, 1800-1910, 2001, http://www.demographia.com/db-nyc-sector1800.htm; Jennie Ivey, "Estimating Winter Hay Needs for Horses: As Temperatures Fall, Consumption Increases," University of Tennessee Institute of Agriculture, Extension News You Can Use, September 30, 2015, https://extension.tennessee.edu/WebPacket/Pages/WP-2015-09-HorsesAndHay.aspx.

389 Demographia, "City of New York and Boroughs: Population & Population Density From 1790, 2001, http://www.demographia.com/dm-nyc.htm.

390 Mullaly, *Milk Trade*, 42.

them the dairy cows that furnished milk for food and medicine.[391] It would have been obvious to everyone involved that the animals tethered in urban milk sheds suffered for lack of good food. The thin, bluish milk given by the beasts at milk time was evidence enough that something was amiss. However, the animals also showed signs of starvation: bony hips; exposed ribs; progressive physical weakness; and the refusal (or inability) to stand.[392] Consumer demand for milk notwithstanding, distillers and brewers were not compelled by any coercive authority to hold animals in such dismal conditions. They alone made the choice to place profit above the health and dignity of their animals.

It is rather to point out that a conscientious dairy operator would have struggled, and likely failed, to do better. Looking back from the twenty-first century, the historian may dream up all manner of "what ifs" that would have improved matters: What if urban dairy operators had entered into partnership with nearby farmers and railroads to furnish hay? What if they had lobbied government officials to subsidize hay and grain production for the purpose of feeding urban dairy cows? What if they had looked further afield, to the farms of the Old Northwest or New England, to make up for the shortfall in hay? Yet none of these were likely in the context of the time. The complex corporate structures that would come to dominate American business and transportation following the American Civil War, making possible the coordination of farming and food/animal transport, were only just beginning to appear during the 1840s and 1850s.[393] Moreover, it was not yet common for state or federal officials to take an active

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391 For more on the birth of the modern animal rights movement, see Diane L. Beers, *For the Prevention of Cruelty: The History and Legacy of Animal Rights Activism in the United States* (Athens: Ohio University Press, 2006).
392 Mullaly, *Milk Trade*, 63.
393 The historian Mark R. Wilson argues that Union military mobilization during the American Civil War hastened the rise of the complex corporate and logistical systems that came to dominate American economic life. See Mark R. Wilson, *The Business of Civil War: Military Mobilization and the State, 1861-1865* (Baltimore: The Johns Hopkins University Press, 2006).

involvement in the day-to-day affairs of farmers.[394] Furthermore, it was unlikely that Northwestern and New England farmers, who grew too little hay to overwinter their own animals, would have been much help in solving the problem. That is assuming, of course, that enough rail cars existed to move the fodder to the milk sheds.

Even if they had, success would still have eluded them. Feeding was only one of three key variables that dairy operators, rural or urban, needed to manage in order to harvest an abundance of clean, chemically consistent milk. They also had to think about breeding and care. Perhaps because they lacked the space and fodder needed to raise thousands of calves to maturity, urban dairies took little interest in the former. Instead, they purchased mature, lactating animals from farmers each spring, and then disposed of the beasts when their milk dried up after a period of three-to-six months. Most everything that happened to city-bound cows from the moment drovers herded them away from the farms of their birth until they reached milk sheds served to sap their strength and flood their bodies with stress hormones that inhibited milk synthesis. And yet, so long as urban dairy operators needed replacement milkers, it was also unavoidable. Caring for the animals once they arrived was even more difficult, for it required dairy operators to confront two opponents -- mountains of animal waste and sudden, inexplicable disease outbreaks -- that bested the best, most conscientious rural dairy operators, such as Winthrop Chenery. Indeed, the urban environment magnified both problems beyond anything that rural dairy operators could imagine. It may be that the twice-daily feedings of distillers' mash were the least of the cows' problems.

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394 Though the United States Department of Agriculture was founded in 1862, most of its work focused on funding agricultural education until the late-1920s. See William Shurtleff and Akiko Ayoyagi, *History of U. S. Federal and State Governments' Work with Soybeans (1862-2017)* (Lafayette, California: Soyinfo Center, 2017), 6-12 and Wayne D. Rasmussen, Gladys L. Baker, and James S. Ward, "A Short History of Agricultural Adjustment, 1933-1975," Economic Research Service United States Department of Agriculture, n.d., https://naldc.nal.usda.gov/download/CAT87210025/PDF.

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The cows destined for the Manhattan, Brooklyn, and Jersey City milk sheds entered the world as tiny, bleating calves, far from the urban distilleries that would take ownership of their bodies and milk. The extent to which they fed and grew strong on their mothers' milk depended on the whims and economic goals of their caretakers. Farmers who kept cows around to furnish the family and close neighbors with a few odd quarts of milk for food and medicine let the calves suckle until such time as their mothers weaned them onto an adult diet, at about ten months of age. Otherwise, farmers separated them from their mothers a few days or weeks after their birth, or as soon they were steady on their feet and able to feed by lapping water-logged grains from a pail. Whatever the case, the calves spent most of their first year running, jumping, and head-butting with animals their own age, learning the social rules that would determine their place in the herd hierarchy. The remainder was spent feeding in grassy pastures and ruminating in the shade of trees. By fifteen months of age, as spring approached, young heifers were ready to meet and mate with a likely bull. Nine months later, as the first green shoots of grass poked up through the soil, they dropped their own calves into the straw.[395]

Unknown to cow and calf, and mercifully so, both would soon begin their journey to the milk sheds. On the day chosen by the owners, someone -- be it the farmer or a team of drovers -- rounded up market-bound cows and calves and herded them out into the road. Likely this caused no great alarm among the animals. The approach of shouting, switch-wielding people was

[395] "Laconics for Farmers," *Western Christian Advocate*, 25 September 1840: 91; "Dairy Husbandry in the State of New York," *Plough, the Loom and the Anvil*, August 1849: 85; "Cows, Not Giving Down Their Milk," *American Agriculturalist*, March 1850: 80; "American Ag. Statistics in Great Britain," *Genesee Farmer*, October 1850: 225; Mihaela Liana Ferícean, Radu Palicica, and Olga Rada, "The Behavior of Calves," *Research Journal of Agricultural Science* 42, no. 2 (2010): 248-254; "At What Age is it Safe to Vreed a Heifer?," University of Nebraska-Lincoln Institute of Agriculture and Natural Resources," https://beef.unl.edu/faq-2009breedingage; Beef-Cattle, "How Long Does a Cow's Pregnancy Last?," Beef Cattle, 2022, https://beef-cattle.extension.org.

stressful but common, given the need to move the animals to fresh pasture from time to time over the summer to prevent overgrazing.[396] This time would be different, however, for the people would continue their shouting and switching for a much longer period than ever before, forcing the milk-heavy cows, trailed by their frightened calves, to walk a much greater distance, at a much faster pace, than the animals were accustomed. Depending on the distance to market, or to the nearest railhead or steamship landing, this forced march could cover ten miles or more, carrying the beasts up and over steep hills and across creeks and rivers via rocky, muddy roads, and taking days to complete.[397] Recall that moderate exercise diverts energy away from milk synthesis. Likely, the cows suffered a decrease in their productive powers even before they reached the milk sheds.[398]

Traveling by rail further diminished the physical and emotional health of market-bound dairy cows. The railroad depot exposed the animals to loud, startling noises: the shouting and cursing of men loading the cars; the hiss of the steam engine; and once underway, the blast of the steam whistle and the squealing of brakes. Packed into the cars, the cows struggled to move and breath. Strange smells filled their noses. Thirst burned their throats. Foamy saliva dripped from lolling, panting tongues.[399] All of this would have had a tangible impact on the cows' health and the chemical composition of their milk. A 2017 study by the scientist Salah Hamed Esmail notes

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[396] "Agricultural. The Pleuropneumonia," *Saturday Evening Post*, 28 June 1862: 8.

[397] Clarence H. Danhof, *Change in Agriculture: The Northern United States, 1820-1870* (Cambridge: Harvard University Press, 1969), 34. It was common in the late-eighteenth century to drive market-bound cattle about ten miles per day. See B.J. Andrew Frantz, "History of Cattle and Stock Yards in Lancaster County Prior to 1800," in *Papers Read Before the Lancaster County Historical Society Friday, March 7, 1924* (Lancaster: Lancaster County Historical Society, 1924), 46; "Inhuman Treatment of Animals Intended for Food," *Maine Farmer*, 20 July 1865: 1.

[398] Sumate Pratumsuwan, "Effect of Walking Extra Distances on the Performance of Grazing Dairy Cows in Early Lactation" (Master's Thesis, Palmerston, New Zealand, Massey University, 1994) and Luisa Magrin et al., "Physiological and Productive Response of Lactating Dairy Cows to the Alpine Transhumance at the End of the Summer Grazing," *Italian Journal of Animal Science* 15, no. 1 (2016): 151–56.

[399] For a contemporary description of the suffering endured by market-bound cattle shipped by train, see George T. Angell, *Cattle Transportation in the United States: An Essay* (Boston: Massachusetts Society for the Prevention of Cruelty to Animals, 1872), 3-4.

that cattle dislike, but may adapt to, noises that measure in the 60-90 dB range, with 60 being equivalent to the volume of a human conversation and 90 being equivalent to a modern internal-combustion lawnmower (or to a group of humans shouting at one another). However, noises that exceed 90 dB, or sudden noises that fall inside the 60-90 dB range, may startle or worry the animals, triggering the production of the stress hormone adrenaline, which depresses the animals' appetite, preventing their putting on or maintaining weight. Beyond reduced appetite, exposure to sudden or chronic noises may trigger an autonomic stress response in cattle that prevents their "letting down" milk by tightening the sphincter muscles that separate udder from teats. It may also prompt an increase in the somatic cell count, defined as the number of white blood cells present in milk, which may alter the taste, aroma, and keeping quality of milk harvested.[400]

On reaching New York, rural cows faced yet another round of bewildering, disorienting experiences. For the third or even fourth time, a group of shouting, switch-wielding people chased the cows from the rail cars and into a holding pen, from which point they were driven out into the street and towards one of the city's marketplaces. As the animals stumbled along, splashing through puddles, stepping over (or simply plowing through) trash piles, and likely cutting their sensitive feet on scrap metal, nails, and discarded bricks, they startled and shied at a new set of loud, unfamiliar sounds -- the banging of carpenters' hammers; the rumble of passing carts, hacks, and freight wagons; the crack of teamsters' whips (combined with vehement cursing and the neighing of horses); and the shouts of peddlers, among myriad others -- and recoiled at a new set of unfamiliar smells -- human and animal waste; rotting food scraps; coal smoke;

[400] Salah Hamed Esmail, "Effects of Noise on Cattle Performance," Dairy Global: Health, November 23, 2017, https://www.dairyglobal.net/Health/Articles/2017/11/Effects-of-noise-on-cattle-performance-215715E/.

unwashed bodies; the rank, greasy odor of rendering plants.[401] Arrival at the marketplace brought no relief. Hundreds, perhaps thousands, of nervous animals jostled and butted one another in pens as people walked among them, running poking, prodding hands over sensitive udders and teats, stomachs, backs, and withers, and perhaps forcing their mouths open to inspect teeth. The din of the auctioneers' rhythmic chant, punctuated here and there by the shouting of bids, filled the air.[402]

It was there, at the marketplace, that cows bound for the distillery- and brewery-run dairies suffered the greatest trauma of their lives up to that point: the sudden, irrevocable removal of their calves. Though a fortunate few of the young were sold along with their mothers to farmers seeking replacement stock, the majority were trussed and tossed into carts or wheelbarrows for transport to one of the slaughterhouses that dotted the city. The cows, of course, knew nothing of their calves' specific fates. However, they did experience a tangible, negative emotional response to the loss that would have trigged yet another release of stress hormones and somatic cells, diminishing their bodies' already depleted supply of glucose even further and altering the chemical composition of their milk. Indeed, some stopped synthesizing milk altogether. Without question, the most important variable in keeping a cow in milk is contact with her calf. Nineteenth-century observers were no less aware of this fact than modern farmers. Editors of the August 22, 1850, *Maine Farmer* noted, "When young cows first come in, when the calves are taken away, they will hold up their milk for a short time, and some will

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401 Catherine McNeur, *Taming Manhattan: Environmental Battles in the Antebellum City* (Cambridge: Harvard University Press, 2014), 97, 104, 137-138, 183; McShane and Tarr, *The Horse in the City*, 19, 25, 39-41, 46, 109.
402 On March 11, 1850, a total of 1,100 beef cattle, 75 cows and calves, and 3,000 sheep and lambs passed through the New York stock market. See *American Agriculturalist* 9, No. 4 (April 1850), 134.

almost dry themselves before they will give it down." Those that stopped producing joined their calves at the slaughterhouse. The rest undertook a final trip to the milk sheds.[403]

The built environment of the milk sheds ensured that dairy cattle endured chronic heat stress. Contemporary observers described the brick and wood buildings as narrow, with low-slung rooves, and almost entirely devoid of windows or any other means to permit the circulation of fresh air. The buildings trapped heat, which came from several sources. Two or three times per day, the men who fed and milked the animals opened spigots on one end of the building, releasing streams of steaming-hot distillers' grains into the animals' troughs. Indeed, the distillers' grains were hot enough to burn the animals' mouths, as evinced by the callouses that witnesses observed on the cows' long, probing tongues as they lapped up their food. The cattle themselves radiated heat. Each animal had a body temperature of 38 to 39.3° C (or 100.4 to 102.8° F). Close packed as they were -- for example, the animals at Johnson's Stables in lower Manhattan were tethered side-by-side in lots of twenty-four, with minimal or no room to lie down -- and with no air circulation, the animals' body heat had no means of dissipating. Moreover, the cows' diet ensured that they excreted a near-constant stream of hot, semi-liquid dung, which only grew hotter as it piled up on the floor, and was colonized by billions of aerobic bacteria. A 2002 essay published in *Microbiology of Composting* indicated that the temperature of composting manure may reach as high as 70° C (or 158° F), and may remain as high as 55° C (131° F) for up to seventy days, thanks to bacterial metabolism. Little wonder that nineteenth-century social reformers recorded ambient temperatures in the milk sheds that reached as high as

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[403] Clive Philips, "Welfare and Cattle Behavior," in Peter D. Cockcroft, ed., *Bovine Medicine* Third Edition (Hoboken, New Jersey: Wiley Blackwell, 2015), 295;"Cows Have Power to Hold Up Their Milk," *Maine Farmer*, 22 August 1850: 1;"Milk and Milking," *Southern Cultivator*, December 1880: 460; "Inhuman Treatment".

48.8° C (or about 120° F) during the hot summer and early fall months, and never fell below 25° C (or 77° F) during the winter.[404]

Contemporary observers agreed that the cattle suffered. During an undercover 1863 investigation of the New York milk sheds, the New York physician Samuel Percy observed symptoms of heat stress in urban dairy cattle. He first noted the temperature inside the building: 120° F. He then checked the animals' rate of respiration -- 90 breaths per minute, as opposed to the normal 20 -- and heart rate -- 150 to 170 beats per minute, as opposed to the normal 80. Percy offered no specific conclusions about the impact that chronic heat stress had on animals. It is nonetheless possible to explain how and why chronic heat harmed the animals. Lactating cattle exposed to temperatures above their "thermoneutral zone" need extra food, as well as abundant drinking water, to maintain their core temperature. Indeed, the dairy scientist John Moran argues that cows' energy needs increase by up to ten percent during periods of heat-related stress. The August 2016 *International Journal of Dairy Science* notes that heat stress may also disrupt cattle's endocrine function by "altering levels of prolactin, thyroid hormones, glucocorticoid, growth hormone, estrogen, progesterone, and oxytocin which ultimately affects the milk production" by disrupting synthesis. Heat stress may alter the chemical composition of milk by reducing the amount of fat and protein. And of course, chronic stress inhibits immune system function by triggering the release of hormones that signal to the body to consume the glucose needed by white blood cells.[405]

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[404] Susan E. Fielder, "Normal Rectal Temperature Ranges," Merck Manual Veterinary Manual, 2019, https://www.merckvetmanual.com/special-subjects/reference-guides/normal-rectal-temperature-ranges; P.A. Gibbs et al., "Environmental Impacts of Cattle Manure Composting," *Microbiology of Composting*, 2002, 445–46; Samuel R. Percy, *Food of Cities*, 10–11.

[405] Percy, *Food of Cities*, 10–11; Cindy R. Lobel, *Urban Appetities: Food and Culture in Nineteenth-Century New York* (Chicago: The University of Chicago Press, 2014), 100; John Moran, *Tropical Dairy Farming: Feeding Management for Small Holder Dairy Farmers in the Humid Tropics* (Collingwood, Victoria, Australia: Landlinks

The built environment also prevented the cattle from resting. Forced to stand for long periods on sloped floors, without opportunities to move about, the dairy cattle's sensitive feet grew sore and inflamed. The weight of milk synthesized in the udder would only have added to the animals' discomfort by pulling down on their hip joints and spines, while also increasing pressure on the hooves, forcing the toes to splay and further damaging the soft tissues between.[406] Although observers failed to mention insect pests, the cows were almost certainly besieged by clouds of flies that swarmed over their bodies, as well as the dung, uneaten food, and other decaying organic matter present in the milk sheds.[407] All would have prevented the animals' resting. Accounting for these variables, it is reasonable to assume that urban dairy cattle suffered chronic sleep deprivation, with negative consequences for their health and ability to synthesize milk. Indeed, chronic sleep deprivation may increase the production of "proinflammatory cytokines (immune-signaling cell) that can lead to chronic low-grade inflammation." It may also decrease the production of cells that promote immune memory, or the body's ability to recognize pathogens and organize a response to the invaders. In both cases, cows' bodies diverted resources away from milk production.[408]

For all of these reasons, long-term confinement increased the likelihood that urban dairy cattle would contract infectious diseases. This is especially true with regard to viral and bacterial respiratory infections, which passed from animal to animal via aerosolized nasal and esophageal mucus. It is difficult to know which of these pathogens were present in the New York dairy sheds during the first half of the nineteenth century. Likely the bacteria that caused bovine

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Press, 2005), ????; Pragna Prathap et al., "Heat Stress and Dairy Cow: Impact on Both Milk Yield and Composition," *International Journal of Dairy Science*, 2016, 2–11.

406 Hartley, *An Historical, Scientific, and Practical Essay*, 286; "Welfare Sheet- Dairy".

407 Hartley, *An Historical, Scientific, and Practical Essay*, 249.

408 Peter Krawczel and Jessie Kull, "Is Sleep Important for Dairy Cows?" (University of Tennessee Institute of Agriculture, January 2017).

tuberculosis, *Mycobacterium bovis*, contributed to the high mortality among animals confined in the New York milk sheds. It may also be that the bovine virus diarrhea virus (abbreviated BVDV), a pathogen which causes a range of temporary or chronic symptoms such as diarrhea, dehydration, fever, and weight loss, also afflicted the cattle confined in the New York dairy sheds.[409]

It seems clear that *Mycoplasma mycoides*, the bacteria that caused contagious bovine pleuropneumonia, infested the milksheds, although the exact date of its arrival is unclear. Contemporary sources agree that an outbreak struck Manhattan in 1843 (or possibly 1849), a full sixteen years before the Massachusetts outbreak, when the captain of an English merchant vessel, *Washington*, sold his ship's cow to milkman Peter Dunn of Brooklyn, who drove the animal to a stable near South Ferry. Unknown to Dunn, or to anyone else, the cow carried *Mycoplasma mycoides* in its lungs, which it then transmitted to its new herd mates by coughing or engaging in normal bovine behaviors, for example, sniffing at or nuzzling the face of a nearby animal. Dunn's hapless "Bossie" died soon thereafter of acute pleuropneumonia. However, the bacteria lived on, taking advantage of Brooklyn's built environment -- clusters of crowded dairy sheds, interspersed with unfenced common pastures -- to leap from animal to animal. Aggravating matters was the near-constant influx of rural, immunologically naïve cattle driven into the city to replace poor or exhausted milkers, as well as cattle dealers' habit of selling off diseased animals to unsuspecting buyers in neighboring cities. In a matter of months, *Mycoplasma mycoides* appeared in Manhattan, as well as Jersey City, Newark, Elizabeth, New

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[409] Mitchell V. Palmer and W. Ray Waters, "Bovine Tuberculosis and the Establishment of an Eradication Program in the United States: Role of Veterinarians," *Veterinary Medicine International*, May 17, 2011, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3103864/; Hanspeter Stalder et al., "Traces of History Conserved Over 600 Years in the Geographic Distribution of Gentic Variants of an RNA Virus: Bovine Viral Diarrhea Virus in Switzerland" 13, no. 12 (December 5, 2018), https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0207604.

Brunswick, and Trenton in New Jersey, all of which resembled Brooklyn in their spatial arrangement. Indeed, it may also have reached as far south and west as Philadelphia and as far north as Albany. There it would remain until the first decades of the twentieth century, killing and maiming thousands of animals annually and costing urban milk dealers tens of millions of dollars in lost revenue.[410]

The stump-tailed cattle that nineteenth-century American temperance advocates and social reformers observed in the New York milk sheds may be attributed to contagious bovine pleuropneumonia -- or more accurately, to dairy operators' efforts to curb the destructiveness of the disease. Convinced that their animals harbored the disease, New York and Brooklyn milk dealers used a crude veterinary procedure of European extraction, the Willemsian prophylactic inoculation, in an effort to prevent subsequent infections and lower mortality. This method involved inserting diseased lung tissue beneath the skin near the tip of a healthy animal's tail via a small incision. If successful, the inoculated animal experienced a painful swelling that traveled two to four inches up the tail before subsiding. It did occur that the swelling traveled up the tail and into the anal folds, after which necrosis set in, causing the bottom third of the tail to slough off. Either way, those that survived the ordeal enjoyed immunity to further infection, or so their owners hoped. Plenty more contracted acute pleuropneumonia and died, although not before passing the bacteria to their neighbors.[411]

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[410] Charles J. Folger, *Letter from the Secretary of the Treasury, Transmitting in Response to Senate Resolution of February 10, 1882, the Report of the Treasury Cattle Commission on the Lung Plague of Cattle, or Contagious Pleuro-Pneumonia* (Washington, D.C.: Government Printing Office, 1882), 22–25, 31.

[411] Massachusetts General Court. Committee on Pleuropneumonia, *Evidence ... May 31, 1860* (n.p., 1860), 52–53; A. D. Campbell and A. W. Turner, "Studies in Contagious Pleuro-Pneumonia of Cattle. II. A Complement-Fixation Reaction for the Diagnosis of Contagious Bovine Pleuro-Pneumonia. Its Use in Experimental Investigations and in the Control of Disease," *Commonwealth of Australia Council for Scientific and Industrial Research, Bulletin No. 97*, 1936, 26; *Department of Agriculture. Special Report – No. 12. Investigation of Diseases of Swine, and Infectious and Contagious Diseases Incident to Other Classes of Domesticated Animals* (Washington: Government Printing Office, 1878), 222, 239; For a first-hand account of the Willemsian Prophylactic in use in New York, see Samuel R. Percy, *Food of Cities*, 7.

Confinement in the milksheds also increased the likelihood that dairy cows would contract a number of dangerous bacterial infections common to farms of the era. Unlike their rural counterparts, which spent much of their time roaming over open pasture land, decreasing the chance that they would walk through feces, the animals confined in urban dairy sheds spent their days standing hock-deep their own semi-liquid dung. This noxious slurry swarmed with billions, indeed trillions of *Fusobacterium necrophorum*, a bacterium that took advantage of cuts and scrapes sustained by the cows during the long trip from farm to milkshed to infest the their toes and lower legs, causing many of the health problems that contemporary observers blamed on the animals' diet, such as swelling, erythema (redness and inflammation), tissue necrosis, weight loss, and lameness. Urban cows also contracted *Clostridium chauvoei*, the bacteria responsible for "black leg" or "quarter ill." Doubtless some of the animals carried *Clostridium* with them as they traveled from farm to milkshed. Others would have picked it up along the way by eating food dropped on the dirt floors of market stalls/pens and milk sheds. Whatever the case, the animals experienced stress and strain enough to trigger black leg, a disease known to cause fever, lameness, and sudden death.[412]

Looking back from the twenty-first century, it is clear that urban distillery-dairy operators could have reduced (without eliminating) the instance of infectious diseases among their animals by raising the ceilings, cutting a few windows, and reducing the number of animals. It is not clear, however, that a conscientious dairy operator would have thought to do so, even when faced with sickness and losses. Generally speaking, nineteenth-century Americans believed that noxious miasmas emitted by decomposing organic matter caused sickness and death in both

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[412] Mangels, "The Many Diseases Caused by Fusobacterium Necrophorum".

people and animals.[413] Far better, then, to prevent breezes from entering the dairy barn, especially if those breezes wafted across dead animals, human and animal feces, rotting vegetables, and other filth that blanketed urban streets. Veterinary scientists cautioned against housing livestock in "tight" barns that the practice aided in spread of diseases such as pleuropneumonia. Yet they were unable to explain how or why free-range cattle contracted the same disease, leaving farmers and officials to muddle through the evidence and decide for themselves.[414] Indeed, it was not until 1863, two years into the American Civil War, that US medical officials concluded that open-air hospitals reduced the incidence of gangrene and other diseases in *human* patients.[415]

Cleaning the milk sheds well enough to reduce the threat posed by dangerous microorganisms with the technologies at hand was literally impossible. The greatest obstacle to sanitation was the abundance of dung excreted by the dairy cattle housed in the milk sheds. Recall that a dairy cow weighing between 250 to 500 lbs. -- that is, about the size of a nineteenth-century dairy cow -- excretes between 20 and 41 lbs. (or about .32 to .66 cubic feet) of dung per day. Taking the smaller of the two numbers as a standard of measurement, the 12,000 animals that inhabited the New York milk sheds excreted about 240,000 lbs. (or about 3,840 cubic feet) or dung per day, and 87,600,000 lbs. (or 1,401,600 cubic feet) per year. By way of offering a visual, it would take 54,000 cubic feet of cow dung to cover a modern American football field, measuring 300 feet long by 180 feet wide, to a depth of one foot.

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413 Theodore H. Tulchinsky and Elena A. Varavikova, *The New Public Health, Second Edition* (Burlington, Massachusetts: Elsevier Academic Press, 2009), 14; Kari Nixon, *Kept From All Contagion: Germ Theory, Disease, and the Dilemma of Human Contact in Late-Nineteenth Century Literature* (Albany: State University of New York Press, 2020),20.

414 Massachusetts General Court, *Evidence . . . May 31, 1860*, 88.

415 Margaret Humphreys, *Marrow of Tragedy: The Health Crisis of the American Civil War* (Baltimore: Johns Hopkins University Press, 2013), 146.

Extrapolating from there, the cattle housed in the New York milk sheds in 1851 produced enough dung each year to cover twenty-eight American football fields to a depth of one foot. The numbers are no less impressive -- or disturbing -- if one uses the acre as a unit of measurement. It would take 43,560 cubic feet of cow dung to cover one acre of land to a depth of one foot. Therefore, at the very least, the cattle confined in the New York milk sheds produced enough dung in 1851 to cover 34 acres of land to a depth of one foot, or about 34 American football fields.[416]

Nineteenth-century dairy operators had none of the labor-saving machines used by modern CAFOs to collect and remove the dung excreted by their cows. They relied instead on hand tools -- shovels, forks, pails, and perhaps wheelbarrows or baskets -- to complete this onerous task.[417] Presuming ideal conditions, it is at least conceivable that they could have succeeded in removing the dung. The Canadian Centre for Occupational Health and Safety estimates that an experienced worker may scoop between 18 and 21 shovelfuls of dirt (or some similar substance), amounting to 1,650 lbs. moved, per 15 minutes of constant laboring. Shoveling at this pace for an extended length of time places a great strain on the worker's back, joints, and cardiovascular system, to say nothing of putting them at risk of dehydration and hypovolemic shock when working in the heat. Consequently, the Centre recommends that workers alternate 15 minutes of shoveling with 15 minutes of rest and hydration until the job is

[416] "Horsfall's Dairy Management," *Transactions of the New Hampshire State Agricultural Society for the Year 1858* (Concord: George G. Fogg State Printer, 1859), 259; R. M. Washburn, "The Relation of Dairying to Profitable Farming," in *The Dairy Record* 15, no. 5 (2 July 1913), 21; James C. Pahulla, Jeffrey V. Krans, and J. Michael Goatley, Jr., *Sports Fields: Design, Construction, and Maintenance* (Hoboken, New Jersey: John Wiley & Sons, 2020), 396.

[417] Joel Mokyr, *The Lever of Riches: Technological Creativity and Economic Progress* (New York: Oxford University Press, 1990), 141; "The Wheelbarrow Emigrant," *Sunday Dispatch*, 1 February 1852; "Important to Farmers," *New-York Daily Tribune*, 11 May 1858; "New York As It Is," *The New York Herald*, 7 May 1859; "Importance of the Clover Crop," *The New England Farmer; a Monthly Journal*, July 1864: 209.

finished. For the same reasons, the Centre recommends that workers limit the distance that they throw shovelfuls of dirt toward trailers, truck beds, or hoppers to about three feet. Using these numbers as a guideline, a modern worker could move 26,400 lbs. of soil or gravel during an eight-hour work day. Extrapolating from there, a team of nine workers could move about 240,000 lbs. of dirt in a single day -- the weight of the dung excreted by urban dairy cows each day in nineteenth-century New York -- so long as the receptacles were kept nearby and emptied during rest periods.[418]

Conditions, however, were not ideal. Contemporary descriptions of the milk sheds suggest that they were too narrow, and the ceilings too low, to permit the entry of horse- and mule-drawn carts -- the trucks and trailers of the era -- that would have sped the process of removing dung.[419] This left individuals armed with shovels, many of them drawn from the ranks of the urban immigrant poor, and many of them suffering from chronic malnutrition and/or other health problems, among them infestation by the body lice known to carry typhus, to move every pound of the smelly, bacteria-laden substance from one end of the building to the other, and then out the door, by way of a time- and energy-consuming scoop-and-throw process.[420] While it is difficult to discover the exact dimensions of the milk sheds, the reformer John Mulally estimated that a series of buildings owned by the Crane, Coggswell, and Co. distillery extended "several hundred feet" from 1st Street in southeast Manhattan to the banks of the East River and housed

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418 "OSH Fact Sheets: Shovelling," Canadian Centre for Occupational Health and Safety," 1 June 2017, https://www.ccohs.ca/oshanswers/ergonomics/shovel.html.

419 Hartley, *An Historical, Scientific, and Practical Essay*, 141; Mullaly, *Milk Trade*, 44.

420 Percy, *The Food of Cities*, 12-13; "Health of New York's Irish Immigrants," City College of New York People of New York Seminar 2," 7 May 2009, macaulay.cuny.edu/seminars/drabik09/articles/h/e/a/Health_of_New-York%27s_Irish_Immigrants_3cd7.html; Mullaly, *Milk* Trade, 53-54; Linda Houhamdi and Didier Raoult, "Louse-Borne Epidemic Typhus," in Didier Raoult and Philippe Parola, *Rickettsial Diseases* (New York: Informa Health Care, 2007), 51-62.

about 1,500 animals.[421] Clearing the buildings would have required workers to move between 30,000 lbs. and 60,000 lbs. (or about 1,200 to 2,400 cubic feet) of dung, over a distance of 100 feet (or more), every day. Assuming that a worker started scooping at the far end of the building, and then threw each shovelful three feet forward, it would have taken about 33 tosses, and about 30 minutes, to move fifteen pounds of dung the full 100 feet. Assuming further that 15 lbs. of dung covered about 0.4 cubic feet of the shed floor, it would take about 99 scoops and throws, and about 90 minutes, to move that one cubic foot.

To be sure, the time and human energy needed to scoop and throw dung would have decreased with each foot that the worker moved toward the door. That decrease was so incremental, however, as to hardly matter. The second cubic foot of dung shoveled by workers would have taken 96 scoops and tosses to reach the door of the milk shed. The third would have taken 93 scoops and tosses, while the fourth would have taken 90 scoops and tosses. So it would have gone, over and over, until the job was finished. Complicating matters, the effective weight of the dung, a number calculated by multiplying the real weight by the number of times it had to be lifted and moved, would have increased with each scoop and toss. Every time a worker scooped and tossed the same 15 lbs. of dung, the effective weight of that one shovelful doubled. Over a distance of 100 feet, the real weight of 15 lbs. of dung increased to an effective weight of 495 lbs. One cubic foot of dung with a real weight of 30 lbs., and requiring 99 scoops and tosses to move the full 100 feet, increased to an effective weight of 990 lbs. Accounting for the reduced distance, and moving in a straight line, the second cubic foot increased to an effective weight of 960 lbs.[422]

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421 Mullaly, *Milk Trade*, 65.

422 "Volume to Weight Conversion Factors," South Carolina Department of Health and Environmental Control, https://scdhec.gov/sites/default/files/Library/CR-011175.pdf; "Shovelling".

It seems unlikely, however, that workers would have traveled in a straight line. The cows confined in the milksheds stood tied to the wall in two parallel rows, facing away from one another and defecating in a central alleyway. Contemporary observers reported that the animals had enough slack in their tethers to permit their lying down. It was therefore possible for the cows to turn their bodies, dropping dung into the space that separated them from their closest neighbors. This space would have been wide enough to permit the entry of a full-grown man with a stool and pail at milking time. Therefore, it would also have been wide enough to permit the accumulation of several cubic feet of dung.[423] Scooping and shoveling this dung would have required workers to move around the shifting feet and flanks and butting heads of nervous 500-lb. animals, even as those animals continued to excrete streams of semi-liquid dung (to say nothing of urine) onto the floor. All of this would have slowed their progress in cleaning the milkshed floor of animal waste.

Once removed, the dung shoveled by workers was left heaped about, knee-deep, on the ground surrounding the stables. There it sat, reeking and swarming with maggots, waiting for the same workers, or a fresh crew, to take up their shovels and begin a second round of scooping and tossing, this time into the bed of wagons and carts to be hauled away, assuming that anyone bothered.[424] Taking the 30,000 lbs. of dung excreted by the animals confined in the Crane, Coggswell, and Co. dairy as a unit of measure, and accounting for breaks and fatigue, it would have taken about eight hours of intense shoveling for a single worker to complete the loading. This assumes, of course, that every shovelful could be tossed into the back of a waiting cart or

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[423] Augustus K. Gardner, *Report of a Committee Appointed by the New York Academy of Medicine, Upon the Comparative Value of Milk, Formed From the Slop of Distilleries and Other Food, With Chemical and Microscopical Analysis* (New York: R. Craighead, 1851), 3; Mullaly, *Milk Trade*, 44; Percy, *The Food of Cities*, 9, 13.

[424] Mullaly, *Milk Trade*, 62.

wagon standing three feet or less from the worker. In fact, loading the dung for transit would have required workers to attack the piles from several directions at once while cartmen or teamsters followed along behind, their horses adding their own dung to the mass produced by the cattle. It assumes further that enough wagons and carts could be found, and then moved to and from some distant disposal point, to keep the workers engaged.

To the extent that they were willing to haul away dung, urban dairy operators would have been forced to rely on the city's 8,500 licensed cartmen to provide transport. To be sure, carts were well-suited to job of hauling bulky, loose matter such as soil or dung. Sitting on two wheels, the carts could be unhitched and tipped on reaching their destination and the contents spilled out onto the ground. This would have obviated the need for a third round of shoveling before the cart could be returned for an additional load. However, they were also slow. City regulations required cartmen to lead their horses on foot, slowing the cart's pace to about 2-3 miles per hour and increasing the time it would have taken to move dung from milkshed to disposal point.[425] Freight wagons would have been a better option in terms of their size and weight capacity. Loaded properly, the freight wagons of the era could carry about 2,800 lbs. if pulled by a team of four horses or mules.[426] Taking this as a standard of measure, it would have taken ninety-two such freight wagons, and the power of 368 horses, to haul away all of the dung produced by New York's dairy cattle each day. All of this would have incurred extra expenses: wages for those who loaded, unloaded, and drove the wagons; repairs to and replacement of wagons, tools, and tack; food and water for the teams; and myriad other things. All would have driven up the cost of milk.

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[425] Tarr and McShane, *The Horse in the City*, 37, 56; Richard F. Selcer, *Civil War America, 1850-1875* (New York: Facts on File, 2006), 111.
[426] Rodney C. Lackey, "Notes on Civil War Logistics: Facts and Stories," accessed December 21, 2019, https://transportation.army.mil/History/PDF/Peninsula%20Campaign/Rodney%20Lackey%20Article_1.pdf.

All of this assumes that dairy operators could have discovered a disposal point that was close enough at hand to ensure the timely return of empty carts. The closest option for New York and Jersey City dairies was the Hudson River, which flanked Manhattan on the east and west and drained south into New York Harbor. Nineteenth-century Americans made regular use of waterways to dispose of trash, human and animal waste, and chemicals. It is therefore reasonable to assume that dairy operators used the river as a dump site.[427] Options were otherwise limited. In his 2002 Work *Down to Earth*, the environmental historian Theodore Steinberg notes that Long Island farmers purchased a modest quantity of dung from Manhattan and Brooklyn stables for use in manuring their vegetable and grain crops.[428] Likely, their counterparts in Harlem, Staten Island, and the Jersey City hinterland did the same. Yet the truck farmers in question lived too far from the dairies to make regular delivery practical. Traveling from Canal Street in Lower Manhattan to 86th Street, the southern edge of Harlem, would have required a round trip of sixteen miles. Horses walk at about 3 miles per hour when pulling a loaded wagon.[429] Consequently, it would have taken a teamster or cartman about 5.5 hours to complete the trip (excluding the time it took to find a buyer and unload the dung). A trip to the margins of Brooklyn or Jersey City, required two time-consuming ferry rides, and would have taken even longer to complete.[430]

It assumes further that the city's cartmen and teamsters would have given over their time and labor to hauling cattle dung. In fact, horse- and mule-drawn carts and wagons were needed

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427 McNeur, *Taming Manhattan*, 139-140.

428 Theodore Steinberg, *Down to Earth: Nature's Role in American History* (New York: Oxford University Press, 2002), 163.

429 Tarr and McShane, *The Horse in the City*, 6; Ann Norton Green, *Horses at Work: Harnessing Power in Industrial America* (Cambridge: Harvard University Press, 2008), 44, 170; "Arrival of the Northern Light," *The New York Herald*, 15 November 1854;

430 For a list of the ferries that operated in New York and its environs in 1857, see T.S. Gillett, *General Index of the Laws of the State of New York, 1777-1857* (Albany: Weed, Parsons & Co., 1859).

elsewhere in the city for all manner of purposes. Every train and steamship that chuffed into New York bearing freight, livestock, and crops for the city's manufacturers, merchant firms, restaurants, and private citizens needed cartmen and teamsters to ferry goods to buyers scattered across the urban landscape. Looking in the other direction, manufacturers relied on carts and wagons to move finished goods from factory to rail yard or river-/sea-port for shipment to distant points.[431] Recognizing that nineteenth-century Americans were less conscious of sanitation than their modern counterparts, to undertake the hauling of a stinking, fly-blown load of semi-liquid cattle dung across antebellum New York during the hot summer months would have been to sully one's wagon or cart, leaving it unsuited to the task of moving food, merchant goods, and other items across the city, and costing the teamster or cartman the opportunity to make money.[432] At the very least, it would have required a good scrubbing, taking time and energy that could be put to better use hauling less objectionable freight.[433]

It assumes, further still, that farmers living on the near-periphery could have or would have used all of the dung excreted by urban dairy cattle. Likely, that was not the case. Much as they had their own livestock to feed, farmers of the New York and Jersey City hinterland had their own dung piles to contend with. The more conscientious among them gathered the solid and liquid matter into piles and ponds to ferment, after which time they loaded it onto carts and wagons for use in manuring grain fields, pastures, and gardens. This, however, was a once- or twice-per-year job, following the plowing and cutting of hay, and one that could be finished with

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[431] Tarr and McShane, *The Horse in the City*, 64;

[432] In fact, it was impossible to clean manure carts, which were made of porous wood that would have absorbed liquid dung. See G.L. Martin, "Making Butter on the Farm," *Montana Extension Service in Agriculture and Home Economics*, no. 57 (June 1922): 3.

[433] This is not to suggest that New York cartmen avoided hauling manure. Some specialized in the task. See Graham Russell Gao Hodges, *New York City Cartmen, 1667-1850* (New York: New York University Press, 2012), 108.

the dung at hand. The rest took little or no interest in manuring, and allowed dung to pile up in the barns, exercise yards, and pastures used by cows and horses without giving much thought to its disposal. Either way, it is inconceivable that farmers of the near-periphery would have bought and disposed of hundreds of thousands of pounds of cattle dung from urban dairy operators each and every day, over the four-to-six month period that the cows were feeding and lactating. There was too little immediate use, and too many other time-consuming tasks at hand for this to be practical.[434]

So it was that most of the dung was left to destroy bovine bodies and taint the milk harvested by urban distillery- and brewery-owned dairies. The thin, bluish fluid that the sweat-soaked "milk maids" drew from the cows' feces-smeared teats with their dirt- and feces-smeared hands into feces-encrusted pails while sitting or kneeling on the feces- and urine-soaked floor was low in the suspended fat globules that scattered light but high in somatic cells (that is, white blood cells produced by the animals' immune systems) that altered the fluid's taste, aroma, and keeping quality. The harvest complete, the milkmaids poured the hot fluid into unrefrigerated wooden vats and barrels that were saturated with dried milk particles to await the arrival of peddlers who would carry it to customers.[435] With each passing minute, indeed with each passing second, the bacteria that caused Shigellosis, Diptheria, and Listeriosis, among myriad others, underwent binary fission, or the splitting of one into two identical organisms. By the time peddlers dipped milk from the vats and into their own (dirty) barrels, the fluid's bacterial load numbered in the thousands, even the millions, of toxin-excreting organisms. Cooling the milk would have slowed, but not stopped, this microbial assault. New York spring and well

[434] "More of That Farmer Who Milks His Own Cows," *The Monthly Journal of Agriculture*, April 1847: 455; "A New York Farmer," *Prairie Farmer*, December 1848: 369; "Travels at Home," *New-York Daily Tribune*, 23 July 1860.

[435] Mullaly, *Milk Trade*, 44; Percy, *The Food of Cities*, 9, 12-14; Martin, "Making Butter," 3.

water hovers around 54° F -- well above the 40° F threshold at which bacteria thrive and reproduce. Ice would have been colder, although without insulation of some type, it would have melted away in the chronic heat in a matter of minutes.[436]

Had none of this been true, had the milk somehow emerged clean and cool from the milk sheds, the urban landscape would have prevented peddlers' keeping it clean and safe for human consumption. The reason for this is simple: the streets of nineteenth-century American cities were almost invariably filthy. Lacking sanitation systems, residents tossed food scraps and human waste into the streets, where it was ground into a noxious slurry by pedestrians, the hooves of tens of thousands of horses and mules (each one adding about fifty pounds of their own dung to the mixture per day), and the wheels of wagons and carts moving raw materials and finished goods throughout the city. Large cities like New York far exceeded smaller towns in sheer accumulation of filth. So thick was the dung and other filth piled in the streets, the journalist Kurt Kohlstedt wrote, that wealthy New York pedestrians paid so-called "crossing sweepers" to clear a path through the muck. Adding to the problem were the corpses of dead cows and horses that were left to rot where they fell. All of this proved irresistible to droves of free-roaming hogs and swarms of rats, to say nothing of the flies that skittered over milk barrels

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[436] Rose Ann Gould Soloway, "Food Poisoning: Your Questions Answered," Poison Control: National Capital Poison Center, April 7, 2013, https://www.poison.org/articles/2013-apr/food-poisoning; Chris Bell and Alec Kyriakides, *Salmonella: A Practical Approach to the Organism and Its Control in Foods* (Oxford: Blackwell Science, 2002), 61; George Lloyd Magruder, *The Solution of the Milk Problem* (Washington, D.C.: R. Beresford, 1913), 17; Milton Joseph Rosenau, *The Milk Question* (Boston: Houghton Mifflin Company, 1912), 120; Cornell University "Milk Facts," http://milkfacts.info/Milk%20Processing/Heat%20Treatments%20and%20Pasteurization.html/.; "Grade 'A' Pasteurized Milk Ordinance" (Washington, D.C.: United States Department of Health and Human Services Public Health Service Food and Drug Administration, 2017); E.H. Hoyle, Pamela Schmutz, and D.T. Vines, "Safe Handling of Milk and Dairy Products," Clemson Cooperative Extension, Home & Garden Information Center, Factsheet (Clemson, South Carolina: Clemson University, March 8, 2007), https://hgic.clemson.edu/factsheet/safe-handling-of-milk-dairy-products/; Thomas Keith, *New Treatise on the Use of the Globes; or, a Philosophical View of the Earth and the Heavens* (London: Longman, Brown, Green, and Longmans, 1848), 81.

and ladles. It also represented a perfect habitat for many pathogens known to contaminate milk and sicken human consumers.[437]

Incidentally, the materials used in making milk delivery vessels also provided an ideal habitat for bacteria. As late as 1853, peddlers ferried milk to consumers in wooden barrels loaded in the back of carts and wagons. John Mullaly described these barrels as "besmeared with swill and dirt, and emitting a most offensive odor," indicating that peddlers seldom cleaned the vessels. And yet, even if they had followed conventional sanitary practices -- scouring the barrels with boiling water to remove all traces of old and/or soured milk -- they would have done little to reduce the threat posed by lactic-acid-producing bacteria, to say nothing of those responsible for rancidity. In fact, they would have increased the likelihood of contamination. In May 1920, the Professor of Dairy Husbandry, G.L. Martin, explained that wooden milk vessels were "impossible to keep clean." On the one hand, they were porous and absorbed a quantity of the milk placed inside. On the other hand, the seams of wooden milk vessels trapped milk particles. Those who used them, Martin insisted, had to follow a strict, three-step process: flush the vessel with luke-warm water; rinse the vessel with hot water to remove the oily, fatty milk particles; and then sterilize the vessel by application of scalding water. To apply scalding water first, as some milk peddlers may have done, served only to transform the casein or milk protein to a glue-like substance that was not only difficult to remove, but also well-suited to the propagation of microbial life.[438]

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[437] Melosi, *Sanitary City*, 11-12; Kurt Kohlstedt, "The Big Crapple: New York City Transit Pollution from Horse Manure to Horseless Carriages," 99% Invisible, November 6, 2017, https://99percentinvisible.org/article/cities-paved-dung-urban-design-great-horse-manure-crisis-1894/; For a first-hand account of dairy cattle left to die in the streets of Manhattan, see Mullaly, *Milk Trade*, 50; McNeur, *Taming Manhattan*, 27-28, 97, 106.

[438] Mullaly, *Milk Trade*, 42; Martin, "Making Butter," 3.

Assuming for argument's sake that peddlers sanitized the barrels in accordance with modern standards, they would *still* have failed in moving safe, sanitary milk to their customers. Delivery carts moved no faster than a person or horse could walk -- about 2-3 miles per hour -- while making frequent stops to dole out milk to buyers. There is little evidence that peddlers used ice, spring water, or some other means to cool the milk. Moreover, delivery routes averaged about 4 to 10 miles and took about 2 to 4 hours (or longer) to complete, giving the *Shigella*, *Listeria*, *Corynebacterium*, and other dangerous microorganisms that almost invariably introduced into the fluid by dairy workers, or picked up along the route, ample time to grow and reproduce by way of binary fission. On a hot summer or fall day, when the ambient temperatures in New York and its environs soared to 80 degrees or higher, this process would have moved forward at great speed, transforming the barrels of milk into a reeking mess long before the peddler reached the end of his route. However, temperatures need not have soared into the 80s or 90s to produce a similar result. Four of the most common psychrotrophic bacteria known to cause milk spoilage (that is, rancidity), *Pseudomonas fluorescens, Pseudomonas gessardii, Pseudomonas fragi*, and *Pseudomonas lundensis*, reproduce at temperatures equal to or above 7° C (or about 45° F).[439]

That urban Americans knew (or at least, suspected) all of this, and yet continued to buy enough of the thin, stinking milk doled out by city peddlers to keep distillery-run dairies in business, speaks to the value that they placed on milk as both food and medicine. Indeed, it speaks to desperation. Most everyone who lived and/or worked in the city -- the physician

[439] Tarr and McShane, *The Horse in the City*, 6; Green, *Horses at Work*, 44, 170; Mulally, *Milk Trade*, 53;"Milk as a Growth Medium," University of Guelph Food Science, n.d., https://www.uoguelph.ca/foodscience/book-page/milk-growth-medium; Lu Meng et al., "Characterization of Pseudomonas Spp. and Associated Proteolytic Properties in Raw Milk Stored at Low Temperatures," Frontiers in Microbiology: Food Microbiology, November 8, 2017, https://www.frontiersin.org/articles/10.3389/fmicb.2017.02158/full.

writing prescriptions for their patients; the daughter nursing her sick, trembling father; the merchant who longed for a refreshing drink; the baker preparing bread for a restaurant or hotel; the immigrant mother in need of a breast milk substitute; the hungry child longing for breakfast; and even the late-night reveler in need of a social lubricant -- had a specific need for new, sweet milk. Among them was the aforementioned physician, Daniel Drake, who bought the odd pint of watery city milk harvested by Louisville brewers and distillers to flavor his tea and coffee, although he thought it a poor substitute for the fatty, creamy milk that he grew up drinking on the Kentucky frontier. Indeed, in an 1847 letter to his son, Drake compared city milk to water drawn from an "impure and sluggish stream long after it has left the rocky fountain." As the urban population continued to increase during the first half of the nineteenth century, so too did the demand for good, clean milk. Whoever succeeded in meeting that demand stood to amass a fortune.[440]

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The only way to solve the problems associated with urban dairy production during the first half of the nineteenth century would have been to shutter the entire enterprise. That is exactly what social reformers and anti-swill-milk activists hoped to accomplish. Near the conclusion of his exposé of the New York milk industry, Robert M. Hartley appealed to farmers living near the newly built rail lines that extended from the city north into the Hudson River Valley, west into New Jersey, and east into Long Island and Connecticut, to stock their grazing lands with cattle and harvest milk for New York consumers. He reasoned that providing New Yorkers with a better quality milk, harvested from rural, grass-fed cows, would "sink" the urban dairy industry. The journalist John Mullaly voiced a similar desire, and offered an identical

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[440] Drake, *Pioneer Life*, 44.

solution: "We may look forward with hope to the time when, through the agency of steam, the whole traffic in [swill milk] will be destroyed."[441]

Farmers and railroad operators were willing to try. Beginning in 1842, the opening of the Erie Railroad brought a sea change in the New York milk trade. For the first time, farmers from the rich farms of distant Orange County, New York, could ship grass-fed milk as far as Jersey City, just across the Hudson River from Manhattan, and connected by ferry, with relative speed. The very first year, running one train per day, they sent 388,505 quarts into the city. The next year, railroad operators added a second, evening train, enabling farmers to ship 3,181,505 quarts of milk into the city. Still, it was insufficient to satisfy New Yorkers' hunger for grass-fed rural milk. In 1844, three years after beginning a milk route, the Erie Railroad shipped 5,095,762 quarts into the city. By the time John Mullaly penned his exposé of the urban dairy trade in 1856, the Erie Railroad brought milk in from as far afield as Otisville, New York, about eighty miles northwest of Jersey City. Other railroads soon joined in the enterprise. The New Jersey Railroad brought milk in from New Brunswick, and Elizabethtown (now Elizabeth), New Jersey; the Paterson and Ramapo Railroad from the rural communities between Paterson, New Jersey, and Suffern, New York. The extension of the New York and Harlem Railroad in 184? Brought milk from Westchester and Dutchess Counties, New York, on the Connecticut border. Beginning in 1853, the Hudson River Railroad brought milk from Sing Sing, Peekskill, Croton, and other distant stations.[442]

Country milk may have looked and tasted better than that of the urban dairies, but it was no more sanitary or safe to drink. Though farmers made an effort to cool their milk before

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[441] Hartley, *An Historical, Scientific, and Practical Essay*, 29; Mullaly, *Milk Trade*, 30.

[442] Mullaly, *Milk Trade*, 25, 29, 35-36, 75, 88-89; Louis V. Grogan, *The Coming of the New York and Harlem Railroad* (Self Published, 1989), 14.

loading it into wagons for transport to the nearest depot, and the railroad operators made some effort to insulate the cans by covering them with blankets or bison robes, the springless, unrefrigerated rail cars in which the milk traveled exposed the milk to numerous hazards. The rocking and jolting of the cars caused the milk to slosh out over the tops of the open cans, where it fell on, and was absorbed by, the porous, wooden carriage floors. There, it supported colonies of dangerous bacteria that were not only difficult to remove, but could also be easily be transferred into cans of untainted -- or at least, minimally tainted -- milk. Moreover, cooling and insulating were only so effective during the summer and fall months, when the morning and evening sun beat down on the cars, raising the ambient temperature to 100° F or higher and heating the milk. As late as 1878, representatives of the Philadelphia County Medical Society reported that the rail cars that carried country milk into Philadelphia each day reeked with the odor of decomposing milk. One of the best descriptions of cars came from the physician Benjamin Lee, who wrote, "The floors [of the cars] are soaked, they are very rarely cleansed, and unquestionably the tainted atmosphere must affect the milk, because, if the milk can get out the air can get in, to take its place."[443]

Assuming that it survived the trip without souring or spoiling, the "pure country milk" touted by rural milk associations had to run the same urban gauntlet as city milk. In 1848, a committee appointed by the New York Academy of Medicine noted that the Orange County Milk Association unloaded its milk cans at Duane Street, near the center of lower Manhattan. From there, the association's milk wagons traveled along routes that meandered for over ten miles through the city streets, with all of its attendant horrors, and took between three and four hours to complete. Moreover, if contemporary observers be believed, almost none of the "pure

[443] "Medical Societies. Philadelphia County Medical Society," *Medical and Surgical Reporter*, March 2, 1878.

country milk" reached consumers without first visiting the "cow with the iron tail," which is to say, the water pump. Though frowned on, social reformers and pure-food advocates tolerated milk peddlers' habit of diluting their milk with water to increase their profits. Indeed, they differentiated between this method of adulteration and the use of chalk, calves' brains, and other vile substances to change the texture, taste, color, and aroma of city milk. Where the former posed a danger to consumers' health, the latter represented rascality, motivated by greed. For all of these reasons, it is inconceivable that any of this milk made it from depot to table without succumbing to infestation by dangerous pathogens.[444]

Unknown to milk-hungry New Yorkers, or their counterparts in Philadelphia, Boston, Chicago, and other growing cities, help was on the way. The former Texas Revolutionary and editor, Gail Borden Jr., had devised a means -- or so he believed -- to satisfy their hunger for good quality, sanitary milk. Building on the work of scientists and ordinary people, who had long-since deduced that dehydrating food retarded decomposition, Borden used a custom-made vacuum pan to evaporate the water content of new, sweet milk, leaving behind only the protein, milk fat, and lactose. So long as the milk was clean when processed, and so long as consumers stored it in a cool, dry place, the viscous, sticky substance could be kept for up to a week or more, without spoiling. It could then be reconstituted by adding water. Dubbed condensed or concentrated milk, the invention proved less reliable than Borden, his contemporaries, and hagiographers believed, yet more popular and useful than modern historians have yet recognized. Either way, it paved the way for his more successful invention, a sweetened condensed milk that used sugar and hermetically sealed tin cans to keep milk safe and edible for months at a time. To Borden's great satisfaction, sweetened condensed milk made him a wealthy man. To his even

[444] Gardner, *Report*, 11; Mullaly, *Milk Trade*, viii, 53, 58.

greater satisfaction, the product went on to save the lives of tens of thousands of Union soldiers during the American Civil War.

Chapter 6:
"I Tried Again and Again and Succeeded":
Gail Borden, Jr. and the Invention of Condensed Milk

Condensed milk pioneer Gail Borden Jr. occupies an ambiguous place in the historiography of dairy production and consumption. Beginning with Secretary of the Maine Board of Agriculture, Stephen Lincoln Goodale's, 1872 *A Brief Sketch of Gail Borden*, hagiographers have depicted the New York-born Texan as an inveterate tinkerer, entrepreneur, and Christian gentleman, whose abiding concern for the wellbeing of American milk drinkers drove him to sacrifice his personal fortune, and his personal health, to furnish consumers with a portable, durable, source of sanitary cow's milk. Since then, others have depicted Borden as an obsessive, yet bumbling capitalist, whose success in furnishing preserved milk to families, to say nothing of soldiers, explorers, miners, and other agents of American imperialism, had as much to do with luck as it did any humanitarian impulse, wisdom, or entrepreneurial skill.[445] Those in the former group paint too rosy a picture of a man who embraced vigilantism, counted himself a proud slaveowner, and dabbled in the anti-immigrant, anti-Catholic politics of nativism.[446]

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[445] Stephen Lincoln Goodale, *A Brief Sketch of Gail Borden, and His Relations to Some Forms of Concentrated Food* (Portland, Maine: B. Thurston & Co., 1872); Clarence R. Wharton, *Gail Borden: Pioneer* (San Antonio: The Naylor Company, 1941); Joe B. Frantz, *Gail Borden: Dairyman to a Nation* (Norman, Oklahoma: University of Oklahoma Press, 1951); Sue Shephard, *Pickled, Potted, & Canned: How the Art and Science of Food Preserving Changed the World* (New York: Simon and Schuster, 2000), 150-152; Andrew F. Smith, *Starving the South: How the North Won the Civil War* (New York: St. Martin's Press, 2011), 81-82; Deborah Valenze, *Milk: A Local and Global History* (New Haven, Conn.: Yale University Press, 2011), 178-187. At least one historian has noted this dichotomy. See Lisa Haushofer, *Wonder Foods: The Science and Commerce of Nutrition* (Berkeley: University of California Press, 2022), 18-19.

[446] Gail Borden Jr. to Trustees New York Condensed Milk Company, 31 May 1860. J. Gail Borden Jr. Papers, 1830-1910, 1932-1937, box 3C18, Dolph Briscoe Center for American History, the University of Texas at Austin; Gail Borden Jr. to Capt. Wm. J. E. Heard, 19 December 1855, J. Gail Borden Jr. Papers, 1830-1910, 1932-1937, box 2N321, Dolph Briscoe Center for American History, The University of Texas at Austin; William J? E? Heard to Gail Borden, 1 January 1855, Joe B. Frantz Papers, 1746, 1801-2010, Box 3J245 Dolph Briscoe Center for American History, University of Texas at Austin; Gail Borden Jr. to Dear Brother, n.d., J. Gail Borden Jr. Papers, 1830-1910, 1932-1937, box 2N321, Dolph Briscoe Center for American History, The University of Texas at Austin; Frank Wells to Arthur G. Clark, 23 July 1918, Joe B. Frantz Papers, 1746, 1801-2010, box 3J245, Dolph Briscoe Center for American History, University of Texas at Austin.

Those in the latter are too quick to condemn a man who embraced charitable giving, paid for his workers (and gave them time off) to attend religious revivals, built a school for free African American children in Texas, and fought his own board of directors to keep condensed milk affordable, even as the New York Condensed Milk struggled to return a profit on condensed milk.[447] He was a complicated man. Owing to a paucity of primary sources, and Borden's tendency to keep personal motives private, he will likely remain one of the most enigmatic of American household names.[448]

Borden's signature product, sweetened condensed milk, occupies an equally ambiguous place in the historiography of nineteenth-century American milk production and consumption. Indeed, historians have struggled to identify and distinguish between (or even notice) the two iterations of the product that appeared during Borden's lifetime: unsweetened condensed milk, which used no sucrose (or refined white sugar) as a preservative; and sweetened condensed milk, which used sucrose as a preservative. Their tendency has been to conflate the two variants under the single heading although the products differed from one another in terms of their portability, durability, taste, and nutritional value.[449] Historians have likewise struggled to identify and describe the processes, raw and finished materials, and technologies that Borden used in manufacturing and packaging condensed milk for transportation and sale to consumers. At least

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447 "Extracts From a Private Autobiography of Mrs. Cornelius DuBois of New York"; "Interview with Mr. Hiram Palmer," 23 May 1918, Joe B. Frantz Papers, 1746, 1801-2010, box 3J245, Dolph Briscoe Center for American History, University of Texas at Austin; Joe B. Frantz, "Gail Borden Jr. (1801-1874)," Texas State Historical Association, https://www.tshaonline.org/handbook/entries/borden-gail-jr; Gail Borden Jr. to Messrs. Bridge and Milbank, 26 January 1858, J. Gail Borden Jr. Papers, 1830-1910, 1932-1937, box 3C18, Dolph Briscoe Center for American History, University of Texas at Austin .

448 Correspondence with representatives of the Porticus Centre of Beatrice revealed that the Hexion Company purchased and disposed of most of the Borden Company's original records in the early twenty-first century. Surviving records -- primarily letterpresses -- reside at the Dolph Briscoe Center for American History at the University of Texas.

449 There are exceptions. See Jacqueline H. Wolf, *Don't Kill Your Baby: Public Health and the Decline of Breastfeeding in the Nineteenth and Twentieth Centuries* (Columbus: The Ohio State University Press, 2001), 159-160.

one, Andrew F. Smith, has argued that Borden's patented *in vacuo* condensing process served to Pasteurize and sterilize milk, although it was not until 1886, twelve years after Borden's death, that the German chemist Franz von Soxhlet first used Pasteur's process to sterilize bottled milk.[450] Moreover, historians assume that Borden packed every drop of condensed milk into hermetically sealed tin cans, without noting that other shipping methods existed. In fact, Borden initially shipped both the unsweetened and sweetened variants to consumers in unsealed tin cans fitted with lids and ice-packed cores, or in unsealed, water-tight barrels.[451] It was not until 1861 that Borden opened a tin shop at his Wassaic, New York, condensing plant that it was possible and practical to can condensed milk for sale. Even then, these cans were only ever used for sweetened condensed milk. It was not until the 1880s that Pasteurization made the canning of unsweetened condensed milk -- now known as "evaporated milk" -- possible.[452]

Still another point of historiographical confusion surrounds the overall cleanliness and nutritional value of Borden's condensed milk products. Borden's hagiographer Goodale depicted condensed milk as an altogether nutritious, sanitary alternative to the "vile secretion of diseased cows fed upon distillery slops, so often sold for 'pure country milk'" in New York and other American cities. Indeed, he gave the product full credit for saving the lives of "uncounted thousands of . . . city-born infants," who would otherwise have perished for want of access to a "supply of pure milk."[453] As the nineteenth century waned, the authors of the *Columbian*

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[450] Smith, *Starving the South*, 81; John A. Jeffries, "The Bacteria of the Alimentary Canal Especially in the Diarrhoeas of Infancy," *The Boston Medical and Surgical Journal* CXIX, no. 10 (6 September 1888), 217-223.

[451] Wolf, *Don't Kill Your Baby*, 160; Andrew F. Smith, *Eating History: Thirty Turning Points in the Making of American Cuisine* (New York: Columbia University Press, 2009), 69; Smith, *Starving the South*; Valenze, *Milk*, 187; Anna Zeide, *Canned: The Rise and Fall of American Confidence in the American Food Industry* (Berkeley: University of California Press, 2018), 16-17; Andrew F. Smith, ed., *The Oxford Encyclopedia of Food and Drink in America* (Oxford: Oxford University Press, 2013), 186; "News and Miscellany. Condensed Milk," *Medical and Surgical Reporter*, 29 October 1864: 191.

[452] Wolf, *Don't Kill Your Baby*, 196.

[453] Goodale, *Brief Sketch*, 9-10;

Biographical Dictionary of Eminent Men of the United States affirmed Goodale's claims, writing, "None of the famous men of America . . . are more deserving of the gratitude of mankind than Gail Borden."[454] In recent years, scholars have been more circumspect. For example, in his 2011 study of Union and Confederate food regimes during the American Civil War, the historian Andrew F. Smith diverged from earlier narratives, arguing that condensed milk was perhaps "not as nutritious," as raw milk, presumably because the high temperatures associated with condensing destroyed heat-labile nutrients such as vitamin A. And yet, in doing so, he fell back on a standard historiographical trope, declaring condensed milk "much safer" than the alternatives available to nineteenth-century consumers, without asking whether or not (or how or why) that was the case.[455]

As with other aspects of the Borden story, the truth lies somewhere between these two contradictory narratives. Thanks to Borden's strict sanitary standards, condensed milk *did* represent a radical improvement over the unsanitary, adulterated product peddled by urban dairies and the so-called country milk associations. Handled and prepared properly, the unsweetened variant of condensed milk would have been no less well-suited to use in hand feeding infants and young children than new, sweet milk drawn straight from the cow.[456] Moreover, and recognizing that sucrose posed a risk to infant health, the sweetened variant would certainly have been safer than the low-fat, low-protein, bacteria-ridden fluid peddled by

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454 Peggy Grodinsky, "Keeper of the Milk," *Houston Chronicle*, 24 May 2006.

455 Smith, *Starving the South*, 81; Matthew Brennan, "The Civil War Diet" (Master's Thesis, Virginia Polytechnic Institution, 2005)69, 79, 87, 93, 107.

456 Frantz, *Gail Borden*, 243–46; Valenze, *Milk*, 218. Clean or not, cow's milk contains more proteins and minerals than human breast milk that may cause intestinal bleeding in children under 12 months of age. See "Cow's Milk and Milk Alternatives," Centers for Disease Control and Prevention: CDC 24/7; Saving Lives; Protecting People, https://www.cdc.gov/nutrition/infantandtoddlernutrition/foods-and-drinks/cows-milk-and-milk-alternatives.html#:~:text=At%2012%20months%20old%20(but,of%20nutrients%20your%20baby%20needs.

urban milk dealers.[457] Of course, both iterations would have been safer for adult consumers than the alternatives. But then, Borden faced the same obstacles as his competitors in terms of delivering a safe, chemically consistent product to consumers. The farmers who did business with Borden's New York Condensed Milk Company were no more skillful at managing their animals' health and nutrition than were other farmers of the era. They were also less inclined (or able) to abide Borden's sanitary regulations than hagiographers have supposed.[458] To be sure, the milk presented for condensing was more sanitary and chemically consistent than most. Judged by modern standards, however, the product was unsanitary -- indeed, positively polluted -- and lacking in nutrition.[459]

Perhaps the greatest historiographical confusion surrounds the relative popularity of condensed milk as a consumer product. Historians agree that Borden's first attempt to make and market condensed milk met with only limited success -- and this in spite of the tainted milk crisis that swept New York City during the mid-1850s, simultaneous to his decision to patent his newest invention. Citing no specific data, the historian Joe Frantz concluded, "Condensed milk was something new and therefore something foreign to most milk purchasers, and the New York Condensed Milk Company sales staff was [too] small" to market the product. This would seem to support the oft-repeated conclusion by historians, most all of whom cite Frantz, that nineteenth-century Americans had no fondness for milk, generally, and hence no fondness for

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[457] Michael Gracey and Valerie Burke, "Sugar-induced Diarrhoea in Children," *Archives of Diseases in Children*, 48 (1 May 1973), 331-336.

[458] Gail Borden Jr. to J. Milbank, 6 April 1865, J. Gail Borden Jr. Papers, 1830-1910, 1932-1937, box 3C18, Dolph Briscoe Center for American History, University of Texas at Austin.

[459] For a contemporary example of Borden rejecting dirty milk, see Gail Borden Jr. to James A. Tuttle, 1 August 1860, J. Gail Borden Jr. Papers, 1830-1910, 1912-1937, box 3C18, Dolph Briscoe Center for American History, University of Texas at Austin; To be fair, modern milk is fortified with vitamin D and other nutrients that were unknown to nineteenth-century Americans, using processes that were likewise unknown. See Mark Lawrence, *Food Fortification: The Evidence, Ethics, and Politics of Adding Nutrients to Food* (Oxford: Oxford University Press, 2013), 195.

condensed milk, specifically.[460] And yet, there is ample evidence -- some of it present in Frantz's research notes -- that Borden found a ready and growing market for unsweetened and sweetened condensed milk among urban consumers in the Northern industrial and Southern port cities, as well as the steamship crews who ferried mail, goods, and chattel slaves between New York, England, Charleston, New Orleans, Mobile, and Galveston.[461] If the company struggled during the years leading up to the Civil War, it had less to do with consumer preferences and more to do with supply. That is, Borden's first factory was too small, and the milk supply too irregular, to meet demand.

It is impossible to place Gail Borden's story in the context of nineteenth-century American milk production and consumption, including his contribution to the health and wellbeing of Union Civil War soldiers, without first untangling these oversimplified and contradictory narratives. Doing so reveals that Gail Borden Jr. and his business partners were, above all other things, flawed human beings. That is to say, they intuited some organic processes well enough to create a working system for preserving new, sweet milk while misunderstanding other organic processes sufficient to prevent their creating a product that was as safe, sanitary, and nutritious as they believed and/or imagined. The same may be said for the scientists, journalists, physicians, and even state and federal agents who toured Borden's factories, sampled his products, and then went on the record in declaring Borden's condensed

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[460] Frantz, *Gail Borden*, 246; Richard A. Meckel, *Save the Babies: American Public Health Reform and the Prevention of Infant Mortality, 1850-1929* (Ann Arbor: The University of Michigan Press, 1990), 64; Borden secured his patent, following three rejections, in 1856. See Gary Allen and Ken Albala, *The Business of Food* (Westport, Connecticut: Greenwood Press, 2007), 52; Smith, *Starving the South*, 81; Dupuis, *Nature's Perfect Food*, 5, 83; Valenze, *Milk*, 178-87.

[461] Gail Borden Jr. to Noah Gridley, Esq., 7 November 1860; Gail Borden Jr. to Thomas Green Esq., 6 August 1860, J. Gail Borden, Jr. Papers, 1830-1910, 1932-1937, box 3C18, Dolph Briscoe Center for American History, University of Texas at Austin; "Interview With Mr. Knight By Mr. Hall," n.d.; "1856-1904," 1911, Joe B. Frantz Papers, 1746, 1801-2010,, box 3J245, Dolph Briscoe Center for American History, University of Texas at Austin

milk superior to new milk drawn straight from the cow. Indeed, the same may be said for historians who have confused some aspects of the narrative, ignored others, overlooked still others, and crafted a metanarrative that is too muddled to be of much use. The creative process requires one to innovate even as they work to correct the errors of the past. No one understood this better than Gail Borden, whose epitaph still reads, "I tried and failed. I tried again and again and succeeded."[462]

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It is unclear when, where, or why Gail Borden Jr. first conceived to extend the shelf life of milk by evaporating its water content in a vacuum boiler. An apocryphal and yet oft-repeated story holds that the idea first came to him in 1851, while he was returning to the United States from London, England, aboard a trans-Atlantic steamship. On taking a walk to stretch his legs, Borden was horrified to discover that the ship's dairy cow was too sick to furnish milk for the starving, weeping immigrant children who were huddled below decks. Having enjoyed some success manufacturing a portable, durable, beef- and flour-based soup starter -- the so-called, and rather unfortunately named "meat biscuit" -- for use by overland migrants, sailors, soldiers, and explorers, Borden vowed to the ship's captain that he would discover a means to preserve milk for use by ship-bound adults and children. Met with gales of laughter, the former Texas Revolutionary responded with a characteristic resolve. Squaring his shoulders, Borden proclaimed that nonperishable milk would soon be as common on board ships as refined white sugar. A mere seven years later (assuming that the conversation actually occurred), Borden had

[462] Mary Ellen Snodgrass, *Encyclopedia of Kitchen History* (New York: Fitzroy Dearborn, 2004), 102.

lived up to his own boast by evaporating the former, mixing it with the latter, and sealing it away in tin cans.[463]

Likely the truth was more prosaic. By the time Borden boarded ship in England in 1851, it was common for European and British migrants to bottle and preserve new, sweet milk for use in trans-Atlantic voyages. This practice may be traced to the French chef and confectioner Nicolas Appert, who first devised a means to preserve fruits, vegetables, meat, and milk in 1795, six years before Borden's 1801 birth. Appert's process called for packing perishable foods in glass vessels, adding sucrose to act as a preservative, heating the bottles in boiling water to force out air (and, unbeknownst to Appert, also killing microorganisms present in the food), and then stoppering the vessels with a waxed cork to create an airtight seal. In 1810, in return for a 12,000 franc prize from France's Bureau of Arts and Manufacturers of the Ministry of the Interior, he published his methods for public consumption.[464] Simple and effective, "Appertization," as the process came to be known, found favor with the European and British public. In 1843, eight years before Borden embarked on his fateful voyage, an emigrants' guidebook advised emigrants traveling from Great Britain to Canada that milk "boiled with loaf sugar, a pound to a quart, and bottled," would provide them with an adequate supply of milk in transit. An 1851 guide for Irish emigrants offered identical advice.[465] It may be that the story of Borden's trans-Atlantic voyage is accurate. It may also be that he saw migrants adding

463 James H. Collins, *The Story of Condensed Milk* (New York: The Borden Company, 1922), 5-7; Frank Crane, "The Borden Company," *Current Opinion* (August 1924), 233-240; Shephard, *Pickled, Potted, and Canned*, 150-151.

464 Martin R. Adams and Maurice O. Moss, *Food Microbiology* (Cambridge, England, United Kingdom: RSC Publishing, 1995), 63-65.

465 Cradock and Company, *Canada, Nova Scotia, New Brunswick, Newfoundland, Etc. With the History, Present State, and Prospects of Those Colonies, in Regard to Emigration* (London: Joseph Masters, 1843), 55–56; An 1851 Irish emigrant's guide offered identical advice. See John O'Hanlon, *The Irish Emigrants Guide for the United States* (Boston: Donahoe, 1851), 34–35.

Appertized milk to their coffee or feeding it to their children and decided to experiment with the process. Whatever the case may be, it is clear that Borden's condensing processes elaborated on an existing idea.

In fact, Borden was not the first inventor to seek patents for milk condensing processes. The Englishman William Newton took out a milk condensing patent in 1835 that called for evaporating the fluid's water content in a vacuum "by any suitable means" and then adding sucrose (refined white sugar) as a preservative. Twelve years later, the English farmer Thomas Shipp Grimwade patented a three-step process that called for adding saltpeter to new, sweet milk, exposing the fluid "to heat in vacuo, so as to evaporate and extract the aqueous particles therof," and then packing the milk into bottles "from which the air has been previously exhausted." There is no evidence, however, that either Newton or Grimwade used their respective processes to manufacture condensed milk for sale. The same could not be said for Grimwade's second, 1855 English patent. This second process was more complicated, involving several new steps. It required the manufacturer to first skim the cream off the top of milk before adding an unspecified quantity of potash. It then called for evaporating the water content in an open pan at 160° F to create a "stiff dough." This done, the dough was dried, rolled, and pulverized to create a "fine powder" that could be reconstituted with water. The physician Dr. Handasyde Duncan, who served as the Immigration Officer and Health Inspector for Port Adelaide, South Australia, endorsed "Grimwade's Patent Desiccated milk" as a suitable food for infants and ocean-going migrants. Moreover, the British nursing pioneer Florence Nightingale fed Grimwade's Milk to sick and wounded soldiers confined at military hospitals in Scutari, during the Crimean War.[466]

Borden knew none of this in 1853, when he first attempted to patent his own *in vacuo* milk condensing process in the United States and England.[467] Indeed, he was shocked and dismayed when Commissioners of the United States Patent Office assigned to review his application cited English patents when dismissing his claim for its perceived lack of novelty and usefulness. On reviewing the patents, Borden and his lawyer, a certain Mr. Barlow of London, countered that his use of a vacuum pan (or boiler) to excluded air when evaporating the water content of milk was indeed novel, not because it represented a new technology -- it was no secret to Borden that sugar refiners used vacuum pans to lower the boiling point of sugar syrup -- but rather because the method had never been used to manufacture condensed milk for sale in any practical sense. On reviewing Borden's second and third applications, Patent Commissioners were willing enough to concede this point. Yet they were less willing to accept his explanation for what made the process "useful" enough to warrant issuance of a unique patent -- that is, that holding the milk in a vacuum through the entire condensing process produced a superior, longer-lasting condensed milk product. Though he knew nothing of microbes, Borden intuited that shielding both raw and condensed milk from contaminants such as dirt and dust slowed its decomposition and extended its shelf life. Indeed, he was correct. A great many of the microorganisms that sour or spoil milk are known to waft through the air aboard dust particles,

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466 Mohan, "Manufacture of Condensed Milk," 11; Beach and Rines, *Americana*; Goodale, *Brief Sketch*, 13; Robin Haines, *Doctors at Sea: Emigrant Voyages to Colonial Australia* (New York: Palgrave Macmillan, 2005), 24, 99–100; Charles Knight, *The English Cyclopaedia: A New Dictionary of Universal Knowledge*, vol. 5 and 6 (London: Bradbury and Evans, 1861), 658; For more on Nightingale's service in Scutari (now Üsküdar, in present-day Istanbul, Turkey), see Christopher J. Gill and Gillian C. Gill, "Nightingale in Scutari: Her Legacy Reexamined," *Clinical Infectious Diseases* 40, no. 12 (June 15, 2005): 1799–1805.

467 Joe B. Frantz, "Gail Borden," Joe B. Frantz Papers, 1746, 1801-2010, box 3J246, Dolph Briscoe Center for American History, University of Texas at Austin.

or enveloped in drops of aerosolized mucus. No more or less ignorant of germ theory themselves, however, the Commissioners were skeptical. The impasse would take three years, thousands of dollars, and the testimony of leading scientists to resolve in Borden's favor. Even then, there is no evidence that the Commissioners accepted the science so much as they wished to be rid of the case.[468]

Never one to dither in the face of opportunity, Borden moved right away to open a milk condensing plant in Walcottville (now Torrington), Connecticut, in an old carriage shop.[469] The venture proved a failure. Although surrounded by the rich dairy farms of Litchfield County, Borden was unable to persuade local farmers to sell him enough milk to cover his operating costs. The problem was a lack of liquid funds. Perhaps because they were skeptical of the entire operation, perhaps because they had already spent enormous sums of money in securing a patent, perhaps because word reached them that a batch of condensed milk purchased by the Collins Steamship Line had molded while in transit (perhaps all three), Borden's business partners in New York refused to send additional cash, leaving him with nothing to offer farmers in return for their milk save a share in future profits.[470] In a 1918 interview, lifelong Walcottville resident Clark S. Weed noted that New Englanders were, generally speaking, too "narrow and hard-headed" to accept such an offer. Though Borden struck them all as someone who was "honest in the extreme and never tried to take advantage of anyone," they insisted on receiving "their money or they would deliver no milk." So it was that mere months after arriving in Walcottville, Borden sold off or gave away his condensing equipment and closed up shop. For some decades

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468 Borden Company, *Story*, 23-26.

469 "Interview with Major Albert Brooker, 20 May 1918, Joe B. Frantz Collection, 3J245, Literary Productions, 1856-1860 (6).

470 Gail Borden Jr. to Mr. Nathaniel R. Mills, 13 February 1856; Walter Gladding to Mr. Henry E. Wells, Mayor, n.d., Joe B. Frantz Papers, 1746, 1801-2010, box 3J245, Dolph Briscoe Center for American History, University of Texas at Austin; Borden Company, *Story*, 27.

after, the tin-lined vat that Borden had used in cooling milk adorned the public square as a horse trough.[471]

Undaunted, with the renewed backing of his partners, Borden returned to Walcottville the following May. He soon leased a building from a local lumberman, Milo Burr, that was situated in a steep gorge, and perched above a swift-moving stream that furnished ample water power.[472] In his 1951 Borden hagiography, *Gail Borden: Dairyman to a Nation*, the historian Joe B. Frantz noted that Borden spent much of his time traveling around to meet with local farmers and solicit milk. Always, the Texan insisted that his suppliers -- or "customers," as he called them -- abide by a series of strict sanitary standards: straining milk once or twice to remove dust, dirt, and other debris that might taint the milk; cooling the milk to a temperature of 50° - 56° F with ice or spring water to slow decomposition; and covering the cans with bison robes or blankets to serve as insulation while in transit to the factory. Always, farmers rolled their eyes at Borden's rules, which they perceived as costly, time-consuming, and unnecessary. And yet, they did agree to sign contracts. In an 1858 report submitted to the Trustees of the New York Condensed Milk Company, Borden noted that farmers had pledged the milk of 200 cows to the Burrville plant. Two years later, in a November 7, 1860, letter to his partners in New York, Borden reported that the Burrville plant had contracted with 30 Litchfield County farmers to furnish just over 2,600 quarts of milk during the first week of November, and this in spite of a lingering drought and local milk shortage.[473]

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471 "Interview with Mr. Clark S. Weed (Milk Dealer), Torrington, Conn. May 20th, 1918," Joe B. Frantz Papers, 1746, 1801-2010, box 3J245, Dolph Briscoe Center for American History, University of Texas at Austin.

472 M.S., "Condensed Milk," *The Independent . . . Devoted to the Consideration of Politics, Social and Economic Tendencies, History, Literature and the Arts*, 9 August 1858: 2; "Interview With Mr. Edward S. Miner, 31 May 1918, Joe B. Frantz Collection, Literary Productions, 1856-1860 (51).

473 Frantz, *Gail Borden*, 243-246; "News and Miscellany," *Medical and Surgical Reporter* (29 October 1864), 191; Reminiscences of John S. Eno, December 1913, Joe B. Frantz Collection, 3J245, Literary Productions, 1861-1865 (7); Borden Company, *Story*, 31; Gail Borden Jr. to Trustees Ny. C.M. Co., 7 November 1860, J. Gail Borden Jr.

On April 5, 1858, even as Borden worked to sign contracts with farmers, the New York Condensed Milk Company published one of the earliest known advertisements for unsweetened condensed milk in the *New-York Daily Tribune*. Borden's word and stylistic choices indicate a desire to set his own product apart from the unsanitary, often-adulterated "swill milk" peddled by New York milk dealers. Indeed, the advertisement fairly shouted, "BORDEN'S CONDENSED MILK It Is Simply Pure Milk, From which, when perfectly fresh, nearly all the water is evaporated, and NOTHING WHATEVER IS ADDED." Recognizing that *Tribune* readers were unfamiliar with condensed milk and its proper use, Borden attached a short tutorial, instructing would-be consumers on how to reconstitute the milk. Combining one quart of condensed milk to four parts water, he wrote, made "5 quarts RICH MILK," identical to that drawn straight from the cow. Those who preferred to water their milk down a bit could combine one quart of condensed milk with six quarts of water to make "7 quarts better Milk than is generally sold in New York." Lest *Tribune* readers doubt the veracity of his claims, Borden cited a January 1858 study published in the *New York Journal of Medicine*, which confirmed that condensed milk was portable, durable, and contained all the nutritive elements found in "Pure milk," and in the correct proportions. Leaving nothing to chance, he offered free copies of the study for distribution to interested parties who dropped by the company's offices at 173 Canal Street, in Manhattan.[474]

There is no evidence that Borden's contemporaries disputed these claims. Condensed milk may have looked and tasted peculiar to nineteenth-century American consumers, with some commenting that the sticky, viscous substance had a cooked or caramelized flavor. Yet

Papers, 1830-1910, 1932-1937, box 3C18, Dolph Briscoe Center for American History, University of Texas at Austin.

[474] "The New-York Condensed Milk Company," *New-York Daily Tribune*, April 5, 1858; "Correspondence," *New York Journal of Medicine*, January 1858.

Americans of the era hardly possessed a consistent image of cow's milk. Those who enjoyed access to a family cow described the fluid, variously, as rich, creamy, sweet, thick, yellowish, sour, tangy, and/or possessed of an "animal" odor and "pasture" flavor.[475] Those who drank city milk used many of the same descriptive terms, while adding a few of their own: thin, watery, rank, ropy, and/or nauseating and smelling of distillers' mash, with a "blue" tint.[476] Some in the latter group rejected whole milk peddled by "Country Milk Associations," citing the thick, noxious layer of "grease" -- that is, cream -- floating on the surface.[477] Whatever they thought of condensed milk's taste, smell, and appearance, the scientists, physicians, and editors who shaped public perception declared the product nutritious. On testing a sample of unsweetened condensed milk in January 1858, the *New York Journal of Medicine* noted that it contained all the elements found in fluid cow's milk -- water, butter fat, casein, milk sugar, phosphates of lime, chlorides of potassium, soda, and Sulphur -- and in the correct proportions. Editors of

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[475] Ebenezer Neal, *Diet for the Sick and Convalescent* (Philadelphia: James Challen & Son, 1861), 27; Solon Bingley, *Facts for Farmers, Also for the Family Circle: A Compost of Rich Materials for all Land-Owners about Domestic Animals and Domestic Economy, Farm Buildings, Gardens, Orchards and Vineyards and All Farm Crops, Tools, Fences, Fertilization, Draining and Irrigation* (New York: Johnson and Ward, 1863), 456 (rich cream); John Wesley, *Primitive Physic, or, an Easy and Natural Method for Curing Most Diseases* (Edinburgh, Scotland, United Kingdom: Thornton & Collie, 1846), 92 (thick); Herbert C. Covey and Dwight Eisnach, *What the Slaves Ate: Recollections of African American Foods and Foodways from the Slave Narratives* (Santa Barbara, California: Greenwood Press, 2009), 137; "Color of Cattle," *Boston Cultivator*, April 3, 1841; "White Cows," *Maine Farmer and Mechanics Advocate*, June 18, 1842; Nicholas Gerber, *Chemical and Physical Analysis of Milk, Condensed Milk, and Infants' Milk-Foods, with Special Regard to Hygiene and Sanitary Milk Inspection. A Laboratory Guide, Developed from Practical Experience, Intended for Chemists, Physicians, Sanitarians, Students, Etc*, trans. Hermann Endemann (New York: Lehmaier & Bro., 1882), 52–54, 58; "American Solidified Milk!," *New Orleans Daily Crescent*, 16 July 1859; "Solidified and Condensed Milk," *Valley Farmer*, March 1860: 82; "News and Miscellany"; "An Essay on Cheese Making," *Ohio Cultivator*, 1 February 1851: 33; "Skim-Milk Vs. Cream-Milk," *The Independent . . . Devoted to the Consideration of Politics, Social and Economic Tendencies, History, Literature, and the Arts*, February 16, 1871.

[476] Robert Milham Hartley, *An Historical, Scientific, and Practical Essay on Milk, as an Article of Human Sustenance; with a Consideration of the Effects Consequent Upon the Present Unnatural Methods of Producing It for the Supply of Large Cities* (New York: Jay Leavitt, 1842), 77; John Mullaly, *The Milk Trade in New York City and Vicinity* (New York: Fowlers and Wells, 1853), 117; C.K. Mader, "Ropy Milk, Its Cause and Prevention," *Canadian Journal of Comparative Medicine* 4, no. 7 (July 1940): 203–5; "Items," *Zion's Herald and Wesleyan Journal*, 2 August 1865: 123.

[477] "Skim-Milk Vs. Cream-Milk," *The Independent . . . Devoted to the Consideration of Politics, Social and Economic Tendencies, History, Literature, and the Arts*, February 16, 1871.

Scientific American likewise vouched for the product, assuring readers, “this article is simply . . . country milk.”[478] Borden’s Condensed Milk was, to put it simply, one more iteration of an already variable substance.

More concerning to Borden’s urban consumers would have been the product’s cleanliness relative to city milk. Here again, they were inclined to accept Borden’s claim to manufacture a pure, sanitary product. It certainly helped that the Texan had a flair for self-promotion. A former newspaper editor with an eye for public relations, Borden welcomed visitors to his factories, including those who wandered up, unannounced. Indeed, he guided them about the grounds, encouraging them to examine the condensing machinery and meet with his employees.[479]

One such visitor, known only as “M.S.” stumbled across Borden’s Wolcottville plant while enjoying a leisurely “ramble up the valley of the Naugatuck [River].” Everything about the plant, M.S. testified in a letter published in *The Independent*, surpassed the urban swill milk dairies in terms of cleanliness, sanitation, and quality of product. The factory building, which stood alongside a “pure rivulet which comes tumbling down from the hills above,” had been scrubbed and whitewashed by Borden’s employees to a dazzling brightness. The milk came from “grass-fed cows” that roamed over the nearby hills and valleys. The “refining process separate[ed] . . . the watery parts and all impurities, while it retain[ed] all of the valuable properties of the milk.” Betraying nineteenth-century Americans’ faith in the power of human ingenuity and technology to improve nature, M.S. concluded that Borden’s condensing process created a substance that was “pure, even purer than the milk” drawn straight from cows. As

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478 Hartley, “Correspondence, *New York Journal of Medicine*, January 1858: 121; “Concentrated Milk,” *Scientific American*, 5 August 1857: 387.
479 Haushofer, *Wonder Foods*, 18; Borden Company, *Story*, 14.

proof, he cited the durability of Borden's sweetened condensed milk, which had survived a trans-Atlantic voyage to England aboard ships of the Collins line.[480]

Thanks in no small part to continued, positive media exposure, Borden's reputation as a purveyor of sanitary, nutritious, and most important, durable milk increased over time. In August 1864, at Borden's invitation, a correspondent from the *New-York Tribune* toured the New York Condensed Milk Company's new Wassaic, New York, condensing plant, located about seventy miles north of New York City, on the New York and Harlem Valley Railroad. Over three days, the correspondent "personally inspected every part of the building and all of the machinery" used in making condensed milk. He also observed "the whole [condensing and packing] process, from the arrival of the milk cans in the farmers' wagons to the shipping of the condensed milk on the railroad cars." This included a trip to the factory's tin shop, where a team of young women filled and sealed some 8,000 cans of sweetened condensed milk per day, six days per week, for shipment to New York and points beyond. His visit convinced him that Borden's milk was clean, nutritious, durable, and suited "for all purposes for which milk is desirable where fresh milk cannot be obtained," such as feeding urban children, trans-oceanic travelers, and soldiers stationed in distant posts.[481] To put it bluntly, Borden's milk was everything that swill milk, and even the country milk shipped into cities by steamship and rail, was not, nor ever could be.

The *Tribune* correspondent was more thorough than earlier visitors in explaining how and why Borden succeeded where so many others failed. He began by citing Borden's meticulous -- and in the context of the era, unprecedented -- cleanliness. Unlike the country milk associations,

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480 "Condensed Milk," *The Independent*, 2. For more on the Collins Line of steamships, see Thomas W. Knox, *The Life of Robert Fulton and the History of Steam Navigation* (New York: G.P. Putnam's Sons, 1886), 369-383.
481 "From the New York Tribune," *Friends' Review: A Religious, Literary and Miscellaneous Journal*, August 20, 1864, 17, 51: 813; "News and Miscellany."

which required only that farmers deliver their milk to a specific rail depot twice per day, Borden required farmers to observe strict sanitary rules as a condition of contract. These simple precautions struck the *Tribune* correspondent as foolproof and effective. It was a "very unusual thing," he wrote, "to find a can" brought from the farm "that has any taint of change." On the receiving end, Borden was unwilling to add even a drop of dirty or tainted milk to the large, tin-lined vats full of clean milk awaiting evaporation. Indeed, to prevent such an occurrence, he posted inspectors at the factory door, whose job it was to smell, taste, and look over the milk presented for condensing, rejecting any that was dirty, sour, rancid, or in some way adulterated. Those shipments that "pass[ed] muster" went into the common pool for processing. From there, they entered Borden's condensing apparatus, to undergo evaporation.[482]

Gail Borden may not have been "the originator of condensed milk," the *Tribune* correspondent noted, but he had perfected the condensing process.[483] As soon as possible after taking possession of milk, factory workers piped the fluid into a series of open-topped brass pails, immersed in hot water, that raised the milk's temperature to 190° - 195° F. This served to coagulate some of the albumin (milk protein), preventing its adhering to boilers, pipes, valves, and generally gumming up the condensing machinery during evaporation. Unbeknownst to Borden or the *Tribune* correspondent, it also killed most -- but not necessarily all -- of the bacteria and yeasts present in the milk. This done, workers passed the milk into open-topped

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[482] "From the New York Tribune"; For a contemporary account of Borden rejecting milk, see Gail Borden Jr. to Mr. James A Tuttle, 1 August 1860, J. Gail Borden Jr. Papers, 1830-1910, 1932-1937, box 3C18, Dolph Briscoe Center for American History, University of Texas at Austin.

[483] Two English inventors, William Newton and Thomas Shipp Grimwade, took out English milk condensing patents before Borden secured his own U.S. patent in 1856. See condensing patents R.T. Mohan, "The Manufacture of Condensed Milk, Milk Powders, Casein, Etc.," *The Chemical Engineer*, July 1915, 11; Frederick Converse Beach and George Edward Rines, eds., *The Americana: A Universal Reference Library, Comprising the Arts and Sciences, Literature, History, Biography, Geography, Commerce, Etc., of the World* (New York: Scientific American Compiling Department, 1912); Stephen Lincoln Goodale, *A Brief Sketch of Gail Borden, and His Relations to Some Forms of Concentrated Food* (Portland, Maine: B. Thurston & Co., 1872), 13.

kettles, where it was heated to the boiling point, about 210° F, which prevented the milk from foaming up during evaporation and revealed defects in the milk such as colostrum, which reacted to intense heat by forming curds. At the same time, they skimmed off and disposed of the coagulated albumin. The third and final step began when workers used an air pump to extract the air from a spherical copper vacuum boiler and then activated a second pump, which drew milk -- 3,200 quarts in all -- into the pan for evaporation. As he watched the milk roil and bubble, the correspondent *smelled* evidence of the milk's growing purification. Betraying a belief in miasma theory, he noted that the pan vented a "fetid, sickening smell" into the air. Indeed, he cited the expulsion of this foul vapor as "one of the most convincing proofs of the value of the process that discharges such a substance from our daily food." The milk thus purified, Borden's workers cooled the milk in an ice bath preparatory to packing it for shipment.[484]

The methods used during this final stage depended on the milk's intended use and destination. Workers poured unsweetened condensed milk straight into forty-quart milk cans, without further preparation, for rail shipment to New York and even as far away as Boston.[485] Though they looked identical to those used by country milk associations and urban milk peddlers, Borden's milk cans came fitted with removable tin cores, which were packed with ice during the summer months to prevent the milk's heating and souring or spoiling while in transit, as well as lids, to prevent dirt, dust, and other airborne contaminants from polluting the milk. Absent refrigeration, this unsweetened condensed milk had a shelf life of three months (or longer), even when stored in what editors of the July 1863 *Scientific American* dubbed, "A

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[484] "From the New York Tribune"; "News and Miscellany"
[485] "Condensed Milk," *Prairie Farmer*, 21 June 1860; "News and Miscellany"

tolerably warm place."[486] Borden's "preserved" or "sugared" milk took more preparation. Though they were unable to explain how and why the process worked, Borden and his contemporaries recognized that sucrose (refined white sugar) worked similar to salt in slowing the decomposition of food. It also tasted good when mixed with milk. With this in mind, Borden's workers added hogsheads of sugar to a portion of the daily milk shipment before pumping it into the vacuum pans for condensing. On the other end, they lugged the sweet, syrupy substance to the tin shop in open-topped, forty-quart cans, which were then emptied it into vats, fitted with valves or "stop-cocks" for filling cans. Overseeing this final step, a visitor wrote, were teams of "intelligent girls of eighteen or twenty years," some of whom filled the cans, and others of whom soldered them shut "about as fast as a dealer could throw cards." The rest went into the same ice-cooled, forty-quart milk cans as the unsweetened variety for shipment to New York.[487]

All of this, the *Tribune* correspondent concluded near the end of his remarks, amounted to an improvement over nature. More specifically, he wrote that Borden's milk, once reconstituted with water, was "better than what is really pure milk, as drawn from the cows, and far better than much that is sold as pure milk." In saying this, he merely concurred with the visitor "M.S.," who had reached a similar conclusion in 1858, writing, "The article which [Borden] furnishes is pure, even purer than the milk as it comes from the grass-fed cows on the surrounding hills." It would be easy to dismiss both comments as boosterism, informed by nineteenth-century Americans' abiding fascination with technology on the one hand, and their

486 "Preserved Milk, Coffee, and Other Extracts," *Maine Farmer*, 21 July 1853.

487 "From the New York Tribune"; "News and Miscellany"; Borden's decision to hire young women merely continued a trend began by New England textile manufacturers. See Thomas Dublin, *Women at Work: The Transformation of Work and Community in Lowell, Massachusetts, 1826-1860* (New York: Columbia University Press, 1993).

sincere (often ecologically destructive) conviction that the people possessed the power and indeed Divine sanction to improve elements of the nonhuman world, on the other.[488] And yet, by 1864, milk occupied a unique place in the American psyche. Cow's milk had long been Americans' favorite comfort food. Beginning with Robert M. Hartley's 1842 critique of the New York urban dairy trade, however, it was fast becoming a "perfect" food -- the only food created by a benevolent deity for the express purpose of feeding and nourishing human infants and children. To argue that milk *needed* improving or even *could* be improved was a bold statement, tinged with a hint of blasphemy. And yet, so far as contemporary observers could tell, that is what Gail Borden had done. In Wassaic, at least, God's perfect food had become Borden's perfect food.[489]

It was not enough, however, for Borden to make a perfect food; he also had to deliver it, safe and sound, to his customers. Here again, the Texan left nothing to chance. He contracted with the New York and Harlem Valley Railroad to whisk ice-cooled, insulated cans of unsweetened condensed milk direct from Wassaic to Canal Street on Manhattan Island, site of Borden's New York office and warehouse.[490] On taking charge of the milk, his New York Condensed Milk Company relied on its own employees, who in turn used the company's own milk cans, pushcarts, and wagons, to complete deliveries. The earliest of these delivery routes saw Borden himself walk the streets of Manhattan, using a ladle to spoon sticky, viscous

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[488] Steven Stoll, *Larding the Lean Earth: Soil and Society in Nineteenth-Century America* (New York: Hill and Wang, 2002), 20, 85; Leo Marx, *The Machine in the Garden: Technology and the Pastoral Ideal in America* (Oxford: Oxford University Press, 2000), 146, 187.

[489] "From the New York Tribune"; M.S., "Condensed Milk," 2; Robert Milham Hartley, *An Historical, Scientific, and Practical Essay on Milk, as an Article of Human Sustenance; with a Consideration of the Effects Consequent Upon the Present Unnatural Methods of Producing It for the Supply of Large Cities* (New York: Jay Leavitt, 1842), 25-26.

[490] "News and Miscellany"; "Milk Contracts," 1 July 1862, Joe B. Frantz Papers, 1746, 1801-2010, box 3J245, Dolph Briscoe Center for American History, University of Texas at Austin.

condensed milk from an open, "tin quart pail" and into the cans, jars, pitchers, and other vessels offered by customers. As business increased in 1856, the Texan invested in a handcart that he or one of his employees pushed through the streets. The following year, Borden invested in a wagon and opened his first permanent, long-range delivery route, which extended from the NYCMC's offices at 173 Canal Street as far north as 51st Street. Business increasing yet again following publication of *Frank Leslie's* damning expose of the urban swill milk trade, he added additional wagons and extended new delivery routes into neighboring Jersey City, Brooklyn, and Harlem. There is little surviving evidence to describe the exact sanitary practices of Borden's delivery drivers. However, it is reasonable to assume that they washed milk cans, carts, and utensils with scalding water before and after each delivery, and used ice cores to keep the milk cool while in transit. [491]

Moving "sugared" or sweetened condensed milk to consumers left a bit more to chance. A portion of the product, which was set aside for local consumption, traveled from Wassaic to New York by train, packed into the same, forty-quart, ice-cooled cans used in transporting unsweetened milk. On taking charge of these cans, Borden's employees distributed the contents to buyers in the usual way, observing the usual sanitary safeguards.[492] And yet, because sweetened condensed milk was more durable, Borden preferred to place the product aboard trans-Atlantic steamships, which plied the waters between New York and Great Britain, or else send it to merchant firms located in hot, humid, milk-poor Southern port cities for resale.[493] This

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[491] "Interview With Mr. Knight By Mr. Hall," n.d.; "1856-1904," 1911, Joe B. Frantz Papers, 1746, 1801-2010, box 3J245, Dolph Briscoe Center for American History, University of Texas at Austin; "Our Exposure of the Swill Milk Trade," *Frank Leslie's Illustrated Newspaper*, 22 May 1859.
[492] "Cost of Sugared Milk as Estimated in Five Batches Made in the Latter Part of May and First of June 1860," J. Gail Borden Jr. Papers, 1830-1910, 1932-1937, box 3C18, Dolph Briscoe Center for American History, University of Texas at Austin.
[493] Gail Borden Jr. to Messrs. E.C. and J.G. Bates, 6 August 1860, 3C18 (123); Gail Borden Jr. to S.L. Goodale, Esq., 30 October 1864, Joe B. Frantz Collection, 3J245, Literary Productions, 1861-1865 (10).

put Borden the perfectionist in an uncomfortable position, for it denied him the chance to watch over shipments once they left New York harbor. Contemporary sources suggest that the sweet, sugary substance did fine on its own. In an August 6, 1860, letter to the New York Condensed Milk Company investor, Thomas Green, Borden confirmed that a shipment of 1,805 lbs. of sweetened condensed milk, divided between seventeen unsealed cans, reached the Galveston merchant J.P. Davie in good order. Indeed, the only shipping/storage problem that Borden ever documented when shipping the product in unsealed cans was an "incipient mold" that formed on the surface of milk. This, he insisted, was easily scooped off, and amounted to a mere inconvenience.[494]

So far as Borden and his contemporaries could tell, packing sugared milk into hermetically sealed tin cans rendered the product near-indestructible. Indeed, a correspondent to the January 1858 *New York Journal of Medicine* marveled that ships of the Collins Steamship Line carried cans of Borden's sweetened condensed milk "to Europe and back without injury," leading him to conclude that the product could remain fresh and sweet "for years," so long as the cans were sealed and undamaged.[495] To be sure, Borden struggled to explain how, exactly, the process served to retard decomposition. In keeping with contemporary scientific wisdom, he attributed the decomposition of organic matter such as milk and fruit to water and oxygen. Again, he knew well enough that sugar added during evaporation worked -- somehow -- to slow decomposition, perhaps by removing water.[496] However, it was the tin can, which resisted rust

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[494] "Correspondence" Gail Borden Jr. to Thomas Green Esq., 6 August 1860, 3C18 (104).

[495] "Correspondence," *New York Journal of Medicine*, January 1858.

[496] Gail Borden Jr. to J. Westhorp, Esq., 24 January 1856; Gail Borden Jr. to J. Westhorp, Esq., 24 February 1856 in J. Gail Borden Jr. Papers, 1830-1910, 1932-1937, box 2N321, Dolph Briscoe Center for American History, University of Texas at Austin; "Milk and Its Preservation," *Scientific American*, 2 July 1860, 2-3. Otto Frederick Hunziker, *Condensed Milk and Milk Powder* (Lafayette, Indiana: Otto Frederick Hunziker, 1914), 10-11; James H. Collins, *The Story of Condensed Milk* (New York: The Borden Company, 1922), 8.

and was impermeable to water and oxygen, that did most of the real work of preservation.[497] But then, in the short term, it made no real difference to Borden or those who purchased canned sweetened condensed milk. The process worked, making it possible to keep new milk sweet, without refrigeration, for an extended period. Doubtless Borden derived great personal and professional pleasure from proving that he *could*, in fact, develop a means to preserve milk for trans-Atlantic voyages for sailors and passengers (assuming, of course, that his 1851 shipboard vow actually occurred).[498]

In an 1872 defense of Gail Borden Jr.'s patent rights, Secretary of the Maine Board of Agriculture, Stephen L. Goodale, sought to integrate Borden and his condensed milk -- by then, known as Eagle Brand -- into the larger sweep of American history. In doing so, he came close to anticipating the historian Frederick Jackson Turner's 1898 "Frontier Thesis," which discovered the origins of American character, institutions, and ideology in the conquest of Indians and wilderness on the Western frontier. As recounted by Goodale, Borden participated in the physical processes of imperial conquest that Turner would later describe -- first as a youth on the Kentucky, Indiana frontiers, and Mississippi frontiers, and later as a Texas Revolutionary, land surveyor, and customs agent. It was there, in the unsettled, sparsely populated West, that Borden learned "the fertility of resource so characteristic of the American pioneer." This resourcefulness enabled him, indeed compelled him to confront and conquer a new type of wilderness, the urban cityscape, populated by a different, but no less savage set of beings: the microorganisms that were by then known to spoil milk, and the milk dealers who peddled "the

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[497] "How the 'Canister' Became a Modern Tin Can," *Canning Age: Devoted to the Canning, Packing and Allied Industries* (August 1922), 25-27.

[498] As evidence, Borden boasted in 1855 that milk would soon "become as common on ship board as sugar." See Gail Borden Jr. to J. Westhorp, Esq., 28 December 1855, J. Gail Borden Jr. Papers, 1830-1910, 1932-1937, box 2N321, Dolph Briscoe Center for American History, University of Texas at Austin.

vile secretion of diseased cows fed upon distillery slops." In Goodale's telling, Borden did more than preserve milk. His efforts saved the lives of "innumerable" urban white children -- the "fathers and mothers of our race" -- who would have died for want of "pure milk." Whatever the United States was destined to accomplish, Goodale reasoned, it owed a debt of gratitude to Gail Borden Jr.[499]

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Historians have shown a curious tendency to take Borden and his contemporaries at their word when writing condensed milk into the narrative of nineteenth-century food production and consumption. Though they disagree about Borden's character and motivations, they do agree on a few points. In no particular order: Borden's rural suppliers were inclined to follow his sanitary guidelines to the letter in harvesting and transporting milk; Borden's workers kept the factory grounds, their own clothing and bodies, and the milk that they handled, in a state of sparkling cleanliness; Borden's condensing process worked as advertised, using *in vacuo* evaporation to create a portable, durable, sanitary condensed milk product; Borden's unsweetened condensed milk offered New York consumers with a safe, nutritious alternative to milk peddled by urban dealers; Borden's canned sweetened condensed milk was well-suited to service aboard trans-Atlantic steamships, in military camps and hospitals, in restaurants, and in private homes; Borden's sweetened condensed milk, with its high sucrose content, was (probably) unsuited to its advertised role as an infant food.[500] A self-effacing man, Borden may not have cared much

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[499] Goodale, *Brief Sketch*, 3-6, 10-11; Frederick Jackson Turner, *The Frontier in American History* (New York: Henry Holt & Company, 1920).

[500] For examples, see Goodale, *Brief Sketch*; James H. Collins, *The Story of Condensed Milk* (New York: The Borden Company, 1922); Clarence R. Wharton, *Gail Borden, Pioneer* (San Antonio, Texas: The Naylor Company, 1941); Frantz, *Gail Borden*; Sue Shephard, *Pickled, Potted, & Canned: How the Art and Science of Food Preserving Changed the World* (New York: Simon and Schuster, 2006); Andrew Smith, *Eating History: 30 Turning Points in the History of American Cuisine* (New York: Columbia University Press, 2009); Andrew F. Smith, *Starving the South: How the North Won the Civil War* (New York: St. Martin's Press, 2011); Deborah Valenze, *Milk: A Local*

about modern criticism of his character.[501] He would have been gratified, however, to learn that his signature product, and the narrative that he worked so hard to construct, remained alive and well in the historiography of food production and consumption.

Reality was far messier. Evidence suggests that Borden's rural subscribers were less cooperative than depicted by Borden, his contemporaries, and historians. Indeed, their behavior indicates that they resented and resisted Borden's efforts to interfere in their day-to-day operations. This may be attributed, in part, to a deep-seated and well-documented mistrust by nineteenth-century American farmers of government authorities, agricultural reformers, veterinary scientists -- indeed, anyone who was presumed by farmers to speak with authority derived from books, rather than practical experience.[502] In Borden's case, it may also be attributed to a society-wide ignorance of nutritional and germ theory, which prevented him from explaining, and his subscribers from understanding, how and why the Texan's advocacy of veterinary care, improved animal feeding regimens, and meticulous cleanliness mattered to those seeking to produce an abundance to clean, chemically consistent milk.[503] That Borden tilled the earth as a youth on the Kentucky and Indiana frontiers, ran beef cattle on Galveston Island

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and Global History (New Haven, Conn.: Yale University Press, 2011); Kathryn Shively Meier, *Nature's Civil War: Common Soldiers and the Environment in 1862 Virginia* (Chapel Hill: University of North Carolina Press, 2013); Margaret Humphreys, *Marrow of Tragedy: The Health Crisis of the American Civil War* (Baltimore: Johns Hopkins University Press, 2013).

501 Gail Borden Jr. to Jeremiah Milbank, Esq., 3 June 1858, J. Gail Borden Jr. Papers, 1830-1910, 1932-1937, box 3C18, Dolph Briscoe Center for American History, University of Texas at Austin.

502 "Different Success in Farming," *New England Farmer, and Horticultural Register*, XXIV, no. 52 (24 June 1846): 411; Henry E. Alvord, "The Farmer and His Family" in *Sixteenth Annual Report of the Secretary of the Connecticut Board of Agriculture. 1882-83* (Hartford: Case, Lockwood & Brainard Company, 1883), 173-188; Willard Range, *A Century of Georgia Agriculture, 1850-1950* (Athens: University of Georgia Press, 1954), 8; Daniel P. Carpenter, *The Forging of Bureaucratic Autonomy: Reputations, Networks, and Policy Innovation in Executive Agencies, 1862-1928* (Princeton: Princeton University Press, 2001), 185.

503 For more on mid-nineteenth-century debates surrounding the germ theory of disease, see Robert P. Gaynes, *Germ Theory: Medical Pioneers in Infectious Diseases* (Washington, DC: ASM Press, 2011), 143-172 and Kari Nixon, *Kept from All Contagion: Germ Theory, Disease, and the Dilemma of Human Contact in Late-Nineteenth Century Literature* (Albany: State University of New York Press, 2020). For more on the discovery of vitamins, see Wolfgang Herrmann and Rina Obeid, "History of the Vitamins: Discovery, Syntheses, Nobel Prizes, Modern Science," in *Vitamins in the Prevention of Human Diseases* (New York, New York: De Gruyter, 2011), 1-3.

following the Texas Revolution, and lacked a formal agricultural education, appears not to have exempted him from such criticism.[504] Thanks in no small part to his Texas drawl and unorthodox, proslavery views that placed him at odds with his neighbors, Borden was always an outsider among the Yankees of eastern Connecticut and the New Yorkers of the Hudson River Valley.[505]

Never were the limitations of Borden's influence and authority more evident than they were during the summer of 1860, as he struggled to arouse his Connecticut milk suppliers to the threat posed by contagious bovine pleuropneumonia, which was then sweeping across central Massachusetts, decimating herds. Borden had reason for concern. Beginning in the late-eighteenth century, and aided by the movement of armies and cattle drovers, the bacteria responsible for bovine pleuropneumonia, *Mycoplasma mycoides*, subspecies *mycoides*, emerged from isolated alpine valleys in the Canton of Zurich, Switzerland, and raced across Europe, infesting herds. From there, the disease followed global trade routes to Great Britain (1842), the United States (1843 and 1859), the South African Republic (1858), and Australia (1858). Wherever pleuropneumonia appeared, cattle owners suffered catastrophic losses. In 1837, the disease killed 7,000 head of cattle in Zeeland, the westernmost province of the Netherlands. During the period 1854-1860, 10 million head of British cattle, or about 166,00 animals per year, succumbed to the disease. Pleuropneumonia proved most destructive in those areas that lacked fences and hence, any means to isolate cattle. Testifying before the Massachusetts Legislature in 1860, the Reverend Daniel Lindley, a missionary to the South African Republic, testified that the

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504 The Borden Company, *The Story of Gail Borden* (New York: The Borden Company, 1937), 5-7; J.H. Parker to Mr. Joe B. Frantz, 10 May 1947, Joe B. Frantz Papers, box 3J244, Dolph Briscoe Center for American History, University of Texas at Austin; "Joe Frantz, archivist San Jacinto Museum of History," Joe B. Frantz Papers, 1746, 1801-2010, box 3J246, Dolph Briscoe Center for American History, University of Texas at Austin.
505 Gail Borden Jr. to Dear Brother, 27 July 1856, J. Gail Borden Jr. Papers, 1830-1910, 1932-1937, box 2N321, Dolph Briscoe Center for American History, University of Texas at Austin.

disease killed ninety-five percent of Dutch and Indigenous cattle that roamed that grasslands north of Cape Town. Russian herders on the Central Asian Steppe lost between 1.6 and 3 million cattle in 1859, while that same year, Australians slaughtered thousands in a futile attempt to halt bovine pleuropneumonia's advance from Melbourne to the continent's northern rangelands.[506]

Never one to stand idly by during times of crisis, Borden embarked on a crusade to raise public awareness of pleuropneumonia and close the Connecticut border to cattle traffic originating in Massachusetts. At times, his actions bordered on the extra-legal. On or about May 22, Borden traveled to nearby Winsted and Winchester Center, there recruiting "prominent men" to stop one of their neighbors, "old Mr. Hayden," from driving a herd of cattle back into Connecticut from summer pastures in Massachusetts. Lest anyone doubt his sincerity, Borden sent for a gun, forwarded a "decisive" letter to Hayden, and vowed to the trustees of the New York Condensed Milk Company, "We will kill the cattle if they are brought into the neighborhood." Cooler heads prevailed in the matter, or at least, Borden gave no indication that he or his followers carried out their bloody mission. The only real confrontation came on May

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[506] W. N. Masiga, J. Domenech, and R. S. Windsor, "Manifestation and Epidemiology of Contagious Bovine Pleuropneumonia in Africa," *Revue Scientifique et Technique (International Office of Epizootics)* 15, no. 4 (1996): 1–2; New York State Agricultural Society, *Transactions of the N. Y. State Agricultural Society with an Abstract of the Proceedings of the County Agricultural Societies*, vol. XIX (Albany, New York: Charles Van Benthuysen, 1860), 785–88; Massachusetts General Court. Committee on Pleuropneumonia, *Evidence ... May 31, 1860* (n.p., 1860), 44–61, https://archive.org/details/evidencemay3118600mass; "Pleuro-Pneumonia," *The New England Farmer; a Monthly Journal*, February 1862; L. B. Bull, "Foreword," *Commonwealth of Australia Council for Scientific and Industrial Research, Bulletin No. 93*, 1936, v; A. D. Campbell and A. W. Turner, "Studies in Contagious Pleuro-Pneumonia of Cattle. II. A Complement-Fixation Reaction for the Diagnosis of Contagious Bovine Pleuro-Pneumonia. Its Use in Experimental Investigations and in the Control of Disease," *Commonwealth of Australia Council for Scientific and Industrial Research, Bulletin No. 97*, 1936, 11–12; *Department of Agriculture. Special Report – No. 12. Investigation of Diseases of Swine, and Infectious and Contagious Diseases Incident to Other Classes of Domesticated Animals* (Washington: Government Printing Office, 1878), 229–30, 237–38; Washburn & Moen Manufacturing Company, *The Fence Question in the Southern States as Related to General Husbandry and Sheep Raising, with the History of Fence Customs, and Laws Pertaining Thereto: And a View of the New Farm System of the South, as Shown in the Census of 1880* (Worcester, Massachusetts: Washburn & Moen Manufacturing Company, 1881), 10.

30, when Hayden's son accused Borden of "getting up an undue excitement, and making people angry with his father" -- a fair enough charge, under the circumstances -- and threatening the Texan with bodily harm. Yet Borden escaped unscathed and unbowed. "I have put myself in the breach," he wrote to New York Condensed Milk Company President Jeremiah Milbank, "and intend to arouse the people to a sense of the danger."[507]

As he traveled about rural western Connecticut, visiting with, or confronting, farmers and delivering impromptu speeches, Borden discovered that the people were not so easily aroused. True, plenty of farmers joined in calling for a suspension of the interstate cattle trade.[508] However, plenty more evinced an apathy in the face of the crisis that verged on fatalism. One farmer proposed that the time for action had passed. Another compared pleuropneumonia to cholera, a baffling malady that appeared from nowhere to scourge humans and animals alike before disappearing into the ether, only to reemerge at some distant point and renew its assault.[509] In a June 7 letter to the trustees of the New York Condensed Milk Company, Borden vented his spleen, cursing these "sordid, selfish, mean, damnable . . . men" for their inaction.[510] Borden's frustration only increased following the Connecticut state legislature's passage of a cattle bill on June 6, 1860. The bill authorized a team of cattle commissioners to investigate farms suspected of harboring bovine pleuropneumonia, albeit subject to request by the selectmen

[507] Gail Borden Jr. to Mr. J. Milbank, 23 June 1860; Gail Borden Jr. to Trustees New York Condensed Milk Company, 31 May 1860, J. Gail Borden Jr. Papers, 1830-1910, 1932-1937, box 3C18, Dolph Briscoe Center for American History, the University of Texas at Austin.
[508] Gail Borden Jr. to Trustees Ny. C. M. Co., 29 May 1860; Gail Borden Jr. to Trustees Ny C M Co., 29 June 1860, J. Gail Borden Jr. Papers, 1830-1910, 1932-1937, box 3C18, Dolph Briscoe Center for American History, the University of Texas at Austin.
[509] Gail Borden Jr. to Trustees, Ny. C. M. Co., 31 May 1860, J. Gail Borden Jr. Papers, 1830-1910, 1932-1937, box 3C18, Dolph Briscoe Center for American History, the University of Texas at Austin.
[510] Gail Borden Jr. to Trustees NY C.M. Co., 7 June 1860, J. Gail Borden Jr. Papers, 1830-1910, 1932-1937, box 3C18, Dolph Briscoe Center for American History, the University of Texas at Austin.

and/or citizens of individual communities.[511] To Borden's great consternation, the farmers he depended on for milk hesitated to use the power placed in their hands. On or about June 9, Borden secured a petition calling for the state cattle commissioners to enforce an immediate ban on the inter- and intrastate cattle trade. Before the ink had fairly dried, however, a "majority" of the signatories dismissed the document as "useless" and "acted and talked as though they wanted their names off the paper." Meanwhile, cattle dealers ignored both the petition *and* Borden and continued driving animals along county roads and across the border into and out of Massachusetts.[512]

All of this took place in 1860, seven years after Borden opened his first commercially viable milk-condensing plant in Burrville, Connecticut, and seven years after he is presumed by his contemporaries and historians to have persuaded farmers to adopt strict sanitary reforms as a condition of contract. This is a reasonable enough presumption, for Borden's requirements were rudimentary and sensible. He asked subscribers to scald milk pans, pails, and other utensils with boiling water before and after every use. He asked them to wash and scrub their cows' udders, teats, and flanks with hot water at milking time to prevent dirt or fecal matter from falling into the milk pan during harvest. He asked them to muck out barns and carry old, dried-out bedding and food waste far enough away to prevent their giving off dust that could taint the milk. He asked them to strain milk into forty-quart tin cans using wire, rather than cloth strainers (he believed that the latter somehow tainted the milk). He asked that they used ice or spring water to cool the milk as soon as possible after harvest. He asked that they cover the cans with blankets

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511 Office of the Secretary of State, *Public Acts, Passed by the General Assembly, of the State of Connecticut, May Session, 1860* (New Haven: Carrington and Hotchkiss, 1860), 16-19.

512 Gail Borden Jr. to Mr. J. Milbank, 23 June 1860; Gail Borden Jr. to Trustees Ny. C.M. Co., 2 June 1860, J. Gail Borden Jr. Papers, 1830-1910, 1932-1937, box 3C18, Dolph Briscoe Center for American History, the University of Texas at Austin.

or bison robes to serve as insulation while in transit to the factory. It may be presumed, although there is no specific documentary evidence, that he forbad subscribers' using water to dilute their milk before handing it over for condensing. To ensure compliance, he sent a representative of the New York Condensed Milk Company to the farm of each and every subscriber, there hanging a printed copy of these sanitary guidelines, amounting to a written contractual obligation, inside the dairy barn. He may also have required them to sign a copy of the regulations.[513]

These rules may have been sensible and rudimentary by modern standards, but they were "fussy" by the standards of the era, amounting to time-consuming, and in some cases, costly mundanities.[514] They were also based on Borden's common sense and intuition, as opposed to any accepted science or practice (not that that would have made much difference to husbandmen who eschewed "book farming" and busybodies) that would have done little to convince subscribers that strict sanitary regulations were altogether necessary or useful. Given their behavior during the contagious bovine pleuropneumonia outbreak of 1859-1860, which posed a grave, well-publicized threat to their dairy herds, it is difficult to imagine Borden's subscribers raising much of a fuss over a bit of dirt or dung falling into the milk pail, or agonizing over the relative effectiveness of wire versus cloth strainers. It is far easier to believe that they paid lip service to Borden and his representatives and then did as they pleased, contracts notwithstanding. Indeed, this is exactly what they did. As late as April 1865, twelve years into Borden's enduring relationship with New York and New England farmers, the Texan complained to the President of the New York Condensed Milk Company, Jeremiah Milbank, that milk handed over to his newly opened condensing plant in Brewster's Station, New York, contained as much Croton River

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513 Frantz, *Gail Borden*; "News and Miscellany. Condensed Milk. *New York Observer and Chronicle* (29 October 1864), 191; James H. Collins, *The Story of Condensed Milk* (New York: The Borden Company), 9-10.
514 The Borden Company, *Story*, 31.

water as it did milk.[515] Such adulteration almost certainly violated Borden's sanitary regulations. It would also have been grounds for Borden's inspectors to refuse the entire shipment or even terminate a subscriber's contract. That is assuming, of course, that the inspectors would have been able to detect the presence of water and other adulterants in milk shipments.

Likely they struggled to do so. When Borden wrote to Milbank in April 1865, the dairy scientist Stephen Moulton Babcock had not yet completed his undergraduate studies at Tufts College in Massachusetts, much less perfected his eponymous "Babcock test," which offered dairy farmers and milk sellers the first reliable means to measure the butterfat content of milk, in 1890.[516] This left Borden's inspectors with two subjective tests -- sight and smell -- to judge the quality of the milk handed over by subscribers for condensing. To be sure, the former would have been sufficient to detect the presence of lactic-acid or rancidity-causing bacteria, both of which gave off a distinctive, and for nineteenth-century Americans, familiar aroma when present in large numbers. The latter would have detected the presence of thick, yellowish colostrum, as well as the stringy, ropy, or slimy texture caused by certain strains of bacteria that infested raw milk, such as *Bacteria viscosum*, or synthesized by cows afflicted with mastitis or garget (inflammation of the udder and teats). Neither test would have detected the presence of water, for the simple reason that the milk harvested by the most well-intentioned nineteenth-century farmers showed great variability in terms of its fat, protein, and water content. The one exception would have been those instances when farmers sought to pass off very thin, bluish-

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[515] Gail Borden Jr. to J. Milbank, 6 April 1865, J. Gail Borden Jr. Papers, 1830-1910, 1932-1937, box 3C18, Dolph Briscoe Center for American History, the University of Texas at Austin.

[516] "Babcock, Stephen, 1843-1931," Wisconsin Historical Society, n.d., https://www.wisconsinhistory.org/Records/Article/CS497.

tinted milk during the height of spring and summer, when cattle fodder was at its most abundant.[517]

None of these tests would have detected small colonies of microorganisms, even if the milk inspectors had known to look for them. This included the dangerous pathogens *E. coli*, *Salmonella typhi*, *Listeria*, and *Corynebacterium diphtheriae*, which have the power to sicken and even kill human milk consumers, in particular the very young, the very old, and those with compromised immune systems. However, it also included yeasts, fungi, and molds that metabolized and fermented milk sugar and proteins. All were present on the farms that furnished milk to Borden's condensing plants. All were invisible to the naked eye and gave off no distinct aroma. All would have been easily transferred to the milk by subscribers who showed improper attention to sanitation, for example by failing to wash cows' udders and teats, allowing fecal matter or urine to fall into the milk pail, kicking up dust on entering or leaving the dairy barn, and even using porous wooden milk pails, which trapped milk particles, creating an ideal medium for microbial growth. Cooling the milk per Borden's instructions would have slowed the growth of these microorganisms, assuming that farmers were able to lower the fluid's temperature rapidly to 40° F and then maintain that temperature until handing the milk over for condensing. This was unlikely, however, given that they depended on spring water, which

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517 *The Ten Master Minds of Dairying: Successful Farming* (Des Moines, Iowa: Meredith Publishing Company, 1930), 12; "Famed Man of Science Heat Victim," *Wisconsin State Journal*, July 2, 1931; For more on efforts to develop a reliable test for measuring the butter-fat content of milk, see Ernest O. Herreid, "The Babcock Test; A Review of the Literature," *Journal of Dairy Science* 25, no. 4 (1942): 335–70; Testing the cream content of milk with lactometers took twelve hours to complete and would have been impractical for Borden's inspectors. See "Lactometer," *Southern Planter*, March 1844. Jennifer Bentley, Ryan Breuer, Ezequias Castillo Lopez, Kim Clark, Paul Kononoff, Hugo Ramirez Ramirez, and Amanda Robinson, "The Newborn Calf and Colostrum Management," Iowa State University Extension and Outreach, n.d., https://www.extension.iastate.edu/dairyteam/files/page/files/FINAL_Newborn%20calves%20%26%20Colostrum%20management.pdf; R.E. Buchanan and B.W. Hammer, "Slimy and Ropy Milk," Research Bulletin, Bacteriology and Dairy Sections (Ames, Iowa: Iowa State College of Agriculture and Mechanic Arts, July 1915).

hovers around 56° F, or ice, which cooled unevenly when packed around the exterior of uninsulated milk cans, as refrigerants.[518]

And yet, even if they followed Borden's sanitary regulations to the letter, it is unlikely that Borden's rural subscribers ever succeeded in furnishing condensing plants with clean milk. To be sure, mucking out barns and cleaning their animals' teats and udders would have helped prevent contamination. However, Borden's subscribers had none of the chemical agents used by modern farmers to sanitize the water used in washing milking equipment or applied to barn floors and other surfaces to kill bacteria, molds, and fungi. In keeping with Borden's sanitary regulations, they relied on hot water as a primary cleansing agent. This would have proved an effective enough technique, assuming that they first heated the water to a temperature hot enough to kill microorganisms: between 140° F to 158° F. However, it was a short-term solution at best. Modern food safety experts affiliated with the United Nations note that bacteria and other

[518] Rose Ann Gould Soloway, "Food Poisoning: Your Questions Answered," Poison Control: National Capital Poison Center, April 7, 2013, https://www.poison.org/articles/2013-apr/food-poisoning; Centers for Disease Control and Prevention, National Center for Emerging and Zoonotic Infectious Diseases (NCEZID), Division of Foodborne, Waterborne, and Environmental Diseases (DFWED), "Listeria (Listeriosis)," Centers for Disease Control and Prevention: CDC 24/7: Saving Lives, Protecting People, September 25, 2019, https://www.cdc.gov/listeria/index.html; J.S. Dickson, "Aerosol and Airborne Transmission of Listeria Monocytogenes: A Potential Source of Cross Contamination," United States Department of Agriculture: Research, Education & Economics Information System, August 14, 2011, https://portal.nifa.usda.gov/web/crisprojectpages/0207482-aerosol-and-airborne-transmission-of-listeria-monocytogenes-a-potential-source-of-cross-contamination.html; Anne-Laure Vivant, Dominique Garmyn, and Pascal Piveteau, "Listeria Monocytogenes: A Down to Earth Pathogen," Frontiers in Cellular and Infection Microbiology, November 3, 2013, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3842520/; Cornell University "Milk Facts," http://milkfacts.info/Milk%20Processing/Heat%20Treatments%20and%20Pasteurization.html/.; "Grade 'A' Pasteurized Milk Ordinance" (Washington, D.C.: United States Department of Health and Human Services Public Health Service Food and Drug Administration, 2017); E.H. Hoyle, Pamela Schmutz, and D.T. Vines, "Safe Handling of Milk and Dairy Products," Clemson Cooperative Extension, Home & Garden Information Center, Factsheet (Clemson, South Carolina: Clemson University, March 8, 2007), https://hgic.clemson.edu/factsheet/safe-handling-of-milk-dairy-products/; "Milk as a Growth Medium," University of Guelph Food Science, n.d., https://www.uoguelph.ca/foodscience/book-page/milk-growth-medium; Lu Meng et al., "Characterization of Pseudomonas Spp. and Associated Proteolytic Properties in Raw Milk Stored at Low Temperatures," Frontiers in Microbiology: Food Microbiology, November 8, 2017, https://www.frontiersin.org/articles/10.3389/fmicb.2017.02158/full; H. Lee Mitchell, "Springs of South Carolina," South Carolina Department of Natural Resources, 2004, https://hydrology.dnr.sc.gov/pdfs/reports/scspringsmap6.pdf.

microorganisms may survive on the tiniest of milk particles, which become lodged in the pores and/or seams of metal milk cans, tables, and utensils and may go undetected by human observers. These tiny lifeforms resume growth and reproduction as soon as environmental conditions -- for example, cooler temperatures -- permit. If Borden's subscribers used water that was very hot to the touch, about 120° F, to wash milk pails and pans, they would have succeeded in breaking up and flushing away milkfat, dirt, and with it, a fair number of microorganisms. However, such water would have been too cold to have any specific antimicrobial properties.[519]

Whatever course they took, Borden's rural subscribers always negotiated the terms of their business relationship from a position of strength. Borden's New York Condensed Milk Company did pay a premium for fluid milk: about 4 cents per quart, depending on the number of subscribers, the company's immediate needs, and the season of the year.[520] Compare this to the New York and Harlem Valley, Erie, and Hudson River Railroads, which offered farmers 2 cents per quart for summer milk and 3 cents per quart for winter milk in 1853.[521] By virtue of their existence, however, the daily milk trains served to diminish Borden's ability to impose his will on farmers. The train operators and urban milk dealers imposed no sanitary guidelines or guidelines of any sort. Likewise, they posted no milk inspectors at the rail depot, whose job it was to sniff and taste the fluid, rejecting any that was soured, spoiled, or adulterated. Indeed, if a correspondent to the October 11, 1860, *New York Observer and Chronicle* be believed, the purchasing agents diluted the milk with water almost as soon as the farmers -- who had almost

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519 D.N. Akam, Francis Dodd, and J. Quick Armand, "Milking, Milk Production Hygiene and Udder Health (FAO Animal Production and Health Paper)," 78 (Food and Agriculture Organization of the United Nations, 1989); Dairy-Cattle, "Cleaning and Sanitizing Milking Equipment," DAIReXNET, 16 August 2019, https://dairy-cattle.extension.org/cleaning-and-sanitizing-milking-equipment/#Cleaning_Agents; "Hot Water Burns," National Ag Safety Database, n.d., http://nasdonline.org/869/d000702/hot-water-burns.html.

520 Gail Borden Jr. to J. Milbank, 3 August 1864, J. Gail Borden Jr. Papers, box 3C19, Dolph Briscoe Center for American History, the University of Texas at Austin.

521 John Mullaly, *The Milk Trade in New York City and Vicinity* (New York: Fowlers and Wells, 1853), 92.

certainly diluted the fluid themselves -- handed it over for shipment.[522] If New York social reformers and food purity advocates be believed, New York milk dealers accepted a certain quantity of sour milk as an unavoidable consequence of shipping the fluid over long distances. Indeed, they found a lucrative market for thousands of gallons of soured milk among New York consumers who had a taste for tangy, fermented milk products.[523] This may account for Borden's willingness to look the other way when subscribers delivered watered-down milk.[524] To do otherwise would have put him at risk of losing his milk supply to competitors.

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Borden's patented condensing process did, as nineteenth-century observers and historians have suggested, provided some defense against the microbes that swarmed, undetected, in subscribers' milk. Recall from the *Tribune* correspondent's 1864 account of Borden's Wassaic, New York, condensing plant that workers heated milk in brass kettles to a temperature of 190° - 195° F -- not quite boiling (212° F), but hot enough to kill microorganisms such as *Listeria*, *E. Coli,* and *Shigella* -- almost as soon as it passed inspection. Workers then transferred the fluid into a closed "steam well" that heated it almost to the boiling point. This done, workers piped the heated fluid into a spherical (some described it as "egg-shaped") iron or copper vacuum boiler for condensing. Using a series of pumps, the operator extracted air from the boiler, lowering the internal pressure to a point lower than that of the external atmospheric pressure. This lowered the boiling point of the milk, making it possible to evaporate the milk's water content without causing fat and protein coagulation. It also shielded the milk from airborne

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522 "Miscellaneous: Autumn on the Hudson," *New York Observer and Chronicle*, October 11, 1860.
523 Mullaly, *Milk Trade*, 71-72.
524 Gail Borden Jr. to J. Milbank, 6 April 1865, J. Gail Borden Jr. Papers, 1830-1910, 1932-1937, box 3C18, Dolph Briscoe Center for American History, the University of Texas at Austin. .

contaminants. Most important, it deprived the milk of eighty percent of its water content, creating a chemical environment hostile to microbial life.[525] This milk may or may not have been sterile. Indeed, in his 1882 *Chemical and Physical Analysis of Milk*, the dairy scientist Nicholas Gerber observed that the bacteria responsible for bovine tuberculosis, which sickened and killed nineteenth-century American milk drinkers, may survive "ordinary boiling." Nevertheless, it was far cleaner than the milk harvested by swill milk dairies, or even the farms that sold milk to the Country Milk Associations. So long as it remained in the vacuum pan, shielded from exposure to the environment, it remained that way.[526]

The problem, of course, is that Borden's workers had to release condensed milk from the vacuum boiler to prepare it for shipment to consumers. In doing so, they exposed it to innumerable sources of contamination: the microscopic, bacteria-laden milk particles that lodged in the seams and pores of tin-plated pipes, milk cans, and ice cores used in packing the milk for transit to New York; the yeasts that wafted through the air aboard dust motes; the fecal matter that traveled from human digestive systems to condensed milk via improperly washed hands and soiled aprons; and the beetles, flies, wasps, and bees that crawled across utensils, pipes, and other surfaces, tracking bacteria and yeasts, in search of sweet, tasty morsels, among myriad others. Borden's use of pressurized steam to clean condensing machinery, milk cans, and utensils before and after each use reduced the risk of microbial contamination.[527] Moreover, his practice of whitewashing the walls and floors made it easier for inspectors to notice and remove dirt and

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[525] "Condensed Milk," *Friends' Review: a Religious, Literary, and Miscellaneous Journal*, August 27, 1864.

[526] Nicholas Gerber, *Chemical and Physical Analysis of Milk, Condensed Milk, and Infants' Milk-Foods, with Special Regard to Hygiene and Sanitary Milk Inspection. A Laboratory Guide, Developed from Practical Experience, Intended for Chemists, Physicians, Sanitarians, Students, Etc*, trans. Hermann Endemann (New York: Lehmaier & Bro., 1882), 34–36.

[527] "Condensed Milk"; Hunziker, 308-309.

other contaminants from the condensing room.[528] Yet neither was foolproof. Steam cleaning was only as effective as factory workers were diligent in its application. Moreover, milk deprived of eighty percent of its water is still twenty percent water. Left unrefrigerated, unsweetened condensed milk succumbed to the same microbial fermentation and spoilage as raw, fluid milk, although the process took longer -- one or two weeks, as opposed to one or two hours.[529]

The train ride to New York created conditions favorable to the growth and reproduction of microbes present in unsweetened condensed milk, while also providing new avenues of contamination. Though he doubtless lectured New York & Harlem Valley Railroad agents about the importance of cleanliness and timeliness in moving unsweetened condensed milk to Manhattan, Borden enjoyed no authority over the workers who handled his product while in transit. Under the best of circumstances, workers bumped and banged the cans into one another, dislodging the can lids and exposing the contents to contamination by bacteria, yeasts, molds, and fungi. Under the worst of circumstances, they tipped and dumped cans of unsweetened condensed milk onto the floor, where the sticky, viscous substance mingled with dirt and other contaminants left behind by livestock, hay, and other farm products shipped in the cars to create a microbe-rich slurry that was as attractive to hungry vermin as it was difficult to remove. Always, during the hot summer and fall months, frequent stops to take on or offload passengers and cargo left the milk to simmer -- sometimes for a few minutes, sometimes for hours -- in sunbaked, uninsulated boxcars. The tin ice cores fitted into the cans provided some defense against the heat, so long as the ice remained frozen. However, it would have been insufficient to

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[528] "Gail Borden's Condensed Milk Laboratory," *The American Farmer, a Monthly Magazine of Agriculture and Horticulture*, May 1860.
[529] "Preserved Milk, Coffee, and Other Extracts"; Otto Frederick Hunziker, *Condensed Milk and Milk Powder* (La Grange, Ill.: Published by the Author, 1918), 348.

prevent the milk's increasing in temperature sufficient to promote the reproduction and growth of bacteria -- that is, anything in excess of 30° F.[530]

Even if unsweetened condensed milk survived packing and shipment with minimal microbial contamination, it is unlikely -- impossible, even -- that the product remained sanitary for long after reaching New York. Distributing the milk to consumers required Borden's delivery drivers to pilot push carts and/or horse-drawn wagons through the same filthy streets as the urban dealers who peddled the milk sold by distillery-run dairies and country milk associations. In doing so, they ran the same gauntlet of biological contaminants: ankle-deep heaps of horse urine and dung, human waste, food scraps, and garbage that covered the streets; clouds of emerald-green blowflies that swarmed up from this noxious slurry to alight on passing horses, wagon and cart wheels caked with mud and dung, and the forty-quart cans and ladles used in delivering unsweetened condensed milk; clouds of choking dust kicked up by wagons, horses, and pedestrians that settled over (and filtered into) everything.[531] Distributing unsweetened condensed milk also took time. Each morning, delivery drivers who served customers in the contiguous boroughs of Manhattan and Harlem traveled in ten or twelve-mile loops, taking about four hours to complete their routes. Those who carried unsweetened condensed milk to Newark and Brooklyn traveled about the same distance, but took longer to finish their deliveries, thanks to the time-consuming ferry rides used in crossing the North and

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530 For more on the filthy state of train cars used in shipping milk, see "Medical Societies. Philadelphia County Medical Society," *Medical and Surgical Reporter*, March 2, 1878; Gail Borden Jr. to Trustees NY C.M.C., 22 June 1860, J. Gail Borden Jr. Papers, 1830-1910, 1932-1937, box 3C18, Dolph Briscoe Center for American History, the University of Texas at Austin.

531 Melosi, *Sanitary City*, 11-12; Kurt Kohlstedt, "The Big Crapple: New York City Transit Pollution from Horse Manure to Horseless Carriages," 99% Invisible, November 6, 2017, https://99percentinvisible.org/article/cities-paved-dung-urban-design-great-horse-manure-crisis-1894/; Mullaly, *Milk Trade*, 50; Catherine McNeur, *Taming Manhattan: Environmental Battles in the Antebellum City* (Cambridge: Harvard University Press, 2014), 27-28, 97, 106.

East Rivers.[532] Every minute, indeed every second that unsweetened condensed milk spent in traversing this landscape, the greater the likelihood of its playing host to dangerous colonies of microorganisms. This proved especially true during the hot summer and fall months, when high ambient temperatures in excess of 90° F melted the ice packed in and around milk cans, reducing its cooling effects.

The greatest threat to the cleanliness of unsweetened condensed milk came during reconstitution and use by consumers. The water used in restoring condensed milk to a more fluid state represented a Trojan Horse for microorganisms, providing them with a convenient means to colonize milk, as well as an abundance of moisture that the tiny lifeforms needed to reproduce and metabolize milk fats and proteins. Simply put, if a consumer poured bacteria-tainted water into their unsweetened condensed milk, they ended up with a fluid milk that was no less dangerous for the very old, the very young, or those with compromised immune systems than the swill milk peddled by urban dealers. Neither Borden nor his consumers were aware of the danger posed by reconstitution. Indeed, it was not until the twentieth century that scientists first discovered a correlation between dirty water, condensed milk, and infant sickness. A 1904 study published by the *Journal of the American Medical Association* provided evidence that Baltimore infants fed on a diet of condensed milk suffered more from fatal "summer dysentery" than did those fed a diet of raw, fluid milk purchased from dealers or small groceries. By way of explaining this phenomenon, the authors noted that mothers who fed their children condensed milk, as opposed to breast milk or raw cow's milk, often belonged to the "lower and middle

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[532] For a list of the ferries that operated in New York and its environs in 1857, see T.S. Gillett, *General Index of the Laws of the State of New York, 1777-1857* (Albany: Weed, Parsons & Co., 1859).

classes" and lacked access to clean water. On reconstituting the milk, they unwittingly introduced the *Shigella* bacillus, transforming a (presumably) sanitary food into literal poison.[533]

These problems notwithstanding, a growing number of consumers in the New York market were willing to pay a premium -- 30 to 40 cents per quart, as opposed to 4 to 5 cents per quart for the milk peddled by distillery-run dairies and country milk associations -- for Borden's unsweetened condensed milk. Indeed, the product was so popular that the New York Condensed Milk Company devoted over 600,000 quarts to making the product between January 1 and June 30, 1864, at a time when the demand for canned sweetened condensed milk emanating from Union military forces is presumed by contemporary observers and modern historians to have exceeded the productive capacity of Borden's wartime milk condensing plants.[534] This stands as a direct refutation of existing narratives, which depict Borden as a bumbling and inept businessman and/or his product as strange and undesirable.[535] In fact, one may conclude that consumers perceived of condensed milk as safer and more nutritious than the alternatives. Certainly it was when compared to the bacteria-laden milk peddled by urban distillery-run dairies or shipped into the city by country milk associations, if only because it possessed more nutritive matter to begin with, while lacking the water content that microorganisms needed to reproduce. Little wonder that those who could afford to do so entrusted their health, and the

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533 J.H. Knox, "A Summer's Experience With Infantile Dysentery," 43, no. 26 (1904), 1924-1930; Charles E. Rosenberg, *The Cholera Years: The United States in 1832, 1849, and 1866* (Chicago: The University of Chicago Press, 1987), 103; For a book-length study of the problems that plagued nineteenth-century urban American water supplies, see Nelson M. Blake, *Water for the Cities: A History of the Urban Water Supply Problem in the United States* (Syracuse: Syracuse University Press, 1956).

534 Mulally, *Milk Trade*, xi, 49; Cost of Preserved Milk made at Wassaic from 1st January to 30th June 1864, J. Gail Borden Jr. Papers, 1830-1910, 1932-1937, Box 3C19, Dolph Briscoe Center for American History, University of Texas at Austin.

535 Valenze, *Milk*, 180-182; Joe B. Frantz, *Gail Borden: Dairyman to a Nation* (Norman, Oklahoma: University of Oklahoma Press, 1951), 246.

health of their children, to Gail Borden Jr. when searching for a source of their favorite comfort food.

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Sweetened condensed milk was more durable and resistant to microbial contamination than unsweetened condensed milk. This may be attributed to the sucrose (or refined white sugar) that Borden's workers added following evaporation. In a 2006 article published online by *Scientific American*, the food scientist Mickey Parish explained how and why sucrose has enjoyed a long, successful history as a preservative. As a primary function, sucrose "attempts to reach equilibrium with the . . . sugar content of the food product with which it is in contact." This "has the effect of drawing available water from within the food to the outside and inserting salt or sugar molecules into the food interior," reducing the "so called product water activity (a_w), a measure of unbound, free water molecules in the food that is necessary for microbial survival and growth." Used in tandem with evaporation, which also reduced the number of unbound, free water molecules present in milk, sucrose represented a formidable barrier indeed to the bacteria that would otherwise have colonized and metabolized the condensed milk, damaging the product's taste, texture, and aroma while also producing toxins dangerous to the health of human consumers. And yet, sucrose may also have specific antimicrobial properties. According to Parish, these include "interfer[ing] with a microbe's enzyme activity," for example, inhibiting the ability of bacteria that possess the enzyme lactase from metabolizing milk sugar, and "weakening the molecular structure of its DNA," interfering with growth and reproduction. It was, in a word, germicide -- and an effective one at that. In a January 15, 1858, letter to his father, Borden boasted that a quantity of sweetened condensed milk had survived for forty days in an unsealed can during a period of unseasonably warm weather. This led him to propose, "The invention [of condensed milk] is a better thing than we even thought it."[536]

Packing sweetened condensed milk into hermetically sealed tin cans added an extra layer of defense against microbial contamination. Properly soldered by experienced tinsmiths, tin cans could rightly be considered air-tight, even by modern standards. This prevented airborne microorganisms from gaining access to the milk. As an added benefit, the cans' internal vacuum starved aerobic bacteria that survived evaporation of the oxygen that they needed to survive, reproduce, and ferment the contents. There is also the fact that the tinplate used in making cans was impervious to water and resisted oxidization or rust that degraded iron vessels. To be sure, the canning technology available to Borden and his contemporaries was imperfect. The lead solder used in assembling and sealing the cans leached into and literally poisoned the contents. Rust ate at away at the seams and other points where the tin coating was too thin or degraded by rough handling to protect the underlying iron sheeting that gave tin cans their strength and durability. Thin, shoddy tinplate sustained punctures during transit that compromised the air-tight seal. But then, they worked, giving sweetened condensed milk an almost indefinite shelf life. Certainly, they were lighter and more durable than the glass vessels used in Appertization.[537]

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[536] Mickey Parish, "How Do Salt and Sugar Prevent Microbial Spoilage," *Scientific American*, 21 February 2006, scientificamerican.com/article/how-do-salt-and-sugar-pre/; Gail Borden Jr. to My Dear Father, January 15, 1858, 3C18 (7).

[537] "News and Miscellany"; "How the 'Canister' Became a Modern Tin Can," *Canning Age: Devoted to the Canning, Packing and Allied Industries* (August 1922), 25-27; John W. Klooster, *Icons of Invention: The Makers of the Modern World From Gutenberg to Gates, Volume I* (Santa Barbara: Greenwood Press, 2009), 103-104; Milk as a Growth Medium," University of Guelph Food Science, n.d., https://www.uoguelph.ca/foodscience/book-page/milk-growth-medium; Lu Meng et al., "Characterization of Pseudomonas Spp. and Associated Proteolytic Properties in Raw Milk Stored at Low Temperatures," Frontiers in Microbiology: Food Microbiology, November 8, 2017, https://www.frontiersin.org/articles/10.3389/fmicb.2017.02158/full; "Manufacture of Tin-Plate," *Scientific American*, 24 August 1861; "Notes on the Preservation of Ferric Structures," *Monthly Journal of the Engineers Club of Baltimore*, 6, no. 3 (September 1916), 56-65; Gabriella Petrick, "The Arbiters of Taste: Producers, Consumers, and the Industrialization of Taste in America, 1900-1960" (Dissertation, Newark, Delaware, University of Delaware,

Useful as they were for protecting condensed milk against bacterial contamination and fermentation, sucrose and tin cans did nothing to halt the depredations of the yeast. Indeed, these tiny, single-celled fungi were among the greatest enemies of the condensed milk industry, even into the twentieth century. The problem began on subscribers' farms, with the routine tasks of dairy husbandry. As farmers moved cows into and out of barns, swept and mucked floors, forked hay into feeding troughs, spread straw for bedding, and brushed the dirt from root vegetables, they sent clouds of yeast swirling into the air. Once aloft, these tiny lifeforms floated about until they came to rest on the cows' udders and teats, the pails and pans used in collecting milk, the strainers used to remove dirt and other contaminants from the milk, the hair and clothing of those who harvested the milk, the milking stool, and the (presumably) clean milk cans that subscribers used in carrying milk to the condensing plant. From there, they tumbled into, or were simply covered over by the warm, sweet milk bound for condensing plants. Plenty of yeast skipped this intermediate stage altogether, passing straight from the air and into new, sweet milk as it stood, waiting for transport. However they got there, yeasts did what they had evolved to do: metabolize milk sugar. The warmer the ambient temperature, and the warmer the milk, the faster yeasts worked.[538]

The problem continued on once fluid milk reached the condensing plant, for yeasts were difficult to destroy. In theory, the hot water bath and forewarmers used to preheat the milk prior to evaporation should have killed any yeasts. Both steps raised the milk's temperature to 190° F

2006), 19; R. M. Lewis for J. H. Wilson to New York Condensed Milk Company, Mr. Houk, 23 January 1864; R. M. Lewis to Augustus Klemm, 18 February 1864; R. M. Lewis to Augustus Klemm, 10 March 1864; United States Sanitary Commission Pennsylvania Archives, Philadelphia Agency, Volume I, box 5, New York Public Library Archives; Adams and Moss, *Food Microbiology*, 64-65.

538 Bertha Morris Parker and Henry Chandler Cowles, *The Book of Plants* (Boston: Houghton Mifflin Company, 1925; 60-61; Hunziker, *Condensed Milk*, 155-156; Hans Welker, *Professional Bread Baking* (Hoboken, New Jersey: John Wiley & Sons, 2017), 130.

or higher, which exceeded the thermal limit for most microbial life, yeasts included. In practice, however, human error led workers to pump milk from the forewarmers into the vacuum pan that had not been heated to a degree sufficient to kill the tiny fungi. Temperatures inside the pressurized pan -- about 130° F to 150° F -- were too low to destroy yeasts that survived the preheating process. Because condensing plant workers "never again heated [the milk] to temperatures high enough to destroy these destructive yeast cells," Hunziker wrote, the tiny lifeforms carried on with their incessant, if mindless, task of metabolizing and fermenting milk constituents. Stirring refined white sugar into vats of warm condensed milk as a preservative only accelerated this process. From the moment these tiny fungi came into contact with sugar crystals, they used the enzyme, invertase, to break the crystals down into fructose and glucose for use as energy. As a side effect, they released tiny amounts of carbon dioxide gas. In small quantities, these CO2 bubbles would have gone unnoticed by Borden's workers. Given enough time, however, they accumulated in quantities sufficient to transform sweetened condensed milk into a bubbling, frothy, unpalatable mess.[539]

It did occur that the sucrose itself transferred yeasts into sweetened condensed milk. The dairy scientist, Otto Hunziker, explained how this happened in his 1914 study of the American condensed milk industry. According to Hunziker, the chutes used to funnel sugar into vats of condensed milk following evaporation collected moisture given off by the steam rising from the condensing pan, the hot wells, and the scalding-hot water used in cleaning and sanitizing machinery and milk cans. As workers sent sugar coursing through the chute, at least some of the crystals adhered to water droplets, creating a warm, damp, sugary crust that provided sucrose-

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[539] Hunziker, *Condensed Milk*, 156-158; Science Buddies, "Single-Celled Science: Yeasty Beasties," Scientific American, April 3, 2014, https://www.scientificamerican.com/article/single-celled-science-yeasty-beasties/.

loving yeasts with an ideal habitat. With each successive use of the chute, the dry sugar dislodged pieces of this crust, sending them, along with their yeasty occupants, tumbling down into the vats of condensed milk. Preventing this, Hunziker insisted, required condensing plant workers to practice the utmost diligence in cleaning and sanitizing the sugar chute: blasting high-pressure steam into seams and crevices and wiping down surfaces after each and every use. To miss even the tiniest particle of sugar crust was to risk contaminating an entire batch of sweetened condensed milk. Knowing the Borden's workers were human and therefore fallible, they almost certainly did so with regularity, especially as they rushed to process large quantities of milk.[540]

Sealing yeasts inside airtight tin cans had no impact on their health or metabolism. Indeed, these microscopic fungi were capable of anaerobic respiration, which enabled them to continue converting sucrose and milk sugar into fructose and glucose, emitting CO2 gas and ethanol as by-products, even when starved of oxygen.[541] It was easy for condensed milk manufacturers and consumers to spot cans of sweetened condensed milk that were infested with yeast. As the CO2 levels increased, pressure built up inside the cans. More often than not, this caused the top and bottom of the can to protrude outward, an anomaly known to condensed milk manufacturers as "swell head."[542] Though Borden never mentioned swell heads in his surviving correspondence, he almost certainly knew of the problem. As late as 1892, long after manufacturers commenced using Pasteurization to sterilize foods, yeasts found their way into sweetened condensed milk. That year, editors of a Maine newspaper estimated that ten percent

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[540] Hunziker, *Condensed Milk*, 309.

[541] Pradip Behare, Jashbhai B. Prajapati, and Rameshwar Singh, "Types and Application of Lactic Starters," in ed. Anil Kumar Puniya, ed., *Fermented Milk and Dairy Products* (Boca Raton, Florida: CRC Press, 2016), 92.

[542] Hunziker, *Condensed Milk*, 154.

of the sweetened condensed milk manufactured by North American condensing plants succumbed to swell head caused internal, yeast-induced fermentation. The following February, editors of the *Northern Leader* assured readers that Borden's much-revered Eagle Brand Sweetened Condensed Milk was no less susceptible to swell head than the milk produced by smaller, independent factories.[543]

Though yeast-based fermentation posed no direct threat to human consumers, it did prove troubling for Gail Borden and his customers. In some cases, the yeasts that lurked, undetected, in the cans attacked and metabolized the lactose (milk sugar) content of the sweetened condensed milk, causing lactic acid fermentation and souring. In other cases, yeasts metabolized the sucrose added during the condensing process as a preservative, producing alcohol.[544] Either way, yeasts had the power to transform entire batches of condensed milk, amounting to tens or even hundreds of cans, into a lumpy, stinking, inedible mess. For those who purchased cans of sweetened condensed milk for home consumption, this would have been as frustrating as it was costly. For those who purchased the product as an emergency medical supply or ration, however, it had the potential to be deadly. This was certainly true of Union caregivers who purchased and shipped literal tons of sweetened condensed milk to the front lines of the American Civil War. Every can that spoiled while in transit, rendering the contents unsuited for use as medicinal milk, was one less can of lifesaving nutrition that could be fed to sick and wounded soldiers.

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[543] "Maine Soil Good for Milk," *The Star-Herald*, 10 November 1892; "Now Aroostook is Talking," *Northern Leader*, 17 February 1893.
[544] Hunziker, *Condensed Milk*, 155-156.

Taking all of these variables into account, it is clear that the extant narratives of Gail Borden Jr. and his patented condensed milk have failed to capture the complexity of both the man and his signature product. Borden was neither saint nor villain, neither superman nor charlatan, neither philanthropist nor miser -- although all of these labels applied to him at one time or another. The same may be said for his patented condensed milk. The product was neither too strange to attract customers nor so popular as to avoid contemporary scrutiny, neither too dirty for human consumption nor so clean as to meet or exceed modern sanitary standards. Indeed, attempts by Borden's contemporaries and modern historians to plug Borden and his signature product into one (or more) of these binaries has served only to create a narrative that places Borden and his condensed milk at the center of the nineteenth-century food preservation revolution, and by extension the Union war effort, even as it relegates both to the status of mere curiosities that succeeded only because a happy accident -- Union soldiers' inexplicable decision to consume mass quantities of milk despite sharing nineteenth-century Americans' disdain for milk, generally, and condensed milk, specifically -- propelled Borden and the product into what the social historian Deborah Valenze describes as the "front ranks of American business."[545]

In fact, Borden succeeded because he offered a product that consumers wanted and needed, for reasons that would have been altogether obvious to him and his contemporaries. This applied to the urbanites who feared and loathed swill milk peddled by urban milk dealers. Given enough time for the product to diffuse across the American landscape, it would also apply to the trans-oceanic voyagers, prospectors, cowboys, soldiers, and others whose profound physical isolation would have forced them, absent Borden's milk and/or their ability to feed and

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[545] Valenze, *Milk*, 187.

care for cows, to do without their favorite comfort food for long periods.[546] Indeed, given this widespread demand, it is reasonable to assume that Borden would have sold enough condensed milk to turn a profit and ensure the long-term success of his business without the demand created by the American Civil War. Yet the Civil War did occur, prompting the single-greatest healthcare disaster in the young nation's history and with it, the single greatest demand for medicinal milk, to date.[547] Whether by fate, chance, Divine intervention, or some other unknowable force, Borden and his New York Condensed Milk Condensed Milk Company were in the right place at the right time to meet and exceed wartime demand. That condensed milk proved far more useful as a Union military medical supply than anyone could have imagined served only to cement Borden in the minds of caregivers and Union veterans as something akin to a hero.[548]

That said, it would take some time for Borden's Milk to reach front line Union military camps and hospitals. It was not until August 1862 that the first cans appeared among the goods peddled by civilian merchants or "sutlers" who did business with Union troops.[549] Moreover, it was not until September 1862, that agents of the United States Sanitary Commission first used the product to treat sick and wounded soldiers as they awaited evacuation from the Virginia

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546 "Letter from Texas," *Nebraska Advertiser*, February 24, 1870; Philip Ashton Rollins, *The Cowboy: His Characteristics, His Equipment, and His Part in the Development of the West* (New York: Charles Scribner's Sons, 1922), 185-186, 255; United States Army, Department of the Platte, *General Orders and Circulars, Department of the Platte, 1867-1882*, Newberry Library, Everett D. Graff Collection, 3-6; United States Army, Department of Dakota, *Headquarters, Department of Dakota, Saint Paul, Minn., May 19, 1867. General orders, no. 27*, Newberry Library, Everett D. Graff Collection, 1, 4; "Local and Other Items," *The Montana Post*, October 8, 1864.

547 Margaret Humphreys, *Marrow of Tragedy: The Health Crisis of the American Civil War* (Baltimore: Johns Hopkins University Press, 2013), 3.

548 Stephen Lincoln Goodale, *A Brief Sketch of Gail Borden, and His Relations to Some Forms of Concentrated Food* (Portland, Maine: B. Thurston & Co., 1872), 9.

549 For a first-hand account of Confederate troops capturing condensed milk during the Battle of Richmond, Kentucky (August 29-30, 1862), see, James L. McDonough, *War in Kentucky: From Shiloh to Perryville* (Knoxville, Tennessee: University of Tennessee Press, 1994), 508.

Peninsula.[550] In the meantime, soldiers and caregivers tried -- and often failed – to discover sources for their favorite comfort food. The South was a milk-poor region in the best of times and a milk desert during much of the conflict, thanks to the depredations of Union and Confederate troops.[551] The Northern states possessed an abundance of milk while lacking any practical means to move the humble fluid to Union camps and hospitals that were located hundreds, and in some cases, thousands of miles away. The notion that anyone who *cared* about the health and wellbeing of Union troops would have tried to recreate urban dairies in Union garrison towns such as Nashville, Tennessee, was so absurd as to defy reason and logic. So too the notion of moving dairy cows into the rural South, which swarmed with Confederate raiders hungry civilians who would have been happy to kill the animals for fresh beef.[552]

But then, the notion that Union medical officials, civilian relief agents, and concerned families would have forced Union soldiers to do without milk, assuming that a reliable source could be discovered, was no less absurd. Americans of the era *knew* that cow's milk worked many wonders, among them healing the sick, nourishing the hungry, and comforting the homesick. For all of these reasons, the milk shortage that plagued Union forces during the first year and a half of the conflict was a crisis, on par with the United States government's short-term failure to organize an ambulance corps and long-term failure to cobble together an efficient means to evacuate sick and wounded soldiers from the warzone. That there were no immediate solutions speaks to the profound difficulties that Americans had long faced in making and moving their favorite comfort food.

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550 Frederick Law Olmsted, *Hospital Transports. A Memoir of the Embarkation of the Sick and Wounded from the Peninsula of Virginia in the Summer of 1862* (Boston: Ticknor and Fields, 1863), 99–114

551 John Davis Billings, *Hardtack and Coffee: Or the Unwritten Story of Army Life* (Boston: George M. Smith & Co., 1888), 124-125.

552 Stephen V. Ash, *When the Yankees Came: Conflict & Chaos in the Occupied South, 1861-1865* (Chapel Hill: The University of North Carolina Press, 1995), 99-104.

Chapter 7:
"Not in the List of Articles . . . Provided by the Government":
The Union Milk Crisis, 1861-1862

The Union nurse Mary "Mother" Bickerdyke placed great faith in the healing powers of cow's milk. Indeed, on traveling to West Tennessee in February 1862 to care for sick and wounded soldiers in Union General Ulysses S. Grant's Army of the Tennessee, she spent much of her time ranging over the rural countryside in an military ambulance, placing herself at great personal risk to acquire a few quarts of the precious fluid. Her greatest allies were the runaway slaves or "contrabands" who took shelter behind Union lines. Most were willing enough -- pleased, even -- to exchange some milk, as well as some butter and eggs, for Northern currency supplied by one Mr. Safford, a wealthy banker in Cairo, Illinois. Southern whites were no less willing to part with milk, and no less grateful for a pocketful of Yankee greenbacks. When money dwindled, Bickerdyke traded her own clothing, as well as extraneous hospital stores, for milk. And yet, try as she might, Bickerdyke struggled to find enough milk of good quality to satisfy the demand emanating from Union hospitals. The contrabands possibly excepted, Southern civilians proved no less willing than their Northern counterparts to adulterate milk with water or chalk. This proved especially true in Memphis, where residents charged Bickerdyke up to fifty cents per quart for milk that she deemed "such poor stuff that if you should pour it into the trough of a respectable pig back home he would turn up his nose and run off, squealing in disgust."[553]

Convinced that "her boys" needed good milk, Bickerdyke asked the hospital's Medical Director, Dr. B.J.D. Irwin, for twenty-days' furlough and transportation to return north and "get

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[553] Julia A. Chase, *Mary A. Bickerdyke, "Mother." The Life Story of One Who, as Wife, Mother, Army Nurse, Pension Agent and City Missionary, Has Touched the Heights and Depths of Human Life* (Lawrence, Kansas: Journal Publishing House, 1896), 13, 18, 25-27, 50.

all the milk and eggs that the Memphis hospitals can use." The idea struck Irwin as comically preposterous. No doubt aware of the problems inherent with keeping new, sweet milk for any length of time, to say nothing of moving it over any great distance, he replied, "Why you could not bring them down here if the north would give you all it had," adding, "A barrel of eggs would spoil, this warm weather, before it could reach us, and how on earth could you bring milk?" Bickerdyke responded that she would "bring down the milk and egg producers" -- the cows and the chickens -- to Memphis. At this, Irwin had heard enough. Exclaiming, "Pshaw! Pshaw!," he predicted that Bickerdyke "would be laughed at from one end of the country to the other if you should go on so wild an errand." Yet Irwin was mistaken. Furlough in hand, Bickerdyke hurried north to Chicago. There, she asked for and received a donation of 100 cows from farmers in Jacksonville, Illinois, as well as a promise from Illinois Governor Richard Yates to ship them south from Springfield, escorted by caretakers, in lots of ten to fifteen animals. The laying hens -- donated by unknown parties -- were taken to Chicago and thence south. Less than two weeks after leaving Memphis, Bickerdyke returned at the head of her "bizarre procession" in "triumph." Never one to mince words, Bickerdyke proclaimed to onlookers, "These are loyal cows and hens; none of your miserable trash that give chalk and water milk, and lay loud smelling eggs."[554]

The Union Nurse Mary Ashton Rice Livermore, who served alongside Bickerdyke throughout the American Civil War, remembered her comrade's expedition as an unqualified success story. "As long as Mrs. Bickerdyke remained in Memphis," she wrote in 1889, "There

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[554] Mary Ashton Rice Livermore, *My Story of the War: A Woman's Narrative of Four Years Personal Experience as Nurse in the Union Army, and in Relief Work at Home, in Hospitals, Camps, and at the Front, During the War of the Rebellion: With Anecdotes, Pathetic Incidents, and Thrilling Reminiscences Portraying the Lights and Shadows of Hospital Life and the Sanitary Service of the War* (Hartford, Conn.: A.D. Worthington and Company, 1896), 512–13; Chase, *Mary A. Bickerdyke*, 50-52; Patricia M. LaPointe, "Military Hospitals in Memphis, 1861-1865," *Tennessee Historical Quarterly* 42, no. 4 (n.d.): 336.

was an abundance of milk and eggs for the use of the hospitals."[555] It certainly helped that Union General Stephen A. Hurlbut, who then had his headquarters in Memphis, gave Bickerdyke permission to house her menagerie on President's Island, an uninhabited, 7,500-acre island located in the Mississippi River about three miles south of the city. Surrounded on all sides by water, the island formed a natural corral, preventing the cows' wandering away and making it easier for their contraband caretakers to round them up at milking time.[556] It also prevented Southern civilians, Confederate soldiers, and secessionist guerillas from driving the animals away for their own use. Were this not enough, Union warships that patrolled the river would have deterred all but the most determined cattle rustlers from attempting a water-borne assault on "Mother" Bickerdyke's dairy.[557] By all accounts, the cattle remained on President's Island, unmolested, until Bickerdyke traveled south in July 1863 to join the Union Army of the Tennessee following the capture of Vicksburg. Unable to take the animals with her, she gave them away to the contrabands.[558] So ended the only documented case of Northern civilians moving dairy cattle to the Southern states during the American Civil War.

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555 Livermore, *My Story*, 514.

556 Chase, *Mary A. Bickerdyke*, 52; Andy Ashby, "Smaller Presidents Island Expansion Plan Moving Forward," *Memphis Business Journal*, September 6, 2013, https://www.bizjournals.com/memphis/news/2013/09/06/smaller-presidents-island-expansion.html?page=all. For more on Union General Stephen A. Hurlbut, see Jeffrey N. Lash, *A Politician Turned General: The Civil War Career of Stephen Augustus Hurlbut* (Kent, Ohio: Kent State University Press, 2003).

557 The Union Navy attacked and defeated a force of eight rebel ships at Memphis on June 6, 1862, ending the Confederate naval threat below the city. See James M. McPherson, *War on the Waters: The Union and Confederate Navies, 1861* (Chapel Hill: University of North Carolina Press,2012), 88-89.

558 Chase, *Mary A. Bickerdyke*," 52; For an account of the Union campaign to capture Vicksburg, Mississippi, see James M. McPherson, *Battle Cry of Freedom: The Civil War Era* (New York, New York: Oxford University Press, 1988), 420–22, 488, 511–12, 577–79, 586–88, 592–93, 625–26, 627–38.

Given the success of Bickerdyke's so-called "Cow-and-Hen Expedition," it is remarkable that no one else attempted such a feat during the American Civil War.[559] After all, Union military medical authorities shared Bickerdyke's conviction that sick and wounded Union soldiers needed access to clean, good-quality medicinal milk. In September 1861, the First Battle of Bull Run having laid bare the inadequacies of the Union Medical Corps, Secretary of War Simon Cameron approved publication of *Regulations for the Medical Department of the Army*. Section 1197 included cow's milk among a list of foods considered "necessary for the proper diet of the sick." Also included was a template for assembling a "Prescription Book, Diet Book, and Diet Table," which offered that sick and injured soldiers placed on a "half diet" should receive a "certain quantity of rice, milk, &c." (although it neglected to state how much of the fluid should be allotted to each soldier, or where surgeons and stewards could expect to find a source of clean, good-quality milk). Published just over a year later, Union Assistant Surgeon, Lt. Col. Joseph Janvier Woodward's *The Hospital Steward's Manual* offered more specific guidance. The manual advised stewards to buy medicinal milk "from some respectable dealer in that article, to be designated by the surgeon in charge." It also provided recipes for milk-based foods -- mush and milk, farina pudding, rice pudding, tapioca pudding, and of course, coffee and tea served with milk -- believed by nineteenth-century American physicians to have curative and palliative properties.[560]

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[559] Mary Ashton Rice Livermore gave the name "Cow-and-Hen Expedition" to Bickerdyke's efforts. See Ashton Rice Livermore, 499.

[560] For a study of the Union medical disaster following the Battle of First Bull Run, see Horace Herndon Cunningham, *Field Medical Services at the Battle of Manassas (Bull Run)* (Athens, Georgia: University of Georgia Press, 1968); United States Army Medical Department, *Regulations for the Medical Department of the Army* (Washington D.C.: Government Printing Office, 1861), 54, 89; Joseph Janvier Woodward, *The Hospital Steward's Manual; for the Instruction of Hospital Stewards, Wardmasters, and Attendants, in Their Several Duties; Prepared in Strict Accordance with Existing Regulations and the Customs of Service in the Armies of the United States of America, and Rendered Authoritative by Order of the Surgeon-General* (Philadelphia: Lippincott, 1863), 171, 185, 190, 194, 244, 254.

The civilians who signed on to serve in Union military hospitals were no less certain that Union convalescents needed an abundance of good-quality milk. It would have been a rare American physician who knew nothing of George Cheyne, John Wesley, William Buchan, or John Gunn and by extension, their prescriptions for using the milk diet and milk-based medicinal draughts to cure all manner of illnesses and injuries. Indeed, their day-to-day civilian practice would have seen them treat burns with milk-and-bread poultices, measles with draughts of milk punch, and consumption with milk clysters, among other remedies.[561] The same was true of the Northern women who joined relief associations or like Mary Bickerdyke, volunteered to serve as Union military nurses. Experienced as they were in caring for sick and injured relatives, having learned and internalized the remedies and recipes passed down from mother to daughter by word of mouth and/or printed in home medical manuals, almanacs, and popular periodicals, women caregivers would have looked to cow's milk as one of the best, first treatments for the sick and injured.[562] Mary Ashton Rice Livermore put it best, arguing that caregivers could "work miracles . . . even when there was a lack of sanitary stores," if only they had "an abundant supply of milk."[563]

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561 George Cheyne, *The Natural Method of Curing the Disease of the Body, and the Disorders of the Mind Depending on the Body* (London: George Strahan, 1742); George Cheyne, *The English Malady: Or, a Treatise of Nervous Diseases of All Kinds, as Spleen, Vapours, Lowness of Spirits, Hypochondriacal, and Hysterical Distempers, &c.* (London: George Strahan, 1733); John Wesley, *Primitive Physic, or, an Easy and Natural Method for Curing Most Diseases* (Edinburgh, Scotland, United Kingdom: Thornton & Collie, 1846); William Buchan, *Domestic Medicine: Or, a Treatise on the Prevention and Cure of Diseases, by Regimen and Simple Medicines: With Observations on Sea-Bathing, and the Use of Mineral Waters: To Which Is Annexed, a Dispensatory for the Use of Private Practitioners* (Exeter, New Hampshire: J. & B. Williams, 1839); John C. Gunn, *Gunn's Domestic Medicine, or, Poor Man's Friend, in the Hours of Affliction, Pain, and Sickness* (New York: C.M. Saxton, Barker & Co., 1860).

562 A robust literature describes nineteenth-century American women's work as primary medical caregivers. See Mercedes Graf, *On the Field of Mercy: Women Medical Volunteers from the Civil War to the First World War* (New York: Humanity Books, 2010); Margaret Humphreys, *Marrow of Tragedy: The Health Crisis of the American Civil War* (Baltimore: Johns Hopkins University Press, 2013); Kathryn Shively Meier, *Nature's Civil War: Common Soldiers and the Environment in 1862 Virginia* (Chapel Hill: University of North Carolina Press, 2013).

563 Ashton Rice Livermore, *My Story*, 511.

Whether they thought about it in explicit medicinal terms, Union soldiers also looked to cow's milk as a source of nutritional and emotional comfort. Indeed, memoirs, correspondence, and official reports abound with tales of Union soldiers begging, buying, or stealing new, sweet milk from Southern civilians whenever and wherever possible. In a December, 17, 1862, report, Colonel John M. Loomis of Twenty-Sixth Illinois Infantry noted that his troops had wandered into a Confederate ambush while searching for milk. Recalling his time serving in Virginia, the Union veteran Charles Davis noted that the Southern "Bossie" unwary enough to wander near his regiment's campsite would find herself besieged by canteen-wielding Yankees eager to "ascertain if they had lost the trick of milking." In a postwar Works Progress Administration interview, the former slave Cull Taylor of Augusta County, Alabama, recalled, "When de Yankees came through, dey . . . drank all de milk dey wanted" from his plantation's "big milk dairy," without compensating the animals' owner. Mostly, Union soldiers used the fluid to perform the comforting culinary rituals of home: adding a dash of creamy, sweet flavor to cups of tea or black coffee; pouring it over crumbled hardtack, cornmeal, or soft bread to make the mealtime staple, mush-and-milk. They also drank it as a beverage. Recounting the story of two Union soldiers who bought a fresh-baked pie and milk from her mother, the former slave Millie Garnes of Noonan, Georgia, noted that the bluecoats gobbled the pastry, but "took time about drinking out of the milk," relishing each sip of the ice-cold, creamy treat. [564]

This demand notwithstanding, there is no evidence that Union military planners discussed the possibility of moving raw, fluid milk from Northern farms to Union military camps and

[564] John Sheldon Moody, ed., *The War of the Rebellion: A Compilation of the Official Records of the Union and Confederate Armies*, vol. 17, 1 (Washington, D. C.: Government Printing Office, 1886), 506; Charles E. Davis, *Three Years in the Army. The Story of the Thirteenth Massachusetts Volunteers from July 16, 1861, to August 1, 1864* (Boston: Estes and Lauriet, 1894), 131-32; Herbert C. Covey and Dwight Eisnach, *What the Slaves Ate: Recollections of African American Foods and Foodways from the Slave Narratives* (Santa Barbara, California: Greenwood Press, 2009), 137, 162–64.

hospitals in the Southern States. At the time South Carolina secessionists fired on Fort Sumter in Charleston Harbor on April 12, 1861, plunging the nation into civil war, raw milk could be shipped only about eighty miles by rail with any reasonable expectation of its remaining fresh and sweet. The distance that it could be shipped by wagon was even shorter -- between three and four miles, assuming that farmers packed the milk cans in ice and covered them with blankets or buffalo robes to act as insulation.[565] So long as Union troops occupied camps or hospitals in the Northern states, it was possible and common for Union surgeons and civilian caregivers to purchase sweet, new milk from farmers or peddlers. The Union surgeon Zenas E. Bliss did just that in May 1861, using locally sourced milk to treat volunteers afflicted with measles while camped near Grand Rapids, Michigan. So too Union surgeons in Washington and Georgetown following the July 21, 1861, Battle of Bull Run, which saw defeated Union troops retreat to and surround both cities with encampments.[566] However, the war soon took Union troops hundreds of miles beyond the fluid milk zone. By June of 1862, Union troops occupied portions of Middle and West Tennessee (including Nashville and Memphis), New Orleans, New Berne, North Carolina, and a swath of the South Carolina coast that included Port Royal, Hilton Head, Beaufort, and the Sea Islands.[567]

Not surprisingly, white Southerners were disinclined to share their animals' milk or meat with Union foraging parties and/or the surgeons, hospital stewards, and civilian relief agents who

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[565] For a study of the Fort Sumter crisis, see Richard H. Current, *Lincoln and the First Shot* (Philadelphia: Lippincott, 1963); For a contemporary account of long-distance milk shipments by rail and wagon, see John Mullaly, *The Milk Trade in New York City and Vicinity* (New York: Fowlers and Wells, 1853), 76, 89.

[566] Zenas E. Bliss, "Second Extract from a Narrative of His Services in the Medical Staff. By Surgeon Zenas E. Bliss, U. S. Volunteers," in *Medical and Surgical History of the War of the Rebellion*, ed. United States Surgeon General's Office, vol. 1 (Washington, D.C.: Government Printing Office, n.d.), 85; Woodward, *Hospital Steward's Manual*, 200.

[567] Bruce Catton, *This Hallowed Ground* (New York: Washington Square Press, 1956), 126, 130, 147, 155, 261; James M. McPherson, *Battle Cry of Freedom: The Civil War Era* (Oxford: Oxford University Press, 1988), 373; Mary Ellen Snodgrass, *The Civil War Era and Reconstruction: An Encyclopedia of Social, Political, Cultural, and Economic History* (New York: Routledge, 2015) Vol. 1 and 2, 142.

needed milk to care for sick and wounded soldiers. When Union troops landed on the South Carolina coast in November 1861, planters and small farmers drove their livestock into the interior of the state. They were wise to do so. The invaders slaughtered abandoned animals for beef without paying much attention to their status as milch cattle. So great were the losses of cattle driven inland by planters and farmers or eaten by soldiers, in fact, that United States Army and Navy authorities issued strict orders forbidding further removal of livestock from plantations by soldiers or civilians.[568]

Mass cattle removals by Southern civilians remained a common practice for the duration of the war. A party of Confederate drovers sent from Georgia into neighboring West Florida -- inside Union lines -- to bring away cattle for slaughter in late 1864 discovered few animals. "The bulk of them," the historian Robert A. Taylor explained in a 1988 article, "had been removed or hidden by their owners."[569] Northern civilians were no different. As Union and Confederate forces converged on Sharpsburg, Maryland, in September 1862, local farmers moved horses, mules, cattle, and even hens north to safety. Following the Battle of Antietam on September 17, an anonymous resident noted a peculiar silence: "You couldn't hear a dog bark nowhere, you couldn't hear no birds whistle or no crows caw. There wasn't no birds around till the next spring. We didn't even see a buzzard with all the stench. . . .The farmers didn't have no chickens to crow. . . . It was a curious silent world."[570]

And yet, even if Southern civilians had been willing to share, it is unlikely that the animals would have satisfied the demand for medicinal milk. For one thing, they were difficult

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[568] Edward L. Pierce, "The Freed Men of South Carolina," *The Anti-Slavery Reporter*, 5 March 1863, 72.

[569] Robert A. Taylor, "Rebel Beef: Florida Cattle and the Confederate Army, 1862-1864," *The Florida Historical Quarterly* 67, no. 1 (July 1988): 30.

[570] Joan E. Cashin, *War Matters: Material Culture in the Civil War Era* (Chapel Hill: University of North Carolina Press, 2018), 69.

to find under the best of circumstances. Like most farmers of the era, nineteenth-century Southerners fenced their crops rather than their livestock. Dairy cattle were turned out, along with beef cattle and pigs, to fend for themselves in the forests, swamps, meadows, scrublands, and canebrakes of region's open range, with minimal human supervision.[571] Harvesting milk under such conditions depended as much on the whims and wanderings of the animals as it did any planning on the part of farm families. Reminiscing about her childhood on the mountainous, western Virginia frontier, the pioneer Harriett Cline West noted her family's beloved bell cow -- "a true 'Bossie,' and the most valued of all our bovine stock" -- disappeared for days at a time, leaving the family without fresh milk. The Kentucky pioneer Daniel Drake's bell cow "Brindle" was more inclined to remain near the family's cabin, thanks to his mother's habit of tossing kitchen slop to the hungry animal each morning at milking time. The rest of the family's dairy herd spent days ranging over the countryside, returning when, and if, they pleased -- and never in a mood to be approached by people. Indeed, Drake expended much youthful energy chasing wild-eyed, semi-feral cows through the forests of the Ohio River Valley. On finding them, he pinned them in a fence corner with a stick long enough for his mother and sister to harvest the animals' milk.[572]

Assuming that they could be found, such animals yielded poor to middling milk -- if indeed they yielded any milk at all. Recall that domestic cattle need a balanced diet of fibrous plant matter, whole grains, legumes, and vegetables, supplemented with an abundance of clean water, to synthesize an abundance of chemically consistent milk. They must also be shielded

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[571] This practice dated to the Colonial Era. See Virginia DeJohn Anderson, *Creatures of Empire: How Domestic Animals Transformed Early America* (Oxford: Oxford University Press, 2006), 9.

[572] Harriet Cline West, *The Life and Travels of Harriet C. West* (Kahoka, Missouri: Talbott Printing Co., 1910), 7, 13; Daniel Drake, *Pioneer Life in Kentucky: A Series of Reminiscential Letters from Daniel Drake, M.D., to His Children* (Cincinnati: Robert Clarke & Co., 1870), 44, 92.

from environmental and physiological stressors, be it extremes of heat and cold, hard or chronic exercise, viral and bacterial infections, or some combination of these stressors. To be sure, free-range Southern cattle derived nutrition from a wide range of indigenous plant species: peavine; wild grasses and flowers common to Southern mesophytic (mixed broadleaf and pine) forests; palmettos and wiregrass shoots; and the secondary growth of shrubs, weeds, and grasses that colonized abandoned fields. The animals' favorite meal, the giant river cane that flourished in Southern bottomlands, proved an abundant, year-round source of calcium, crude protein, and phosphorous.[573] And yet, under the best of circumstances, the animals had to move about constantly in search of food, expending energy that could have been devoted to synthesizing milk. They often did without shelter, veterinary care, or supplemental food, all of which would have further diminished their health and hence, the quality and abundance of their milk. Such animals were capable of producing enough milk to satisfy local demand. However, this was far too little to meet the demand of Union military hospitals treating thousands of sick and wounded soldiers.[574]

The demand for medicinal milk notwithstanding, Union commanders frowned on the practice of seizing dairy cows and milk from Southern civilians. On October 23, 1863, as the Union Army of the Cumberland languished in Chattanooga, Tennessee, besieged by Confederate forces, Col. William J. Palmer ordered the 15th Pennsylvania Cavalry into the Sequatchie and Tennessee River Valleys to seize sheep and cattle for use in feeding the starving garrison. If ever a Union officer had a good excuse for disregarding the rules of civilized warfare, it was Palmer.

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573 Robbie Ethridge, *Creek Country: The Creek Indians and Their World* (Chapel Hill: University of North Carolina Press, 2003), 164–65; Robert E. Gabler, James F. Petersen, and L. Michael Trapasso, *Essentials of Physical Geography* (Canada: Thomson Brooks/Cole, 2007), 319.
574 Sumate Pratumsuwan, "Effect of Walking Extra Distances on the Performance of Grazing Dairy Cows in Early Lactation" (Master's Thesis, Massey University, 1994).

Nonetheless, he ordered the 15th to leave all "yoke cattle and milch cows" to their owners, for use in feeding their families. The following year, as the Union Army of the Cumberland pursued Confederate General John Bell Hood's Army of Tennessee northwest from Atlanta, Assistant Adjutant General William Sinclair enforced similar orders. Writing to Union General Jefferson Davis on October 18, 1864, from Trion Factory, Georgia, Sinclair ordered Davis to "have foraging parties organized in each brigade of your corps . . . to procure supplies from the country." Though he authorized Davis to seize "cattle . . . also hogs, sheep, bacon in smoke-houses, potatoes, and corn," Sinclair forbad foragers from taking milch cows. Two months later, Union Captain G.W. Davis of the 13th Illinois Cavalry took 100 troopers in search of beef cattle near Pine Bluff, Arkansas. In doing so, he too "prevented as far as possible the driving of milch cows and work oxen." Even Union General Phil Sheridan, who ordered the plunder of Virginia's Shenandoah Valley, refrained from taking milk cows. Indeed, on sending cavalry troopers out in December 1864 to capture "herds of cattle that are being collected near Bloomfield and Union," he instructed officers to leave civilians' milk cows.[575]

Why, then, did Mary "Mother" Bickerdyke's "Cow-and-Hen Expedition" represent the first and only large-scale movement of the dairy cattle from north to south during the Civil War? Certainly, the Northern states possessed the animals, fodder, and transportation necessary to repeat Bickerdyke's logistical feat many times over. In 1860, the Northern states and loyal Border States boasted 5,556,477 dairy cattle, enough to furnish between 27,782,385 and

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[575] George B. Davis, Leslie J. Perry, and Joseph W. Kirkley, *The War of the Rebellion: A Compilation of the Official Records of the Union and Confederate Armies* Series I, vol. XXXI, part I (Washington: Government Printing Office, 1890), 831; George B. Davis, Leslie J. Perry, and Joseph W. Kirkley, *The War of the Rebellion: A Compilation of the Official Records of the Union and Confederate Armies* Series I, vol. XLVII, part I (Washington: Government Printing Office, 1896), 142-143; George B. Davis, Leslie J. Perry, and Joseph W. Kirkley, *The War of the Rebellion: A Compilation of the Official Records of the Union and Confederate Armies* Series I, vol. XXXIX, part III (Washington: Government Printing Office, 1892), 347; George B. Davis, Leslie J. Perry, and Joseph W. Kirkley, *The War of the Rebellion: A Compilation of the Official Records of the Union and Confederate Armies*, vol. XLIII, I, Part II (Washington D.C.: Government Printing Office, 1893), 806.

55,564,770 quarts of new, sweet milk per day, assuming that each animal yielded an average of five to ten quarts at each milking.[576] The loyal states were also rich in hay. Northern farmers harvested 17,610,057 tons, or 35,220,114,000 lbs., of hay in 1860, enough to feed each of the aforementioned cattle 17 lbs. of hay per day, or an amount just shy of the 20 lbs. per day recommended by veterinary scientists and livestock breeders of the era.[577] In terms of moving cows and fodder, the region boasted 22,000 miles of railroad track, served by hundreds of locomotives and thousands of boxcars.[578] Northern railroads connecting those states with the highest concentrations of dairy cattle -- New York and New England -- and hay -- Ohio, Pennsylvania, New York, and Illinois -- with port cities on the Atlantic Seaboard and the Ohio and Mississippi Rivers that served as staging areas for Union military operations in the Eastern and Western Theaters and the Trans-Mississippi West. From there, cows and hay could travel great distances via the hundreds of steamers and sailing ships that plied the nation's inland waterways and coastal waters.[579]

There is also the fact that Union military planners were adept at moving cattle over long distances under combat conditions. As Union General George McClellan's Army of the Potomac advanced northeast up the Virginia Peninsula in May 1862, Union commissary officers drove thousands of cattle overland from Fortress Monroe to "overtake the army" and furnish soldiers with fresh beef. Many thousands more landed at White House, on the Pamunkey River,

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576 Joseph C.G. Kennedy, *Agriculture of the United States in 1860; Compiled from the Original Returns of the Eighth Census, under the Direction of the Secretary of the Interior* (Washington D.C.: Government Printing Office, 1864), 14, 16, 30, 38, 46, 54, 58, 70, 72, 74, 76, 80, 88, 96, 98, 100, 112, 120, 122, 126, 152, 166.

577 Ibid., 12, 14, 16, 32, 40, 48, 56, 60, 70, 72, 74, 78, 82, 90, 96, 98, 102, 114, 120, 124, 126, 152, 168.

578 "Railroads of the Confederacy," American Battlefield Trust, battlefields.org/learn/articles/railroads-confederacy; In April 1861, the Illinois Central Railroad alone possessed 2,600 freight cars and 110 engines. See Carl Russell Fish, "The Northern Railroads, 1861," *The American Historical Review* 22, no. 4 (July 1917): 790, 792.

579 Kennedy, *Agriculture of the United States in 1860*, 14, 32, 70, 74, 96, 100, 102, 114, 124, 152. Cincinnati, alone, launched twenty-five steamships on the Ohio River between 1811 and 1825. See "Steamboats," Ohio History Central, ohiohistorycentral.org/w/Steamboats.

having been ferried to the war zone from Northern port cities aboard Union military transport ships. Later that November, as the Army of the Potomac pursued the Confederate Army of Northern Virginia south of the Potomac River, commissary officers followed close behind, driving two, perhaps even three "large herd[s]" of beef cattle, to be slaughtered as needed by the Yankees. The animals arrived "in good season" -- that is, in good time with no great losses.[580] Indeed, Union forces' bovine wealth prompted Confederate General Wade Hampton to stage the so-called "Beefsteak Raid" during the 1864 siege of Petersburg, Virginia, which saw rebel cavalry capture and drive off 2,468 beef cattle held just behind Union lines, a mere five miles from General Ulysses S. Grant's headquarters. Though troublesome in the short-term, the raid appears not to have caused much hunger among the Yankees. Doubtless this accounts for President Abraham Lincoln's dismissal of the raid as the "slickest piece of cattle-stealing I ever heard of."[581]

The most obvious answer, and the one most often cited by historians, is that Borden's Sweetened Condensed Milk absolved Union medical officials and civilian aid workers of the need to ship cows or fluid milk to the war zone. Yet the product's widespread diffusion across the Eastern and Western Theaters of Military Operations was a gradual, uneven process. Historiographical wisdom notwithstanding, there is no evidence that Union military authorities *ever* purchased Borden's milk for as a hospital store or regular army ration.[582] Indeed, it was not

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580 Robert N. Scott, *The War of the Rebellion: A Compilation of the Official Records of the Union and Confederate Armies*, series I, vol. XI, part I (Washington: Government Printing Office, 1884), 174, 168.
581 James I. Robertson, Jr., *The Civil War Letters of General Robert McAllister* (Baton Rouge, Louisiana: Louisiana State University Press, 1965), 504, n. 11; For an account of Confederate General Wade Hampton's "Beefsteak Raid," see Richard W. Lykes, "The Great Civil War Beef Raid," *Civil War Times Illustrated*, February 1967.
582 Joe Frantz's Borden hagiography was the first historical work to argue that Union commissary agents purchased Borden's milk for use as rations as early as 1861. See Joe B. Frantz, *Gail Borden: Dairyman to a Nation* (Norman, Oklahoma: University of Oklahoma Press, 1951), 254-258; For subsequent historical works that cite Joe Frantz's claims about Union military purchases of Borden's Sweetened Condensed Milk, see Sue Shephard, *Pickled, Potted, & Canned: How the Art and Science of Food Preserving Changed the World* (New York: Simon and Schuster, 2006), 151; Andrew F. Smith, *Starving the South: How the North Won the Civil War* (New York: St. Martin's Press,

until Union General George McClellan's ill-fated Peninsula Campaign (March-August 1862) that agents of the United States Sanitary Commission are known to have first purchased and shipped the product to its agents in Virginia for use as a hospital store. Even then, it was not until the chaotic weeks following the Battle of Fair Oaks (May 31-June 1, 1862), as hospital steamships worked around the clock to evacuate sick and wounded soldiers from White House Landing, on the Pamunkey River, that agents first mentioned using the product.[583] Borden's milk was even slower to reach Union camps and hospitals in the Western Theater. To be sure, it does appear that civilian merchants had commenced selling the product to Union troops in Tennessee and Kentucky by August 1862. However, it was not until Spring 1863 -- about the same time that Bickerdyke headed to Illinois in search of dairy cattle and laying hens -- that agents of the Western Sanitary Commission made the first shipments of Borden's Sweetened Condensed Milk to Union General Ulysses S. Grant's Army of the Tennessee as it confronted rebel troops near Vicksburg, Mississippi.[584]

A more likely explanation is that dairy cows were so poorly suited to life in the war zone as to render their transport to Union camps and hospitals not only impractical, but also unthinkable. The Union medical director, Dr. B.J.D. Irwin's outburst on hearing of Bickerdyke's plan -- "Pshaw! Pshaw!" -- suggests that this was obvious to anyone familiar with the emotional

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2011), 81; Deborah Valenze, *Milk: A Local and Global History* (New Haven, Conn.: Yale University Press, 2011), 83. Borden's correspondence reveals that he was seeking government contracts as late as September 1864. See Gail Borden Jr. to Jeremiah Milbank, 14 September 1864, J. Gail Borden Jr. Papers, 1830-1910, 1932-1937, box 3C18, Dolph Briscoe Center for American History, the University of Texas at Austin.

583 Frederick Law Olmsted, *Hospital Transports. A Memoir of the Embarkation of the Sick and Wounded from the Peninsula of Virginia in the Summer of 1862* (Boston: Ticknor and Fields, 1863), 99–114; For an account of McClellan's Peninsula Campaign that includes Fair Oaks (or Seven Pines), see James M. McPherson, *Ordeal by Fire: The Civil War and Reconstruction* (New York: Knopf, 1982), 454–89.

584 For a first-hand account of Confederate troops capturing condensed milk during the Battle of Richmond, Kentucky (August 29-30, 1862), see, James L. McDonough, *War in Kentucky: From Shiloh to Perryville* (Knoxville, Tennessee: University of Tennessee Press, 1994), 508; For a first-hand account of condensed milk use by Sanitary Commission agents near Vicksburg in May 1863, see "Dr. Wariner's Report," *The Sanitary Reporter*, May 15, 1863.

and physiological needs of dairy cattle, to say nothing of the well-publicized failures of the urban milk trade. Bickerdyke herself made no guarantees that the plan would work, only that she was certain Illinois farmers "ache[d] to do something for the boys down here" and would give her cattle "for just the asking."[585] It may also be that Union medical authorities' general lack of preparedness during the first two years of the war, which saw Union forces march into battle with no organized ambulance corps, no evacuation plan for the wounded, and no means of distributing food and medicine to Union hospitals, extended to provision for medicinal milk.[586] This, of course, is all speculative. Lacking any hard evidence, it is impossible to say for sure.

A far better question: Would it have been possible for Union medical authorities to move dairy cattle to Union garrison towns, camps, and hospitals in the Southern states -- including those on located the front lines, in sight and hearing of troops engaged in combat -- with any reasonable expectation of success? Almost certainly not. To understand why, it is useful to return to Mary "Mother" Bickerdyke's "Cow-and-Hen Expedition," asking how and why it worked. Doing so reveals that her success in bringing cows to Memphis depended on a unique set of environmental and political/military variables that were impossible to recreate elsewhere in the Union-occupied South. This included secure garrison towns such as New Orleans, which fell to Union forces on May 1, 1862, and Nashville, which fell to Union forces on June 6, 1862. It also included the Union military camps and supply depots located at Alexandria, Virginia, and

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585 Ashton Rice Livermore, *My Story*, 512.

586 For an account of the early failings of Union medicine during the Civil War, see Horace Herndon Cunningham, *Field Medical Services at the Battle of Manassas (Bull Run)* (Athens, Georgia: University of Georgia Press, 1968) and Margaret Humphreys, *Marrow of Tragedy: The Health Crisis of the American Civil War* (Baltimore: Johns Hopkins University Press, 2013), 20-47.

Fortress Monroe, on the tip of the Virginia Peninsula, southeast of Richmond, just to name a few.[587]

To begin with, Mary Bickerdyke's experiment with dairy production in the warzone was short-lived. It was not until January 1863 that she first reported to Dr. B.J.D. Irwin in Memphis and took up duties in the city's military hospitals.[588] Moreover, it was not until the spring -- Mary Livermore declined to state an exact date -- that Bickerdyke asked for permission to go north to Illinois in search of dairy cattle.[589] Assuming that she left during the first week of March, and returned before the expiration of her twenty-day furlough, Bickerdyke and her bovine charges would have reached Memphis no later than the end of that month. Knowing that she gave away or sold the herd soon after the Union Army of the Tennessee's capture of Vicksburg, Mississippi, on July 4, 1863, it is reasonable to assume that the experiment lasted about 100 days. If the 100 animals yielded five quarts of milk per day, her animals would have yielded 50,000 quarts for Memphis hospitals, or enough to give 1,100 soldiers one or two pints per day. In the short term, this may be deemed a logistical success. Not so in the long term, for it absolved Bickerdyke or Union medical authorities of any need to manage the animals' gestational and lactation cycles, or to furnish them with shelter and enough fodder to see them through the winter.

Memphis's location on a Union-controlled stretch of the Mississippi River eased the process of moving dairy cattle south from Illinois, decreasing the likelihood that the animals

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587 For an account of the Union capture of New Orleans and Nashville, see Stephen V. Ash, *When the Yankees Came: Conflict & Chaos in the Occupied South, 1861-1865* (Chapel Hill: The University of North Carolina Press, 1995), 16–18. For an account of Union control of Alexandria, Virginia, and Fortress Monroe, see Catton, *This Hallowed Ground*, 46, 103.
588 LaPointe, "Military Hospitals in Memphis, 1861-1865" 42, no. 4 (Winter 1983): 325-342; Chase, *Mary A. Bickerdyke*, 42.
589 Livermore, *My Story*, 503.

would endure prolonged environmental or emotional stress, and therefore decreasing the likelihood of their going dry. By the time Mary Bickerdyke headed north in search of cows, Union forces enjoyed naval supremacy on the Mississippi River as far south as Vicksburg, Mississippi, save for the occasional guerilla or Confederate cavalry patrol taking potshots at passing ships. This allowed people, freight, and livestock to pass by water or rail from every corner of the loyal states to Cairo, Illinois, located at the confluence of the Ohio and Mississippi Rivers, and thence to Memphis by steamship, without significant fear of molestation.[590] It also allowed for relatively fast travel. In 1861, a rail trip from Chicago to St. Louis took about twelve hours to complete. It would have taken longer -- perhaps four to six additional hours -- to reach Cairo, although the trip could have been made in less than twenty-four hours. Likewise, the steamship trip from Cairo to Memphis took less than one day to complete. Assuming an efficient loading and unloading of the animals, good weather, and a minimum of stops to report to federal authorities posted along the route, Bickerdyke's cattle could have reached Memphis in forty-eight hours -- longer than the animals preferred to be crowded into rail cars or steamship holds, perhaps, but not long enough to subject them to long-term emotional and physiological stress.[591]

The animals of Bickerdyke's "Cow-and-Hen Expedition" also benefited from their static, island pasture ground. Encompassing 7,500 acres (about half the size of Manhattan Island),

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[590] William L. Shea and Terrance J. Winschel, *Vicksburg is the Key: The Struggle for the Mississippi River* (Lincoln: University of Nebraska Press, 2003), 20-21; Robert Gudmestad, "Union Gunboats Didn't Just Attack Rebel Military Sites – They Went After Civilian Property Too," The Conversation, https://theconversation.com/union-gunboats-didnt-just-attack-rebel-military-sites-they-went-after-civilian-property-too-129846; Thomas Weber, *The Northern Railroads in the American Civil War, 1861-1865* (Westport, Conn.: Greenwood Press, 1952), 4.

[591]Mark J. Perry, "Maps of the Day: Travel Times from NYC in 1800, 1830, 1857, and 1930," American Enterprise Institute, 5 October 2016, https://www.aei.org/carpe-diem/maps-of-the-day-travel-times-from-nyc-in-1800-1830-1857-and-1930/.

President's Island gave the cattle ample room to stretch their legs. The river that surrounded it on all sides acted as a natural corral, preventing the animals' wandering great distances in search of food and burning energy that would otherwise have gone to supporting milk synthesis. It also protected them from Confederate raiders or hungry civilians who might steal the animals and slaughter them for beef and hides. Because the island was sparsely populated, having as its sole human residents in 1863 a small contraband community, it abounded with nutritious wild edibles: peavine, wildflowers, meadow grasses, and the shrubs and weeds that populated disturbed soils. More important, it would have been home to stands of giant river cane or reeds, a nourishing plant that offered free-range cattle an abundance of calcium, crude protein, and phosphorous, all of which were important to milk synthesis. This absolved their human caretakers of the need to devote time, energy, and resources to the task of finding and moving enough hay -- twenty pounds per animal per day -- to feed the animals. Most important, from the cows' perspective, the island was quiet and covered in trees. Save twice-a-day milking sessions, and the ever-present biting flies that pestered livestock North and South, the animals would have spent their days doing much as they pleased -- kneeling in the shade, drowsing and chewing their cud.[592]

Few if any Southern cities occupied by Union troops during the first two years of the American Civil War afforded such an ideal location. Though New Orleans stood along the banks of the Mississippi River, there were no nearby islands similar to President's Island, in terms of size or security, on which to confine dairy animals. Moreover, it was not until Union forces captured Vicksburg, on July 4, 1863, that the Mississippi River was opened to steamship

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592 Ashby, "Presidents Island"; Elkhanah Beard, "The Freed People in the South-West," *Friends' Review: A Religious, Literary and Miscellaneous Journal*, December 19, 1863. For more on the plant species available to free-range cattle in the South, see Ethridge, *Creek Country*, 164–65.

traffic originating in the cattle-rich states of Missouri, Illinois, Indiana, Ohio, and Kentucky. This would have forced would-be Mary Bickerdykes in the Crescent City to import cattle from eastern port cities, the closest of which was Baltimore, some seven to ten days distant by ship. By then, however, regular shipments of Borden's condensed milk had rendered the need for such an importation moot. Hundreds of miles to the northeast, the Union garrison town of Nashville, Tennessee, enjoyed a direct, relatively secure railroad connection to the Ohio River port of Louisville via the Louisville & Nashville Railroad. The city also stood along the banks of the Cumberland River, which was dotted with islands. Yet none of the islands exceeded twenty or thirty acres -- the minimum acreage needed to sustain one free-range cow, according to contemporary and modern sources -- in size.[593] In both cases, Union dairy operators would have faced two choices: confine the animals in the city; or turn them out to fend for themselves in the rural countryside.

By 1861, the New York "swill milk" crisis had long-since demonstrated the problems of harvesting milk in an urban setting. Though they misunderstood the causes, physicians and veterinary scientists of the era understood that tethering dairy cattle in hot, stifling dairy sheds, surrounded by great heaps of animal waste, with little or no access to open land and fresh air, damaged the animals' physical and emotional health and with it, their ability to synthesize an

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593 Charles F. Zimpel, *Topographical Map of New Orleans and Its Vicinity, Embracing a Distance of Twelve Miles Up and Eight and Three Quarters Miles Down the Mississippi*, The Collins C. Diboll Vieux Carré Digital Survey, a Project of the Historic New Orleans Collection, https://www.hnoc.org/vcs/more_maps.php?set=2; McPherson, *Battle Cry*, 636-637; The distance from New York to Liverpool is 3,201 nautical miles and took about 11 days to complete in 1857. New Orleans is 1,947 nautical miles from Baltimore, accounting for the shorter travel time. See John Austin Stevens, Jr., *Memorial of the Chamber of Commerce of the State of New York, to the Senate and Representatives of the United States* (New York: John W. Amerman, 1864), 13 and "Sea Route and Distance," Ports.com, 2020-2022, http://ports.com/sea-route/port-of-new-orleans,united-states/port-of-baltimore,united-states/; For more on the Louisville and Nashville Railroad, see Maury Klein, *History of the Louisville and Nashville Railroad* (Lexington: University Press of Kentucky, 2003). It did occur that Confederate raiders attacked and damaged the line of the Louisville and Nashville Railroad. See Thomas Lawrence Connolly, *Autumn of Glory: The Army of Tennessee, 1862-1865* (Baton Rouge: Louisiana State University Press,), 29, 122; Nashville (Tenn.) Board of Health, *Map of the City of Nashville and Vicinity (1879)*, Tennessee Virtual Archives, https://teva.contentdm.oclc.org/digital/collection/p15138coll23/id/426/.

abundance of good-quality milk. Some suspected that close confinement also contributed to the rapid spread of deadly infectious diseases such as bovine tuberculosis and contagious bovine pleuropneumonia that killed thousands of urban dairy animals each year while rendering the survivors unfit for milk or beef production. All agreed that poor feeding practices -- in particular, dairy operators' reliance on wet distillers' grains, in lieu of hay, grains, and vegetables -- added to the problem by poisoning their cattle and tainting their milk. And yet, it is unlikely that urban dairy operators could have done better. Importing enough hay, grain, and vegetables to provide urban dairy cattle a balanced diet would have taken a veritable army of people, draft animals, and wagons to accomplish, assuming that enough could be found to make the project worthwhile. Removing the animals' waste would have been no less troublesome, for many of the same reasons. Reformers' suggestions notwithstanding, the only way to solve the problems of urban dairy production during the nineteenth century would have been to shutter the enterprise.[594]

Urban dairy production in Union garrison towns and military camps would have suffered from similar problems and limitations. This is especially true of diseases. Much as it did in Northern cities, crowding dairy cattle in milk sheds or open-air corrals would have promoted the spread of bacterial, viral, and fungal infections that killed or maimed dairy cattle. It is reasonable to assume that bacteria responsible for contagious bovine pleuropneumonia, which raged among New England and Mid-Atlantic cattle, and lay dormant in the lungs of infected cattle for three to six months, could easily have passed undetected from Northern ports to

[594] For contemporary accounts of "swill milk" production in nineteenth-century New York, see Robert Milham Hartley, *An Historical, Scientific, and Practical Essay on Milk, as an Article of Human Sustenance; with a Consideration of the Effects Consequent Upon the Present Unnatural Methods of Producing It for the Supply of Large Cities* (New York: Jay Leavitt, 1842) and John Mullaly, *The Milk Trade in New York City and Vicinity* (New York: Fowlers and Wells, 1853).

Southern garrison towns, there infecting and destroying herds. It is no less reasonable to assume that the bacteria responsible for bovine tuberculosis, *Mycobacterium bovis*, would have accompanied Northeastern dairy cattle to Union camps and garrison towns. It may also be that the bovine virus diarrhea virus (abbreviated BVDV), a pathogen which causes a range of temporary or chronic symptoms such as diarrhea, dehydration, fever, and weight loss, afflicted Northeastern dairy cattle, and wound have passed into the South via dairy herds. Scientists agree that the disease emerged at a much earlier than 1946, the date that it was isolated and described in the United States.[595]

Urban dairy producers in Union garrison towns and camps would also have faced the problem of feeding the animals. Indeed, it would have been more difficult to provide the animals with adequate nourishment. In his study of Union-occupied Nashville, the historian Stephen V. Ash described the hinterland of Union garrison towns as a "no-man's-land" that stretched away -- at times, in more than one direction -- to the Confederate frontier. Foraging parties and guerillas from both armies roamed over the countryside with impunity, seizing or buying grain, vegetables, and hay needed to feed draft animals. They also killed or drove away the oxen, horses, and mules used in cultivation, seized pigs and chickens, looted the contents of smokehouses, corncribs, and springhouses, tore down the fences that kept domestic and wild animals at bay, and stripped barns of boards for use in building semi-permanent shelters. Indeed,

[595] Charles J. Folger, *Letter from the Secretary of the Treasury, Transmitting in Response to Senate Resolution of February 10, 1882, the Report of the Treasury Cattle Commission on the Lung Plague of Cattle, or Contagious Pleuro-Pneumonia* (Washington, D.C.: Government Printing Office, 1882), 22–25, 31; Massachusetts General Court. Committee on Pleuropneumonia, *Evidence ... May 31, 1860* (n.p., 1860); Mitchell V. Palmer and W. Ray Waters, "Bovine Tuberculosis and the Establishment of an Eradication Program in the United States: Role of Veterinarians," *Veterinary Medicine International*, May 17, 2011, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3103864/; Hanspeter Stalder et al., "Traces of History Conserved Over 600 Years in the Geographic Distribution of Gentic Variants of an RNA Virus: Bovine Viral Diarrhea Virus in Switzerland" 13, no. 12 (December 5, 2018), https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0207604.

some Union soldiers were so adept at looting that they made off with entire beehives filled with honey. Deprived of their food supply and livestock, farmers in no-man's-land faced three unappealing choices: stay put and hope for the best; take shelter in a Union or Confederate garrison towns; flee the warzone altogether. Whatever they did, depopulation and lawlessness led to a collapse of the local agricultural economy, leaving Union occupiers to import food for people and livestock from the loyal states.[596]

Importing enough hay and grain to feed dairy cattle would have strained an already overburdened Union logistical network. In addition to the food, arms, and equipment needed for soldiers, the *Revised United States Army Regulations of 1861* indicated that horses should receive fourteen pounds of hay and twelve pounds of oats, corn, or barley per day. Mules were also allotted fourteen pounds of hay, although they received less grain -- nine pounds. The pressed hay carried by the army weighed 11 lbs. per cubic foot, or about 300 lbs. per bale. The oats, corn, and barley used in supplementing the animals' diet or as a substitute for hay weighed 32 lbs. per bushel, 56 lbs. per bushel, and 60 lbs. per bushel respectively. All of this had to be moved to garrison towns or encampments by rail car or freight wagon. The historian Rodney C. Lackey estimated the rail cars of the era had an interior capacity of 10 short tons (or about 20,000 lbs.), while Union supply wagons had a weight capacity of about 1.5 tons. Because hay bales were bulky and uneven in size, Lackey estimated that each rail car could carry about 180,000 lbs. of baled hay. Because it was possible to pile hay higher than the top of the wagon box, Lackey estimated that each could carry about 2.33 tons of hay, although it did increase the number of draft animals needed to pull the load. Using these measurements, Lackey estimated

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[596] Stephen V. Ash, *When the Yankees Came*, 99–104; Isaac Gause, *Four Years with Five Armies: Army of the Frontier, Army of the Potomac, Army of the Missouri, Army of the Ohio, Army of the Shenandoah* (New York, 1908), 186-190;

that number of rail cars, wagons, and six-mule teams needed to move forage for the Union Army of the Potomac on November 1, 1862. That one day, the army reported having 12,483 mules and 8,693 horses, which needed 261 short tons or 35,400 cubic feet of forage. Moving this would have required 380 six-mule wagon loads or 30 railroad boxcars to accomplish.[597]

Equine rations could be increased or decreased, depending on the army's location and movement, as well as the relative availability of forage. As the Army of the Potomac settled into fortifications north, east, and south of Petersburg, Virginia, in June, 1864, quartermasters lowered the daily hay ration for horses and mules to 10 lbs. per animal per day. To make up for the short fall, they increased the "short forage" (that is, grain) given to horses and mules to 18 and 15 lbs. per animal per day respectively. On the march, owing to the difficulty of moving forage while on campaign, the same animals would receive ten pounds of grain and no hay. Whether or not Union military authorities much cared, sudden changes in the type and amount of food given to military horses and mules disrupted and even damaged their digestive systems, diminishing the animals' health and capacity for doing useful work. This proved especially true when horses and mules accustomed to diet heavy in pasture grasses and hay were given nothing but grain without an adjustment period. The latter requires the production of gut enzymes in the small intestine for use in metabolizing fats, proteins, sugars, and starches. Grain fed to horses that lack these enzymes will often pass through the digestive system without being fully digested, leading to malnutrition and a host of potentially deadly problems such as scouring and colic. Indeed, it a diet too heavy in grains may contribute to laminitis, a condition characterized

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[597] United States War Department, *The Revised United States Army Regulations of 1861, with an Appendix Containing the Changed Laws Affecting Army Regulations and Articles of War to June 25, 1863* (Washington D.C.: Government Printing Office, 1863), 166; Rodney C. Lackey, "Notes on Civil War Logistics: Facts and Stories," accessed December 21, 2019, https://transportation.army.mil/History/PDF/Peninsula%20Campaign/Rodney%20Lackey%20Article_1.pdf.

by the separation of an animal's hoof from the distal phalanx (or coffin bone) of the toe, crippling it for life.[598]

This feeding system worked, not because it was good for the animals, but rather because it fulfilled Union military expectations for equine health. Generally speaking, Union military personnel took a Cartesian or utilitarian view of the horses and mules that served as draft animals. The animals' physical and emotional health mattered only to the extent that it helped or hindered their ability to do useful work. Indeed, it hardly mattered at all. Union cavalry troopers pushed their animals far beyond their physical limits. They were also lax in the most basic aspects of care: brushing and combing their horses; looking after their sensitive toes and hooves; or even feeding them properly. That is assuming, of course, that the troopers possessed the proper training and tools, both of which were often lacking. Teamsters were no more inclined to treat their horses and mules as emotionally sensitive, sentient beings. Union correspondence and memoirs abound with tales of the red-faced wagon master, whip in hand and a curse on his lips, thrashing wild-eyed, shrieking animals as they struggled to pull heavy loads.[599] There was little expectation that the animals would survive long-term. When horses collapsed and died, some still standing in the traces, troopers and teamsters retrieved their tack and left the animals to rot where they fell.[600] Quartermasters replaced the fallen with remounts seized from Southern

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598 Lackey, *Notes on Civil War Logistics*; Kentucky Equine Research, "Rules of Feeding: Changing Feeds," Vetzone, November 16, 2012, https://www.vetzone.com.au/Horses/Articles/Article/tabid/1968/ArticleID/1977/Rules-of-Feeding-Changing-Feeds.aspx#.Xf5PIa3MzUo; "Laminitis in Horses," American College of Veterinary Surgeons, Large Animal Topics, accessed December 21, 2019, https://www.acvs.org/large-animal/laminitis-horses.

599 Stephen Z. Starr, *The Union Cavalry in the Civil War, Volume I: From Fort Sumter to Gettysburg, 1861-1863* (Baton Rouge: Louisiana State University Press, 1979), 42; Gene C. Armistead, *Horses and Mules in the Civil War: A Complete History with a Roster of More Than 700 War Horses* (Jefferson, N.C: McFarland & Company, Inc., 2013), 57.

600 In his postwar memoirs, Union General Ulysses S. Grant recalled that the road from Bridgeport, Alabama, to Chattanooga, Tennessee, during the fall of 1863 was "strewn with . . . the carcasses of thousands of starved mules and horses." See Ulysses S. Grant, *Personal Memoirs of U. S. Grant* (Old Saybrook, Connecticut: Konecky and Konecky, 1992), 354.

civilians or purchased from farmers and livestock breeders in the loyal states.[601] Whether or not the animals experienced intestinal distress or lameness from a sudden change of food mattered so little as to be hardly worth mentioning.

Treating dairy cattle in a similar fashion would have impaired their ability to perform useful work. Sudden changes in the type and amount of food given to lactating cows may disrupt the interrelated processes of fermentation and absorption in the rumen, which may in turn alter the chemical composition and amount of milk synthesized in the udder. This is especially true when carbohydrate-rich grains, starchy vegetables, and gas-producing legumes are fed in excess, or instead of, fibrous pasture grasses or hay. Converted to volatile fatty acids in the rumen, excess carbohydrates and starches may lower a cow's digestive pH, slowing the reproduction of, or even killing off the gut flora responsible for metabolizing the vitamin-A-rich cellulose and hemicellulose present in green pasture grasses and hay. This serves in turn to impair milk synthesis, which requires about 100,000 IUs (or International Units) of vitamin A per day to complete. To be sure, the legumes alfalfa and white and red clover are rich in protein and therefore beneficial for lactating cattle. However, they are also rich in galacto-oligosaccharides -- that is, small, unabsorbed fibrous carbohydrates -- that produce gas when fermented by a ruminant's gut flora. Animals fed an excess of legumes experience a rapid gas accumulation, a condition known as "bloat," that may damage the internal organs, inhibit lactation, and trigger spontaneous abortions in pregnant cows. In some cases, bloat may even kill otherwise healthy animals.[602]

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[601] Anne Norton Greene, *Horses at Work: Harnessing Power in Industrial America* (Cambridge, Massachusetts: Harvard University Press, 2008), 135; Jay Luvaas and Harold W. Nelson, eds., *Guide to the Battle of Antietam: The Maryland Campaign of 1862* (Lawrence: University Press of Kansas, 1996), 269.

[602] Heather Smith Thomas, *Storey's Guide to Raising Beef Cattle* (North Adams, Massachusetts: Storey Publishing, 2009), 95; "Legumes and Flatulence," Grains & Legumes Nutrition Council, 2019, https://www.glnc.org.au/legumes-2/legumes-and-health/legumes-and-flatulence/.

Union military encampments were awash in the sudden and chronic loud noises that stressed dairy cattle, decreasing the abundance and quality of their milk. [603] Buglers sounded calls throughout the day: "Reveille" to rouse sleeping soldiers; "Breakfast Call" to signal morning mealtime; "Retreat" to summon them to camp; "Taps" to send them off to sleep. All of these calls reached a level of 70 to 100 decibels.[604] Many provoked a tirade of shouted oaths and curses from tired, careworn soldiers. Indeed, shouting and cursing were favorite pastimes of Union Civil War soldiers. Teamsters shouted, cursed, and cracked bullwhips at stubborn horses and mules that shied or refused to haul heavy loads. Officers and sergeants shouted at recruits or distracted veterans to "fall in!" or "close up ranks!" or "By file from the right -- March!," among other orders.[605] Soldiers shouted at one another with joy, anger, sorrow, confusion, or some combination of the four while playing rounders, racing horses, betting on cards, or singing camp songs.[606] Still other noises abounded. Target practice saw soldiers discharge muskets and cannon, both of which created noise in excess of 150 decibels, and both of which could be heard

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[603] "Effects of Noise on Cattle Performance," Dairy Global, 23 November 2017, https://www.dairyglobal.net/health-and-nutrition/health/effects-of-noise-on-cattle-performance/#:~:text=Noise%20and%20milk%20production&text=This%20has%20resulted%20in%20an,following%20exposure%20to%20sudden%20noise.

[604] Theodore Gerrish, *Army Life: A Private's Reminiscences of the War* (Portland, Maine: Hoyt, Fogg & Donham, 1882), 98; George Rabbai, *Infantry Bugle Calls of the American Civil War* (Pacific, Missouri: Mel Bay Publications), 17-19; By way of comparison, a modern trumpet produces tones that range from 70 to 100+ decibels. See Murray Cambell and Clive Greated, *The Musician's Guide to Acoustics* (Oxford: Oxford University Press, 1987), 133-134.

[605] Gene C. Armistead, *Horses and Mules in the Civil War: A Complete History with a Roster of More Than 700 War Horses* (Jefferson, North Carolina: McFarland & Company, 2013), 57; For more on Union military drill and commands, see Brigadier General Silas Casey, *Infantry Tactics, for the Instruction, Exercise, and Manoeuvers of the Soldier, a Company, Line of Skirmishers, Battalion, Brigade, or Corps D'Armée* (New York: D. Van Nostrand, 1862) vol. III.

[606] On December 25, 1862, a game of rounders played by Union troops at Hilton Head, South Carolina, drew 40,000 spectators. See William J. Ryczek, *Baseball's First Inning: A History of the National Pastime Through the Civil War* (Jefferson, North Carolina: McFarland & Company, 2009), 22; Don Pedro Quaerendo Reminisco, *Life in the Union Army, by a Two-Years' Volunteer* (New York: H. Dexter, Hamilton, & Co., 1864), 136; Mason Long, *The Life of Mason Long, the Converted Gambler* (Mason Long: Fort Wayne, Indiana, 1883), 49; Cullen B. Aubrey, *Recollections of a Newsboy in the Army of the Potomac, 1861-1865. His Capture and Confinement in Libby Prison, After Being Paroled, Sharing the Fortunes of the Famous Iron Brigade* (n.p., n.d.), 122-124.

for distances of up to ten miles of more.[607] Drill and parades saw regimental drummers beat a range of rolls and calls, each of which came close to that of firearms -- up to 140 decibels (or greater) -- in volume.[608]

The only alternative, turning dairy cattle out to fend for themselves in a garrison town's or camp's rural hinterland, would also have failed. To be sure, food would have been less of a problem for free-ranging cattle. The Southern countryside offered an abundance of wild forage, including the weeds and shrubs that invaded abandoned fields in the no-man's-land. And yet, unattended dairy cattle would have been easy pickings for the Union and Confederate foragers, hungry civilians and bands of Unionist/secessionist guerillas who ranged over the countryside, poaching livestock with little regard for such legal formalities as ownership. Preventing this would also have required drovers -- accompanied by armed guards -- to accompany the animals at all times. It would also have required them then perform one of two actions, twice per day: milking the animals on the spot or finding and driving them to a safe location for milking. The former would have required the party to transport wagonloads of cans and some means of cooling and insulating the milk, lest it spoil during transit to hospitals. The latter would have stressed and tired the animals, diminishing the likelihood of their yielding an abundance of chemically consistent milk. Whatever method used, turning the animals out to graze would have denied them access to shelter, exposing them to heat and cold stress.[609]

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607 George A. Mocsary, Nicholas James Johnson, E. Gregory Wallace, and David B. Kopel, "In-Depth Explanation of Firearms and Ammunition" (2020) *Faculty Book Chapters*. 4.

608 Timothy A. Ditmar, *Audio Engineering 101: A Beginner's Guide to Music Production* (New York: Focal Press, 2012), 4.

609 Ethridge, *Creek Country*, 164-165; For more on the threat posed by Unionist and secessionist guerillas, see Noel C. Fisher, *War at Every Man's Door: Partisan Politics and Guerilla Violence in East Tennessee 1860-1869* (Chapel Hill: University of North Carolina Press, 1997); Daniel E. Sutherland, ed., *Guerillas, Unionists, and Violence on the Confederate Homefront* (Fayetteville: The University of Arkansas Press, 1999); T. R. Pirtle, *History of the Dairy Industry* (Chicago: Mojonnier Brothers, 1926), 295; Sumate Pratumsuwan, "Effect of Walking Extra Distances on the Performance of Grazing Dairy Cows in Early Lactation" (Master's Thesis, Palmerston, New Zealand, Massey University, 1994); Luisa Magrin et al., "Physiological and Productive Response of Lactating Dairy Cows to the

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Whether she knew it or not, Mary Bickerdyke's decision to take leave of Memphis in July 1863 coincided with a new, fluid phase of the American Civil War. Beginning with Union General Ulysses S. Grant's successful campaign to capture Vicksburg, Mississippi, which drew Bickerdyke south in the first place, Union commanders showed an increased willingness to abandon their supply lines, live off the land, and effect rapid advances deep into Confederate territory. Beginning in May 1864, Grant and his subordinate, General William T. Sherman, put this strategy to use in a two-pronged invasion designed to hasten the end of the war. The former crossed the Potomac River into Virginia and launched a series of continuous attacks on the Confederate Army of Northern Virginia. The latter struck out from Chattanooga, Tennessee, with the goal of seizing the Confederate railroad hub of Atlanta, Georgia. With every step that Grant's and Sherman's armies took, they inflicted tens of thousands of casualties on their Confederate foes, destroyed or captured resources, and pushed the nascent Confederate government ever closer to the brink of collapse. And yet, with every forward step, they also took their own soldiers, who also fell wounded by the tens of thousands, further and further from the Northern hospitals and garrison towns that could furnish them with beds, surgical intervention, and nourishing foods.[610]

This new phase of combat magnified the problems that Americans had long struggled to resolve in terms of making and moving culinary and medicinal milk over *any* distance, much less

Alpine Transhumance at the End of the Summer Grazing," *Italian Journal of Animal Science* 15, no. 1 (2016): 151–56; Lewis F. Aiken, "Cattle Feeding in the Western States," *Ohio Farmer*, February 23, 1856, and "Making Forage and Wintering Stock," *Southern Cultivator*, January 1857.

[610] For more on Union General Ulysses S. Grant's 1863 Vicksburg Campaign, see McPherson, *Ordeal*, 205–9, 444–45. For more on Union General Ulysses S. Grant's 1864 Virginia Campaign, see Bruce Catton, *A Stillness at Appomattox* (New York: Knopf Doubleday, 1990). For more on Union General William T. Sherman's 1864 Atlanta Campaign, see Earl J. Hess, *Kennesaw Mountain: Sherman, Johnston, and the Atlanta Campaign* (Chapel Hill: University of North Carolina Press, 2013).

a great distance. It also introduced a new problem: discovering some means to move perishable milk toward a target that shifted and moved with every passing minute and hour. The notion that plodding, milk-heavy cows could have (or would have) kept pace with Union forces as they marched, wheeled, and smashed into their Confederate opponents time and again, for weeks at a time, without having access to a balanced diet of hay and grain, with any hope of their synthesizing large quantities of high-fat, high-protein milk, would have been absurd to any thinking person. So too the idea that the skittish, emotionally fragile animals could be made to give down their milk within sight, sound, and smell of the combat. Likely they would have dried up altogether. This is assuming, of course, that the animals would have survived for more than a few days or hours when surrounded by thousands of hungry Union troops and Confederate raiders. Moving perishable milk from railheads in unrefrigerated (or poorly refrigerated) cans piled into the backs of wagons, over rough terrain, would have been no less absurd. Again, this is assuming that the Union authorities, who depended on wagons to move ammunition, rations, and other supplies, would have set a handful aside for such a use. So long as Union medical officials and civilian caregivers were bound by these intractable problems, Union sick and wounded would suffer for want of their favorite comfort food. At the risk of overstatement, the millions of gallons of milk harvested by Northern dairy farmers each year would have been no more or less accessible had the cows been stabled on the moon.

Chapter 8:
"A 'Real God-Send' to Us Poor Sick Soldiers":
Gail Borden, Jr. and the Union Milk Lift, 1862-1865

Beginning in 1862 and continuing through the end of the American Civil War, civilian aid workers and merchants (or "sutlers") moved hundreds of thousands, if not millions of quarts of cow's milk harvested on Northern farms to Union military camps and hospitals scattered across the Eastern and Western Theaters of military operations. Every last drop of this milk made the trip packed in hermetically sealed tin cans manufactured by Gail Borden Jr.'s New York Condensed Milk Company or one of several licensed affiliates. On reaching the war zone, Borden's Sweetened Condensed Milk gave Union caregivers a nourishing food that could be fed direct to patients too sick or injured to eat solid food, or mixed with other ingredients to prepare meals in accordance with the "special diet," a food regimen devised by Union medical authorities as an alternative to the salt pork or salt beef, beans, hardtack, bitter black coffee, and other "coarse far" that made up regular army rations. Many a Union convalescent subsisted on "mush and milk," a staple of the nineteenth-century sickroom made by pouring condensed milk over ground wheat or hominy, while confined in a hospital. Many more relished milk punch, a popular toddy and medicinal draught of the era made by adding lemon wedges to iced or boiled condensed milk and then spiking the concoction with whiskey or brandy.[611]

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[611] In the week following the September 17, 1862, Battle of Antietam, the United States Sanitary Commission shipped 2,620 lbs. of condensed milk to Sharpsburg, and Frederick, Maryland, military hospitals. See Charles Janeway Stillé, *History of the United States Sanitary Commission, Being the General Report of Its Work During the War of the Rebellion* (Philadelphia: Lippincott, 1866); In the ten days following the July 1-3, 1863, Battle of Gettysburg, the Sanitary Commission shipped 12,500 lbs. of condensed milk to Gettysburg military hospitals. See Frederick Law Olmsted, "Preliminary Report of the Operations of the Sanitary Commission with the Army of the Potomac, During the Campaign of June and July, 1863," *The Sanitary Reporter*, August 15, 1863, 49–50; *Laws of the General Assembly of the State of Pennsylvania, Passed at the Session of 1864, In the Eighty-Eighth Year of Independence* (Harrisburg, Pennsylvania: Singerly & Myers, State Printers, 1864), 44; *Acts and Resolves Passed by the Forty-Third Legislature of the State of Maine. 1864* (Augusta, Maine: Stevens and Sayward, Printers to the State, 1864), 328-29; Matthew Brennan, "The Civil War Diet" (Master's Thesis, Virginia Polytechnic Institution, 2005);

Those on the receiving end testified that Borden's Sweetened Condensed Milk worked wonders -- miracles, even -- for sick and injured Union soldiers. In a July 1863 letter to her mother, the Union nurse Emily Bliss Thacher Souder dubbed the humble product "invaluable" to the task of treating tens of thousands of wounded men in the weeks and months following the three-day Battle of Gettysburg. The United States Sanitary Commission agent Dr. A. N. Read concurred with Thacher Souder's assessment, insisting that milk punch made with sweetened condensed milk "saved hundreds of lives" during the 1863 siege of Chattanooga, Tennessee. Lest anyone doubt the veracity of his claims, Read added, "This was the testimony of all the surgeons I heard speak of it." Though he gently mocked "consecrated milk" in his postwar memoirs, Union General William T. Sherman ordered Sanitary Commission agents to stockpile the product in Nashville, Tennessee, his army's primary supply depot, before embarking on his 1864 campaign to capture Atlanta, Georgia. A soldier hospitalized during the fighting, the Illinois native James Springer, referred to Borden's Milk as "a 'real god-send' to us poor sick soldiers."[612]

The story of the Union "milk lift" -- for want of a better descriptive term -- lived on for decades following the American Civil War. On August 19, 1865, editors of the Chicago-based *Prairie Farmer* praised Gail Borden Jr. for his tireless efforts on behalf of Union fighting men, noting that the New York-born Texan kept milk condensing plants running "day and night" to

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"A Recipe for Milk Punch," *Gleason's Pictorial Drawing-Room Companion*, November 1, 1851; "What the Auxiliary Relief Corps Has Done," *The Sanitary Commission Bulletin*, August 15, 1864, 623.

[612] Emily Bliss Thacher Souder, *Leaves from the Battlefield of Gettysburg: A Series of Letters from a Field Hospital: And National Poems* (Philadelphia: C. Sherman Son & Company, 1864), 23; William A. Hammond M.D., *A Treatise on Hygiene: With Special Reference to the Military Service* (Philadelphia: J. B. Lippincott & Co., 1863), 508; The Sanitary Commission, *The Sanitary Commission Bulletin* (New York: The Sanitary Commission, 1866), 513; William Tecumseh Sherman, *Personal Memoirs of Gen. W.T. Sherman*, 3rd ed., vol. 2 (New York: Charles L. Webster & Company, 1890), 391; For more on Sherman's 1864 Atlanta campaign, see James M. McPherson, *Battle Cry of Freedom: The Civil War Era* (New York, New York: Oxford University Press, 1988), 743–56, 773–75; "Condensed Milk," *Friends' Review: A Religious, Literary and Miscellaneous Journal*, August 20, 1864.

meet Union military demand for sweetened condensed milk. In an 1872 defense of Borden's patent rights, the Secretary of the Board of Agriculture of the State of Maine, Stephen L. Goodale, took a similar tack. Noting that Borden's Sweetened Condensed Milk gave Union caregivers a portable, durable means to deliver medicinal milk to Union hospitals, he insisted that "uncounted thousands of soldiers, in camp and in hospital [held Borden] in grateful remembrance and esteem." It would be easy to dismiss both accounts as boosterism. *Prairie Farmer* readers stood to benefit from Borden's newest condensing plant, which opened in Elgin, forty miles west of Chicago, in 1865, while Goodale was a friend and business partner of Borden with a personal stake in the condensed milk industry. Yet in praising Borden and Eagle Brand, they merely reiterated the words of those who used the product while serving on the front lines of the American Civil War.[613]

In fact, contemporary observers were correct to praise Borden's Sweetened Condensed Milk. The humble product nourished Union soldiers' bodies with calories derived from sugar and fat, fed and boosted their immune systems, and gave emotional comfort to the afflicted. Thanks to the hermetically sealed tin cans and sugar that protected Borden's Milk against contaminants and decomposition, the product also gave Union caregivers an unprecedented degree of logistical flexibility. Boxes of Borden's Milk required none of the care and upkeep of dairy cattle, and were less bulky to transport than the plodding, clumsy animals and their fodder. Cans of condensed milk were also (mostly) impervious to the physical and environmental

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[613] "Condensed Milk," *Prairie Farmer*, August 19, 1865; Stephen Lincoln Goodale, *A Brief Sketch of Gail Borden, and His Relations to Some Forms of Concentrated Food* (Portland, Maine: B. Thurston & Co., 1872), 9. For more on Stephen L. Goodale's relationship to Gail Borden Jr., see "From the New York Tribune," *Friends' Review: A Religious, Literary and Miscellaneous Journal*, August 20, 1864, Gail Borden Jr. to S. L. Goodale Esq., 23 March 1864, and Gail Borden Jr. to James Bridge Esq., 3 August 1864, J. Gail Borden Jr. Papers, 1830-1910, 1932-1937, box 3C18, Dolph Briscoe Center for American History, the University of Texas at Austin; *Acts and Resolves*, 328-29.

stressors such as heat, cold, loud noises, and long-distance travel that may annoy dairy cows, causing the physically powerful, but emotionally fragile animals to hold up their milk or dry up altogether. This made it possible for Union caregivers to move fat- and nutrient-rich milk over many miles, keeping pace with armies on active campaign duty as they passed through the most burned-over, barren districts of the warzone and even to the front lines of combat, where no lactating dairy cow could be expected to travel. Consequently, Borden's Milk reduced the time that wounded soldiers had to wait for nutritional support from days to hours to minutes.[614]

By all accounts, the humble fluid was as much a "god-send" to Union caregivers as it was to Springer and his comrades. Unlike front-line military personnel, civilian aid workers seldom faced the prospect of violent death or serious injury in the combat zone. However, they did share in the horrid sights, sounds, and smells of the battlefield and field hospital, all of which proved traumatizing to even the hardiest, most experienced among them. Like most Americans of the era, Union caregivers attributed tangible, even magical healing powers to cow's milk. At the same time, they inscribed milk with gendered symbolic value that only enhanced its perceived usefulness as medicine. Milk evoked images of motherhood -- the source of life and nourishment and the font of (most) antebellum medical knowledge -- and the feminine domestic sphere -- site of most practical medical care during times of injury and illness. Add to this Americans' longstanding associations of milk with divinity, prosperity, and fertility, and the

[614] For more on the impact of physical and emotional stress on milk production in dairy cattle, see Pragna Prathap et al., "Heat Stress and Dairy Cow: Impact on Both Milk Yield and Composition," *International Journal of Dairy Science*, 2016, 2–11, Sumate Pratumsuwan, "Effect of Walking Extra Distances on the Performance of Grazing Dairy Cows in Early Lactation" (Master's Thesis, Palmerston, New Zealand, Massey University, 1994), ??, and Luisa Magrin et al., "Physiological and Productive Response of Lactating Dairy Cows to the Alpine Transhumance at the End of the Summer Grazing," *Italian Journal of Animal Science* 15, no. 1 (2016): 151–56. For more on the "no-man's land created by Union and Confederate armies, see Stephen V. Ash, *When the Yankees Came: Conflict & Chaos in the Occupied South, 1861-1865* (Chapel Hill: The University of North Carolina Press, 1995), 99-104. For front-line medical treatment with condensed milk, see N. Read, "The Western Department. In the Field," *The Sanitary Commission Bulletin*, September 1, 1864, 650.

humble substance appeared powerful indeed. When Union caregivers fed milk to mangled, trembling soldiers, they believed that it would work. This lifted their spirits, making it possible to continue the harrowing, often Quixotic work of tending to sick and injured Union military personnel.[615]

On a more mundane level, Union soldiers testified that they derived emotional comfort from the cans of Borden's Sweetened Condensed Milk sent to them by family members, given to them by civilian relief agents, or purchased -- or stolen -- from sutlers. Many a bluecoat used Borden's Milk to practice the comforting culinary rituals of home, among them, adding a bit of creamy sweetness to morning coffee or tea or pouring it over crumbled hardtack to make a passable rendition of mush and milk. Many more blended sweetened condensed milk with whiskey or brandy to make milk punch for use in makeshift celebrations and memorials. Still others sat in a circle with comrades, passing the can from hand to hand and spooning the sweet, syrupy substance into their mouths. However they used it, Borden's Sweetened Condensed Milk pleased the palate, filled their bellies, and made them feel better. Doubtless this accounts for their willingness to spend as much as 75 cents, a considerable portion of their monthly salary of $13, for a single can.[616]

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615 For an account of traumatized civilian aid workers, see Frederick Law Olmsted, *Hospital Transports. A Memoir of the Embarkation of the Sick and Wounded from the Peninsula of Virginia in the Summer of 1862* (Boston: Ticknor and Fields, 1863), 102–7. For more on the social and symbolic significance of milk in Western societies, see E. Melanie DuPuis, *Nature's Perfect Food: How Milk Became America's Drink* (New York: New York University Press, 2002), Hannah Velten, *Milk: A Global History* (London: Reaktion Books, 2010), Deborah Valenze, *Milk: A Local and Global History* (New Haven, Conn.: Yale University Press, 2011), Kendra Smith-Howard, *Pure and Modern Milk: An Environmental History since 1900* (Oxford: Oxford University Press, 2014), and Andrea S. Wiley, *Cultures of Milk: The Biology and Meaning of Dairy Products in the United States and India* (Cambridge, Mass.: Harvard University Press, 2014).

616 For an account of soldiers receiving condensed milk from family, see Richard T. Van Wyck, *A War to Petrify the Heart: The Civil War Letters of a Dutchess County, N.Y. Volunteer*, ed. Virginia Hughes Kaminsky (Hensonville, New York: Black Dome Press, 1997), 46–47; For an account of soldiers receiving condensed milk from relief agents, see Jacob Gilbert Forman, *The Western Sanitary Commission; a Sketch of Its Origin, History, Labors for the Sick and Wounded of the Western Armies, and Aid Given to Freedmen and Union Refugees, with Incidents of Hospital Life* (St Louis: R. P. Studley & Co., 1864), 37; For an account of soldiers stealing condensed milk, see J. W. Muffly, ed., *The Story of Our Regiment: A History of the 148th Pennsylvania Vols* (Des Moines,

Moving in the other direction, cans of Borden's Sweetened Condensed Milk made it possible for Union caregivers and soldiers to tap into the full agricultural and industrial might of the Northern heartland. In her 2003 study of the Klondike Gold Rush, the environmental historian Kathryn Morse noted that miners who lived on canned meats, fruits, and vegetables absorbed "the labor not only of food processors, but of ranchers, cowboys, slaughterhouse workers, and railroad shippers." So it was with those who used Borden's Sweetened Condensed Milk. The solar energy stored in pasture grasses and grains, the nutrients that passed from manure to soils to plants to cows to milk, the muscle power expended by people and draft animals, even the trees that cast shade on dairy cows as they kneeled, ruminating and synthesizing milk in peaceful silence: all were packed into the tin cans manufactured by Gail Borden Jr.'s condensing plants. Going two or even three steps further, Borden's Milk grafted the Union war effort into energy flows that originated in the cassiterite (tin ore) mines of British Malaya and the sugarcane fields of Spanish Cuba, both of which exploited slave or unfree laborers while exacting a heavy toll on the nonhuman world. This dependence raises questions about the relationship between the Union war effort, slavery, and colonialism that are worth exploring in their own right.[617]

Iowa: The Kenyon Printing & MFG. Co., 1904), 516. For an account of soldiers using condensed milk in coffee and tea, see Oliver Wilcox Norton, *Army Letters, 1861-1865: Being Extracts from Private Letters to Relatives and Friends from a Soldier in the Field During the Late Civil War, with an Appendix Containing Copies of Some Official Documents, Papers and Addresses of Later Date* (Chicago: O. L. Deming, 1903), 176. For an account of soldiers making condensed milk punch for makeshift parties, see Cullen B. Aubrey, *Recollections of a Newsboy in the Army of the Potomac, 1861-1865. His Capture and Confinement in Libby Prison, After Being Paroled, Sharing the Fortunes of the Famous Iron Brigade* (n.p., n.d.), 122-124. If dietary monotony also sapped morale, it stands to reason that dietary variety had the opposite effect on soldiers' emotional wellbeing. According to Thomas D. Marbaker, soldiers of the 11th New Jersey paid exorbitant prices to the sutler -- for example, $0.75 per can for condensed milk that retailed for about $0.43 -- to alleviate "the sameness of government rations." Thomas D. Marbaker, *History of the Eleventh New Jersey Volunteers From Its Organization to Appomattox* (Trenton, NJ: MacCrellish & Quigley, 1898), 36; Bell I. Wiley, *The Life of Billy Yank: The Common Soldier of the Union* (Indianapolis: Bobbs-Merrill, 1951), 37-38.

617 Kathryn Morse, *The Nature of Gold: An Environmental History of the Klondike Gold* Rush (Seattle: University of Washington Press, 2003), 142; Elliott West, *The Contested Plains: Indians, Goldseekers, and the Rush to Colorado* (Lawrence: University Press of Kansas), 52; Steven Stoll, *Larding the Lean Earth: Soil and Society in*

Important though it was at the time, the story of the Union "milk lift," to say nothing of Gail Borden Jr.'s role in making it possible, has faded from the American historical consciousness. Civil War military, medical, and food historians often, but not always, include a nod to the wartime popularity of Borden Sweetened Condensed Milk when listing the technological, logistical, and nutritional advantages that Union armies enjoyed relative to their Confederate counterparts. At least two have placed the product in military hospitals as part of the "special diet" fed to Union convalescents. Yet in doing so, they never quite get around to explaining why Union doctors, nurses, and soldiers placed such a premium on cow's milk, or what they did with all of that milk when it reached the front lines. This being the case, it is perhaps no surprise that they have neglected to ask whether Borden's Sweetened Condensed Milk performed any useful medical service. The presumption among scholars, based on a handful of poorly sourced Borden hagiographies, is that everyone involved used Borden's Milk to add a bit of flavor to the coffee and tea served in camps and hospitals. Without question this is true. To stop there, however, is to overlook the central role that milk played in nineteenth-century medical care, while reducing one of the great medicinal innovations of the American Civil War to a mere condiment.[618]

It is time for the Union "milk lift" to take its place alongside the other, more well-known wartime medical innovations identified by historians. These were, in no particular order: the

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Nineteenth-Century America (New York: Hill and Wang, 2002), ??. For a study of unfree Chinese labor in British Malaya, see W. L. Blythe, "Historical Sketch of Chinese Labour in Malaya," *Journal of the Malayan Branch of the Royal Asiatic Society* 20, no. 1 (June 1947): 64–114; For more on slavery and sugar in Spanish Cuba, see Sidney Mintz, *Sweetness and Power: The Place of Sugar in Modern History* (New York: Viking Penguin, 1985); For more on tin mining as a cause of landscape degradation in Malaysia, see Corey Ross, *Ecology and Power in the Age of Empire: Europe and the Transformation of the Tropical World* (Oxford: Oxford University Press, 2017), 136–63.

[618] James M. McPherson, *Ordeal by Fire: The Civil War and Reconstruction*, 3rd ed. (Boston: McGraw-Hill, 2001), 400; Margaret Humphreys, *Marrow of Tragedy: The Health Crisis of the American Civil War* (Baltimore: Johns Hopkins University Press, 2013), 115; Andrew F. Smith, *Starving the South: How the North Won the Civil War* (New York: St. Martin's Press, 2011), 80-81; Valenze, *Milk*, 178-87.

widespread use of anesthesia to reduce the pain of surgeries and exploratory procedures; the phasing out of harmful prepared drugs such as calomel (mercury); the construction of pavilion-style hospitals that permitted airflow and reduced incidence of infectious diseases; the collection, curation, and study of tissue and bone samples by Union military physicians; the widespread use of disinfectants and fumigants that prevented the onset and spread of hospital gangrene; the creation and training of a Union ambulance corps; the organization and training of a women's nursing corps; the tireless efforts of civilian aid societies such as the United States Sanitary Commission to purchase, transport, and distribute food, medical stores, and other vital supplies to front-line camps and hospitals; and the widespread adoption of self-care regimens by individual soldiers. All gave Union physicians and caregivers an edge in treating the wounds, secondary infections, and camp diseases that killed hundreds of thousands of soldiers during the American Civil War. All prevented the conflict from being that much more destructive of human life.[619]

That said, a caveat is in order. Any good that Borden's Sweetened Condensed Milk did for sick and wounded Union soldiers must be weighed against the technological and scientific limitations of the era, to say nothing of the human beings who used it as medicine. To be more specific, the sweetened condensed milk that reached the front lines was only as fresh and sanitary

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619 George Worthington Adams, *Doctors in Blue: The Medical History of the Union Army in the Civil War* (Baton Rouge: Louisiana State University Press, 1996); Humphreys, *Marrow of Tragedy*; Shauna Devine, *Learning from the Wounded: The Civil War and the Rise of American Medical Science* (Chapel Hill: The University of North Carolina Press, 2014); Michael A. Flannery, *Civil War Pharmacy: A History*, Second (Carbondale, Illinois: Southern Illinois University Press, 2017); Mercedes Graf, *On the Field of Mercy: Women Medical Volunteers from the Civil War to the First World War* (New York: Humanity Books, 2010); For two works that treat self-care as a viable medical strategy for Union soldiers, see Bell I. Wiley, *The Life of Billy Yank: The Common Soldier of the Union* (Baton Rouge: Louisiana State University Press, 1952), 124-151 and Kathryn Shively Meier, *Nature's Civil War: Common Soldiers and the Environment in 1862 Virginia* (Chapel Hill: University of North Carolina Press, 2013), 1-15, 126-146. The American Civil War killed approximately 750,000 Union and Confederate soldiers. See J. David Hacker, "A Census-Based Count of the Civil War Dead," *Civil War History* 57, no. 4 (December 2011): 307–48; Humphreys, *Marrow of Tragedy*, 1.

as Borden's workers were careful in preparing, preserving, and packaging the milk, and the stevedores and teamsters who loaded and unloaded the boxes were careful in protecting the cans against dents, punctures, and excess heat and cold during transit. Although it is difficult (likely impossible) to quantify, accidents did occur. In some cases, the damage was superficial and harmless, resulting in swollen or burst cans and/or discolored, odd-tasting sweetened condensed milk. In other cases, it amounted to microbial contamination that had the potential to sicken or kill those with compromised immune systems.[620] Similarly, the condensed-milk-based delicacies served to Union convalescents in field hospitals and aid stations were only as sanitary as the pails, ladles, buckets, barrels, water, and other utensils and ingredients used in their preparation. Given physicians' and aid workers' ignorance of germ theory, it is reasonable to assume that they served contaminated milk punch to soldiers with more or less regularity. This would have been especially true of those on the front lines, where biotic contaminants -- swarms of flies, piles of amputated limbs, and the corpses of dead men and horses, among others -- abounded.[621]

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[620] Otto Frederick Hunziker, *Condensed Milk and Milk Powder* (La Grange, Ill.: Published by the Author, 1918), 242-52; B.W. Hammer, *Studies on Formation of Gas in Sweetened Condensed Milk* (Ames: Iowa State College of Agricultural and Mechanical Arts, 1919), 211. For a contemporary account of damaged sweetened condensed milk cans, see R. M. Lewis for J. H. Wilson to New York Condensed Milk Company, Mr. Houk, 23 January 1864; R. M. Lewis to Augustus Klemm, 18 February 1864; R. M. Lewis to Augustus Klemm, 10 March 1864; United States Sanitary Commission Pennsylvania Archives, Philadelphia Agency, Volume I, box 5, New York Public Library Archives

[621] For more on mid-nineteenth-century debates surrounding the germ theory of disease, see Robert P. Gaynes, *Germ Theory: Medical Pioneers in Infectious Diseases* (Washington, DC: ASM Press, 2011), 143-172 and Kari Nixon, *Kept from All Contagion: Germ Theory, Disease, and the Dilemma of Human Contact in Late-Nineteenth Century Literature* (Albany: State University of New York Press, 2020). For an account of the lack of sanitation that plagued Union field hospitals, see Roland R. Maust, *Grappling With Death: The Union Second Corps Hospital at Gettysburg and the Action of the Hospitals, Along With Lists of Patients Who Died or Were Wounded* (Dayton, OH: Morningside, 2001).

To understand how and why Borden's Sweetened Condensed Milk helped Union soldiers wounded in combat, it is necessary to treat their wounding not as a singular moment, but rather as one in a series of traumatic events that extended backward and forward in time and space. By the time a Union soldier wheeled into line of battle, he had often endured hours, days, or even weeks of punishing physical exertion and nutritional privation. That exertion and privation continued on as the wounded soldier passed from battlefield to field hospital, and from field hospital a permanent hospital in the Border or Northern states, a trip that took weeks or even months to complete and exposed him to further physical and mental trauma and suffering. It is likewise necessary to think of Union soldiers' bodies as a collection of interrelated organic systems, all of which depended on energy inputs to maintain the homeostatic processes -- immune systems function and the regulation of blood glucose and blood volume, among others -- necessary to sustain human life. With each new insult to the body and mind, be it a hasty battlefield amputation or a night spent languishing in the hold of a steamship, the soldier's body burned energy at an accelerated rate in an all-or-nothing bid to keep him alive. Under the circumstances, a cup of calorie- and nutrient-rich Borden's Milk made the difference between life and death. Indeed, the product served the same purpose as a modern, intravenous fluid bolus.[622]

Nutritional privation stalked the Union soldier on active campaign duty from almost they moment he broke camp and fell into a column of march. Generally speaking, Union infantrymen on active campaign duty marched between 8 and 20 miles per day, carrying weapons, ammunition, canteens, blankets, and other gear that weighed as much as fifty pounds. Under

[622] Sarvani Palaparthi, "Role of Homeostasis in Human Physiology: A Review," *Journal of Medical Physiology & Therapeutics* 1, no. 2 (April 12, 2017), https://www.omicsonline.org/open-access/role-of-homeostasis-in-human-physiology-a-review.pdf.

ideal circumstances, this load included enough food to meet their daily caloric needs: about 3,110 per day.[623] Yet circumstances were seldom ideal. In his study of the common Union soldier, *The Life of Billy Yank*, the historian Bell I. Wiley noted that Union Commissary officials had enough trouble feeding soldiers when they idled in camp, much less when they were on active campaign duty, passing through difficult terrain, their supply lines haunted by Confederate raiders who burned bridges, wrecked railroads, and captured supply wagons. Moreover, it was common for Union soldiers to eat all of the food issued them soon after breaking camp. For all of these reasons, it was unlikely that hungry troops would receive timely or accurate supplemental rations while *en route*.[624] Some made up for the nutritional deficit by slipping away to beg, buy, or steal corn, bread, chickens, milk, and other food from civilians along their line of march.[625] Yet it often occurred that Union soldiers on the march suffered from hypoglycemia -- that is, low blood sugar caused by rigorous exercise and lack of food.[626]

Likely the soldier also suffered from dehydration. Union troops did most of their marching and fighting during the hot summer and early fall months while clad in thick woolen uniform jackets and trousers and burdened with the aforementioned weapons and

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623 The Union Army of the Potomac made two multi-day marches during the Maryland Campaign of 1862. The first of these, which took the army from Washington, D.C. to Frederick Maryland, took seven days to complete (September 7-13, 1863). The second leg, which took it from Frederick, Maryland, to Sharpsburg, Maryland, took four days to complete (September 13-16). Union General Ulysses S. Grant's 1864 Overland Campaign took the Army of the Potomac from the vicinity of Chancellorsville, Virginia, to Petersburg, Virginia, in fifty-two days (May 4-June 24), with most of it spent in combat. See Stephen W. Sears, *Landscape Turned Red: The Battle of Antietam* (New York: Warner Books, Inc., 1983) and Bruce Catton, *A Stillness at Appomattox* (New York: The Fairfax Press, 1984); Brennan, "The Civil War Diet," 37–39.

624 Bell Wiley, *The Life of Billy Yank: The Common Soldier of the Union* (Indianapolis, IN: Bobbs-Merrill Company, Inc., 1951), 224–36.

625 For first-hand accounts of Union soldiers' foraging, see Charles E. Davis, *Three Years in the Army. The Story of the Thirteenth Massachusetts Volunteers from July 16, 1861, to August 1, 1864* (Boston: Estes and Lauriet, 1894), 131–32 and Isaac Gause, *Four Years with Five Armies: Army of the Frontier, Army of the Potomac, Army of the Missouri, Army of the Ohio, Army of the Shenandoah* (New York: The Neale Publishing Company, 1908), 186–90.

626 Cleveland Clinic, "Hypoglycemia (Low Blood Sugar)," Cleveland Clinic, March 2, 2017, https://my.clevelandclinic.org/health/diseases/11647-hypoglycemia-low-blood-sugar.

accoutrement.[627] As they trudged through choking clouds of dust beneath the burning sun, Union soldiers sweated out water -- and with it, water-soluble C and B complex vitamins, electrolytes, and potassium -- at a rate of between 1 and 2 liters per hour.[628] The canteen that every soldier carried provided scant relief, not only because they held too little water -- about 3 pints or 1.4 liters -- to make up for soldiers' hydration deficit, but also because they were difficult to refill while marching. Union armies had no practical means to carry water in large volume, leaving tens of thousands of men, as well as horses, mules, and beef cattle, to compete for access to creeks, ponds, and even puddles along the line of march.[629] Adding to soldiers' misery (and likely related to drinking tainted water) was chronic diarrhea, a common affliction during the American Civil War that further dehydrated the body. All of this placed soldiers at risk of hypovolemic shock, or a drop in blood pressure caused by rapid fluid loss, leading to seizures and/or heat stroke. At the very least, soldiers became dehydrated, leaving them lethargic, confused, irritable, and thirsty.[630]

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[627] The following major battles occurred during the summer/fall: First Bull Run -- July 21, 1861**;** Peninsula Campaign (VA) -- March 17-July 1, 1862**;** Antietam (MD) -- September 17, 1862**;** Gettysburg (PA) -- July 1-3, 1863**;** Chickamauga (GA) -- September 18-20, 1863**;** Vicksburg Campaign (MS) -- April 29, 1863 – July 4, 1863. Overland Campaign (VA) -- May 4-June 24, 1864**;** Atlanta Campaign (GA) -- May 7-September 2, 1864. For an overview of these and other Civil War campaigns and battles, see James M. McPherson, *Ordeal by Fire: The Civil War and Reconstruction* (New York: Knopf, 1982). For more on Union military uniforms, see Wiley, *Billy Yank*, 21–23, 58–61.

[628] Bernadette M. Marriott, ed., *Nutritional Needs in Hot Environments: Applications for Military Personnel in Field Operations* (Washington, D.C.: National Academy Press, 1993), 87–96, 137–60.

[629] Eric Fein, *Weapons, Gear, and Uniforms of the Civil War* (North Mankato, Minnesota: Capstone, 2012), 13; *The War of the Rebellion: A Compilation of the Official Records of the Union and Confederate Armies* vol. 11, 1 (Washington, 1880-1901), 167-169; Rodney C. Lackey, "Notes on Civil War Logistics: Facts and Stories," accessed December 21, 2019, https://transportation.army.mil/History/PDF/Peninsula%20Campaign/Rodney%20Lackey%20Article_1.pdf; *Until Antietam: The Life and Letters of Major General Israel B. Richardson, U.S. Army* (Carbondale: Southern Illinois University Press, 2009), 141.

[630] Wiley, *Billy Yank*, 136–37; Douglas J. Casa et al., "Historical Perspectives on Medical Care for Heat Stroke, Part 2: 1850 Through the Present," 2009, 178–90.

Combat only added to the Union soldier's physical and nutritional duress, while also exposing him to an array of sights, sounds, and smells that were as revolting and nauseating as they were terrifying. As he maneuvered around the battlefield, he would have witnessed the catastrophic damage done to human bodies by Civil War-Era weapons. Spherical and conoidal rounds fired from high-caliber smooth-bore and rifled muskets crushed and tore muscle, bruised soft tissue, splintered bones, ruptured arteries and veins, tore ligaments and tendons, compressed or severed nerves, punctured organs, and spilled bodily wastes into the peritoneal (body) cavity. Solid and high-explosive artillery rounds sheared off arms and legs, lacerated flesh with red-hot shrapnel, tore open abdomens, exposing the intestines, and in some cases, exploded men, sending arms, legs, and head flying in different directions. Throughout the battle, a terrific din of rifle and artillery fire, shouting, cursing, and the screams of wounded men and horses filled his ears. The air reeked of sulphur, blood, sweat, bile, urine, and feces. The soldier likely experienced disorientation. Albeit rare, it did occur that the he experienced hand-to-hand combat, forcing him to use his bayonet, the butt of his musket, or his bare hands to maim or kill enemy soldiers.[631]

When a Union soldier's physical and emotional stress exceeded a certain threshold, his body activated a series of autonomic endocrinological and metabolic changes, the so-called "fight or flight" response, that evolved to help humans escape or fend off danger. The process

[631] For a first-hand account of the human carnage at Gettysburg, see Jacob Hoke, *Reminiscences of the War; Or Incidents Which Occurred in and about Chambersburg, During the War of the Rebellion* (Chambersburg, Pennsylvania: M. A. Foltz, Printer and Publisher, 1884), 82–83; Allen C. Guelzo, *Gettysburg: The Last Invasion* (New York: Alfred A. Knopf, 2015), 366-367; Martin L. Fackler, "Wound Ballistics: A Review of Common Misconceptions," *Journal of the American Medical Association* 259, no. 18 (1988): 2730–36; Paul Dougherty and Herbert Collins, "Wound Ballistics: Minié Ball vs. Full-Metal Jacketed Bullets--A Comparison of Civil War and Spanish-American War Firearms," *Military Medicine* 174, no. 4 (April 2009); Gerald Linderman, *Embattled Courage: The Experience of Combat in the American Civil War* (New York: The Free Press, 1989), 19; Mark M. Smith, *The Smell of Battle, the Taste of Siege: A Sensory History of the Civil War* (New York: Oxford University Press, 2015), 75; Grady C. McWhiney and Perry D. Jamieson, *Attack and Die: Civil War Military Tactics and the Southern Heritage* (Tuscaloosa: The University of Alabama Press, 1982), 78-9.

began in the soldier's hypothalamus, which signaled his adrenal glands to release the stress hormone epinephrine into his bloodstream. At the same time, the hypothalamus prompted the pituitary gland to release a second stress hormone, ACTH (adrenocorticotropic hormone), which traveled to the adrenal glands via the bloodstream to activate production of a third stress hormone, cortisol. As epinephrine and cortisol circulated through the soldiers' body via the bloodstream, they bound with cells, initiating signaling cascades that suppressed the immune system, dilated the pupils, increased the heart rate, increased the rate and efficiency of breathing, and increased blood flow to the muscles.[632] Doubtless this accounts for the euphoria that some Union soldiers experienced during combat, as well as the blind panic that set others to flight.[633] However they experienced it, fight or flight consumed blood glucose at an accelerated rate, further depleting the energy stores of soldiers already weakened in the days leading up to combat.

It was in this physically depleted, emotionally charged state that the Union soldier suffered wounds. The likelihood that he survived long enough to receive surgical and pharmaceutical intervention at a Union field hospital depended, first, on the location and severity of his injuries. Those who sustained penetrating/lacerating injuries to the brain, spinal cord, lung(s), heart, tracheobronchial tree, esophagus, liver, or one of the major vessels died in about ten minutes, from one of three complications: severe hemorrhage leading to hypovolemic shock, obstructed airway, or tension pneumothorax, a laceration to the chest that allowed air to the enter the peritoneal cavity but not escape, collapsing the lung(s) and, in extreme cases, causing cardiac

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[632] "Understanding the Stress Response: Chronic Activation of This Survival Mechanism Impairs Health," Harvard Health Publishing, Harvard Medical School, May 1, 2018, https://www.health.harvard.edu/staying-healthy/understanding-the-stress-response.
[633] To date, Civil War historians have treated fear as a social rather than a biological process. See Wiley, *Billy Yank*, 86–90; Linderman, *Embattled Courage*, 24.

arrest. Those wounded in the extremities, including those who suffered sudden, traumatic amputations, might live for hours or days without triage care, assuming that they devised some means, for example, a makeshift tourniquet, to stop or slow bleeding. The same may be said for those who sustained maxillofacial injuries -- that is, injuries to the jaw, teeth, nose, eyes, and tongue.[634]

The likelihood that they survived long enough to receive surgical and pharmaceutical intervention at a Union field hospital depended, second, on the timeliness of nutritional intervention. From almost the moment a Union soldier fell wounded in combat, his body initiated a biphasic metabolic and endocrinological response, known as the systemic inflammatory response to traumatic injury, in an attempt to maintain life-sustaining homeostatic processes and repair damaged tissues. The first or "ebb" phase, which began moments after the soldier fell wounded, preserved energy by slowing both the heart rate and respiration, constricting blood vessels, and suppressing the metabolism of glucose. The second or "flow" phase, which started between 24 to 72 hours after the ebb phase, saw the body make an "all or nothing" bid to preserve life by initiating the rapid metabolism of glucose stores, supplemented by the catabolism (that is, the breaking down) of bone and muscle proteins and fats into compounds that could be converted into more glucose. Properly managed with aggressive nutrition and stress mitigation, this hypermetabolic phase lasts between two and three weeks and assists the body in healing. Left unchecked, it may lead to diminished muscle and bone mass,

[634] Ivan Kuhajda et al., "Penetrating Trauma," *Journal of Thoracic Disease* 6, no. Supplement 4 (October 6, 2014): S461–65; A. Franke et al., "The First Aid and Hospital Treatment of Gunshot and Blast Injuries," *Deutsches Ärzteblatt International* 114, no. 14 (April 7, 2017): 237–43.

necrobiosis (irreversible shock resulting from insufficient oxygenation of cells), organ systems failure, and death. [635]

Borden's Sweetened Condensed Milk provided Union surgeons and civilian aid workers with a portable, durable means to deliver concentrated, life-saving nutrition to hypermetabolic Union wounded. A standard, one-quart can of the product offered 3,928 calories, or more than a typical Union soldier needed to eat during a twenty-four hour period spent on active campaign duty.[636] It is unlikely, of course, that Union caregivers would have fed an entire can of Borden's Milk to an individual soldier, no matter how serious his condition. Instead, they would have diluted the product with an unspecified amount of water and alcohol to make milk punch, which was then portioned out in servings that varied in size from one pint to one quart, depending on the volume of the tin cups and "muckets" that Union soldiers carried as part of their mess gear.[637] Assuming that civilian aid workers adhered to Gail Borden Jr.'s exacting standards and diluted the sweet, syrupy substance with four quarts of water to make five quarts of fluid milk (and excluding the caloric content of the added alcohol), sweetened condensed milk provided Union wounded anywhere from 196 calories per one-pint tin cup -- an amount equal to about

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[635] H. B. Stoner, "Interpretation of the Metabolic Effects of Trauma and Sepsis," *Journal of Clinical Pathology* 40, no. 9 (September 1987): 1108–17; E. M. Breznock, "The Systemic Response of the Traumatized Patient," *The Veterinary Clinics of North America. Small Animal Practice* 10, no. 3 (August 1980): 523–32; Turgay Şimşek, Hayal Uzelli Şimşek, and Nuh Zafer Cantürk, "Response to Trauma and Metabolic Changes: Posttraumatic Metabolism," *Turkish Journal of Surgery* 30, no. 3 (September 1, 2014): 153–59.

[636] Nutritional values based on a modern, one-pint can of sweetened condensed milk. See "Basic Report: 01095, Milk, Canned, Condensed, Sweetened," United States Department of Agriculture, Agricultural Research Service: Nutritional Nutrient Database for Standard Reference Legacy Release, April 2018, https://ndb.nal.usda.gov/ndb/foods/show/01095?fgcd=&manu=&format=&count=&max=25&offset=&sort=default&order=asc&qlookup=01095&ds=&qt=&qp=&qa=&qn=&q=&ing=.

[637] For an example of Sanitary Commission agents diluting sweetened condensed milk to make milk punch, see J.P.T. Ingraham, "Letter from Rev. Mr. Ingraham," *The Sanitary Reporter*, July 15, 1864; Francis A. Lord, *Civil War Collector's Encyclopedia: Arms, Uniforms and Equipment of the Union and Confederacy* (Mineola, New York: Dover Publications Inc., 2004).

three chicken eggs -- to 786 calories per one-quart mucket or cup -- an amount equal to about ten chicken eggs.[638]

No less important than the number of calories present in sweetened condensed milk were the micronutrients from which those calories were derived. A substantial portion of the calories in sweetened condensed milk came from the sucrose used as a preservative (about 988 per one-quart can). Assuming that a wounded soldier's small intestine was intact and functioning, his digestive system would have rapidly converted sucrose into the monosaccharide glucose, replacing some of that lost to hypermetabolism and providing his body with a sudden burst of energy. No less important, however, were the calories derived from fat -- about 688 per one-quart can.[639] Once more, assuming proper digestive function, a wounded Union soldier's body would have converted fat into fatty acids and glycerol, which not only served alongside glucose to restore energy lost to hypermetabolism, but also assisted his body in absorbing fat-soluble vitamins A, D, K, and E present in sweetened condensed milk and other emergency rations.[640]

Civilian aid workers took advantage of the portability and durability of sweetened condensed milk to push life-saving nutritional intervention into the combat zone, where no dairy cow would have thrived or produced an abundance of medicinal milk. In the week following the

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638 M.S., "Condensed Milk," *The Independent . . . Devoted to the Consideration of Politics, Social and Economic Tendencies, History, Literature and the Arts*, August 9, 1858; Nutritional values based on one modern chicken egg. See "Basic Report: 01123, Egg, Whole, Raw, Fresh," United States Department of Agriculture, Agricultural Research Service: National Nutrient Database for Standard Reference Legacy Release, April 2018, https://ndb.nal.usda.gov/ndb/foods/show/01123?fgcd=&manu=&format=&count=&max=25&offset=&sort=default&order=asc&qlookup=raw+egg&ds=&qt=&qp=&qa=&qn=&q=&ing=.

639 "Basic Report"; "Causes and Diagnosis of Lactose Intolerance," National Library of Medicine, National Center for Biotechnology Information, 29 November 2018, https://ncbi.nlm.gov/books/NBK310263/.

640 "Glycerol," National Library of Medicine, National Center for Biotechnology Information, n.d., https://pubchem.ncbi.nlm.nih.gov/compound/Glycerol#section=Information-Sources; Matthew Brennan, "The Civil War Diet" (Master's Thesis, Blacksburg, Virginia, Virginia Polytechnic Institution, 2005), 112; Jean-Pierre Montmayeur and Johannes le Coutre, *Fat Detection: Taste, Texture, and Post-Ingestive Effects* (New York: CRC Press, 2010), 268; Stephanie Dutchen, "What Do Fats Do in the Body?," National Institute of General Medical Sciences," 15 December 2010, https://www.nigms.nih.gov/education/Inside-Life-Science/Pages/what-do-fats-do-in-the-body.aspx

September 17, 1862, Battle of Antietam, agents of the United States Sanitary Commission used wagons to ferry 2,620 cans of condensed milk from Washington, D.C. direct to the battlefield.[641] The following July 18, as Union troops assaulted Fort Wagner, South Carolina, the nurse Clara Barton used cans of condensed milk to prepare milk punch in the lee of a sandhill, just back from the front lines.[642] The following summer, as Union General Ulysses S. Grant's Army of the Potomac fought a series of brutal battles in northern Virginia, Sanitary Commission agent Frank B. Fay sent a wagon loaded with sweetened condensed milk and other food to meet a Union ambulance train bearing wounded soldiers to White House, Virginia. On reaching the train, agents fed each of the wounded a meal of soft crackers and condensed milk punch. Fay later declared the effort "entirely successful" and a model that "should be followed hereafter when opportunity offers."[643] Sanitary Commission agent F. W. Foster did just that. Anticipating the Union assault on Fort Fisher on the North Carolina coast, Foster landed several boat-loads of supplies, sweetened condensed milk included, through the surf on January 13, 1865. Because he located his depot near Union General Alfred Terry's headquarters, Foster was in position to give milk punch and soft crackers to the wounded as they limped, shuffled, or were carried to the rear.[644]

By all accounts, nutritional intervention with sweetened condensed milk increased the likelihood that Union wounded would survive long enough to make it to the relative safety of a

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[641] Charles Janeway Stillé, *History of the United States Sanitary Commission, Being the General Report of Its Work During the War of the Rebellion* (Philadelphia: Lippincott, 1866), 266–67.

[642] L.P. Brockett and Mary C. Vaughan, *Woman's Work in the Civil War: Profiles in Strength During the Civil War* (Zeigler, McCurdy & Co., 1867), 126. For more on the Union assault on Fort Wagner, see Peter Burchard, *One Gallant Rush: Robert Gould Shaw and His Brave Black Regiment* (New York: St. Martin's Press, 1989).

[643] "What the Auxiliary Relief Corps Has Done," *The Sanitary Commission Bulletin*, 15 August 1864, 623.

[644] F.W. Foster, "From Fort Fisher," *The Sanitary Commission Bulletin*, 15 February 1865, 1016-1017. For more on the Union's Wilmington Campaign, which culminated in the Battle of Fort Fisher, see Rod Gragg, *Confederate Goliath: The Battle of Fort Fisher* (Baton Rouge: Louisiana State University Press, 1991).

Union field hospital. Consider the testimony of United States Christian Commission delegates, who rushed a wagon load of condensed milk and brandy south from Chattanooga, Tennessee, on the night of November 29, 1863, to meet an ambulance train bearing 150 Union soldiers wounded during the failed Union assault on Ringgold Gap, Georgia. On meeting the grim processional, the delegates wasted no time in stoking fires, brewing milk punch, and feeding the injured soldiers, some of whom hovered on the brink of death. By morning, the "wounded heroes" appeared "relieved, refreshed, and strengthened," prompting the ambulance train to resume its "painful course." Surgeons in Chattanooga later assured the delegates, "Six of these men, now safe here, would have died before morning if you had not met us last night as you did."[645] Consider also the testimony of the Sanitary Commission agent Dr. A. N. Read, who followed close behind Union General William T. Sherman's blue-clad legions as they clashed with Confederate forces north of Atlanta, Georgia, during the summer of 1864. For sixteen days, soldiers wounded in action streamed to the rear, where they waited, "cold, shivering, thirsty, [with] life failing them from the first shock of injury" for help. For sixteen days, Read watched as the "administration of . . . timely stimulants" such as milk punch and beef tea revived the shattered men.[646]

Union wounded were no less needing of nutritional support on reaching field hospitals. By necessity, surgeons subjected the battered men to all manner of invasive medical procedures: the amputation of hands, arms, feet, and legs; the use of long metal probes and forceps to locate and remove bullets and shrapnel from open wounds; the excision of necrosed bone fragments;

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645 United States Christian Commission, *United States Christian Commission, for the Army and Navy. For the Year 1863. Second Annual Report* (Philadelphia, 1864), 108–9.

646 A.N. Read, "The Western Department. In the Field," *The Sanitary Commission Bulletin*, September 1, 1864, 650; For more on Union General William T. Sherman's 1864 Atlanta Campaign, see James M. McPherson, *Battle Cry of Freedom: The Civil War Era* (New York, New York: Oxford University Press, 1988), 743–53.

the insertion of catheters into damaged urethras and bladders; the removal of blood- and soil-encrusted field dressings; the setting and splinting of simple and compound fractures. These procedures were not only physically painful, but also emotionally traumatizing. Ether, chloroform, and opiates offered relief from both. So too the whiskey and brandy that hospital stewards and aid workers served straight or blended with sweetened condensed milk.[647] Indeed, at least one Union soldier who quaffed strong milk punch before his appointment with the "saw bones" recalled, "I didn't care if they cut off both hands and threw in one leg for good measure!"[648] Their feelings notwithstanding, wounded soldiers' bodies were unable to distinguish between combat injuries and helpful -- or at least, well-intentioned -- surgical intervention. Their sympathetic nervous systems responded to surgeons' probing and cutting by releasing another round of immune-suppressing, metabolism-accelerating epinephrine and cortisol into their bloodstreams.[649]

Once again, Union surgeons and civilian aid workers recognized that sweetened condensed milk worked a remarkable transformation on soldiers made "low" by surgery.[650] Among them, the Union nurse Emily Bliss Thacher Souder, who made the rounds of the Union Second Corps Field Hospital at Gettysburg, Pennsylvania, in late July 1863, passed by a Union soldier who "seemed to appeal, though mutely, for special attention." Observing that the unfortunate fellow was recovering from a jaw injury, she offered him liquid nourishment: milk punch fortified with beaten eggs. On sipping the concoction through "scarcely opened lips,"

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647 W. J. Harmon and C.K. McAllister, "The Lion of the Union: The Pelvic Wound of Joshua Lawrence Chamberlain," *The Journal of Urology* 16, no. 3 (March 2000): 713–16; Glenna R. Schroeder-Lein, *The Encyclopedia of Civil War Medicine* (New York: Routledge, 2008), 15–17, 121.
648 Joseph E. Crowell, *The Young Volunteer; The Everyday Experiences of a Soldier Boy in the Civil War* (Paterson, New Jersey: Joseph Crowell, 1906), 443–45.
649 Celeste C. Finnerty et al., "The Surgically-Induced Stress Response," *Journal of Parenteral and Enteral Nutrition* 37, no. 50 (September 2013): 21S-29S.
650 Humphreys, *Marrow*, 32.

Thacher Souder later observed, the wounded man "at once seemed revived."[651] Indeed, it was common for glucose-depleted, hypermetabolic soldiers to plead with civilian aid workers for sweetened condensed milk and other sugary foods, and for civilian aid workers to provide, insofar as possible, for their needs. The Union nurse Cornelia Hancock, who ministered to Union soldiers confined in a Fredericksburg, Virginia, field hospital during the summer of 1864, recalled these cravings, writing, "How the men watched for the dessert of farina and condensed milk, and those more severely wounded for the draughts of milk punch." Far to the south, a group of "amputation cases" confined in a field hospital near Alatoona, Georgia, during Union General William T. Sherman's Atlanta campaign begged Eliza C. Porter for "something [they] could relish." Unwilling that the men be "disappointed in their expectations," Porter made her way to a Sanitary Commission supply depot, returning with dried currants, cherries, and cans of sweetened condensed milk. [652]

Assuming that they survived their wounding and emergency surgery, Union wounded next faced a grueling, multi-stage journey from the field hospital to a more permanent hospital located in the occupied South or the Northern states. This process began when surgeons deemed the wounded fit enough to travel -- or too injured to benefit from further front-line care -- and ordered them sent to the nearest rail depot or steamship landing for evacuation. Those who could walk did so, shuffling along for miles in the burning summer heat or the freezing winter cold. Others made the trip in the backs of ambulances or farm wagons, with each bump of the springless vehicles sending shocks of pain through their broken bodies.[653] It often occurred that

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[651] Souder, *Leaves*, 23.

[652] Brockett and Vaughan, *Woman's Work*, 169, 286.

[653] Katharine Prescott Wormeley, *The United States Sanitary Commission. A Sketch of Its Purposes and Its Work. Compiled from Documents and Private Papers* (Boston: Little, Brown & Co., 1863), 125–26.

medical officials made no provision for Union wounded while in transit. Following the 1862 Battle of Fair Oaks, a nurse identified only as "N." noted that Union wounded carried from front-line hospitals to the steamship landing at White House, Virginia, were arranged on the ground, without food, water, or bedding, and then abandoned.[654] The nurse Katherine Prescott Wormeley described a similar scene in the weeks after the Battle of Gettysburg, writing, "Once the men have the surgeons' permission to go, they are off; and there may be an interval of a day, or two days, should any of them be too weak to reach the train in time, during which these poor fellows belong to no one."[655] Meanwhile, on landing at the Union supply depot of Port Royal, Virginia, in 1864, the Sanitary Commission agent "J.J.B." found himself "besieged" by a crowd of "half-starved" Union wounded.[656] That same summer, the Sanitary Commission agent Frank B. Fay noted that ambulance drivers unloaded and then abandoned some 500 Union wounded on top of Marye's Heights, about a mile distant from hospitals located in Fredericksburg, Virginia.[657]

This lack of planning on the part of Union medical officials extended to the steamships and trains that carried the wounded north. On boarding the steamship *Vanderbilt* in June 1862, the aforementioned nurse N. discovered a shocking scene: "Men in every condition of horror, shattered and shrieking, were being brought in on stretchers, borne by contrabands, who dumped them anywhere, banged the stretchers against pillars and posts, and walked over the men without compassion." Hunger aggravated the evacuees' misery and endangered their lives. The

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654 Frederick Law Olmsted, *Hospital Transports. A Memoir of the Embarkation of the Sick and Wounded from the Peninsula of Virginia in the Summer of 1862* (Boston: Ticknor and Fields, 1863), 99. For more on the Battle of Fair Oaks (or Seven Pines), see McPherson, *Battle Cry*, 461-62.
655 Wormeley, *The United States Sanitary Commission. A Sketch*, 125.
656 J.J.B., "Three Months in the United States Sanitary Commission. No. II - Scenes and Incidents at Port Royal, Va.," *The Sanitary Commission Bulletin*, November 15, 1864.
657 William Howell Reed, ed., *War Papers of Frank B. Fay with Reminiscences of Service in the Camps and Hospitals of the Army of the Potomac, 1861-1865* (Boston: George E. Ellis, 1911), 105

unfortunate men had “mostly been without food” for five days. Yet there was almost nothing on hand with which to feed them. A nurse who served alongside N. on the *Vanderbilt*, Mrs. John Harris, later stated, “How much we wished for some concentrated milk” with which to feed those “shot in the face or neck,” who “begged for liquid food.”[658] Union wounded sent north from Georgia during the summer of 1864 endured similar, trying circumstances. Trains carried Union wounded first to Chattanooga and then to Nashville, for admission to military hospitals. Yet ammunition and troop trains headed to the front took precedence over evacuation trains, slowing the latter’s progress and increasing the stress and strain on their human cargo. One such train bearing 150 Union wounded rolled into Nashville, Tennessee, in July 1864, having been forty-eight hours in traveling from Chattanooga. The Reverend J.P.T. Ingraham recalled that the men packed into the hot rail cars had gone without food and water for the duration. They were, consequently, “exhausted,” with some being too weak to “waste strength in words.”[659]

Once more, nutritional intervention with sweetened condensed milk worked a remarkable transformation on Union wounded. The sanitarian William Howell Reed claimed as much, noting that milk punch “refreshed” the weakened, half-starved Union wounded who stumbled into hospitals following the 1864 Battle of Spotsylvania Court House.[660] So too the aforementioned Reverend Ingraham. After “one good swallow” of milk, Ingraham later reported, the exhausted men aboard the evacuation train just arrived from Chattanooga recovered their spirits enough to joke and laugh while giving hearty, boisterous thanks to Ingraham and the sanitarians.[661] Nurses and relief agents assigned to the Sanitary Commission steamship *Red*

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[658] Olmsted, *Hospital Transports*, 100; Brockett and Vaughan, *Woman’s Work*, 149–52.

[659] J.P.T. Ingraham, “The Western Department,” *The Sanitary Commission Bulletin*, August 1, 1864, 595; C., “On a Hospital Train,” *The Sanitary Commission Bulletin*, August 1, 1864.

[660] Reed, *War Papers*, 105

[661] Ingraham, “Western Department,” 595.

Rover made liberal use of sweetened condensed milk as they ferried Union soldiers wounded in the Vicksburg and Red River campaigns from field hospitals at Miliken's Bend, and Young's Point, Louisiana, to more permanent hospitals in Memphis, Tennessee, and Cairo, Illinois.[662] In Gettysburg, U. S. Sanitary Commission agents set up three hospital tents, as well as a smaller tent that housed a make-shift field kitchen, near the town's rail depot. Twice per day, a certain nurse Woolsey, assisted by Sanitary Commission agents, fed milk punch and other nutritious food to the Union wounded present at the depot. Likewise, twice per day, they walked from rail car to rail car, handing additional helpings of milk punch, soup, and water to the wounded before seeing them off to Harrisburg, Pennsylvania, or Baltimore, Maryland, and then to points north and east.[663]

Union caregivers continued to treat Union wounded with milk-based remedies on receiving them in Northern hospitals. The difference, of course, was that Union hospitals stood inside -- or at least, close to -- the Northern dairy belt, obviating the need for caregivers to rely on Borden's Sweetened Condensed Milk. Consider the case of Union Private J. Morrin of the 126th New York Infantry, who suffered a gunshot wound to his lower left leg, followed by a hasty battlefield amputation, during the Battle of Gettysburg. On reaching Philadelphia's Mower Hospital on September 9, the young private suffered from two life-threatening illnesses: a gangrenous infection in his damaged leg and typhoid fever. In keeping with the treatment protocols outlined in the *Hospital Steward's Manual*, surgeons fed him a diet of beef tea and milk punch "at pleasure." Though it took him almost two years (and a second amputation) to recover, Morrin did survive and claimed a pension in 1865. Consider also Private J. Dullahan of

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662 Navy Department Division of Naval History, "History of U.S. Navy Hospital Ship Red Rover," (n.p., n.d.).
663 Brockett and Vaughan, *Woman's Work*, 331.

the 3rd Vermont Infantry who fell, shot through the ankle, during the May 5, 1864, Battle of the Wilderness. On reaching Philadelphia's South Street Hospital, Dullahan showed "great pain and swelling" in the wound site, prompting surgeons to prescribe morphine for the pain, combined with milk punch and beef tea as nutritional support. By June, Dullahan was well enough to join the Convalescent Corps at Brattleboro, Vermont. The following July, he, too, mustered out of the service and claimed his pension.[664]

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Destructive as combat was to Union soldiers' bodies and minds, most of the 200,000+ Union soldiers who died during the American Civil War succumbed to viral and bacterial infections. Environmental historian Timothy Silver has likened this biotic disaster to Alfred Crosby's "virgin soil epidemics," and the comparison is apt. The Civil War uprooted millions of people -- most of them hailing from isolated agricultural communities -- and muddled them together in crowded, unsanitary military and refugee camps. Smallpox, typhoid fever, influenza, and measles raced from tent to tent and person to person, taking a fearful toll on those who lacked natural or acquired immunity.[665] Adding to soldiers' misery were the mosquitoes and lice that swarmed over their bodies, transmitting malaria and yellow fever. So too the bacteria that flourished in military hospitals, transforming otherwise survivable wounds into deadly secondary infections. This is a familiar story, yet one that continues to inspire historiographical treatment.

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664 Joseph K. Barnes, George A. Otis, and D.L. Huntington, *The Medical and Surgical History of the War of the Rebellion (1861-1865)* 3, 1 (Washington, D.C.: Government Printing Office, 1883), 463, 579; Joseph Janvier Woodward, *The Hospital Steward's Manual; for the Instruction of Hospital Stewards, Wardmasters, and Attendants, in their Several Duties; Prepared in Strict Accordance with Existing Regulations and the Customs of Service in the Armies of the United States of America, and Rendered Authoritative by Order of the Surgeon-General* (Philadelphia: Lippincott, 1863), 185, 190, 192-193.

665 Jim Downs, *Sick From Freedom: African-American Illness and Suffering During the Civil War and Reconstruction* (Oxford: Oxford University Press, 2012), 4; Amy Murrell Taylor, *Embattled Freedom: Journeys Through the Civil War's Slave Refugee Camps* (Chapel Hill: The University of North Carolina Press, 2018), 99, 127, 141; Jenny Goellnitz, "Statistics on the Civil War and Medicine," Ohio State University Department of History eHistory, https://ehistory.osu.edu/exhibitions/cwsurgeon/cwsurgeon/statistics.

Among recent scholars to tackle the subject, Katherine Shively Meier observed that microorganisms posed a greater threat to soldiers' health, and hence, to the effectiveness of Civil War armies, than did all the bullets and artillery shells deployed in four years of combat.[666]

Much as they did with treating wounds, Union surgeons claimed success in using sweetened condensed milk to cure -- or at the very least reduce the severity of -- the camp diseases that plagued Union Civil War soldiers. Writing from a Brook's Station, Virginia, field hospital in March 1863, the surgeon Robert Hubbard testified that milk punch made with sweetened condensed milk "operate[d] the best" in stopping the "intractable diarrhea" common to typhoid patients. The surgeon James Bryan made similar claims, noting that a diet of fresh, boiled (most likely sweetened condensed) milk and lemonade not only checked soldiers' diarrhea, but also protected them against the "peculiar gastralgia" common to the swampy bottoms about Vicksburg, Mississippi. Although he made no specific reference to sweetened condensed milk, Surgeon General of the United States Army William H. Hammond shared his subordinates' faith in the curative powers of milk punch. In his *Treatise on Military Hygiene* (1863) Hammond urged hospitals to make liberal use the concoction, arguing, "Nothing more useful . . . can be employed in the treatment of the low types of fever so frequently met with in armies."[667]

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666 James M. McPherson, *Battle Cry of Freedom: The Civil War Era* (New York, New York: Oxford University Press, 1988), 485; Drew Gilpin Faust, *This Republic of Suffering: Death and the American Civil War* (New York: Vintage Books, 2008), 48; Timothy Silver, "Yancey County Goes to War: A Case Study of People and Nature on Home Front and Battlefield, 1861-1865," in *The Blue, the Gray, and the Green: Toward an Environmental History of the Civil War*, ed. Brian Allen Drake (Athens, Georgia: The University of Georgia Press, 2015), 52–66; Wiley, *Billy Yank*, 112; Kathryn Shively Meier, *Nature's Civil War: Common Soldiers and the Environment in 1862 Virginia* (Chapel Hill: University of North Carolina Press, 2013), 1-15. For more on disease and Union military casualties, see Paul E. Steiner, *Disease in the Civil War: Natural Biological Warfare in 1861-1865* (Springfield, IL: Charles C. Thomas, Publisher, 1968) and Andrew McIlwane Bell, *Mosquito Soldiers: Malaria, Yellow Fever, and the Course of the Civil War* (Baton Rouge, Louisiana: Louisiana State University Press, 2010

667 Charles Smart, *The Medical and Surgical History of the War of the Rebellion (1861-1865)*, 3, 1 (Washington: Government Printing Office, 1888), 547; William A. Hammond M.D., *A Treatise on Hygiene: With Special Reference to the Military Service* (Philadelphia: J. B. Lippincott & Co., 1863), 508.

Surgeons also used sweetened condensed milk to treat the near-inevitable secondary infections that afflicted soldiers wounded in combat, albeit with less satisfactory results. When Private "James M-----" of the 14th New Jersey sustained a gut wound during the Battle of Winchester, Virginia, that spilled fecal matter, along with billions of bacteria, into his peritoneal cavity, surgeons placed him on a diet of milk punch and farina. Despite this nutritional intervention, Private "M-----" died, most likely from complications of bacterial sepsis. Another private, "T. McC-----," suffered a similar fate. Days after a bullet shattered his humerus during the Battle of Culpepper Courthouse, the private developed a life-threatening gangrenous infection. Surgeons excised necrosed bone fragments and fed him the "best possible diet," including milk punch. Yet he succumbed to the infection ten days later. And yet, other Union soldiers who received near-identical treatment lived. For example, Private Joseph Brown of the 3rd Michigan not only survived a gunshot wound to the thigh received during the Battle of Second Bull Run, but also a subsequent gangrenous infection that caused his leg to swell and emit a "fetid odor." Brown's surgeon gave equal credit to surgery to excise necrosed bone fragments and "concentrated nourishment" -- milk punch, eggs, and beef tea -- for saving the private's life. A soldier shot through the rectum during the Battle of Cold Harbor, Private S. Denegan of the 58th Massachusetts took milk punch to counter a secondary infection and chronic diarrhea. By December, surgeons declared Denegan well and granted him a formal medical discharge from the army.[668]

Likely sweetened condensed milk did help, although not because it possessed any antibiotic properties. Rather, the product performed two vital nutritional functions: It fed the immune system, increasing the likelihood that sick Union soldiers' bodies could mount an

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[668] Joseph K. Barnes and George A. Otis, *The Medical and Surgical History of the War of the Rebellion. Part II*, vol. II (Washington: Government Printing Office, 1877), 67, 252-43.

effective defense against disease-causing microorganisms; and it replenished glucose and fat lost to hypermetabolism, which was no less a consequence of a serious illness than it was of battlefield injuries. Absent modern antibiotics, sweetened condensed milk represented one of the best defenses against disease available to Union soldiers short of exposure avoidance. At the very least, it did no harm, which is more than could be said for the toxic calomel, purgatives, blistering agents, and other so-called medicines that made up the nineteenth-century military medical toolkit.[669]

From almost the moment a Union soldier's body detected the presence of dangerous microorganisms (or antigens), it mobilized an immune response to locate, attack, and destroy the invaders. It began when the soldier's lymphoid organs -- the adenoids and tonsils, thymus, spleen, lymph nodes, Peyer's Patches (lymphatic tissue located in the small intestine), and appendix – released millions of white blood cells into his bloodstream and lymphatic system. Some of these cells, known as B lymphocytes, specialized in the location and destruction of bacteria via the release of antibodies that directed phagocytes -- another specialized white blood cell -- to attack and devour the invaders. Others, known as T lymphocytes, bound themselves to cells that harbored viruses and delivered a lethal chemical attack. Aiding B and T lymphocytes and phagocytes in the offensive were a series of twenty-five inactive complement proteins that circulated through the soldier's bloodstream. On colliding with antibodies, these proteins started a chain reaction that punctured and killed infected cells. This process continued until all the invaders were destroyed.[670]

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[669] Humphries, *Marrow*, 26-27; Schroeder-Lein, *Encyclopedia*, 248; Flannery, *Civil War Pharmacy*, 140.

[670] U.S. Department of Health and Human Services National Institutes of Health, *Understanding the Immune System: How It Works*, 2003.

All of this required a great deal of energy. A sick Union soldier's B and T lymphocytes derived their energy from four sources: fatty acids or lipids stored in his adipose tissue; glutamine, an amino acid that drove protein synthesis; ketone bodies, a group of three water-soluble molecules produced in his liver; and glucose, which was also produced and stored in his liver. Of these, however, glucose proved the most important. This simple sugar provided the soldier's T and B lymphocytes with most of the energy that they needed, on encountering antigens, to expand in size, commence reproducing via a process known as proliferation, and attack and/or kill the invaders.[671] Without question, sweetened condensed milk delivered a substantial dose of glucose to sick Union soldiers' immune systems. Recall that a standard, one-quart can of the product offered about 108 grams (or about 988 calories) of sugar, most of it sucrose, or refined white sugar. Assuming that their small intestines were intact and functioning, sick soldiers' bodies would have converted sucrose into glucose for immediate use by T and B lymphocytes.

Sick soldiers' immune systems also needed vitamin A, a micronutrient common to milk, liver, eggs, kidneys, and green, leafy vegetables, vitamin A performed a variety of functions: Promoting the secretion of oral and intestinal mucus that barred the entry of antigens; regulating the growth and development of T and B lymphocytes, phagocytes, and other specialized white blood cells; inducing T lymphocytes to migrate from the bone marrow to the lymphoid organs; maintaining bone marrow homeostasis; and contributing to the synthesis of immunoglobulins -- that is, the antibodies that order T lymphocytes and phagocytes to attack and destroy antigens -- by B lymphocytes. Vitamin A has also been shown by modern studies to reduce morbidity and

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[671] Isabelle Wolowczuk et al., "Feeding Our Immune System: Impact on Metabolism," *Clinical and Development Immunology*, February 25, 2008, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2266987/; U.S. Department of Health and Human Services National Institutes of Health, *Understanding the Immune System*.

mortality among children afflicted with measles, pneumonia, tuberculosis, diarrhea, malaria, and mumps. All were common to Union military camps and hospitals. All would have been treated, to one extent or another, with milk punch made with sweetened condensed milk.[672]

Likely, Borden's Sweetened Condensed Milk offered sick Union soldiers with a modest dose of immune-boosting vitamin A. In his 2005 thesis, "The Civil War Diet," the historian Matthew Brennan noted that vitamin A is heat-labile -- that is, it breaks down when exposed to high temperatures. If so, Gail Borden's patented condensing process, which saw workers boil fluid milk not once but twice before sealing it in tin cans, would have destroyed the fluid's vitamin A content, or else reduced it to miniscule, nutritionally inconsequential levels. Indeed, Brennan claimed as much, insisting that Borden's Milk offered Union soldiers precious little vitamin A.[673] Yet he may have been mistaken. In his 1988 *Principles of Food Chemistry*, the food scientist John M. deMan noted that vitamin A is heat stable, so long as it is shielded from ultraviolet light, oxygen, and substances that promote lipid oxidation, such as copper and iron. Ignorant though he was of vitamins and their relative heat lability or stability, Gail Borden Jr. did much to protect the vitamin A content of his sweetened condensed milk. He insisted that his suppliers use buffalo robes or blankets to keep fluid milk cool and dark while in transit. Moreover, his workers held the milk in a vacuum before and during processing, reducing the

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672 Brennan, "Civil War Diet," 46, 107; Richard D. Semba, "Vitamin A as 'Anti-Infective' Therapy, 1920-1940," *The Journal of Nutrition* 129, no. 4 (April 1999): 783–91; "The Story of Vitamin A," Johns Hopkins Bloomberg School of Public Health: News, 2003, https://www.jhsph.edu/news/stories/2003/sommer-vita.html; Zhiyi Huang et al., "Role of Vitamin A in the Immune System," *Journal of Clinical Medicine* 7, no. 9 (September 2018): 258; Rene F. Najera, "Vitamin A and Measles," The History of Vaccines: An Educational Resource by the College of Physicians of Philadelphia, March 12, 2019, https://www.historyofvaccines.org/content/blog/vitamin-a-measles.
673 Brennan, "Civil War Diet," 69, 79, 87, 93, 107.

chance that copper and iron vacuum pans would react with oxygen to degrade vitamin A. It is therefore plausible that the micronutrient survived.[674]

Likely the vitamin A content of Borden's Milk offered some defense against the measles virus, Paramyxovirus, genus *Morbillivirus*, which took advantage of overcrowded conditions to race through Union camps and hospitals, striking down soldiers, civilian aid workers, refugees, merchants, and assorted camp followers. Most at risk were those who hailed from isolated agricultural communities and therefore lacked immunity acquired during childhood. However, the virus also targeted those suffering from malnutrition and/or a compromised immune system. Soldiers and civilians afflicted with mild cases suffered from conjunctivitis (inflammation of the eyes) and a host of flu-like symptoms: fever, sore throat, coughing, runny nose, vomiting, and diarrhea. In more extreme cases, the virus attacked the patient's lungs and brain, causing measles-associated pneumonia and/or encephalitis (inflammation and swelling of the brain) that killed the patient outright, or in the best case scenario, did lasting damage to their vision, hearing, or cognitive abilities (or some combination of the three).[675] Lacking preventative vaccines, Union surgeons treated symptoms as they appeared with the prepared drugs and foods at hand. This included regular doses of milk punch made with fluid or canned sweetened condensed milk.

At least one case study included in the voluminous *Medical and Surgical History of the War of the Rebellion* suggests that the vitamin A content of milk punch (in this case, made from raw as opposed to condensed milk) may have contributed to the recovery of Union soldiers afflicted with the measles virus (Paramyxovirus, genus *Morbillivirus*).[676] While camped near

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[674] John M. deMan, *Principles of Food Chemistry*, 3rd ed. (New York: Springer Science & Business Media, 1999), 355–61.

[675] Patricia Clayton-LeVasseur, *What You Need to Know About Measles* (Santa Barbara, California: ABC-CLIO, 2022), XVII, 2, 7, 42, 65, 67, 74, 102; Alfred W. Crosby, "Virgin Soil Epidemics as a Factor in the Aboriginal Depopulation in America," 33, no. 2 (Apr. 1976): 292-293.

[676] Clayton-LeVasseur, *Measles*, 35.

Grand Rapids, Michigan, in May 1861, 100 newly-minted soldiers of the 3rd Michigan Infantry contracted measles. Assistant Surgeon Zenas E. Bliss treated the men, whose symptoms included bronchial irritation, but nothing "unusual" for the disease, with milk punch, wine whey, laxatives, tartarized antimony (an emetic that caused vomiting), morphine, beef tea, and mucilage. All recovered save one, who died of a "protracted "pulmonary inflammation" that Bliss considered unrelated to the disease.[677] Looking back, it is impossible to know whether or not the vitamin A content of the milk punch was responsible for reducing morbidity and mortality among Bliss's patients. However, considering that 4,000 Union soldiers out of 67,000 known to have contracted the disease died of measles, the recovery rate among the Michigan volunteers is striking.[678] There are, unfortunately, no documented cases of Union surgeons using Borden's Milk to treat measles patients. Considering the ubiquity of the product in the Eastern and Western theaters by spring of 1863, it is reasonable to assume that they did, with similar positive effects.

The vitamin A content of Borden's milk would also explain Union caregivers' observation that milk punch checked diarrhea among Union soldiers. A study conducted in Omdurman, Sudan, in the 1980s discovered a direct cause-and-effect relationship between vitamin A supplements and decreased incidence of diarrhea among at-risk children.[679] A similar study of at-risk children in Mexico City produced the same results, indicating that vitamin A

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677 Zenas E. Bliss, "Second Extract from a Narrative of His Services in the Medical Staff. By Surgeon Zenas E. Bliss, U. S. Volunteers," in *Medical and Surgical History of the War of the Rebellion*, ed. United States Surgeon General's Office, vol. 1 (Washington, D.C.: Government Printing Office, n.d.), 85.

678 Michael B. A. Oldstone, *Viruses, Plagues, & History: Past, Present, and Future* (New York: Oxford University Press, 2010), 146–47.

679 H.E. el Bushra et al., "Interrelationship Between Diarrhea and Vitamin A Deficiency: Is Vitamin A Deficiency a Risk Factor for Diarrhea?," *The Pediatric Infectious Disease Journal* 11, no. 5 (May 1992): 380–84.

supplements reduced instances of watery diarrhea.[680] In fact, the World Health Organization recognizes vitamin A as an effective means of treating diarrhea.[681] Where vitamin A has been shown to check diarrhea, both sucrose and glucose added to electrolyte solutions have been used to successfully treat small children suffering dehydration associated with diarrhea (glucose being the more effective of the two).[682] Once more assuming that the vitamin A in raw milk survived Gail Borden's condensing process, it is plausible that the micronutrient worked alongside sucrose to check soldiers' diarrhea, as claimed by Union surgeons. Of course, any such claim must be weighed alongside the known negative consequences of feeding dairy to those suffering gastrointestinal distress.

In fact, *any* curative benefits attributed to sweetened condensed milk must be weighed against Union soldiers' overall vitamin A levels at the moment they received treatment. Generally speaking, Union soldiers who reported sick to military hospitals or developed secondary infections suffered from vitamin A deficiency before taking their first sip of milk punch. This may be attributed to their diet. Regular army rations offered little access to vitamin A-rich foods, such as milk, liver, kidney, eggs, fish oils, and green leafy vegetables. Individual soldiers made up for this by foraging for sweet potatoes and/or purchasing beef liver, eggs, and sweetened condensed milk from civilian merchants. Yet this deficiency remained a problem for Union armies throughout the conflict, as evinced by reports of night blindness, a disorder caused by insufficient vitamin A consumption.[683] The sweetened condensed milk used by Union

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680 K.Z. Long et al., "Supplementation With Vitamin A Reduces Watery Diarrhoea and Respiratory Infections in Mexican Children," *The British Journal of Nutrition* 97, no. 2 (February 2007): 337–43.

681 A Imdad et al., "Vitamin A Supplementation for Preventing Morbidity and Mortality in Children From 6 Months to 5 Years of Age," World Health Organization, E-Library of Evidence for Nutrition Actions (eLENA), n.d., https://www.who.int/elena/titles/review_summaries/vitaminA-children/en/.

682 World Health Organization, "Readings on Diarrhoea: Student Manual" (Geneva: 1992), 17.

683 Brennan, "Civil War Diet," 106-107.

surgeons only ever provided low doses of vitamin A. Diluted with water and divided into one-pint to one-quart portions by aid workers, a standard can of sweetened condensed milk would have offered individual soldiers between 125 and 250 IUs per dose-- far less than a single 200,000 IU capsule used by modern physicians.[684] But then, a sick soldier's body would have accumulated vitamin A in his liver, such that repeated doses of milk punch would have made up for the deficit, albeit gradually.[685]

This chronic vitamin A deficiency notwithstanding, soldiers who reported sick to Union military hospitals would still have derived immediate, tangible benefits from milk punch made with sweetened condensed milk. Soon after drinking milk punch, their bodies would have converted the concoction's sucrose to glucose for use in feeding the T and B lymphocytes and phagocytes responsible for locating, attacking, and destroying antigens. This rather straightforward chemical reaction helps explain Surgeon General William Hammond's observation that milk punch helped cure the "low types" of fever that afflicted Union soldiers confined in military encampments.[686] Whatever the specific cause, fever occurs when the hypothalamus detects an active immune response and raises body temperature to assist lymphocytes in destroying heat-sensitive bacteria and viruses. As with any of the autonomic, adaptive processes that the body uses to maintain homeostasis, fever accelerates the metabolism and hence, the consumption of energy. Almost any food rich in protein, fat, and carbohydrates –

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[684] "Basic Report: 01095, Milk, Canned, Condensed, Sweetened," United States Department of Agriculture, Agricultural Research Service: Nutritional Nutrient Database for Standard Reference Legacy Release, April 2018, https://ndb.nal.usda.gov/ndb/foods/show/01095?fgcd=&manu=&format=&count=&max=25&offset=&sort=default&order=asc&qlookup=01095&ds=&qt=&qp=&qa=&qn=&q=&ing=.

[685] Food and Nutrition Board Institute of Medicine Panel on Micronutrients, Subcommittees on Upper Reference Levels of Nutrients and of Interpretation and Uses of Dietary Reference Intakes, and the Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, *Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc* (Washington, D.C.: National Academy Press, 2001), 94.

[686] Hammond, *Treatise*, 508.

for example, the beef tea, farina, and soft bread served alongside milk punch -- would have replenished energy stores, giving a Union soldier's immune system an edge in mounting an effective response. However, their bodies made faster work of converting sucrose into glucose than it did slow-burning fats and carbohydrates, placing sweetened condensed milk on top as a source of immediate energy.[687]

By contrast, Union soldiers who developed wound-related secondary infections derived fewer immediate benefits from drinking milk punch made with sweetened condensed milk. Recall that soldiers who suffered serious combat injuries entered into a hypermetabolic state of two- to three-week's duration, during which their bodies burned glucose, fatty acids, carbohydrates, and proteins, at an accelerated rate. Consequently, the activation of glucose-hungry lymphocytes by secondary infection only increased the nutritional burden placed on hypermetabolic soldiers' already depleted bodies. It is difficult to know how a wounded Union soldier's body would have apportioned the glucose derived from sweetened condensed milk under these circumstances. Two scenarios seem likely: It divided glucose among all systems in an attempt to repair damaged tissues, locate and eradicate invasive microorganisms, and restore/maintain homeostasis; it shunted glucose to the system or systems most in danger of failure, denying it to others that were no less in need. Either (or neither) being true, it is clear enough that hypermetabolism associated with traumatic injury, when coupled with the immune response to serious secondary infection, created an enormous energy drain that would have been difficult for the sucrose in sweetened condensed milk to replace. This, perhaps, accounts for the

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[687] Mark Fischetti, "Fact or Fiction?: Feed a Cold, Starve a Fever," Scientific American, January 3, 2014, https://www.scientificamerican.com/article/fact-or-fiction-feed-a-cold/.

product's poor showing in treating wounded soldiers who were afflicted with gangrene and the like.[688]

There is little evidence that Union surgeons and civilian aid workers used sweetened condensed milk as a prophylaxis against camp diseases and secondary infections. Thousands of pages of receipt books, official reports, and correspondence compiled by the United States Sanitary Commission reveal that relief agents issued the product to Union surgeons, stewards, nurses, and clergy for use in treating those who reported sick or injured to one of the regimental and divisional hospitals that dotted Union military encampments, or else to one of the hospital ships that plied the Mississippi and Ohio Rivers and/or moved along the Gulf and Atlantic Coasts. While it did occur that agents gave the occasional can to Union officers or individual soldiers deemed worthy of "special relief" (a term that went undefined in Sanitary Commission documents), such cases were rare. It is safe to assume that surgeons and sanitarians thought of sweetened condensed milk as possessing curative and palliative, rather than preventive properties.[689]

The sick endured an evacuation process similar to that endured by the wounded. Civilian aid workers cared for these men in the same manner as those who fell wounded in combat: by feeding them liberal doses of milk punch. One such incident occurred on May 5, 1862, near Yorktown, on the Virginia Peninsula. An officer of the United States Sanitary Commission, identified only as "M.," took charge of an unspecified number of typhoid patients who had been left behind by their regiments the previous night as the Army of the Potomac advanced to capture

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[688] For examples of Union gangrene patients who died following treatment with milk punch, see the cases of Private S. Dick, Private N. Hollenbeck, Corporal P. Lovell in Joseph K. Barnes, *The Medical and Surgical History of the War of the Rebellion (1861-1865)*, 3, 2 (Washington, D.C.: Government Printing Office, 1883), 6, 430, 448.

[689] "Supplies Received and Forwarded," 1863 October - 1865 June**.** United States Sanitary Commission, Washington D.C. Archives, box 212, New York Public Library Archives.

Williamsburg. With the "roar of artillery" audible in the background, M. discovered that the sick men had been carried by ambulance over "frightful swamp corduroy roads" to the wharf and there left, untended and exposed to the rain, to await evacuation. Adding to their misery, none of the sick soldiers had eaten for at least twenty-four hours. "It was obvious," M. wrote, "that the men were, many of them, very ill. Some were, in fact, in a dying state." M. later recalled, "To get proper food for all, decently cooked and distributed, has given me more concern than anything else." Taking them aboard the *Ocean Queen*, a group of women fed them gruel and then served beef tea and milk punch "to all who required it." It was important, she later recalled, to provide the sick with "every essential that could be given them in their own homes."[690]

Had milk punch made with Borden's Milk offered none of the aforementioned health benefits, it would still have served a useful purpose, if only because it gave a morale boost to civilian aid workers, who *believed* in its power to heal sick and wounded Union soldiers. Though they seldom faced the prospect of grievous wounds or violent death, Union caregivers witnessed untold horrors in performing their duties. On the morning of June 1, 1862, for example, the civilian nurse "A." watched as train cars rolled into the soon-to-be-abandoned Union wharf at White House, Virginia, bearing Union soldiers wounded during the Battle of Fair Oaks. For unknown reasons, those in charge lifted the shattered men from the cars and abandoned them on the ground. There, A. noted, they lay on litters, "gasping in the fervid sun," with no one but the civilian aid workers on hand to tend to their needs. Employing the understatement common to Americans of the era, she wrote only, "I do not describe such a scene." As the day wore on, the situation at the landing deteriorated. Trains continued to arrive, each filled to capacity with dead and dying men. The mangled soldiers reeked of sweat, feces,

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[690] Frederick Law Olmsted, *Hospital Transports. A Memoir of the Embarkation of the Sick and Wounded from the Peninsula of Virginia in the Summer of 1862* (Boston: Ticknor and Fields, 1863), 29–37.

blood, urine, and vomit. Their untended wounds boiled with maggots. The men shrieked and moaned as they were lifted from the cars. To function under such circumstances took a great deal of nerve. A. recalled that even the "strong men" among the team of relief agents wavered, turning away from the revolting scene to vomit before resuming the grim task of feeding the wounded and preparing them for evacuation.[691]

Reports and correspondence compiled by civilian aid workers abounded with similar stories. For weeks following the Battle of Gettysburg, the aforementioned nurse Woolsey watched as a grim procession of wounded soldiers arrived at the Gettysburg rail depot, seeking evacuation to general hospitals in Harrisburg, Pennsylvania, or Baltimore, Maryland. The "scenes of suffering" that greeted Woolsey each day were enough to render her "morbid and depressed."[692] Another nurse who served in Gettysburg, Emily Bliss Thacher Souder, wrote that the sights, sounds, and smells that greeted her arrival in Gettysburg "beggar[ed] description." Indeed, the "groans, the cries, [and] the shrieks of anguish" emerging from a nearby field hospital at night were so "awful indeed to hear," she later wrote, that she buried her head in her pillow in a vain attempt to shut out the horrible sounds.[693] The following November, the Reverend Andrew Cather traveled from the Union supply depot at City Point, Virginia, to minister to soldiers of the Army of the Potomac, then besieging Petersburg. Overall, Cather was touched and reassured by the "Christian heroism" on display among the troops that he met. However, one moment gave him pause. On reaching Deep Bottom, scene of a recent battle, Cather beheld a terrible sight: row upon row of Union wounded arrayed on the ground, their clothing stiff with dried blood, many of them shivering with fever or from exposure (or both);

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691 Olmsted, *Hospital Transports*, 105-106.
692 Brockett and Vaughan, *Woman's Work*, 324.
693 Thacher Souder, *Leaves From the Battlefield*, 28

nearby, within sight of the wounded men, surgeons amputated arms, legs, hands, and feet. Similar to Thacher Souder, Cather noted that the scene "beggard description," with the "'groans and dying strife' fill[ing] the heart with horror."[694]

Hard evidence does exist that sweetened condensed milk bolstered aid workers' morale. Among the nurses who cared for Union wounded as they waited for evacuation from the Gettysburg rail depot during the summer of 1863, nurse Woolsey derived an emotional boost from serving milk punch to the battered, hungry men. "And then the milk," she wrote, "particularly if it were boiled and had a little whiskey and sugar . . . how good it all was, and how lucky we felt ourselves in having the immense satisfaction of distributing these things."[695] To read the "War Journal" of nurse Abby Hopper Gibbons is to encounter the frustration that she faced in feeding and caring for sick and wounded Union soldiers and refugees, as well as the relief that she felt on receiving boxes of sweetened condensed milk. On one occasion in 1864, Gibbons had nothing on hand to feed a group of bedraggled "contrabands" just arrived in Washington from Virginia. In a deeply human moment, she vented her spleen, shouting, "These people *must be fed*, and those who refuse, will have to pay the penalty; your houses shall be marked!'" Contrast this with another occasion, on which Gibbons took charge of "cadaverous looking" Union soldiers released from captivity in Richmond, Virginia. Of all the supplies on hand, Gibbons singled out the "consecrated milk" as a "god send."[696] Such praise was common. On writing from City Point, Virginia, to request additional supplies in March 1863, a nurse

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694 "Letter from City Point, Rev. A. Cather," *The Sanitary Commission Bulletin* 1, no. 25, 770.

695 Brockett and Vaughan, *Woman's Work*, 324, 327–33.

696 Sarah Hopper Emerson, ed., *Life of Abby Hopper Gibbons, Told Chiefly Through Her Correspondence* (New York: G.P. Putnam's Sons, 1897), 296, 362, 364.

identified only as "Sally" noted, "Condensed milk, we *always* want."[697] Writing from Gettysburg four months later, the nurse Emily Bliss Thacher Souder dubbed sweetened condensed milk "an invaluable thing" and noted, "Condensed milk and canned meats are what we depend upon in this emergency."[698]

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Beginning with Bell I. Wiley's 1952 study of common Union fighting men, *The Life of Billy Yank*, historians have recognized that soldiers who took proactive steps to look after their own physical and mental wellbeing tended to enjoy better health. To that end, Union soldiers' "self-care regimens," to borrow a term coined by the historian Kathryn Shively, included any number of mundane activities: washing the dirt from their bodies; boiling their uniforms and underdrawers to kill lice; scalding plates, dishes, and utensils; reading and writing letters; building semi-permanent shelters to protect against the elements; seeking medical care from friendly civilians; falling out on marches to rest and recover from illness; staging impromptu holiday celebrations; or even playing rounders (a game similar to modern baseball) or card games with their comrades. It also included buying (or in some cases, stealing) canned goods and other delicacies from sutlers or asking – indeed, begging -- friends and family to ship them south via one of the private parcel services that moved care packages from the home front to Union military camps. All of these activities served in one way or another to fortify soldiers against camp diseases and infections and/or stave off "melancholy," the term used by nineteenth-century Americans to refer to homesickness and depression.[699] However, Borden's Milk

[697] Sarah Hopper Emerson, *Life of Abby Hopper Gibbons, Told Chiefly Through Her Correspondence*, Vol. 2 (New York: G.P. Putnam's Sons, 1896), 2-4.
[698] Thacher Souder, *Leaves*, 24, 39, 47.
[699] Wiley, *Billy Yank*, 124-51; Shively Meier, *Nature's Civil War*, 1-15, 126-146. See also Katherine Shively Meier, "'No Place for the Sick': Nature's War on Civil War Soldier Mental and Physical Health in the 1862 Peninsula and Shenandoah Valley Campaigns," *The Journal of the Civil War Era* 1, no. 2 (2011): 176–206

occupied a unique place, for in addition to offering dietary and mood-altering benefits, it gave soldiers residing in the milk-poor, war-ravaged South an opportunity to practice the most comforting culinary rituals of home.

Borden's Milk offered the same nutritional benefits to (relatively) healthy soldiers that it offered to the sick and wounded. At the risk of needless repetition, each can of the sweet, syrupy substance offered calories derived from fat, protein, and sucrose, as well as micronutrients. The product's vitamin A would have boosted soldiers' immune systems, while the sucrose content would also have trigged the release of dopamine -- the so-called "feel-good hormone" -- into their bloodstreams, giving them a tangible, if short-lived, emotional boost.[700] If nothing else, condensed milk rounded out their diet, offering welcome culinary relief from the bland, even coarse protein- and carbohydrate-rich fare -- salt beef, salt pork, beans, hardtack, and desiccated (or in soldiers' parlance, "desecrated") vegetables -- that made up soldiers' daily rations.[701] Union soldiers used the product as they would have used fluid milk. In some cases, they mixed the product with toasted soft bread to make mush and milk. In other cases, they spooned it straight from the can and into their mouths, which is not unlike pouring and drinking a glass of new milk, straight from the cow. Among the most popular uses, and the one most commonly cited by historians, was the adding of condensed milk to the bitter black coffee that were a cornerstone of soldiers' daily rations as a condiment.[702] Indeed, it would be difficult to overestimate the importance that this simple culinary act played in the day-to-day lives and mental wellbeing of Union soldiers.

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[700] "Dopamine," Cleveland Clinic, 23 March 2022, https://my.clevelandclinic.org/health/articles/22581-dopamine.
[701] Brennan, "Civil War Diet," 33-34.
[702] Benjamin Williams Chidlaw, *The Story of My Life* (Philadelphia: Hurst, 1890), 253; Van Wyck, *A War to Petrify the Heart*, 46-47; Valenze, *Milk*, 178-87.

New Union recruits were often shocked to discover that there was no milk to be had for their coffee. The Union veteran Charles E. Davis of the 13th Massachusetts recalled one such newcomer who, soon after reaching camp, asked his comrades where to acquire milk for his coffee. As young men will, Davis and his fellow veterans engaged in some good-natured hazing. That is, they directed the hapless fellow to the captain's tent, assuring him that the officer would point him in the right direction. Perhaps because he sympathized with the young man's milk hunger, perhaps because he had once fallen for a practical joke, the captain took pity on the recruit. In a gentle voice, he explained that "milk was not in the list of articles of diet provided by the government."[703] Looking back on their wartime experiences, many a Union veterans confessed to his own milk hunger on reaching his first camp while also dismissing it as a sort of passing weakness. Among them, the Union veteran Joseph Crowell wrote that "coffee without milk was not very palatable, at the start, but from that time on, for many, many months, the majority of these soldier boys never saw such a things as milk." He waved the matter off, insisting, "Milkless coffee isn't so bad when one is once used to it." The aforementioned Charles Davis made similar claims, noting that "most of us cared little about the deprivation of milk" once they had adjusted to black coffee. [704] In his well-known memoir, *Hardtack and Coffee*, the Union veteran John Billings noted that there were too few dairy cows present in war-torn Virgina to furnish soldiers with even a modest supply. But then, he "doubt[ed] whether one man in ten, before the war closed, would have used the lactic fluid in his coffee from choice."[705]

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703 Charles E. Davis, *Three Years in the Army. The Story of the Thirteenth Massachusetts From July 16, 1861 to August 1, 1864* (Boston: Estes and Lauriat, 1894), 131-132.
704 Crowell, *Young Volunteer*, 19.
705 John Davis Billings, *Hardtack and Coffee: Or the Unwritten Story of Army Life* (Boston: George M. Smith & Co., 1888), 124-125.

In fact, Union soldiers took every opportunity to acquire sweetened condensed milk for use in coffee (or simply to eat). Some requested cans from home.[706] Concerned parents did their best to provide, with some even learning to make and bottle a homemade version of sweetened condensed milk rather than force sons, brothers, and fathers to do without.[707] Others purchased the product from civilian merchants or sutlers at inflated prices. The Union veteran Cullen Aubrey recalled that the exhausted, demoralized soldiers of the Army of the Potomac consumed vast quantities of canned milk and peaches purchased from sutlers following Union General Ambrose Burnside's disastrous "'Stuck in the mud' march" of December 1862. Indeed, the Union veteran C.W. Bardeen noted that demand for Borden's Milk was so great that soldiers had to "strike a sutler when he first opened up" if they hoped to buy the product for 75 cents per can.[708] Still others resorted to theft. A soldier in the 148th Pennsylvania made a sport of asking sutlers to retrieve "some small trinket in the remotest corner of the establishment, and while the sutler's back was turned . . . transfer cans of condensed milk . . . into the enormous . . . pockets of his army overcoat." Another tactic described by the Union veteran J.W. Muffly saw soldiers cut the ropes and collapse sutlers' tents and then take advantage of the chaos to make off with cans of condensed milk.[709]

However they came by the product, soldiers used condensed milk to satisfy their milk cravings and stave off melancholy. In his postwar memoir, Union veteran Private Leander Stillwell recalled spending a miserable night outside Murfreesboro, Tennessee, huddling on the

[706] Van Wyck, *A War to Petrify the Heart*, 46-47.
[707] "A Card," *Cleveland Morning Leader*, 14 April 1862; "Condensed Milk," *Lewistown Gazette*, 23 April 1862; "Condensed Milk," *Union County Star and Lewisburg Chronicle*, 25 April 1862.
[708] Aubrey, *Recollections*, 105; C.W. Bardeen, *A Little Fifer's War Diary* (Syracuse, NY: C.W. Bardeen, Publisher, 1910), 47.
[709] Muffly, *The Story of Our Regiment*, 516.

cold ground as military engineers worked to repair a break in the railroad tracks. Determined to raise his friend's sagging spirits, Stillwell's messmate, Bill, urged him to focus on delicacies to come: "This is a little tough, Stillwell, but just think of that bully dinner we'll have when we get to Murfreesboro! You've your can of condensed milk and I've mine of lobsters; we'll have coffee with milk in it, and then, with some hard-tack, we'll have a spread that will make up for this." Such practices extended to the civilians who traveled south to assist the African American refugees. In May 1865, a group of teachers employed by the U.S. Freedman's Bureau struggled to make do without a supply of their favorite comfort food. Unable to stomach another meal of beans, salt pork, hard bread, and black coffee, the New England native Emily Bliss wished aloud, through tears, "that the grave [she] saw hoed out at the church," during an afternoon walk "was to lay her in." A makeshift dinner of sweetened condensed milk, butter, and cornmeal bartered from a civilian merchant by her friend and fellow teacher, Mary Ames, carried Emily through her moment of emotional and dietary crisis. Afterward, she "concluded to live a while longer."[710]

More than a mere condiment, Borden's Milk played a starring role in Union soldiers' impromptu celebrations. In a December 12, 1862, letter to his parents, Corporal Richard T. Van Wyck of the 150th New York Infantry, then stationed at Camp Belgar, Maryland, described one of the rare treats afforded soldiers: a care package laden with condensed milk, tobacco, fruit preserves, and other good things, sent to one of his messmates by a family member back home. Thankful for any opportunity to alleviate the boredom of camp life, Van Wyck and his comrades staged a Christmas feast. The men crowded into a tent and took their places, elbows bumping,

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710 Leander Stillwell, *The Story of a Common Soldier of Life in the Civil War, 1861-1865* (Erie, Kansas: Franklin Hudson Publishing Company, 1920); Mary Ames, *From a New England Woman's Diary in Dixie in 1865* (Springfield, Massachusetts: Plimpton Press, 1906), 32–33.

around a board that served as a makeshift table. Van Wyck presided over the ceremonies. He began by carving and handing out portions of two chickens purchased from a free African American man who peddled goods outside Camp Belgar. However, the real treat came afterward, when the soldiers divided the contents of the box. A pious man, Van Wyck abstained from the tobacco. He did, however, help himself to a share of the "Preserves, Cake, Butter, [and] Concentrated milk." His stomach full, his sweet-tooth satiated, his boredom relieved, at least momentarily, Van Wyck concluded his letter with an appeal to his parents for a similar box. Lest he be perceived as extravagant, however, he added, "my stockings (Woolen) would be very acceptable"[711]

Union officers staged similar events, and for similar reasons. One such celebration, described as a "sumptuous, palatial repast" by fifer Cullen Aubrey, who helped with preparations, took place at Belle Plain, Virginia, during the winter of 1862, following the disastrous Battle of Fredericksburg and the even more disastrous -- at least as far as morale was concerned -- "Mud March." To prepare for the feast, officers of the "Old Sixth" (better known as the "Iron Brigade") first secured use of a tent from the medical department and then sent a sutler to Washington to purchase "a large supply of condensed milk, sardines, cheese, bread, ham and wet groceries." This done, they sent invitations to the entire officer corps of the brigade. They made clear in doing so that "a regret sent in would subject the sender to a peremptory challenge."

Of all the good things served at the party, the condensed milk appears to have done the most to lift the officers' spirts and restore morale. Over forty years later, Aubrey recalled the "novel scene" presented by cooks brewing milk punch in two iron kettles over a "huge fire." He

[711] Van Wyck, *A War to Petrify the Heart*, 46-47.

even recalled the recipe: "condensed milk and weak whiskey, from the U. S. commissary, flavored with nutmeg." This, combined with the "royal repast" of boiled ham and bread, hot coffee, cheese, and cakes was deemed "better than anything we had sat down to since we left our bright homes in Wisconsin." He devoted the most attention, however, to describing the alcohol-fueled mirth and merriment that came after. Holding cups of hot milk punch aloft, ignoring "the wreck and the tables," the assembled throng shouted a series of toasts: to the Union, to the President, and of course, to the "popular generals." Toasts gave way to songs, among them a rendition of the "Red, White & Blue" that "would have reflected credit on an organized and well trained male chorus," and a good-natured roast of the singers' first colonel, titled "Old Robinson Crusoe." The lone solemnity came near the end of the party when the officers, standing shoulder to shoulder, drank a final round of milk punch to their fallen comrades in respectful silence. Overall, Aubrey wrote, "The object was accomplished, [and] the gloom dispelled."[712]

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It is tempting to declare the Union "milk lift," and the Borden's Milk that made it possible, an unqualified success. Certainly, the product did much to reduce the physical and mental suffering of Union soldiers and caregivers and with it, the horror of a conflict that killed or maimed about 1.5 million Americans and maimed countless others.[713] And yet, an accurate retelling of the story requires one to acknowledge that Borden's Milk was an imperfect product, made and used by imperfect people. Carelessness in canning and handling exposed the product to yeasts, excess heat, and other agents of spoliation. Given the great cost of buying and shipping Borden's Milk, and the role that it played in healing sick and wounded soldiers, the loss

[712] For more on the "Iron Brigade," see Alan T. Nolan, *The Iron Brigade: A Military History*, (Bloomington: Indiana University Press, 1961); Aubrey, *Recollections*, 122-125.
[713] "Civil War Casualties," American Battlefield Trust, n.d., https://www.battlefields.org/learn/articles/civil-war-casualties.

of even a single can had a real, life-and-death significance for those who depended on the product as a military medical supply. More troublesome and dangerous than spoilage were the biological contaminants that lurked everywhere that Union caregivers undertook the treatment of their patients. The battlefields and field hospitals that were the locus of triage care were almost unimaginably filthy. Although the sugar used as a preservative and alcohol added in making milk punch would have had some antibiotic properties, Borden's Milk likely served as yet another route by which dangerous microorganisms entered soldiers' digestive systems, afflicting them with one of several deadly gastrointestinal disorders that claimed far more lives than combat during the conflict.

Although it is difficult to find evidence, at least some of the Borden's Milk that Union caregivers and soldiers depended on spoiled while in transit. The smallest puncture in the tin cans, caused by stevedores and teamsters who bumped, banged, and crushed the boxes, would have permitted the entry of rancidity-causing bacteria. Moreover, the yeasts that survived condensing and canning would have emitted gasses that caused cans to swell and burst. Furthermore, storing the milk in extreme temperatures -- for example, next to a steamship boiler or in a freezing, unheated rail car -- would have damaged the cans and their precious contents.[714] Manufacturing errors were also a problem. In a January 23, 1864, letter to the New York Condensed Milk Company, R.M. Lewis of the Philadelphia branch of the United States Sanitary Commission, complained that 14 cans of Borden's milk purchased for military medical relief were leaking milk and thus, unusable. He blamed the problem on the poor quality of tin used in the cans, which he described as so thin that the "pressure of the hand will open The Seam." Lest the company doubt his claims, Lewis noted that the cans showed "no marks of rough usage" by

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[714] Otto Frederick Hunziker, *Condensed Milk and Milk Powder* (La Grange, Ill.: Published by the Author, 1918), 14, 156-158, 358, 359.

the railroad that moved them to Philadelphia. It is unclear whether the NYCMC replaced the defective cans, although it seems likely that Gail Borden would have done so (assuming that he knew). Either way, the problem did nothing to dissuade Lewis from buying more Borden's Milk. Records indicate the Lewis and the Philadelphia Commission ordered 50 dozen, 2-lb. cans on February 18, 1864, and an identical-sized amount less than one month later on March 10, 1864.[715]

Given the scientific limits of the era, evidence that Union caregivers served contaminated Borden's Milk to sick and wounded soldiers is nonexistent. However, it could not have been avoided. To understand why, one need only consider conditions at the Union Second Corps Field Hospital, which stood approximately four miles away from the Gettysburg battlefield in July 1863, and mirrored the conditions found at field hospitals scattered across the embattled South. Clouds of emerald-green blowflies swarmed over everything: gangrenous wounds; corpses laid out near the hospital for burial; macabre piles of hands, feet, arms, and legs amputated by Union surgeons; manure deposited by equine teams; latrines; soiled bedding and clothing. These same flies, their tiny feet swarming with bacteria, then danced over the utensils and open condensed milk cans that nurses used in preparing milk punch for the soldiers, as well as the pails, ladles and tin cups that they used to dispense milk punch to sick and wounded soldiers. Thunderstorms that began almost as soon as the battle ended washed tainted soil and infectious waste into local water sources. Indeed, the stream that Second Corps nurses depended on for water to dilute the Borden's Milk used in making milk punch for sick and wounded

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[715] R. M. Lewis for J. H. Wilson to New York Condensed Milk Company, Mr. Houk, 23 January 1864; R. M. Lewis to Augustus Klemm, 18 February 1864; R. M. Lewis to Augustus Klemm, 10 March 1864; United States Sanitary Commission Pennsylvania Archives, Philadelphia Agency, Volume I, box 5, New York Public Library Archives.

soldiers ran high with silt, human and animal waste, and blood. The air reeked of death and decomposition.[716]

Doubtless every Union field hospital in the vicinity of Gettysburg endured similar conditions. Union Surgeon William Bushrod Jackson of the Second Corps Hospital believed as much, noting that most every source of fresh water for miles around harbored "poisons" dangerous to human digestion.[717] Likely he was correct. During the three-day Battle of Gettysburg, approximately 150,000 soldiers and 72,000 horses and mules tramped back-and-forth across an ill-defined parcel of southeast Pennsylvania farmland measuring twenty-five-square miles (or more) in size.[718] Soldiers engaged in combat needed fresh water, not only to hydrate their and their draft animals' bodies, but also to swab black-powder residue and stray sparks from musket and cannon barrels in order to prevent fouling and/or misfires. Consequently, they drained springs and wells, both of which needed time to replenish. They also tracked human and animal waste into creeks and farm ponds as they bumped and jostled one another while filling up canteens. Were this not enough, wounded men covered in blood, urine, and feces (or some combination of the three) hobbled or crawled to any water source in their reach, desperate to slake the terrible thirst caused by hemorrhage. There they knelt or lay, swallowing great mouthfuls of the tainted water.[719]

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716 Maust, *Grappling With Death*.

717 Ibid.

718 "The 'Horses of Gettysburg'," *The Frederick News-Post*, 1 July 2007; Lt. Col. E.B. Cope, "Map of One Square Mile or 1/25 of the Battlefield of Gettysburg," 1898, Library of Congress Geography and Map Division.

719 Billings, *Hardtack and Coffee*, 96, 177; *Reports of Experiments With Small Arms for the Military Service by Officers of the Ordnance Department, U.S. Army* (Washington, D.C.: A.O.C. Nicholson, 1856), 113; Harry W. Pfanz, *Gettysburg: Culp's Hill and Cemetery Hill* (Chapel Hill: The University of North Carolina Press, 1993), 147, 378; Guelzo, *The Last Invasion*, 128, 199, 327; Kent Masterson Brown, *Cushing of Gettysburg: The Story of a Union Artillery Commander* (Lexington: The University Press of Kentucky, 1993), 236.

Hospitals located behind Union lines were often just as unsanitary. In his "Report on Typhus," O.K. Reynolds, the Acting Assistant Surgeon for the Fifteenth United States Infantry at Camp Wood, Kentucky, noted that hospital tents were "situated on low ground near the head of ravine," and not twenty-five feet away, and downhill from a shallow "sink," or latrine. Around the clock, soldiers afflicted with diarrhea stumbled up the rise to evacuate their bowels. Woods noted that the latrines stank "abominably . . . after a few days exposure in the sinks to a warm sun." Without question, they boiled with flies that flitted from feces to rotting food trash to open wounds to the buckets, pails, utensils, and surgical tools used in feeding and treating sick and wounded Union soldiers. On returning, soldiers almost certainly tracked fecal matter swarming with fecal coliform bacteria into the tents. To make matters worse, the soldiers "lay on old straw which could not be replaced on account of the scarcity of that article." Woods attributed the dampness of the bedding to the soil. Considering the chronic intestinal disorders that afflicted and weakened the soldiers present in the hospitals, preventing their rising, it seems just as likely that urine and fecal matter may be blamed for the "putrescent fluids" that saturated soldiers' bedding.[720]

The Union military camps that housed otherwise healthy soldiers were only marginally cleaner than hospitals. In fact, they swarmed with dangerous pathogens that posed a direct threat to the food supply, Borden's Milk included. An account of the Seventy-Seventh New York's encampment near Washington, D.C., published by Brigade Surgeon J.H. Warren in 1862, is instructive. The New Yorkers, Warren wrote, did a poor job policing the camp, which is to say that they left trash and food scraps lying about to decompose and attract vermin. Even worse was the atmosphere. Just down the hill from the camp was an open field, covered in the bloated

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[720] *Medical and Surgical History* 3, 1, 328.

corpses of horses and mules that had succumbed to glanders -- a bacterial infection that caused nasal ulcerations, septicemia, and death -- and been left "upon the surface . . . to remain and decompose." A proponent of miasma theory, Warren suspected that the "malarial odor" arising from the dead animals poisoned the air and sickened the soldiers. Indeed, he blamed the trash and the horses for an outbreak of typhus that had claimed the lives of "ten to twelve" soldiers of the regiment.[721]

It stands to reason that the sugar content used in making Borden's Milk, and the alcohol added by caregivers in making milk punch, reduced the danger of milk-borne illness. Recall that adding sucrose to milk reduces the number of free-water molecules, creating a desert of sorts that is hostile to microbial life. This would have prevented small numbers of bacteria introduced by flies or dirty hands from reproducing in numbers sufficient to have sickened and killed soldiers who drank contaminated punch. Where sucrose merely slowed microbial growth, alcohol had the power to kill bacteria. When stirred into reconstituted condensed milk, whiskey and brandy would have destroyed bacteria through a process known as "denaturation." That is, on coming into contact with bacteria, the alcohol molecules bonded with and destroyed the delicate membranes that kept the tiny organisms' internal structures -- ribosomes, nucleoids, and cytoplasm -- intact and inside. Unknown to the Union soldiers who lay gasping in the sun, and the caregivers who worked to heal them, the bacteria that lurked in open cans and pails of Borden's Milk may well have dissolved or melted away as caregivers stirred in alcohol to make milk punch. It is difficult to know, although the extent to which either sucrose and/or alcohol served as antimicrobials would have depended on the number of bacteria present in the milk, the amount of alcohol that was added, and the speed with which it was served would have made

[721] Ibid., 486.

some difference. Suffice to say at least some bacteria survived long enough to transmit illnesses.[722]

And yet, context matters, for the Borden's Milk and milk punch that appeared in Union camps and hospitals would have been no more or less contaminated than anything else. Indeed, every plate of food and cup of drink that Union caregivers served to sick and wounded soldiers alongside Borden's Milk, from farina to beef tea to lemonade to soft bread, was also tainted with bacteria that caused one the several gastrointestinal disorders, and for the same reasons. So too the bacon, beans, hardtack, water, and special treats such as Borden's Milk that soldiers ate in their day-to-day rations or bought for special occasions. There were, quite simply, too many people and draft animals present in too small a space with too little knowledge of disease transmission and sanitation to keep anything clean for any great length of time. Assuming for argument's sake, then, that everything was contaminated, Borden's Milk at least offered the fats, proteins, and vitamins that fed soldiers' immune systems and gave them a fighting chance against legion unseen dangers. Thanks to denaturation, the milk punch made with whiskey or brandy may even have been sanitary by the standards of the era. On the balance, milk punch made with Borden's Milk was more nutritious and cleaner than any other special diet food or regular ration served to Union soldiers during the conflict. Without it, the already terrible death toll of Union soldiers during the Civil War, which exceeded 200,000, would have been much higher.

[722] "What to Know About Using Alcohol to Kill Germs," 30 June 2021, healthline.com/health/does-alcohol-kill-germs; Simone De Martino, et. al., "Presence of Pathogenic Bacteria in Ice Cubes and Evaluation of Their Survival in Different Systems," *Annals of Microbiology* 67 (2017), 827-835.

Epilogue:

No one benefited more from the wartime popularity of sweetened condensed milk than did Gail Borden Jr. and his New York Condensed Milk Company. Union military purchases gave Borden the capital that he needed to expand his operations, first to Brewster's Station, New York, about fifty-five miles north of Manhattan on the Harlem Valley Railroad, and then to Winsted, Connecticut, amid the prosperous dairy farms of Litchfield County.[723] Seeking a share of the profits, the canning firm of Numsen, Carroll, & Company purchased a license to make and sell Borden's Sweetened Condensed Milk inside a ten-mile radius of Baltimore -- incidentally, one of the most important Sanitary Commission supply depots -- in 1863.[724] Borden's business associate, Stephen L. Goodale, secured a similar license for the Rokomeka Company of East Livermore Falls, Maine, in the summer of 1864.[725] As the new year dawned, and Union troops at last gained an upper hand in the war, Borden moved to expand the market for sweetened condensed milk beyond the Southern war zone to the milk-poor regions of North America and the Greater Caribbean Basin. In a January letter, he assured James Bridge of the Rokomeka Company that sales agents were drumming up interest in condensed milk in the Southern Port cities captured by Union troops (Charleston and Beaufort in South Carolina and New Orleans),

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723 Walter Gladding to Mr. Henry E. Wells, Mayor, n.d., Joe B. Frantz Collection, Literary Productions, 1856-1860, box 3J245 (69); "Interview With Mrs. Ruth H. Munsill," n.d., Joe B. Frantz Collection, 1746, 1801-2010, box 3J245, Dolph Briscoe Center for American History, the University of Texas at Austin.

724 Olmsted, Frederick Law. *Hospital Transports. A Memoir of the Embarkation of the Sick and Wounded from the Peninsula of Virginia in the Summer of 1862*. Boston: Ticknor and Fields, 1863), 25; Memorandum of Agreement," June 1863, Joe B. Frantz Collection, 3J245 (28)

725 "From the New York Tribune," *Friends' Review: A Religious, Literary and Miscellaneous Journal*, August 20, 1864. Stephen Goodale worked with longtime Borden business partner James Bridge to open the Rokomeka Company in East Livermore Falls, Maine, in August 1864. See Gail Borden Jr. to S. L. Goodale Esq., 23 March 1864, and Gail Borden Jr. to James Bridge Esq., 3 August 1864. See also *Acts and Resolves Passed by the Forty-Third Legislature of the State of Maine. 1864* (Augusta, Maine: Stevens and Sayward, Printers to the State, 1864).

in the mining regions of the American West, and even abroad in Quebec, Nova Scotia, Nassau, and Bermuda.[726]

These ventures notwithstanding, Borden was most interested in moving his operations west to the prairies of Illinois, in the hope of tapping into the Chicago milk market. He reasoned that Chicagoans, who were no strangers to the hazards posed by unsanitary urban dairies, would exchange a few extra cents per quart for the peace of mind, not to mention the pleasant taste, that came with a can of Borden's Milk.[727] At least one Union veteran, the Lockport, Illinois, native James Springer, would have agreed. During his convalescence in a Chattanooga, Tennessee, military hospital during the summer of 1864, Springer enjoyed cups of milk punch made with Borden's Milk. He was so impressed with the product that he transcribed the label of a can, only to lose it during the trip home, following his discharge from the army. Undaunted, Springer wrote to the *New-York Tribune* seeking information about the manufacturer. As if anticipating Borden's decision to open a plant in the Chicago hinterland, Springer ended with a question: "I want to know whether [Borden's Condensed] milk could be made here in Illinois."[728]

The answer was "yes," and with all due haste. On January 31, 1865, Borden wrote to an agent of the New York Condensed Milk Company, W. G. Hubbard, about his desire to open a condensery in Elgin, Illinois, about 40 miles west of Chicago. Soon thereafter, he wrote to James Bridge, informing him that he expected to commence operations at the new plant by May

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[726] Gail Borden Jr. to S.L. Goodale, Esq., 30 October 1864, Joe B. Frantz Collection, 3J245, Literary Productions, 1861-1865 (10, St. Louis and Western cities); Gail Borden Jr. to James Bridge, 18 January 1865, J. Gail Borden Jr. Papers, 1830-1910, 1932-1937, box 3C18, Dolph Briscoe Center for American History, the University of Texas at Austin..

[727] Gail Borden Jr. to S.L. Goodale, Esq., 30 October 1864, Joe B. Frantz Papers, box 3J245, Dolph Briscoe Center for American History, the University of Texas at Austin.; According to the *Prairie Farmer* Borden's Sweetened Condensed Milk sold for about "six and a quarter cents" per quart. Exact retail prices for raw milk in Chicago have been difficult to obtain. Raw milk sold for around 4.6 cents in New York in 1870. Doubtless Chicago prices were comparable. "Condensed Milk. Agriculture Connected with Manufactures," 121; John J. Dillon, *Seven Decades of Milk: A History of New York's Dairy Industry* (Redditch, U.K.: Read Books Ltd., 2013).

[728] "Condensed Milk," *Friends' Review,* 813.

1, if not sooner. The project moved forward apace. Borden located a suitable property in Elgin and dispatched workers to set up a condensing plant. As of March 28, workers were busy installing the boilers that would furnish the steam needed for heating the milk-holding vats and powering the condensing machinery used in processing milk. Word reached Borden at almost the same moment that an Eastern foundry was putting the finishing touches on a cast-iron vacuum pan, similar to those that had proven so successful in evaporating milk for civilian and military consumers, for use in Elgin. In an 1865 letter, Borden expressed optimism that the device would soon wend its way by train to Elgin. He made it clear in closing that the new plant, dubbed the "Elgin Milk Works," would employ the same rigorous sanitary standards, while providing the same durable product, as did his eastern operations.[729]

This rapid expansion proved troubling to Borden in the short-term. Union victory in the Civil War, and with it a contraction in the demand for condensed milk, came in April 1865, just as the Elgin plant opened.[730] Borden honored the contracts that he had signed with farmers and continued evaporating milk through the fall. If the Wassaic plant's wartime output is any indication, however, he soon accumulated a surplus that amounted to hundreds of thousands of cans.[731] Absent reliable documentation, it is difficult to know how Borden disposed of the excess milk. Doubtless at least some of the supply went to Eastern consumers, who used the product in lieu of swill milk. Plenty more went to California. The summer of 1866 found the

[729] Gail Borden Jr. to W.G. Hubbard, 31 January 1865, Gail Borden Jr. to James Bridge, Esq., 1 March 1865, J. Gail Borden Jr. Papers, 1830-1910, 1932-1937, box 3C18, Dolph Briscoe Center for American History, the University of Texas at Austin; Frantz, *Gail Borden*, 263; Valenze, *Milk*, 185; "Condensed Milk. Agriculture Connected with Manufactures," *Prairie Farmer*, August 19, 1865, 121.

[730] For more on the end of the American Civil War, see Bruce Catton, *This Hallowed Ground*, 476-486; "Condensed Milk," *Prairie Farmer*, August 19, 1865.

[731] During the six-month period from July to December 1864, the Wassaic Plant processed 990,931 quarts of milk. See Gail Borden Jr. to Mr. J. Milbank, 6 April 1864, J. Gail Borden Jr. Papers, 1830-1910, 1932-1937, box 3C18, Dolph Briscoe Center for American History, the University of Texas at Austin.

San Francisco merchants Fordham & Jennings selling cases and single cans of Borden's Sweetened Condensed Milk from their storefront at the corner of Front and Jackson Streets, indicating that such shipments were common and perhaps even predated the end of the war. Indeed, on May 11, 1866, the steamer *Granite State* slipped its moorings in New York Harbor, bearing 34 cases of condensed milk bound for Golden State buyers. The product found a ready market. On June 16, 1867, editors of the *Marysville Daily Appeal* expressed hope that Californians would "go largely into the 'condensed milk' business," with an eye to meeting local demand while also capturing a growing Asian market for the product.[732] And yet, for the moment, Eastern manufacturers maintained their control of the trade. In August 1868, a West Brookfield, Massachusetts, condensing plant owned by one W. K. Lewis, and licensed by Borden to produce milk under Borden's patent and trademark, received an order for 1,728,000 cans of the sweet, syrupy substance from China.[733]

In the longer-term, Borden's Sweetened Condensed Milk remained a popular condiment among American military personnel stationed in the milk-poor West. Indeed, the product was so desirable, and so expensive and rare the further one moved away from the Northeastern epicenter of Borden's condensing operations, that quartermasters and civilian merchants tried, with varying degrees of success, to profit from a black market in condensed milk. Court martial documents compiled by United States military authorities made reference to the product among items that were stolen and/or hoarded for resale. In August 1870, Regimental Commissary Sergeant Charles Vieweg of the 13th Infantry, who worked in the Subsistence Department of

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[732] "Fordham & Jennings," *Daily Alta California*, 30 July 1866; "Our New York Commercial Letter," *Daily Alta California*, 15 May 1866; "The Turning Tide in California Trade," *Marysville Daily Appeal*, 16 June 1867.

[733] No Title, *Marysville Daily Appeal*, 23 August 1868; Gail Borden Jr. to N. Roberts, 7 July 1864, J. Gail Borden Jr. Papers, 1830-1910, 1932-1937, box 3C18, Dolph Briscoe Center for American History, the University of Texas at Austin. .

Camp Douglas, Utah Territory, was tried and convicted of selling condensed milk, along with 18 ¾ pounds of New York cheese, to post trader E.B. Zabriskie without accounting for them. Two years later, on January 7, 1872, Private Alvin W. Chorrman, then serving as storekeeper for the Subsistence Department of Fort Abercrombie, Dakota Territory, sold two cans of condensed milk to Private Edward Kuhlthan without turning the money over to the Acting Commissary of Subsistence.[734] Doubtless others were more successful in evading authorities. That they risked criminal penalties for the sake of a can or two of Borden's Milk speaks to the product's enduring popularity.

Beyond its military significance, Borden's Sweetened Condensed Milk remained popular among those who traveled to or through milk-poor regions in search of cheap land, mineral wealth, adventure, or some combination of the three. This was especially true of cowboys, who carried Borden's Milk in their saddlebags as they drove herds of beef cattle from the coastal plain of south Texas to railheads in Kansas and Nebraska, or combed vast ranches on horseback in search of free-range animals. On settling around the campfire at night, ranch hands amused themselves with what the writer Philip Ashton Rollins described as a "competitive reciting of the inscriptions upon the labels of the cans of condensed milk and other foodstuffs habitually used." Indeed, Rolling recalled that the sight and sound of "twelve or fourteen men," singing (shouting?) "a full-throated chorus beginning with 'Condensed milk is prepared from,' and continuing for some minutes" was enough to delight "the appreciative ears of an audience with cloven hoofs." However, it was also true of miners. Doubtless the prospectors who flooded into

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[734] United States Army, Department of the Platte, *General Orders and Circulars, Department of the Platte, 1867-1882*, Newberry Library, Everett D. Graff Collection, 3-6; United States Army, Department of Dakota, *Headquarters, Department of Dakota, Saint Paul, Minn., May 19, 1867. General orders, no. 27*, Newberry Library, Everett D. Graff Collection, 1, 4.

Virginia City, Montana Territory, during the mid-1860s purchased cans from the mercantile firm of McBride, Baumgardner & Co., which urged readers of *The Montana Post* to "try a box."[735]

Alone among the milk hungry, urban Americans appear never to have embraced Borden's Sweetened Condensed Milk as a fluid milk substitute. Likely this had something to do with the product's shortcomings as an infant food. Already by 1858, physicians recognized that cow's milk and human breast milk differed in their chemical composition, with the former having almost twice the casein (protein) content as the latter. To feed cow's milk direct to young children was to risk what the physician William Cumming described as "serious indigestion, with consequent gastric and intestinal disorders." And yet, preparing new, sweet milk was an imperfect process, for in diluting the casein with water, caregivers also diluted the nutritious butterfat to a level below that of human breast milk, to say nothing of introducing microbes that were no less dangerous for going unnoticed. Unsweetened Borden's Milk suffered from the same limitations, while the sucrose used in preserving the sweetened variant tended to irritate the bowels of small children, contributing to life-threatening diarrhea. A 1904 study published by the *Journal of the American Medical Association* would seem to bear these conclusions out, providing evidence that Baltimore infants fed on sweetened condensed milk suffered more from "summer dysentery" than did those fed a diet of raw, fluid milk purchased from dealers or small grocers. At least one male resident of Roundout, Maine, blamed his "small stature" and "stunted growth" on the diet of sweetened condensed milk that his mother fed him as an infant.[736]

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[735] "Letter from Texas," *Nebraska Advertiser*, February 24, 1870; Philip Ashton Rollins, *The Cowboy: His Characteristics, His Equipment, and His Part in the Development of the West* (New York: Charles Scribner's Sons, 1922), 185-186, 255; "Local and Other Items," *The Montana Post*, October 8, 1864.

[736] William H. Cumming, *Substitute for Human Milk* (New York: n.p., 1858); "Editorial Gleanings," *The Happy Home and Parlor Magazine*, July 1859-January 1860: 72; Knox, "A Summer's Experience," 1924-1930; No Title, *The Bridgeton News*, 7 May 1886.

By the mid-1880s, a series a scientific and technological innovations obviated any need to use Borden's Sweetened Condensed Milk as a nutritious substitute for new cow's milk and/or human breast milk. The first and most important of these was widespread acceptance of germ theory and with it, the recognition that microbes caused food spoilage and illness in human consumers. The second came in 1867-1868, with the invention of refrigerated rail cars capable of slowing the decomposition of fluid milk -- to say nothing of meat and vegetables -- while in transit from farm to market.[737] The third came in 1884, when the Swiss immigrant and former Anglo-Swiss Condensed Milk Company employee, John Baptist Meyenberg, secured a U.S. patent for a condensing process that made it possible to realize Gail Borden's unfulfilled dream of making unsweetened condensed milk (or "evaporated milk," as it was often known) shelf-stable for months or even years.[738] The fourth came in 1886, with the German chemist Frans von Soxhlet's call for using Pasteurization -- the superheating of food to kill microorganisms -- to extend the shelf-life of fluid milk without canning.[739] The Borden Company embraced these and other changes to achieve near-total dominance over the American milk market during the twentieth century. Yet it continued to market sweetened condensed milk as a healthy food and superior in terms of digestibility and nutritive properties than breast milk and fluid cow's milk. Indeed, a 1924 school nutrition guide published by the Borden Company proposed that Eagle

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737 "Contagion: Historical Views of Diseases and Epidemics," Harvard Library, 2018, https://curiosity.lib.harvard.edu/contagion/feature/germ-theory; Davis, William, Detroit Historical Society Encyclopedia of Detroit, 2023, https://detroithistorical.org/learn/encyclopedia-of-detroit/davis-william; Andrew F. Smith, *Eating History: Thirty Turning Points in the Making of American Cuisine* (New York: Columbia University Press, 2009), 88.

738 Otto Frederick Hunziker, *Condensed Milk and Milk Powder* (La Grange, Ill.: Published by the Author, 1918), 46-47; Gail Borden first attempted to seal unsweetened condensed milk in cans in 1856. See Gail Borden Jr. to Capt. A. J. Fletcher, 19 February 1856, J. Gail Borden Jr. Papers, 1830-1910, 1932-1937, box 2N321, Dolph Briscoe Center for American History, the University of Texas at Austin.

739 Alfonso Manning, *Food Microbiology and Food Processing* (Waltham Abbey Essex, United Kingdom: Ed-Tech Press, 2019), 296.

Brand Milk should be used as an "essential feature" in American public schools' drive to counter chronic malnutrition in students.[740]

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The decline of sweetened condensed milk as food and medicine notwithstanding, Americans' devotion to milk drinking only increased in the decades following the American Civil War. So too their conviction that the humble fluid and its by-products possessed near-magical healing powers. This included the soldiers, sailors, marines, and airmen who traveled abroad on behalf of the emergent American empire, and the physicians and civilian aid workers who cared for them. When U.S. troops confronted Spanish colonial forces in Cuba in 1898, the former Union nurse and founder of the American Red Cross, Clara Barton, drew on her experience tending to Union sick and wounded when organizing relief supplies. In fact, the rations furnished to military hospitals were almost identical to those furnished to Union troops by the Sanitary Commission during the Civil War: potatoes, vegetables, cornmeal, rice, soup, and an abundance of condensed (likely unsweetened "evaporated") milk. Looking back on his service in the Caribbean, Colonel (and future President) Theodore Roosevelt of the 1st United States Volunteer Cavalry -- the so-called "Rough Riders" -- was certain that canned evaporated milk and soup had given "new heart and strength" to the soldiers who served on the front lines of the Spanish-American War. He was no less certain that the sick and wounded confined in military hospitals received the same benefits from "such simple delicacies as rice and condensed milk," or at least did so in those instances when relief agencies such as the American Red Cross were able to provide a few cans.[741]

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740 Helen Rich Baldwin, *Nutrition and Health* (New York: The Borden Company, 1924), 28.
741 For more on Clara Barton's Union medical service, see Elizabeth Brown Pryor, *Clara Barton: Professional Angel* (Philadelphia: University of Pennsylvania Press, 1987); Theodore Roosevelt, *The Rough Riders* (Charles

Like sweetened condensed milk before it, evaporated milk reached the zenith of its popularity during a time of unprecedented human suffering -- in this case, the First World War. This time, however, military planners saw fit to include canned milk in soldiers' rations and relief shipments from almost the beginning of the conflict. Between 1914 and 1918, the British government purchased approximately 250,000 cans of evaporated milk per month for use by the "Tommies" who manned the trenches of the Western Front, hunted German U-Boats in the North Sea and English Channel, or spent time recuperating from wounds and illness in military hospitals. Civilian relief agencies in the U.S. such as the Red Cross and YMCA did a similar service for American troops and European civilians, buying and shipping cans of evaporated milk to the front lines following American entry into the war in 1918. [742] Meanwhile the United States Commission for Relief in Belgium purchased evaporated milk, among other supplies, for use by the millions of Belgian and French civilians made destitute and hungry by the 1914 German invasion and occupation. In an October 7, 1916, report, the commission's chairman, Herbert Hoover, reported sending 500 tons of condensed milk per month to Belgium at a cost of £50,000 per shipment. That he did so had everything to do with the local shortage of dairy cattle, which had been culled by the German military for beef, leaving too little milk for both the German occupiers and civilians.[743]

Though it remained a vital source of nutrition, milk, condensed or otherwise, lost much of its military medical significance during and after the First World War. A cursory survey of the journals and diaries compiled by physicians and nurses during World War One reveals few

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Scribner's Sons, 1899), 201, 274; Margaret Humphreys, *Marrow of Tragedy: The Health Crisis of the American Civil War* (Baltimore: Johns Hopkins University Press, 2013), 30, 114, 117, 119.

742 *Hearings on General Tariff Revision Before the Committee on Ways and Means House of Representatives*. Part III (Washington: Government Printing Office, 1921), 2221.

743 George I. Gay and H. H. Fisher, *Public Relations of the Commission for Relief in Belgium* (Stanford: Stanford University Press, 1929), 165-172.

references to milk as either a curative or palliative, although caregivers almost certainly fed the humble fluid to sick and wounded soldiers when available.[744] But then, the war years saw medical, technological, and logistical innovations that obviated, or at least, reduced the need for military caregivers to rely on medicinal milk, paired with a dose of faith, to restore soldiers to health. Military physicians and nurses who tended to the sick and wounded on the Western front knew that bacteria caused life-threatening gangrene and sepsis. Consequently, they took the offensive against infection, using a procedure pioneered by the French physician Alexis Carrel and the British biochemist Henry Dakin -- the aptly named Carrel-Dakin method -- to irrigate wounds with a solution of sodium hypochlorite, an antiseptic that was strong enough to kill infectious agents without burning or destroying healthy tissue. At the same time, American volunteers ran a motorized ambulance service that moved wounded soldiers from the front lines to hospitals equipped with anesthesia and the aforementioned antiseptics with a speed that would have astonished their Civil War forebears. Similar to Borden's Milk, these innovations reduced soldiers' suffering and prevented the conflict from claiming untold thousands of additional lives.[745]

Military medical innovation continued on through the conflicts of the twentieth century, further obviating the need for caregivers to rely on medicinal milk. Where Union caregivers had once depended on nourishing foods to feed and boost the immune system and cure diseases, American military authorities deployed the chemical agent, DDT (dichloro-diphenyl-trichloroethane) during the Second World War to kill the mosquitoes that spread malaria and yellow fever and the lice that spread typhus before they had a chance to bite and infect

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[744] See Dr. H. F. B. Walker, *A Doctor's Diary in Damaraland* (London: Edward Arnold, 1917) and Harvey Cushing, *From a Surgeon's Journal, 1915-1918* (Boston: Little, Brown, and Company, 1936).

[745] ; Ellen Hampton, "How World War I Revolutionized Medicine," *The Atlantic*, 24 February 2017, https://www.theatlantic.com/health/archive/2017/02/world-war-i-medicine/517656/.

servicemembers and civilian refugees.[746] They likewise took the offensive against microbes, deploying antibiotic agents such as sulfa drugs (invented in 1935) and penicillin (invented in 1939) to attack and kill the bacteria that invaded soldiers' bodies before they had a chance to devour bodily tissues and excrete deadly toxins.[747] Meanwhile, blood transfusions pioneered during the First World War proved far more effective than a milk, sugar, and alcohol solution given orally at restoring blood volume and staving off hypovolemic shock.[748] Military authorities first used helicopters as ambulances during the Korean Conflict, reducing the time required to move sick and wounded soldiers from battlefield to hospital from the weeks or months required during the American Civil War to hours or even minutes. Air evacuation continued on during the Vietnam War, while the advent of frozen blood products made it possible to store intravenous boluses for up to eight months.[749] It is now common for specialized medical teams to travel into combat alongside soldiers to deliver lifesaving aid -- intravenous fluids, antibiotics, painkillers, and nutritional support -- within moments of wounding.[750] It perhaps goes without saying that physicians and lay healers on the home front adapted these and other preventative and curative treatments and technologies to the treatment of civilian patients.

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[746] Edmund Russell III, *War and Nature: Fighting Humans and Insects with Chemicals from World War I to* Silent Spring (Cambridge: Cambridge University Press, 2001), 126-127, 134.

[747] John E. Lesch, *The First Miracle Drugs: How the Sulfa Drugs Transformed Medicine* (Oxford: Oxford University Press, 2007), 3, 249; Jonathan Wood, "Penicillin: The Oxford Story," University of Oxford, News and Events, 16 July 2010, https://www.ox.ac.uk/news/science-blog/penicillin-oxford-story.

[748] Steven R. Pierce, "Blood Transfusion in the First World War," University of Kansas Medical Center, n.d., https://www.kumc.edu/school-of-medicine/academics/departments/history-and-philosophy-of-medicine/archives/wwi/essays/medicine/blood-transfusion.html.

[749] Kaylene Hughes, "Army Helicopters in Korea, 1950 to '53," United States Army, 28 October 2016, https://www.army.mil/article/177302/army_helicopters_in_korea_1950_to_53. John Schlight, *The War in South Vietnam: The Years of the Offensive, 1965-1968* (Washington: Office of Air Force History, 1988), 97; Jan K. Herman, *Navy Medicine in Vietnam: Oral Histories from Dien Bien Phu to the Fall of Saigon* (London: McFarland and Company, Inc., 2009), 169.

[750] Nick Lake and Brian M. Moore, "Advances in Surgical Techniques, Procedures, and Wound Care," in Daniel E. Banks and Timothy K. Jones, eds., *Otolaryngology/Head and Neck Surgery Combat Casualty Care in Operation Iraqi Freedom and Operation Enduring Freedom* (Fort Sam Houston, Texas: Office of the Surgeon General, Borden Institute, 2015), 643-657.

And yet, American military personnel remained fond of milk as both a food and condiment. During the Second World War, American servicemembers consumed enormous quantities of milk and milk by-products. Indeed, the April 1946 edition of *Nutrition Reviews* noted that individual recruits consumed about 74.5 pounds of evaporated milk, 25 pounds of butter, 9.5 pounds of cheese, and 2.7 gallons of ice cream -- amounting to about 91.25 quarts of milk -- per one year spent in training camps. On reaching the warzone, these same servicemembers received regular rations of evaporated and/or powdered milk to satisfy their milk cravings. A 1956 Study published by the dairy scientist Elliott H. Parfitt of the Chicago-based Evaporated Milk Association noted that American condensing plants almost doubled production of evaporated milk during the conflict, from 48 million to 87 million cases. Of these, an estimated 38 million cases traveled by ship and plane to the European and Pacific Theaters, where it went to feed soldiers and civilian refugees.[751] That said, military consumers preferred the fresh, fluid milk of home. Captain David Baker wrote to his family from the Pacific, “I believe I miss cold milk more than any one thing when we are away from civilization.” Doubtless First Lieutenant Francis King of the Army Air Corps would have agreed. Recalling his return to the United States, King wrote, “You landed and the first thing they asked you was, ‘Would you like a glass of milk?’ If you’ve not had a glass of milk for almost a year, you could not believe how good that tasted.”[752]

On the home front, the mobilization of civilian war workers and volunteers brought with it -- indeed, required -- the mobilization of Americans’ favorite comfort food. As it once had

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[751] Elliott H. Parfitt, “The Development of the Evaporated Milk Industry in the United States,” *Journal of Dairy Science* 39 (1956): 838-842.

[752] “Dairy Products in the Army Ration,” *Nutrition Reviews* 4, no. 4 (April 1946), 112-113; Megan Harris, “A Surprising Answer to the Question, ‘Got Milk?’,” Folklife Today, 11 January 2017, https://blogs.loc.gov/folklife/2017/01/a-surprising-answer-to-the-question-got-milk/.

during the great bloodletting of 1861-1865, the Borden Company led the way in promoting milk drinking as an effective means to build and maintain a healthy population. In 1942, as Americans rushed to recruiting stations to volunteer for service, the company released a short film, aptly titled "White Ammunition," that drew a direct, causative link between the mundane habit of milk drinking and the ultimate success of American arms. Though it made no direct reference to the Union Milk Lift, it did feature an homage to Gail Borden Jr., who had worked tirelessly, and "fought tooth and nail" with farmers, to ensure that Americans had access to the clean milk that they depended on for good health. The filmmakers took pains to show that Borden's bottling and condensing plants were the standard by which all others should be judged (and found lacking). Interspersed were images of healthy, active children and sturdy, industrious adults who took time during the day to drink milk or pour it over their morning cereal. The production ended with images of war: fighter planes diving from the sky; naval ships firing heavy guns; and soldiers charging forward with fixed bayonets. The message was clear: Milk makes the healthy civilians and soldiers that the United States needed to wage an all-out war effort. Or, as the producers put it, "The more milk you put into a soldier, the more fight you get out of him." It would be easy (and likely true, to an extent) to ascribe the film to a cynical profiteering motive by the Borden Company. Nevertheless, given Americans' longstanding love of milk, it likely resonated with viewers eager to see their nation, and their children, through a terrifying crisis.[753]

Baker's and King's longing for the sweet taste of cow's milk echoed in the comments of American servicemembers who served in Korea and Vietnam. To be sure, those who served in both conflicts enjoyed access to preserved milk products. Yet they were always a poor substitute

[753] Borden's Farm Products. "White Ammunition." YouTube Video, 24:35. 1942. Youtube.com/watch?v=s9cC45H4S7w.

for fresh fluid milk. On April 28, 1951, Private First Class Robert Barber took a moment to scratch a brief letter to his mother from the vicinity of Hill 902 (or Ka-san as it was known to his South Korean allies). The previous twenty-four hours had exposed Barber to myriad horrors: a combined Chinese and North Korean offensive that drove him from his position, and the physical and emotional trial of carrying a dead comrade almost four miles down the mountain under enemy fire. Barber was exhausted and homesick. He was also hungry. Like many a soldier before him, Barber's mind turned to the simple comforts of home. "If only I could be home with a big glass of milk and just sitting listening to the radio and reading the paper," he wrote to his mother, "I'd give a million dollars." Almost fifty years later, an American veteran identified as "Uncle Jay" recalled how much he enjoyed the food sent to him by his wife, noting that "food from home was always better than the food we were served [by the army] regardless of what was sent." He was especially fond of sweet, fluid milk, which was impossible to come by in Vietnam, leaving him to satisfy his cravings with a "reconstituted" (likely powdered) variant. On traveling to Hawai'i on leave, he sat down with his wife at a restaurant and ordered three glasses of his favorite comfort food. On seeing the server place a single glass before him, Jay's wife responded, "You might as well bring the other two, because he's going to be done with this before you can go and come back."[754]

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Taking the broad view, it is impossible to untangle Americans' culinary and medicinal practices from their political and military ambitions. Whatever their belief in or devotion to a specific cause, those who marched off to fight the nation's wars have always carried the

[754] "A Surprising Answer"; Lisa Bramen, "Fishing with Grenades and Cooking with C4: A Veteran's Vietnam Food Memories," *Smithsonian Magazine*, 10 November 2010, https://www.smithsonianmag.com/arts-culture/fishing-with-grenades-and-cooking-with-c4-a-veterans-vietnam-food-memories-104572114/.

mundane habits of civilian life with them, including a longing for the food and drink of home. Servicemembers have long used a variety of means – some legal, some illegal -- to satisfy their cravings. In some cases, this meant begging or stealing from civilians. In other cases, it meant buying portable, durable canned goods and pre-made foods from merchants or government commissary agents, or making do with ersatz (and always inferior) versions included in their rations. In still other cases, it meant doing without. The extent to which servicemembers tolerated this third option depended on the individual, to say nothing of the relative importance that they placed on a coveted yet unattainable food. During the American Civil War, no other food was more beloved, useful, or scarce in the Southern war zone than cow's milk. Hence, no other food earned such overt praise from Union soldiers as did Borden's Milk, which satisfied their cravings, healed and strengthened their bodies, and made them feel normal, if only for a moment. [755]

To date, historians have treated the story of Antebellum American milk production and consumption, the industrialization of the nation's milk supply, and the American Civil War as separate -- or at best, nominally related -- stories. In doing so, they have created a series of piecemeal and contradictory narratives that offer glimpses of the full story without ever quite getting to the truth. Indeed, one is reminded of the old Indian folk tale, which saw a group of blind men touch different parts of an elephant, leading each to draw different conclusions about the nature of the beast. One man, having felt only the animal's immense body, described the elephant as a wall. Another, having touched only its trunk, described the elephant as a snake. Still another insisted that the elephant was a sharp spear, having touched only the ivory tusk that

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[755] Christopher R. Mortensen and Paul J. Springer, eds., *Daily Life of U.S. Soldiers: From the American Revolution to the Iraq War, 3 Volumes* (Santa Barbara, California: ABC-CLIO, 2019); John Davis Billings, *Hardtack and Coffee: Or the Unwritten Story of Army Life* (Boston: George M. Smith & Co., 1888), 124.

emerged from the animal's mouth. On and on they went, until such time as the Rajah cautioned the men against drawing conclusions from such narrow evidence. Chastened, they agreed to work together to create a more accurate image.[756]

So it has been with the historians who have studied -- or at least mentioned – milk production and consumption in the nineteenth-century United States. Civil War and Reconstruction historians have recognized that Borden's Milk was popular among Union soldiers and caregivers, without paying much attention to how or why Union armies put the product to use once it reached the front lines. These same historians have devoted no attention to the culinary and medicinal meanings that antebellum and postbellum Americans assigned to milk, condensed or otherwise, that may have contributed to that popularity.[757] Food and social historians have done the opposite, devoting most of their attention to the antebellum and postbellum years while reducing the Civil War to a few sentences or paragraphs.[758] In feeling about, the former have overlooked on the greatest military medical innovations of the nineteenth century. Meanwhile, the latter have struggled to explain how and why Union soldiers and caregivers, who would have shared nineteenth-century Americans' presumed disdain for milk, bought enough Borden's Milk to ensure the product's long-term success. The solution to this

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756 "The Blind Men and the Elephant," United States Peace Corps Educator Resources, n.d., https://www.peacecorps.gov/educators/resources/story-blind-men-and-elephant/.

757 James M. McPherson, *Ordeal by Fire: The Civil War and Reconstruction*, 3rd ed. (Boston: McGraw-Hill, 2001), 178-187; Andrew F. Smith, *Starving the South: How the North Won the Civil War* (New York: St. Martin's Press, 2011), 80-82; Margaret Humphreys, *Marrow of Tragedy: The Health Crisis of the American Civil War* (Baltimore: Johns Hopkins University Press, 2013), 115, 117; R. Douglas Hurt, *Food and Agriculture During the Civil War* (Santa Barbara, California: ABC-CLIO, 2016), 15; Judkin Browning and Timothy Silver, *An Environmental History of the Civil War* (Chapel Hill: The University of North Carolina Press, 2020), 90-91.

758 E. Melanie DuPuis, *Nature's Perfect Food: How Milk Became America's Drink* (New York: New York University Press, 2002), Deborah Valenze, *Milk: A Local and Global History* (New Haven, Conn.: Yale University Press, 2011), Hannah Velten, *Milk: A Global History* (London: Reaktion Books, 2010), Kendra Smith-Howard, *Pure and Modern Milk: An Environmental History since 1900* (Oxford: Oxford University Press, 2014), and Andrea S. Wiley, *Cultures of Milk: The Biology and Meaning of Dairy Products in the United States and India* (Cambridge, Mass.: Harvard University Press, 2014).

shared problem is simple enough: Historians must share their findings across discrete fields. To do otherwise is to risk reducing the elephant to a wall, a snake, or a spear.

Recent trends suggest that scholars are working to strike a balance between traditional military history and newer categories of analysis when researching and writing about the Civil War Era. Political and economic historians have produced works that treat the ebb and flow of Civil War combat as a key variable in the relative success and failure of civilian wartime policies.[759] Likewise, a small but growing number of ecologically minded scholars have applied environmental analysis to the causes and consequences of the conflict, the outcome of specific military campaigns, and the problems of disease and medical care, with promising results.[760] Meanwhile, social and cultural historians have paired their own unique analytical tools with military history to craft works that foreground the experiences of women, African Americans, and Indigenous Peoples during the conflict even as they do credit to the battles and campaigns that shaped their lives.[761] That said, the tendency to treat the war years as a discrete period,

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[759] Gary Gallagher, *The Confederate War: How Popular Will, Nationalism, and Military Strategy Could Not Stave Off Defeat* (Cambridge, Mass.: Harvard University Press, 1997); Stephanie McCurry, *Confederate Reckoning: Power and Politics in the Civil War South* (Cambridge, Mass.: Harvard University Press, 2010); James D. Oakes, *Freedom National: The Destruction of Slavery in the United States, 1861-1865* (New York: W. W. Norton & Company, 2013).

[760] Brian Black, "Addressing the Nature of Gettysburg: 'Addition and Detraction' in Preserving an American Shrine," in *Militarized Landscapes: From Gettysburg to Salisbury Plain* (London: Continuum Books, 2010), 171–88; Andrew McIlwane Bell, *Mosquito Soldiers: Malaria, Yellow Fever, and the Course of the Civil War* (Baton Rouge, Louisiana: Louisiana State University Press, 2010); Matthew M. Stith, "'The Deplorable Condition of the Country': Nature, Society, and War on the Trans-Mississippi Frontier," *Civil War History* 58, no. 3 (September 2012): 322-347;; Shively Meier, *Nature's Civil War*; Lisa Brady, "Nature as Friction: Integrating Clausewitz into Environmental Histories of the Civil War," in *The Blue, the Gray, and the Green: Toward an Environmental History of the Civil War* (Athens, Georgia: The University of Georgia Press, 2015), 144–62

[761] DeAnne Blanton and Lauren M. Cook, *They Fought Like Demons: Women Soldiers in the American Civil War* (Baton Rouge: Louisiana State University Press, 2002); John David Smith, *Black Soldiers in Blue: African American Troops in the Civil War Era* (Chapel Hill: University of North Carolina Press, 2002); Margaret S. Creighton, *The Colors of Courage: Gettysburg's Forgotten History* (New York: Basic Books, 2005); Clarissa W. Confer, *The Cherokee Nation in the Civil War* (Norman: University of Oklahoma Press, 2007); Stephanie McCurry, *Women's War: Fighting and Surviving the American Civil War* (Cambridge: The Belknap Press of Harvard University Press, 2019); Jim Downs, *Sick From Freedom: African-American Illness and Suffering During the Civil War and Reconstruction* (Oxford: Oxford University Press, 2012); Ari Kelman, *A Misplaced Massacre: Struggling Over the Memory of Sand Creek* (Cambridge, Mass.: Harvard University Press, 2013).

related to and yet somehow separate from the antebellum and postbellum periods, remains strong. It remains to be seen whether historians of the nineteenth century and the American Civil War will move beyond this temporal binary in the same way that they have sought to merge their analytical approaches.

One thing is clear: It is impossible to understand the short- and long-term popularity of Borden's Milk, or the industrialization of the nation's milk supply, without accounting for the many variables that shaped American milk use before, during, and after the American Civil War. To exclude even one -- the gendered meanings that Euroamericans assigned to milk, the emotional needs of lactating dairy cattle, the lack of urban sanitation systems, Americans' belief in magic, and the specific needs of Union soldiers wounded in combat, among myriad others -- would undermine the coherence of the entire narrative. It may be that Union "milk lift" is but one of many stories that have been hiding in plain sight, unnoticed by historians, in the 157 years since the end of the American Civil War. If so, they await nothing more than the historian who is willing to pluck at the most mundane of loose threads and then shoulder the weight of following the evidence, wherever and whenever it may lead.

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The Montana Post

The Nevada Journal

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The Southern Press

The Spirit of Democracy

The Star-Herald

The Western Democrat

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Vermont Phoenix

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Genesee Farmer and Gardener's Journal

Gleason's Pictorial Drawing-Room Companion

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