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The Global Staff of Life: Wheat, Flour, and Bread in Britain, 1846-1914

DISSERTATION

submitted in partial satisfaction of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

in History

by

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Dissertation Committee:
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DEDICATION

To

my wife,
without whom this work,
and life itself, would be unimaginable

my daughter,
whose arrival changed my world,
and who has been a constant inspiration

my son,
who has renewed my inspiration,
though he will only ever know the time after this work

and my grandfather,
whose tales and deeds started me on the path to history,
but who never got to know this work.

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FIELD OF STUDY

Cultural and environmental history of modern Britain, the British empire, and the world

ABSTRACT OF THE DISSERTATION

The Global Staff of Life: Wheat, Flour, and Bread in Britain, 1846-1914

By

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Doctor of Philosophy in History

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Professor Douglas Haynes, Chair

This research examines the cultural and environmental history of wheat, flour, and bread in Britain in the second half of the nineteenth century. As a result of liberal, Free Trade policies implemented in 1846, Britain effectively outsourced its food supply, coming to rely on distant fields for more than four-fifths of its daily bread by the outbreak of the First World War. This globalization of the wheat ecology that fed Britain required the proliferation of new forms of biopolitical expertise, state intervention, and cultural meaning, visible in the histories of millers, bakers, physicians, and consumers. Their combined expertise served to connect British bodies to global environments, and to produce bread that was significantly whiter than before. At the same time, the cultural distance between the production and consumption of food grew to lengths never before seen: the specific origins of Britons' chief article of diet became impossible for consumers to discern.

INTRODUCTION

From the middle of the nineteenth century until the First World War, perhaps as at no other time, wheaten bread was the principle article of diet for the majority of Britons. Henry Mayhew began his 1849 account of the working classes of London by explaining that

> Those who obtain their living in the streets of the metropolis are a very large and varied class; indeed, the means resorted to in order to 'pick up a crust,' as the people call it, are so multifarious that the mind is long baffled in its attempts to reduce them to scientific order or classification.[1]

Sixty years later, in her study of working-class London households conducted between 1909 and 1913, the Fabian Socialist Maud Pember Reeves asserted of the children who populated the metropolis that

> Bread… is their chief food. It is cheap; they like it; it comes into the house already cooked; it is always at hand, and needs no plate and spoon. Spread with a scraping of butter, jam, or margarine, according to the length of the purse of the mother, they never tire of it as long as they are in their ordinary state of health. They receive it into their hands, and can please themselves as to where and how they eat it. It makes the sole article in the menu for two meals in the day.[2]

Together, these authors illustrate bread's role as both the cultural and caloric foundation of Britons' diets: to "pick up a crust," or the more common phrase "earn one's bread," carried meanings both literal and metaphorical. Bread, the "Staff of Life," stood in for one's living, so that earning one's bread included not merely feeding oneself, but also caring for a family, providing shelter, clothing, and basic amenities, and even pursuing a career by devoting oneself to expertise in a particular line of business. And yet, for many Britons in the nineteenth century, the "bread" they earned was *literally* bread, for it dominated British

[1] Henry Mayhew, *London Labour and the London Poor* (London: Penguin, 1985), 5.
[2] Magdalen Reeves, *Round About a Pound a Week*, Repr. (London: Virago, 1994), 97.

diets, providing the bulk of calories: working men could eat a pound or more per day.[3] For women and children, bread was even more important, for custom dictated that the father—the "breadwinner"—got what meat or other protein was available.[4]

Bread also took on political salience at critical moments. In 1846, the newly enfranchised industrial middle classes lobbied successfully for repeal of the Corn Laws, a set of duties on imported grain imposed in 1815.[5] Although the process of removing restrictions on the international grain trade was longer and more drawn out than the scholarly focus on 1846 acknowledges,[6] there is no doubt that Repeal was one of the pivotal moments of Victorian politics. It was a central piece of Liberal legislation, and it signaled the ascendance of "Free Trade" as both political and moral value. And, it was built around bread: the campaign to remove import duties was framed as a campaign to emancipate "the People's Bread" from the self-interest and greed of the landowning classes.[7] Some sixty years later, the 1906 General Election was fought in large part on the issue of Free Trade. The Conservative Party's "Tariff Reform" plan sought to reintroduce import duties to protect British businesses from foreign competition, while the Liberal Party advocated a continuation of Free Trade. In campaigning, the Liberal Party

[3] Derek Oddy, *From Plain Fare to Fusion Food: British Diet from the 1890s to the 1990s* (Woodbridge, Suffolk, U.K.: Boydell Press, 2003), 4.
[4] Petersen calls 1770 to 1870 the "century of the wheaten loaf," although somewhat earlier work by E. J. T. Collins suggests that wheat became the default grain slightly later, and lasted beyond 1870. See Christian Petersen, *Bread and the British Economy, C. 1770-1870*, ed. Andrew Jenkins (Aldershot, Hants., England: Scolar Press, 1995); E. J. T. Collins, "Dietary Change and Cereal Consumption in Britain in the Nineteenth Century," *The Agricultural History Review* 23, no. 2 (1975): 97–115; On the caloric privileges of adult males over women and children, see Oddy, *From Plain Fare to Fusion Food*, 52–4; On the history of the "breadwinner" wage and class formation, see Anna Clark, *The Struggle for the Breeches: Gender and the Making of the British Working Class* (Berkeley: University of California Press, 1995).
[5] Cheryl Schonhardt-Bailey, *From the Corn Laws to Free Trade: Interests, Ideas, and Institutions in Historical Perspective* (Cambridge, Mass.: MIT Press, 2006); Norman McCord, *The Anti-Corn Law League: 1838-1846*, Reprint (London: Routledge, 2013).
[6] Paul Sharp, "'1846 and All That': The Rise and Fall of British Wheat Protection in the Nineteenth Century," *Agricultural History Review* 58, no. 1 (2010): 76–94.
[7] Paul Pickering, *The People's Bread: A History of the Anti-Corn Law League* (London: Leicester Univ. Press, 2000).

consistently made its case for Free Trade with images of the "Big and Little Loaves," a pair of loaves of bread: a large "Free Trade" loaf and a much smaller "Protection" loaf. The message was clear: Free Trade, symbolized by the Big Loaf, meant prosperity, while tariffs, even protective tariffs, meant a return to scarcity and the Little Loaf.[8] With this message, the Liberals won decisively. For Britons across the late nineteenth and early twentieth centuries, then, bread, prosperity, and Free Trade—and hence the world beyond Britain's shores—were inextricably linked.

Mayhew and Reeves's accounts combined the power of bread as a political symbol in 1846 and 1906 illustrate its continuing role as the cultural and caloric foundation of British society. This continuity, however, conceals tremendous environmental change. In 1846, Britain grew about three-quarters of all the wheat that it consumed. By the start of World War I, less than seventy years later, Britain imported more than four-fifths of its wheat, an increase approximately ten-fold in absolute numbers.[9] These imports came from distant and often newly cultivated lands around the world. The United States was nearly always the single largest source, followed by Russia, India, Canada, Australia, and Argentina. Nearly every grain-exporting region in the world supplied Britain at some point, even relatively minor exporters such as New Zealand, Egypt, Chile, and Persia.[10] In the late nineteenth century, Britain dominated the global grain trade so thoroughly that London and Liverpool effectively set the world price for wheat.[11] So important was imported food

[8] Frank Trentmann, *Free Trade Nation: Commerce, Consumption, and Civil Society in Modern Britain* (Oxford: Oxford University Press, 2008).
[9] B. R. Mitchell, *British Historical Statistics* (Cambridge, U.K.: Cambridge University Press, 1988), 221–6.
[10] Wilfred Malenbaum, *The World Wheat Economy, 1885-1939* (Cambridge, Mass.: Harvard University Press, 1953).
[11] C. Knick Harley, "Transportation, the World Wheat Trade, and the Kuznets Cycle, 1850–1913," *Explorations in Economic History* 17, no. 3 (1980): 230–1.

for Britain that it played a pivotal if often underappreciated role in world affairs, and came under direct assault by German U-Boats in both World War I and II.[12]

This globalization of Britain's food supply was part of an environmental process of world-historical significance: the cropped and grazed area of the world increased by about 75% from 1800 to 1914. This necessarily entailed enormous environmental change and human consequences. On the frontiers of European and American empires, foraging and pastoral people were at best subordinated and expropriated, and at worst exterminated in genocidal campaigns. Agrarian settlers felled forests, plowed grasslands, drained wetlands, and irrigated deserts, and they brought these transformed lands into emerging world commodity markets with canals, maritime trade, railways, steamships, and telegraphs.[13] Without this tremendous expansion in the cultivated areas of the world and the environmental and social change it entailed, it is impossible to imagine Britain's expanded imports.

Food and Environment in British Historiography

Wheat, flour, and bread form a chain connecting global environments to British bodies, but this chain has featured in British historiography only in fragments, and some segments not at all. The one substantial study of bread is Christian Petersen's thorough but economically oriented *Bread and the British Economy*. Petersen argued that the century from 1770 to 1870 was the "century of the wheaten loaf," the moment at which wheat

[12] Avner Offer, *The First World War: An Agrarian Interpretation* (Oxford: Oxford University Press, 1989); Ina Zweiniger-Bargielowska, *Austerity in Britain: Rationing, Controls, and Consumption, 1939-1955* (Oxford: Oxford University Press, 2000); R. J. Hammond, *Food and Agriculture in Britain, 1939-45: Aspects of Wartime Control* (Stanford, Calif.: Stanford University Press, 1954).
[13] Giovanni Federico, *Feeding the World: An Economic History of Agriculture, 1800-2000* (Princeton: Princeton University Press, 2005), 34–5.

displaced other grains such as rye, barley, and—to a lesser extent, particularly in Scotland and northern England—oats, so that wheaten bread became the standard article of diet across the kingdom.[14] Older research by E.J.T. Collins, and more recent work by Michael Nelson and Derek Oddy suggest that Petersen ended his study too early, because diets remained narrowly focused on bread until at least 1900, if not 1914 or even later. [15] Other historians have investigated discrete elements of the wheat, flour, and bread chain: John Burnett's description of the difficult labor journeymen bakers endured is the only account of the nineteenth-century baking trade in any depth; Richard Perren's study of the nineteenth-century milling industry found firms to be unlikely but successful examples of consolidation after 1870, while Glyn Jones's trade history of millers is a strong overview from a perspective inside the industry; Andrea Broomfield's superb but short demonstration of the importance of toast as a sign of a well-run middle-class household remains the only cultural history of bread in Britain.[16] In the twentieth century, bread's importance to the British diet steadily declined as animal proteins played a larger and larger role and British diets diversified.[17] Despite some very high-quality studies, then, the research on the single most important article of diet in nineteenth-century Britain must be described as sporadic as best.

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[14] Petersen, *Bread and the British Economy*; Collins, "Dietary Change and Cereal Consumption in Britain in the Nineteenth Century."

[15] "Dietary Change and Cereal Consumption in Britain in the Nineteenth Century"; Michael Nelson, "Social-Class Trends in British Diet, 1860-1900," in *Food, Diet, and Economic Change Past and Present*, ed. Catherine Geissler and Derek J. Oddy (Leicester, U.K.: Leicester University Press, 1993); Oddy, *From Plain Fare to Fusion Food*.

[16] John Burnett, "The Baking Industry in the Nineteenth Century," *Business History* 5, no. 2 (1963): 98–108; Richard Perren, "Structural Change and Market Growth in the Food Industry: Flour Milling in Britain, Europe, and America, 1850-1914," *Economic History Review*, New Series, 43, no. 3 (August 1990): 420–37; Glyn Jones, *The Millers: A Story of Technological Endeavour and Industrial Success, 1870-2001* (Lancaster, U.K.: Carnegie Publishing, 2001); Andrea Broomfield, *Food and Cooking in Victorian England: A History* (Westport, Conn.: Praeger, 2007).

[17] Oddy, *From Plain Fare to Fusion Food*.

Its spare treatment of bread aside, the historiography of food in Britain has established food's importance in three major ways, all of which are relevant to wheat, flour, and bread. First, the industrial revolution transformed Britons' diets, in ways directly related to the changes in relationships between Britons and their environments. It is not typically framed as such, for environmental history's older cousins, agrarian and rural history, dominate this branch of British historiography (more on this below). Second, the empire and globalization have had profound effects on the British diet, by bringing both new products and new people, and therefore new foods and new tastes, to the archipelago. And third, food carries cultural and political meanings. These have already been noted in the case of bread, but, drawing on a long tradition of anthropological and sociological research, historians have explored the cultural and political salience of a wide range of foods.

Diets in early modern Britain were functions of the open field system, access to the commons, and the overall rural nature of life. Access to commons allowed families to furnish at least some of their own fruits, vegetables, wild edibles, and animal products without necessary recourse to the market. Enclosures, the rise of the tenant farmer, the growth of towns, and the broader commercialization of society in the seventeenth and eighteenth centuries included—and even required—an assault on the open fields and commons of earlier times, with the result that more and more people had to resort to the market.[18] The industrial revolution dramatically accelerated this trend, for as the nation urbanized, its city-dwelling inhabitants had few opportunities to grow or collect anything of their own and lost all access to non-market edibles. Their homes were also smaller, with

[18] J. C. Drummond, Anne Wilbraham, and Dorothy F. Hollingsworth, *The Englishman's Food: A History of Five Centuries of English Diet* (London: Pimlico, 1991).

tiny or non-existent kitchens, and little storage space to allow families to carry out their own food processing, as they had done with seasonal produce in the past. Andrea Broomfield, for example, documents changes in the British diet visible in the transformation of recipes from the eighteenth to the nineteenth century. Eighteenth-century cookbooks were filled with recipes for processing and preserving large amounts of a wide variety of goods: apples, rose hips, bacon, and the like. These recipes reflected a primarily rural and agricultural population accustomed to harvesting and preserving the countryside's seasonal bounties. Nineteenth-century cookbooks, however, featured none of these recipes, instead assuming that families would purchase on a weekly or even daily basis virtually everything they needed to prepare meals.[19] For many poor Britons in industrial cities, diets narrowed to bread, jam, and tea, all of which were purchased ready to consume. Such a diet led not surprisingly to deficiency diseases like scurvy and rickets, and this problem intensified in the 1880s and 1890s when white bread became nearly universal, replacing the older brown bread.[20] Further, the rapid growth of industrial cities, the commercialization of all food provision, and the Liberal state's belief in *laissez-faire* meant that the food provided by the market was frequently adulterated. In some cases, adulterants were poisonous, as with lead in candy and copper sulphate in meat. In most cases, though, adulterants were more dishonest than harmful, as with rice meal in bread and watered-down milk.[21]

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[19] Broomfield, *Food and Cooking in Victorian England: A History*.
[20] Nelson, "Social-Class Trends in British Diet, 1860-1900."
[21] John Burnett, *Plenty and Want: A Social History of Diet in England from 1815 to the Present Day* (London: Scolar Press, 1979); E. J. T. Collins, "Food Adulteration and Food Safety in Britain in the 19th and Early 20th Centuries," *Food Policy* 18 (1993): 95–109; Michael French and Jim Phillips, *Cheated Not Poisoned? Food Regulation in the United Kingdom, 1875-1938* (Manchester, U.K.: Manchester University Press, 2000).

In addition to the transformation wrought by the industrial revolution, the empire and world trade also played significant roles in shaping the modern British diet. They provided tropical produce like sugar and tea, both of which were luxury items in the eighteenth century that became household necessities in the nineteenth.[22] The development of wider fossil-fuel transportation networks combined with new retailing practices made available a wider range of produce, including off-season goods from distant markets.[23] The development of the American Midwest and the emergence of refrigeration and meat processing in Chicago brought more meat to British homes than ever before, although it was often fraught with danger.[24] Finally, in the twentieth century, migration into Britain from former colonies brought about substantial changes to British cuisine. Curry, for example, has come to define Britain's post-colonial cuisine, although its presence in Britain stretches back to the late eighteenth and early nineteenth centuries.[25]

Finally, scholars of food have established its cultural and political importance.[26] Anne Murcott summarized the early anthropological and sociological literature on food by explaining that eating habits "are not solely a matter of the satisfaction of physiological and

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[22] Sidney Mintz, *Sweetness and Power: The Place of Sugar in Modern History* (New York: Viking, 1985); Piya Chatterjee, *A Time for Tea: Women, Labor, and Post/Colonial Politics on an Indian Plantation* (Durham, N.C.: Duke University Press, 2001); John Burnett, *Liquid Pleasures: A Social History of Drinks in Modern Britain* (London: Routledge, 2012); Erika Rappaport, *An Acquired Taste: Tea, the British Empire, and the Making of a Global Consumer Culture* (New York: Bloomsbury, Forthcoming).

[23] Oddy, *From Plain Fare to Fusion Food*, 7–31; Victoria De Grazia, *Irresistible Empire: America's Advance Through Twentieth-Century Europe* (Cambridge, Mass.: Harvard University Press, 2009).

[24] William Cronon, *Nature's Metropolis: Chicago and the Great West* (New York: W.W. Norton, 1991); Robyn S. Metcalfe, *Meat, Commerce and the City: The London Food Market, 1800–1855* (Abingdon, U.K.: Routledge, 2015).

[25] Lizzie Collingham, *Curry: A Tale of Cooks and Conquerors* (Oxford, U.K.: Oxford University Press, 2006); Oddy, *From Plain Fare to Fusion Food*.

[26] The anthropological and sociological literature on food is vast, considerably larger than the historical literature on the same subjects. For a sampling of the most influential works, see Claude Levi-Strauss, "The Culinary Triangle," in *Food and Culture: A Reader*, ed. Carole Counihan and Penny Van Esterik (Abingdon, U.K.: Routledge, 1997); Mary Douglas, *Food in the Social Order: Studies of Food and Festivities in Three American Communities* (London: Routledge, 2009); Jack Goody, *Cooking, Cuisine, and Class: A Study in Comparative Sociology* (Cambridge , U.K.: Cambridge University Press, 1982).

psychological needs, nor merely a result of individual preference. Food has also to be seen as a cultural affair… Foods themselves can be seen to convey a range of cultural meanings."[27] For scholars of British history, the most fruitful areas of investigation in the cultural meaning of food have been in understanding how it marked social groups. Sugar, for example, became a staple in substantial measure because of the symbolic importance it carried for British consumers, distinguishing rich from poor and generating imitative consumption down the social scale as it became cheaper.[28] Tea, similarly loaded with cultural meanings that distinguished rich from poor, underwent a similar process.[29] National and imperial identity is also articulated through food: beef played a particularly important role in defining "Englishness" for Georgian England. A tradition of meat eating distinguished them from their French rivals, and reinforced their self-perceptions of relative prosperity.[30] For Victorian Britons, beef remained a staple, but they asserted their Britishness by redefining British culinary traditions, long overshadowed by French influence.[31]

The most compelling recent work in the history of food, but one that also captures the field's weakness, in James Vernon's cultural and political history of hunger. He argued that food was most conspicuous in its absence, for hunger made apparent the aims and limits of the British state's biopolitcs—the rendering of life as an object of political power. Hunger proved to be a potent political critique for Irish and Indian anti-colonialists, while

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[27] Anne Murcott, "The Cultural Significance of Food and Eating," *Proceedings of the Nutrition Society* 41, no. 02 (June 1982): 203.
[28] Mintz, *Sweetness and Power*.
[29] Erika Rappaport, "Packaging China: Foreign Articles and Dangerous Tastes in the Mid-Victorian Tea Party," in *The Making of the Consumer: Knowledge, Power and Identity in the Modern World*, ed. Frank Trentmann (Oxford: Berg, 2006); Chatterjee, *A Time for Tea*.
[30] Linda Colley, *Britons: Forging the Nation, 1707-1837* (New Haven: Yale University Press, 1992), 35–6.
[31] Lauren Goldstein, "Cooking up a Nation: Exploring British Food Identity through Class, Gender, Empire, and the Continental Relationships, 1830-1930" (PhD Dissertation, McMaster University, 2015).

for working-class Britons it was a basis from which to argue for the creation of a state more willing to intervene in the market on behalf of the well-being of the working classes, especially children. The state itself took on hunger as a political problem from the middle of the nineteenth century, first by sponsoring research into nutrition and then by taking a measure of responsibility for nutrition itself, beginning with school lunches in the early twentieth century.[32] However, although Vernon makes a compelling argument for the role of hunger in Britain's modern history, it remains essentially a history of political discourse and cultural representations. Without the material reality of food to ground the study, "there is no there there," and the problems and contradictions of Britain's modern environmental history remain disconnected from Britain's food history. And, even when historians of food have considered its material nature, they have done so with very little reference to food outside culinary spaces such as shops, kitchens, and dining tables. With this in mind, it is particularly unfortunate that wheat, flour, and bread have featured so little in the historiography of food, for the three main strands of food historiography—industrialization, empire, and culture—are also deeply intertwined in wheat, flour, and bread.

British environmental history and its older cousins agrarian history, rural history, landscape history, and historical geography, have arrived at a set of conclusions about the British environment similar to those reached by historians of food, although there has been precious little overlap between the two bodies of research. Environmental history is at its core an inquiry into the relationships between humans and the non-human world, and it

[32] James Vernon, *Hunger: A Modern History* (London: The Belknap Press of Harvard University Press, 2007).

typically takes two forms, one material, and the other cultural.[33] The material relationships between humans and the non-human world include the environmental or geographical contexts in which human activity takes place, the human activities that draw on or relate to the non-human world: agriculture, forestry, mining, fishing, and other productive endeavors, as well as activities that engage with or affect the non-human world in some way, such as pollution, water management, and conservation. At times, the effects of the non-human world on humans have also been treated by environmental history, as with histories of disease or "natural" disasters. The cultural and intellectual dimension of environmental history deal with representations of the non-human world and ideas about it: animals, plants, gardens, landscapes, and ideas of "wilderness," "nature," or other abstractions of the non-human world.

As with the history of food, environmental historians in Britain have established the transformative nature of industrialization, the influence of the empire on metropolitan Britain, and the cultural relevance of environments, particularly in defining human groups. Although there are persistent claims that British environmental history is "underdeveloped," in fact studies of the land, ecology, and people of Britain have a long history, dating back to well before historians began to use the term "environmental" in the late 1960s and early 1970s.[34] These include the now-classic works of historical geography

[33] Some historians have identified three parts to environmental history: material, political, and cultural/intellectual; however, given that the political management of environments is nearly always rendered in material terms, that distinction seems unnecessary. See John R. McNeill, "Observations on the Nature and Culture of Environmental History," *History and Theory* 42, no. 4 (2003): 37.
[34] Sverker Sörlin and Paul Warde, "The Problem of the Problem of Environmental History: A Re-Reading of the Field," *Environmental History* 12, no. 1 (January 1, 2007): 107–30; Verena Winiwarter et al., "Environmental History in Europe from 1994 to 2004: Enthusiasm and Consolidation," *Environment and History* 10, no. 4 (2004): 501–30.

by H. C. Darby, the history of flora and fauna by Oliver Rackham, and H. G. Hoskins's account of the historical uses and alterations of landscapes.[35]

The development of explicitly "environmental" history in the United States in the 1960s and 1970s was a direct result of historians seeing the rapid and often catastrophic environmental changes of post-war American capitalism: clear-cutting in the redwood forests, oil spills in rivers and on coasts, and litter on the roadsides. This was an environmental history inspired by Rachel Carson and Greenpeace, with often obvious environmental-*ist* motives, and its early practitioners in the United States tended to focus on issues of environmental "degradation" or "destruction."[36] When British (and other European) historians, responding to similar concerns of pollution in the 1980s, took up similar studies, the industrial revolution was a natural focal point. This moment produced extensive histories of air and water pollution that documented the environmental changes wrought by heavy industry and urbanization.[37] As British environmental history has matured and synthetic treatments have appeared, they too have seen the nineteenth-century industrial revolution as a pivotal moment.[38]

British environmental historians have also been attentive to the empire's influence on the metropolis, although this has almost always been seen in intellectual terms. Richard

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[35] Henry Clifford Darby, *An Historical Geography of England Before A.D. 1800: Fourteen Studies* (Cambridge, U.K.: Cambridge University Press, 1957); Oliver Rackham, *The History of the Countryside: The Classic History of Britain's Landscape, Flora and Fauna* (New Haven, Conn.: Phoenix Press, 2000); W. G. Hoskins, *The Making of the English Landscape*, Reprint (London: Penguin, 1985).
[36] McNeill, "Observations on the Nature and Culture of Environmental History," 15–9.
[37] Peter Brimblecombe, *The Big Smoke: A History of Air Pollution in London since Medieval Times*, Reprint (Abingdon, U.K.: Routledge, 2012); Bill Luckin, *Pollution and Control: A Social History of the Thames in the Nineteenth Century* (Bristol, U.K.: A. Hilger, 1986); Lawrence E. Breeze, *The British Experience with River Pollution, 1865-1876* (New York: P. Lang, 1993).
[38] B. W. Clapp, *An Environmental History of Britain Since the Industrial Revolution* (Abingdon, U.K.: Routledge, 2014); I. G Simmons, *An Environmental History of Great Britain: From 10,000 Years Ago to the Present* (Edinburgh: Edinburgh University Press, 2001); John Sheail, *Nature Conservation in Britain: The Formative Years* (London: Stationery Office, 1998).

Grove, for example, argued that modern environmentalism is a product of the experience of scientists, physicians, and imperial administrators who saw the rapid environmental change caused by imperial policy and commercial exploitation. After witnessing these effects on the microcosms of "tropical island Edens," he argued, these imperial experts took their knowledge and understandings of environmental change to India and other, larger imperial possessions; from there, it trickled back into the metropolis to ultimately influence the twentieth-century environmental movement in Britain.[39] Other historians have made similar arguments with respect to science, the empire, and environments; the three were mutually intertwined, with science and other forms of expertise operating as a discourse to render imperial environments legible, governable, and available for exploitation.[40]

And, as with historians of food, environmental historians in Britain have been attentive to the cultural meanings of environments, particularly as they have operated to construct and delineate social groups. One area in which this is evident is landscape history, a body of literature most concerned with the ways that landscapes—environments specifically under the gaze of particular individuals, and their representations—have operated to define Englishness, to root historical memory, and to reinforce cultural and political positions.[41] A second strand of environmental history that emphasizes the cultural

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[39] Richard Grove, *Green Imperialism: Colonial Expansion, Tropical Island Edens, and the Orgins of Environmentalism, 1600-1860*, 1st pbk. ed (Cambridge [England]: Cambridge University Press, 1996).

[40] John M. MacKenzie, *The Empire of Nature: Hunting, Conservation and British Imperialism* (Manchester, U.K.: Manchester University Press, 1997); Richard Harry Drayton, *Nature's Government: Science, Imperial Britain, and the "Improvement" of the World* (New Haven, Conn.: Yale University Press, 2000); Jefferson Dillman, *Colonizing Paradise: Landscape and Empire in the British West Indies* (Tuscaloosa, Alab.: University of Alabama Press, 2015); Daniel Clayton, *Islands of Truth: The Imperial Fashioning of Vancouver Island* (Vancouver: University of British Columbia Press, 2000).

[41] David Matless, *Landscape and Englishness* (London: Reaktion Books, 1998); Simon Schama, *Landscape and Memory* (New York: Vintage Books, 1995); Ann Bermingham, *Landscape and Ideology: The English Rustic Tradition, 1740-1860* (Berkeley: University of California Press, 1989); Nigel Everett, *The Tory View of*

meanings of environment deals with ideas of "nature," the creation of national parks, and the modern environmental movement.[42] In Britain, this has focused most on Scotland, the largest expanse of something resembling "wilderness" in the archipelago.[43] Overall, environmental historians have dealt remarkably little with food, instead leaving that to agrarian and rural historians. Certainly, no historians have considered the environmental importance of wheat, flour, and bread in modern Britain.

The Human-Nature Binary and the Problem of Food and Environment

At its core, the blindness of historians to the cultural and environmental importance of wheat, flour, and bread lies in one of the most fundamental assumptions of modern Western culture: that humans and nature are in fact distinct and mutually exclusive categories.[44] History, as a humanistic or social scientific pursuit, privileges the human world over the non-human and therefore sits firmly on one side of the human-nature binary. This is visible where historians have chosen to draw boundaries around their inquiries: historians of food, for example, are interested in material objects defined as food. But, as Claude Levi-Strauss's early work on the structures of mythology argued, items

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Landscape (London: Paul Mellon Centre for Studies in British Art, 1994); Donna E. Landry, *The Invention of the Countryside: Hunting, Walking, and Ecology in English Literature, 1671-1831* (London: Palgrave, 2001).

[42] Clarence J. Glacken, *Traces on the Rhodian Shore: Nature and Culture in Western Thought from Ancient Times to the End of the Eighteenth Century* (Berkeley: University of California Press, 1976); Keith Thomas, *Man and the Natural World: Changing Attitudes in England 1500-1800* (London: Penguin, 1991).

[43] T. Christopher Smout, *Nature Contested: Environmental History in Scotland and Northern England since 1600* (Mankato, Minn.: Capstone, 2000); Sheail, *Nature Conservation in Britain*; John Sheail, *British Ecological Society* (Wiley Online Library, 2002), http://onlinelibrary.wiley.com/doi/10.1002/9780470057339.vab033/full; Harvey Taylor, *Claim on the Countryside* (Edinburgh: Edinburgh University Press, 1998); Michael Wheeler, *Ruskin and Environment: The Storm-Cloud of the Nineteenth Century* (Manchester: Manchester University Press, 1995); Dewey Hall, *Romantic Naturalists, Early Environmentalists: An Ecocritical Study, 1789-1912* (Farnham, U.K.: Ashgate Publishing, Ltd., 2014); William Taylor, "The Culture of 'Environmentality' and the Exceptionality of the Countryside," in *The Victorian World*, ed. Martin Hewitt (Abingdon, U.K.: Routledge, 2013), 259–75.

[44] Raymond Williams, "Ideas of Nature," in *Culture and Materialism: Selected Essays* (London: Verso, 2005), 68–85; Moore calls this the "Cartesian binary"; see below. Jason Moore, *Capitalism in the Web of Life: Ecology and the Accumulation of Capital* (London: Verso Books, 2015).

deemed "food" have always already been removed from "nature" and incorporated into the human realm through the act of cooking, if not before, through harvesting or processing.[45] For historians of food, then, it takes an additional step to consider their subjects as environmental objects, and there are precious few accounts of food that take environmental relationships seriously; Sidney Mintz's history of sugar and Doug Sackman's history of oranges are the two most well known.[46] This problem is evident in a similar way with economic and agrarian history. These disciplines pay particular attention to the grain trade, bread prices, and farm labor, but their interests are exclusively on the human side of the binary: the soils, roots, and stalk of the wheat plant matter not at all in comparison to the grain—the only part that fully enters the human world of the market.

Environmental history, on the other hand, investigates both sides of the human-nature binary. It asks about the relationships between things deemed "human" and things deemed "nature"—humans and rivers, for example, or humans and pollution. And, in studying both sides of the human-nature binary, historians have laid bare the constructed nature of that binary in a range of ways: Raymond Williams argued that "nature" contained "an extraordinary amount of human history" through human labor in and on the non-human world.[47] William Cronon identified in the concept of "wilderness" a "boundary" between humans and nature that is itself historical, changing over time as humans imagined and reimagined that lands that they understood to be uninhabited and

[45] Claude Lévi-Strauss, *The Raw and the Cooked: An Introduction to a Science of Mythology*, trans. Claude Weightman and John Weightman (New York: Pimlico, 1969).
[46] Mintz, *Sweetness and Power*; Douglas Sackman, *Orange Empire: California and the Fruits of Eden* (Berkeley: University of California Press, 2005).
[47] Williams, "Ideas of Nature," 67.

fundamentally "not human."[48] And, yet, despite these powerful and inspirational insights, environmental historians have largely reinforced the human-nature binary in their work, even as they have attempted to deconstruct it. Few environmental historians, for example, consider anything without humans in it, keeping themselves firmly rooted in the human world, even as they peer across the binary. [49] And, the great majority of social, economic, cultural, and political historians regard environment as something "out there," a matter simply not relevant to their studies. Even critical scholars developing ideas of Marxist ecology and of the "metabolic" links between humans and nature have continued to reproduce the binary, speaking of human "disruptions" to apparently once-pristine nature, and of a metabolic "rift" between nature and industrial society.[50]

At its core, the problem is that while we may recognize that "humans" and "nature" are constructed categories, we lack a language to describe the world and our place in it differently. As such, environmental histories have had a difficult time fully combining the material and the cultural elements of the discipline. We are stuck in an epistemology that imagines "humans *and* nature," interacting with one another but always distinct; we imagine that humans change nature through their labor or their pollution, and in the declensionist tradition of older environmental history, humans "ruin," "disrupt," or "protect" it. Sometimes, nature strikes back with floods, plagues, or other "natural" disasters. And, humans observe and represent "nature." But, in the end, "the environment"

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[48] "The Trouble with Wilderness; Or, Getting Back to the Wrong Nature," in *Uncommon Ground: Toward Reinventing Nature* (New York: W.W. Norton & Co, 1995), 69–90.
[49] But see David Christian and William H. McNeill, *Maps of Time: An Introduction to Big History, With a New Preface* (Berkeley: Univ of California Press, 2011).
[50] John Bellamy Foster, *Marx's Ecology: Materialism and Nature* (New York: New York University Press, 2000); John Bellamy Foster, Richard York, and Brett Clark, *The Ecological Rift: Capitalism's War on the Earth* (New York: New York University Press, 2011); Paul Burkett, *Marx and Nature: A Red and Green Perspective* (New York: Palgrave Macmillan, 1999); David Pepper, *Eco-Socialism: From Deep Ecology to Social Justice* (New York: Routledge, 2002).

remains an Other, a thing "out there" that does not extend into human society. This fixation on a version of nature as the Other has resulted in a persistent American fascination with the "frontier" as the point at which humans and nature met, and with the West as a more "natural" part of the country.[51] For scholars in Britain, the Other has appeared in other guises: particular interest in the pre-Roman or pre-industrial landscape,[52] the Scottish Highlands,[53] and the empire.[54] And, the result is that while historians have increasingly acknowledged the role of the environment in human affairs, "history" has remained a largely human narrative. The study of wheat, flour, and bread in Britain has remained disaggregated, and almost wholly disconnected from its environmental dimensions: agrarian and economic historians have studied "wheat," the work of human labor that appears in the market; food historians have studied bread, the food that appears in British kitchens; political historians have studied bread's role in politics; and cultural historians have studied its representations. In some cases, these sub-disciplines overlap, but on the whole, wheat, flour, and bread do not appear as a linked phenomenon in British historiography.

The *Oikeios*, Biopolitics, and the Commodity Chain

If the problem in connecting environments and food is our inability to describe environmental relationships without reinforcing the human-nature boundary, the solution, then, is two-fold: a new language and a new method. Jason Moore's concept of the *oikeios* and Michel Foucault's concept of "biopolitics" combine to provide a language that

[51] Frederick Jackson Turner, *The Significance of the Frontier in American History*, Reprint (London: Penguin, 2008); *Under an Open Sky: Rethinking America's Western Past* (New York: W.W. Norton, 1992).
[52] Darby, *An Historical Geography of England Before A.D. 1800*.
[53] Smout, *Nature Contested*.
[54] Grove, *Green Imperialism*; MacKenzie, *The Empire of Nature*; Drayton, *Nature's Government*.

deconstructs the human-nature boundary and reveals the mutually constitutive nature of humans and nature through a world-ecology of which both are irreducibly a part. At the same time, they call attention to the forms of knowledge, cultural meaning, and political power that are necessary for making a world-ecology a material reality, but that simultaneously deny the existence of that material reality, insisting on the ontological separation of humans and nature. Immanuel Wallerstein and Terence Hopkins's concept of the commodity chain, in turn, provides a method through which to see this process as it operates in specific historical contexts.

There has been no shortage of attempts to integrate humans, nature, ecology, environments, economics, and so on, but there has been a distinct lack of specific theories that can truly span the constructed boundaries between humans and nature. Jason Moore, a geographer (though working in a sociology department and writing environmental history), proposes the *oikeios* as a means to overcome the human-nature binary, and to enable historians to construct more holistic narratives of environmental history. The *oikeios* is the web of life, the "creative, generative, and multi-layered relation of species and environment" in which humans and nature are not merely connected, but are internal to one another: humans exist within nature, nature exists within humans, and the two are engaged in an ongoing, co-producing dialectic that he calls the "double internality."[55] If we are attentive to the constructed nature of "wilderness," then we must acknowledge that humans have inhabited virtually all environments on earth at one time or another, and are products of those environments. There are of course uninhabited lands, but humans are among the most widely dispersed species on the planet, and the places that escape our

[55] Moore, *Capitalism in the Web of Life*, 296.

touch are rare and tiny.[56] At no point did a group of humans suddenly extricate themselves from ecological relationships because they had developed a particular technology or adopted a certain way of living. Further, human action does not remove something from an ecology; plowing grassland to create a wheat field makes a different kind of ecology, but land, species, and humans remain part of the web of life, the *oikeios*. Moore attempts to dissolve the boundaries between humans and nature, then, by positing the *oikeios* as a kind of "world-ecology" in which the forest, the wheat field, the industrial suburb, and the human body are all components of a universal web of life.

Key to the concept of *oikeios*, and to overcoming our own cultural rendering of uninhabited spaces as "natural" or "wild," while inhabited spaces are somehow exclusively "human" or "settled," is understanding how the human-nature binary operates as a cultural formation, particularly in the history of capitalism. Moore calls this binary "Cartesian," arguing that it emerged during the Scientific Revolution as a "world-praxis," combining empirical observation and rational comprehension, to produce representations of the non-human world as *distinct from and external to* humans. It is, in other words, a broad pattern of forms of knowledge, cultural meaning, and political power that draws a sharp line between the human and non-human realms. In so doing, it generates a distinct coding of value on the "human" side of that line while simultaneously rendering the "nature" side of that line available for human appropriation. On the human side, Marx's theory of value obtains: *value* is commodified labor-time. Physically, commodities are bundles of labor time and the material products of nature. To become "commodities" properly, they are

[56] And with climate change, humans have become geological agents, so that no part of the earth's surface is disconnected from humans. Dipesh Chakrabarty, "The Climate of History: Four Theses," *Critical Inquiry* 35, no. 2 (2009): 197–222.

placed in simplified, homogenizing categories that make them fungible and therefore most fit for market exchange.[57] However, as Marxist ecologists and feminists have pointed out, labor cannot be reproduced without considerable *uncommodified* (and therefore unpaid) “work” or “energy” drawn from outside the circuit of capital, performed by “women, nature, and colonies.”[58] The same applies to commodities. For example, the commodity of “wheat” is priced according to the wages necessary to produce it, the element that registers on the “human” side of the human-nature binary. But, sunlight, rain, soil, the plant itself, and the rest of the ecology of the wheat field are also necessary for the production of wheat. Those elements are the unpaid work/energy of the “nature” side of the binary. And, while the actual materials grown and harvested by human labor within the world-ecology are infinitely variable, their coding as a commodity elides that variability, rendering them examples of a stream of apparently homogeneous materials, such as “wheat.” By focusing “value” exclusively on labor, the human-nature binary creates an incentive to increase the amount of unpaid work/energy appropriated by labor, for any such increase is effectively an increase of labor productivity. In this way, the key to the accumulation of capital is not merely the exploitation of wage labor, but also the appropriation of unpaid work/energy from nature.

Of course, appropriating unpaid work/energy from nature is no simple matter. Far more than a simple seizure of “resources” or the “destruction” of nature, it is instead a *remaking* of the *oikeios* to produce streams of unpaid work/energy for human

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[57] Cronon, *Nature’s Metropolis*; Aashish Velkar, *Markets and Measurements in Nineteenth-Century Britain* (Cambridge, U.K.: Cambridge University Press, 2012).
[58] Maria Mies, *Patriarchy and Accumulation on a World Scale: Women in the International Division of Labour* (London: Zed Books, 2003), 77.

appropriation. "It takes work," Moore argues, "to make nature work" for humans.[59] Bearing in mind that the human-nature binary is a constructed one, and humans and nature remain inextricably bound in the web of life, it becomes clear that rather than destroying nature, *capital is in fact dependent on it—even as the knowledge, culture, and power we deploy insists on our utter separation from it.* We can, however, extend Moore's powerful insights into the function of the Cartesian binary further. He identifies an effect of the human-nature binary—a particular coding of value on the human side—but beyond noting that scientific knowledge quantifies and disaggregates the "nature" side of the binary to facilitate its appropriation, he says relatively little about the specific political and cultural means through which ecologies are generated and maintained. In his rendering, the Cartesian binary is essentially a frame for the political and cultural relationships that accompany the creation of a capitalist world-ecology.

Foucault's concept of "biopolitics" fills this frame, encompassing the knowledge, meaning, and power necessary for generating a capitalist world-ecology, and it does so with particular relevance to food and environments. Biopolitics, he argues, emerged in the eighteenth century as a set of forms of government, discipline, and regulation that made the management of life the object of political power. This was a novel development, for more older, more "traditional" forms of sovereign power emphasized political control of death, typically through the exercise of bodily violence. With its focus on life, biopolitical governmentality took a far more expansive view of the state and its relationship to both the environments it occupied and the human beings it governed. Biopolitcs operates along several different axes running through society. One is the axis Foucault calls "discipline," a

[59] Moore, *Capitalism in the Web of Life*, 70–1.

means of governing individualized bodies by placing them in perceptual grids and hierarchies, as in the prison, the clinic, or the workhouse. In this way, the behavior of individuals could be "corrected"; violence still operated on these individuals, but it was rationalized as bringing about future improvements: "the pauper will be converted into the sturdy laborer; the prisoner will be rehabilitated; savage populations will be civilized."[60]

A second biopolitical axis is what Foucault calls "security," a form of governmentality that seeks to maximize the circulation of material elements necessary for life, or what Karl Polanyi and others have called the liberal state, with the principle of economic freedom as a central element. As early modern states became more concerned with the spatial organization and management of their territory and their population, ensuring the circulation of water, air, and food in cities became more difficult. Addressing this issue, and in particular the problems associated with food and scarcity, was pivotal to the development of biopolitical apparatuses. Traditionally, under the mercantilist states and economies of the early modern period, hunger and scarcity were considered more or less natural, matters of misfortune or divine condemnations of "man's evil nature."[61] With this view in mind, state and society upheld the population's rights to subsistence through what Foucault called an "anti-scarcity system," E. P. Thompson a "moral economy," and John Bohstedt the "politics of provisions": a set of fairly direct interventions by the state through a combination of customs, laws, and practices that regulated food in order to prevent, ameliorate, or at least address scarcity.[62] These typically included "a mixture of

[60] David Nally, "The Biopolitics of Food Provisioning," *Transactions of the Institute of British Geographers* 36, no. 1 (January 1, 2011): 38; Foucault develops his ideas of discipline most in his history of prisons and incarceration. See Michel Foucault, *Discipline and Punish*, n.d.
[61] Vernon, *Hunger*, 3.
[62] Michel Foucault, *Security, Territory, Population: Lectures at the Collège de France, 1977-1978*, ed. Michel Senellart, trans. Graham Burchell (New York: Picador, 2004); E. P. Thompson, "The Moral Economy of the

price controls, curbs on exportation, the operation of public granaries, prohibitions on the use of provisions for the distillation of alcohol, and the duty-free import of victuals."[63] It featured a series of Corn Laws regulating the import and export of grain, prohibitions on certain aspects of the internal grade trade such as regrating, forestalling, and engrossing, requirements that grain merchants make provisions available to individuals at particular markets, and the Assize of Bread, a price-fixing scheme for bakers that set bread prices according to the price of wheat.

Foucault's anti-scarcity system, Thompson's moral economy, and Bohstedt's politics of provisions differ in key ways: Foucault emphasizes the action of the state, Thompson the nature of economic exchange, and Bohstedt the agency of the working population. However, they each describe a system with a common function: the maintenance of social and political stability, as articulated in the relationships between humans and nature. Underlying all three of these terms is the notion that everyone in society possessed a "right to subsistence"; in environmental-historical terms, that each person was entitled to a relationship between themselves and the non-human world that guaranteed access to food. The right of subsistence was built on a moral foundation that held that relationships between the production and consumption of food should be as direct as possible. Anyone standing between the production and consumption of food—or interposing themselves between a person and the non-human world—was at best a morally suspect "middleman," and at worst an outright danger to social stability. This moral position meant that, if a state properly performed its duty to prevent manipulation of the food supply by middlemen,

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English Crowd in the Eighteenth Century," *Past & Present*, no. 50 (February 1971): 76–136; John Bohstedt, *The Politics of Provisions: Food Riots, Moral Economy, and Market Transition in England, C. 1550–1850* (Farnham, U.K.: Ashgate Publishing, Ltd., 2013).

[63] Nally, "The Biopolitics of Food Provisioning," 39.

then any shortage that did occur was necessarily the result of forces outside human control, whether natural or supernatural. Anti-scarcity systems operated less to actually prevent scarcity or keep prices low—the long history of famines stretching back to Antiquity testifies to its ineffectiveness in that regard—than to ameliorate, circumscribe, and define food shortages in certain ways; they functioned to ensure that humans could not directly cause scarcity through means unjust or otherwise immoral. Famines occurred, but in an anti-scarcity system, famines were necessarily the misfortune of nature or the wrath of God, rather than the malice of landlords or the greed of merchants. In that sense, then, an anti-scarcity system attempted to preserve stability—if not of food supplies, then at least stability of political institutions and social structures in the face of scarcity.

Foucault identified the rise of biopolitical ideas in food provision with the French physiocrats in the eighteenth century, who regarded scarcity as less of a moral or cosmological problem than a governmental one. Key to this shift was the notion that liberalism, in the form of private enterprise and the free circulation of grain, was a better mechanism of security than the older, more direct, and more morally-inflected anti-scarcity measures. The state took a step back from the direct regulation of food, and instead aimed at creating the conditions for the greater production and freer circulation of food. The material benefits available to individuals in a system of private enterprise and free trade would encourage farmers to grow more and to maximize productivity, to specialize, and to follow the incentives of prices. It would ensure that in regions with shortages, as prices rose, so too would the incentive to import supplies in order to take advantage of those high prices. Over time, the uneven geography of abundance and scarcity would level out. But, putting this system of free trade in place was not simply a matter of *laissez-faire*, of the state doing nothing. This state had on the one hand to cede control of some aspects of society that it had previously sought to control, but in other ways it had to be imposed, requiring, as Foucault put it, a revision of "the permitted and the forbidden."[64] The older anti-scarcity system had to be systematically disassembled, revolts against markets quelled, and attempts to seize food supplies—and thereby re-impose the norms and morals of the anti-scarcity system—prevented. Disciplinary measures had to be instituted, including the protection of property by police forces and penitentiaries and the forced participation in the labor market through the coercive institutionalization of hunger. And, the new apparatus of security does not banish hunger. Rather, by placing food provision in the hands of the market, a planned scarcity continues to operate, but it does so as a means to force participation in a labor market, to set prices, and therefore to generate a wider security for the aggregated *population*, even if some individuals within it remained hungry. Indeed, as Foucault argued, "the scarcity that caused the death of individuals not only does not disappear, it *must not* disappear" (emphasis added).[65]

David Nally identifies a "clear analog" to the intellectual developments of the French physiocrats at roughly the same time in Britain. This included the theorizing on liberal political economy by Adam Smith, Edmund Burke, and, somewhat later, David Ricardo. Further, the Irish famine of 1847 provided a key opportunity for the extension of market mechanisms for addressing food scarcity, as endorsed by J. S. Mill.[66] In the specific case of wheat, flour, and bread, there was also pressure from within the provisioning system of early modern Britain. While the various statutes and customs that made up the anti-

[64] Foucault, *Security, Territory, Population: Lectures at the Collège de France, 1977-1978*, 45–6.
[65] Ibid., 42.
[66] Nally, "The Biopolitics of Food Provisioning," 40–1; Christopher Otter, "Ecology, Security, Pathology: British Nutrition in World-Historical Context" (North American Conference of British Studies, Minneapolis, Minn., 2014).

scarcity system covered the internal and external grain trade, baking, and provisions for the poor, milling was never included in a comprehensive way. As such, in the eighteenth century, "men of capital" entered the milling trade and the grain trade, buying, grinding, and selling wheat and flour on their accounts. Their entry both facilitated the provisioning of Britain's growing cities, and served to undermine the anti-scarcity systems that operated in baking and the grain trade, despite the state's best efforts to preserve it. By the early nineteenth century, the anti-scarcity system was unworkable.[67] Repealing the Assize of Bread between 1815 and 1836 and the repeal of the Corn Laws in 1846 were key moments in dismantling the old anti-scarcity system and replacing it with the apparatus of security; those were also key moments in the creation of a liberal state.[68]

The apparatuses of discipline and security are frequently intertwined, and built into the shift to an apparatus of security and a liberal state was a disciplinary distinction between the aggregated "population" who contributed to the free circulation of materials and whose wellbeing was ensured by it, and the individualized "peoples" who opposed it. The "people" became threats to the "population," and therefore subject to disciplinary intervention. Nally identifies this in the New Poor Law of 1834, another central piece of liberal legislation, which "established for the first time an epistemological separation and legal distinction" between a "pauper," the social delinquent who needed to be disciplined in the workhouse, and the "laboring poor" who merely struggled to make ends meet. "The Poor Law," he argued, was therefore "a techné for separating the 'normal' from the 'pathological' in such a way as to *naturalize* the violence of incarceration and correction,"

[67] See Chapters One, Two, and Three.
[68] C. R. Fay, "The Miller and the Baker: A Note on Commercial Transition, 1770-1837," *Cambridge Historical Journal* 1, no. 1 (1923): 85–91; Petersen, *Bread and the British Economy*.

particularly that associated with enforcing the operation of the market.[69] John Bohstedt identified this same transition in the "politics of provisions" in the eighteenth and early nineteenth centuries. Food riots had long been a part of the "moral economy," but by the early nineteenth century, two shifts had significantly reduced riots' effectiveness. In the first place, workers began to agitate for higher wages, and not lower bread prices, and riots became more a matter of industrial organization and action, rather than a moral economy of food provision. Second, Bohstedt argues, after 1812 there was a shift in the "calculus of governance" that rendered food riots a "police" problem, a matter of "order." At that point, "food riots seemed no longer to be the efficacious component of provision politics that they had been in the eighteenth century."[70] In biopolitical terms, by the early nineteenth century, the apparatus of security was firmly entrenched, and those resisting it were subject to coercive discipline.

Foucault did not develop the environmental dimensions of biopolitics, but he did note that security necessarily deals with what he called the "milieu," a set of "natural givens—rivers, marshes, hills—and a set of artificial givens—an agglomeration of individuals, of houses," and so on.[71] Taken alongside Moore's concept of *oikeios*, "security" expands to describe the many interventions of power, knowledge, and culture that make it possible to appropriate a stream of unpaid work/energy from nature. Foucault suggested that the apparatus of security took a step back from the juridical-disciplinary attempts to control the market directly that comprised anti-scarcity systems. Instead, the object of power and knowledge in an apparatus of security became the grain itself: "everything that

[69] Nally, "The Biopolitics of Food Provisioning," 40–1.
[70] Bohstedt, *The Politics of Provisions*, 254.
[71] Foucault, *Security, Territory, Population: Lectures at the Collège de France, 1977-1978*, 21.

may happen to it and will happen to it naturally, as it were, according to a mechanism and laws in which the quality of the land, the care with which it is cultivated, the climatic conditions of dryness, heat, and humidity, and finally the abundance or scarcity… and its marketing and so forth will also play a part."[72] This, then, is "security" as a techné of environmental relationships, within Moore's Cartesian binary and its coding of value on the human side of the human-nature binary. It is a way of managing "what happens to the grain between seeding and the time when it will have finally produced all the profits that it can," because that time represents an accumulation of unpaid work/energy, made available for human appropriation.[73] The Cartesian binary, therefore, *is* a biopolitical apparatus.

At the heart of the Cartesian binary and its biopolitical operation, however, is a profound contradiction. The apparatus of security facilitates the circulation of materials through an ecology, thus establishing and supporting the physical connections between bodies and environments; but, at the very same time, the apparatus of discipline, by placing bodies in perceptual grids and hierarchies, insists on the absolute separation of human bodies and non-human environments. The multiple axes of biopolitical power, then, are at cross-purposes: they simultaneously connect and separate bodies and environments.

In connecting the environments and bodies that comprise the capitalist world-ecology, and in articulating the human-nature binary that underlies Western culture, the commodity assumes a central role. For Moore, the commodity frontier is the moment at which human labor appropriates the unpaid work/energy of nature, bundling the two together in a form that contains particular value, and that may thereby travel through the "human" side of the human-nature binary on the strength of that value. And, while Foucault

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[72] Ibid., 36.
[73] Ibid.

does not use the term, the commodity is also the practical term for the material elements that the apparatus of security facilitates the circulation of. The idea of the "commodity" itself is, of course, a cultural construction, beyond Moore's point that it involves a particular coding of value.[74] Commodification requires not only investing materials with value, but also placing them into homogeneous categories, rending them fungible and thus exchangeable on the largest possible market. The homogenizing nature of commodification entails stripping away the meanings originally associated with it, but it also makes possible and even necessary the reconstruction of meanings in order for that object to function within specific human contexts. Wheat, for example, as a bundle of human labor and unpaid work/energy from a field, loses the specific connections to its cultivation when it becomes "No. 2 Spring Wheat" in a Chicago grain elevator; at that point, it enters a stream of homogenized "wheat."[75] But, in order for those objects to move through the human world, and be milled, baked, and consumed, they must be systematically reinvested with meaning at each point, for they remain cultural objects: as a particular kind of flour, as a certain kind of bread, and as a specific meal.

Seeing the operation of the commodity as it moves through a capitalist ecology therefore requires a specific method: Immanuel Wallerstein and Terence Hopkins's concept of the "commodity chain" provides this, for it allows the scholar to "take an ultimate item and trace back the set of inputs that culminated in this item—the prior transformations, the raw materials, the transportation mechanisms, the labor inputs into

[74] Thomas Richards, *The Commodity Culture of Victorian England: Advertising and Spectacle, 1851-1914* (Stanford, Calif.: Stanford University Press, 1990).
[75] Cronon, *Nature's Metropolis*.

the material processes, and food inputs into the labor."[76] For Wallerstein and Hopkins, this was a useful tool through which to see the spatial divisions of the global economy. In their rendering of the capitalist world-system, commodity exchange generated differential accumulations of surplus value as objects were invested with value and transformed along their journeys through "core" and "periphery" zones.[77] Repurposed as an optic to view the environmental history of a commodity, the concept of commodity chain brings into view both Moore's *oikeios* and Foucault's biopolitics: it follows the material connections between environments and bodies that make the capitalist world-ecology a material reality, while also showing the many forms of knowledge, expertise, meaning, labor, and power that operate on and through that ecology.

The Wheat Ecology and British History

Wheat, flour, and bread, seen through Moore's *oikeios*, Foucault's biopolitics, and Wallerstein and Hopkins's commodity chain, provide the means to unify histories of food and environment in Victorian Britain. This approach allows three interventions. First, the environmental history of Britain expands both outward to a global scale, and inward to the bodies of Britons. Environmental historians studying the British past have largely confined themselves to the archipelago or the empire, but wheat, flour, and bread reveal the connections between irrigation in California's Central Valley, railways in Australia, and

[76] Terence K. Hopkins and Immanuel Wallerstein, "Patterns of Development of the Modern World-System," *Review (Fernand Braudel Center)* 1, no. 2 (October 1, 1977): 128.
[77] Immanuel Maurice Wallerstein, *World-Systems Analysis* (Chapel HIll, N.C.: Duke University Press, 2004); Terence K. Hopkins and Immanuel Wallerstein, "Commodity Chains in the World-Economy Prior to 1800," *Review (Fernand Braudel Center)* 10, no. 1 (July 1, 1986): 157–70; Gary Gereffi and Miguel Korzeniewicz, *Commodity Chains and Global Capitalism* (Santa Barbara, Calif: ABC-CLIO, 1994); For an overview and analysis of this vast topic, see Jennifer Bair, *Frontiers of Commodity Chain Research* (Stanford, Calif.: Stanford University Press, 2009).

settlement along the banks of the Volga in southern Russia, the contraction of wheat cultivation on the heavy soils of the Home Counties, the concentration of milling in Liverpool, labor in subterranean bakeries in London, and meals in workhouses and people's homes.[78] At the same time, environmental historians have not attended to the human body nearly enough, and when they do it is typically through the lenses of disease or public health.[79] The ecology of wheat, flour, and bread, however, extends into human bodies. Bodies and environments literally make one another in a physical sense. The shores of the archipelago, the borders of the empire, the thresholds of homes, and the bellies of consumers were not meaningful boundaries for wheat, flour, and bread.

Second, this approach opens up an environmental history of biopolitics, or perhaps a biopolitical history of environments. With the dismantling of the old anti-scarcity system, and its replacement with systems of security and discipline, the relationships between British bodies and global environments came to be governed by a set of biopolitical apparatuses. These included the milling trade, the baking trade, and the medical profession. In all three of these cases, a body of experts, endorsed, facilitated, and adapted to the globalization of Britain's wheat ecology. If Britons' bread in the eighteenth century was largely a product of local environments and was situated within local cultural contexts, Britons' bread by the late nineteenth century was a global product, and situated within a network of expert discourses, who used their expertise to secure the proper circulation of

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[78] With the important exception of Kenneth Pomeranz, *The Great Divergence China, Europe, and the Making of the Modern World Economy* (Princeton, N.J: Princeton University Press, 2000).

[79] Linda Nash, *Inescapable Ecologies: A History of Environment, Disease, and Knowledge* (Berkeley: University of California Press, 2006); Warwick Anderson, *Colonial Pathologies: American Tropical Medicine, Race, and Hygiene in the Philippines* (Durham, N.C.: Duke University Press, 2006); William McNeill, *Plagues and Peoples* (New York: Knopf Doubleday Publishing Group, 2010).

goods and to regulate and discipline the spaces and people those objects passed through. Bread in Victorian Britain was, in short, an object of biopolitics.

Finally, this approach opens up a cultural history of environments and bread that positions wheat, flour, and bread at the heart of British culture. Objects must be invested with meaning in order to be *food*; in the anti-scarcity system, the meaning of food was, more than anything else, an articulation of local human-environment relationships. The anti-scarcity system's moral foundation of an ideal relationship between humans and nature that was as direct as possible set up the cultural registers for food's meaning in early modern Britain. It was an articulation of rural life, agricultural labor, tenancy and land ownership, and the many dimensions of an agrarian society. With the creation of a global wheat ecology, however, those meanings were undermined. No longer did the bulk of Britain's population spend the bulk of its time producing food for itself. Britain urbanized, industrialized, and outsourced its food production. As such, a kind of gap in the meaning of food opened up—a gap that biopolitical expertise filled. Millers increasingly mediated not merely between the processes of production and consumption, but between disaggregated producing and consuming populations, and their environments. Bakers adopted new methods and new materials, allowing them to consistently make whiter bread than ever before, satisfying demands for white bread. In recommending wheaten bread and endorsing a global wheat ecology, physicians lent their expertise to the state and to the population in food selection—a problem that does not exist in agrarian societies that simply eat what they grow. And, for the laboring population, brown bread became both a disciplinary weapon used against them—a marker of their subordination and dependence on the state in the workhouse or the prison—while white bread became the symbol of a material life if not completely prosperous, at least free and independent of the state.

This research is organized in six chapters, each of which touch on the globalization of Britain's wheat ecology, the implementation of biopolitical apparatuses of security and discipline, and the cultural and environmental meanings and relationships bound up in bread. First, because the size of the world wheat ecology necessarily puts it far beyond the scope of this project to treat comprehensively and in any detail, the existing scholarship in world environmental history and British economic history serve to establish that global environments and British bodies were in fact integrated in a world wheat ecology. British imports exploded in the second half of the nineteenth century, at the same time that world wheat markets integrated, and British living standards improved, as measured by the size of British bodies.

The milling industry was vital to the successful operation of a world wheat ecology, and is the subject of Chapter Two. Milling is a biopolitical discourse, necessary for the operation of the market, and changed dramatically in the 1870s and 1880s in response to the increase in imported wheat. Because wheat varieties are highly variable, British millers found considerable difficulty in milling the larger quantities of foreign wheat they received. This was compounded by the fact that supplies fluctuated from year to year according to the weather, politics, and many other factors. Some years, the American crop was large and high quality, and other years the Russian. Some years, prices were low throughout the world; in other years, war, drought, or other disasters drove prices up. Millers responded to these challenges by shifting the geography of milling to the ports, reflecting their global supplies, by employing new technologies, and by institutionalizing the creation and dissemination of expertise in global wheat environments. However, their primary goal was not to share this expertise, but to produce the whitest, most consistent flour possible. "Flour" was, after all, a commodity, and bakers above all demanded flour that was homogeneous and consistent, while baking the largest and whitest loaves possible. As such, while the supplies of wheat changed considerably from year to year, and millers were acutely aware of this, they produced flour that was as consistent as possible, effectively concealing from those further along the chain the origins of their wheat, flour, and bread.

Chapters Three and Four follow flour into bakeries. Chapter Three explores the biopolitics of baking in the 1860s, using it as an opportunity to illustrate the tensions at the heart of the relationships between bodies and environments. In the wake of a series of adulteration scandals in the 1850s, bakeries took on particular importance for the British medical profession, and ultimately for the British state. Doctors and medical inspectors took particular interest in London bakeries and found there bodies and environments in such intimate contact that they essentially made each other. And within the frame of the Cartesian binary, such intimate contact was a threat to the health of the bakers themselves, and a threat to health of the population. As such, from the 1860s, the state turned a biopolitical gaze upon bakeries, disciplining the bodies, environments, and food found there.

Chapter Four examines the baking trade from the 1870s, when it encountered similar problems to millers. Not all bakers purchased blended flours from millers, and millers did not always produce totally consistent blends, but bakers were required by their customers to produce consistent loaves of bread. As such, they developed a comparable body of expertise. Further, with whiter flour available from millers, bakers developed techniques that ensured lighter-textured, whiter loaves of bread: the "proper white bread" that George Orwell described in his dystopian novel *1984*.[80] Together, then, millers and bakers combined to transform the flour and bread consumed by the British public, to make sure that it was as consistent as possible, and to pass along as little knowledge as possible about its origins despite the highly variable nature of Britain's wheat supply.

Chapter Five considers the role of medicine in the history of food and environments through a history of physiology in the nineteenth century. British, European, American, and colonial doctors and researchers developed the study of nutrition and physiology at this time, and did so in ways that reflected both the emergence of global wheat supplies and the frame of the Cartesian binary. They imagined that bodies and environments were each essentially homogeneous and mutually exclusive categories, interacting only through the exchange of chemicals and represented in food. Despite wide variations in their ideas of just how the body digested food, they remained convinced that bread was the best food, or the bigger part of the best diet for all human bodies, and that—because environments were essentially homogeneous as well—the origins of that bread were immaterial. They thus imagined bodies and environments as mutually constitutive on the most universal and abstract level.

Finally, Chapter Six concludes with an investigation of the meanings associated with bread consumption. Bread was, for Victorian Britain, a synecdoche of material life, the cultural and caloric foundation of the British diet. It stood for one's ability to work and live, if not comfortably, at least with some level of material sufficiency. And, the poorer one was, the greater the importance bread loomed, and the more desperate was the struggle for this

[80] George Orwell, *1984* (Boston: Houghton Mifflin Harcourt, 1983), 308.

one particular item; the wealthier one was, the more bread became an adjunct to other elements of material and cultural life.

The chief distinction among bread was in color, and the liberal—or perhaps il-liberal—state used this distinction as a disciplinary weapon. The British working classes were exposed to an unregulated market following the passage of the New Poor Law in 1834, and central to this process were the workhouse and the prison: disciplinary institutions that enforced participation in the market and protected property. And there, in the hated workhouse and the feared prison, brown bread was the rule. Poor Law administrators, including Edwin Chadwick himself, perhaps the most influential liberal reformer in the nineteenth century, insisted that inmates of workhouses and prisons eat brown bread. As a result, the demand among the working population for white bread, a demand that was practically universal and had brought anxiety to the middle and upper classes for generations, took on a new meaning: white bread was the sign of freedom. And, the globalization of Britain's wheat ecology meant that white bread was available for all. For Victorian Britons, then, bread contained their cultural and environmental relationships in one package; it embodied their labor and their freedom even as it replenished their bodies. It is no wonder, then, that it was commonly called "the Staff of Life."

CHAPTER ONE

GLOBAL WHEAT AND BRITISH BODIES

The globalization of Britain's wheat in the nineteenth century was part of an environmental process of world-historical significance. When viewed through the lens of the *oikeios*, the capitalist world ecology in which the commodity plays such a central role, the expansion of commodity market is the pivot on which modern world environmental history turns. Materials circulated the globe at levels far above anything seen before, connecting bodies to environments in a world ecology. But, despite the importance of global commodity markets in the nineteenth century, scholars of world environmental history have recognized it only rarely.

In part, this blindness is a result of a light treatment of the nineteenth century overall in world-environmental-historical scholarship. For example, John Richards argued that, from the perspective of the core regions in the North Atlantic, Middle East, and South and East Asia, the early modern world until 1800 appeared to have an "unending frontier," with uncultivated lands, untapped resources, and relatively small populations beyond the borders of empires around the world. In part, Richards stopped at 1800 because the industrial revolution of the nineteenth century brought change of a different order than what came before.[1] J. R. McNeill argued that the twentieth century witnessed economic development and human-caused environmental change fundamentally different in speed, scope, and scale from anything before; he began at 1900, because he argued that only at

[1] John F. Richards, *The Unending Frontier an Environmental History of the Early Modern World* (Berkeley: University of California Press, 2003).

that point was the impact from industrialization truly global.[2] Between those two accounts, the nineteenth century sits uncomfortably, omitted from both Richards's narrative of many local changes with a family resemblance, and McNeill's narrative of comprehensive, planetary-level change. And yet, it was the nineteenth century that saw the shift from one to the other, as humans remade the *oikeios*, appropriating ever-larger streams of work/energy for the accumulation of capital by extending commodity frontiers. Richards's work does not extend far enough, stopping at the turn of the nineteenth century and thereby missing the enormous expansion of commodity frontiers that had begun in the sixteenth century (if not before) and only accelerated after 1800; McNeill's work begins too late, overlooking that same transformation despite its global scope.

The research exists, however, to see this process. If world environmental history has been uncomfortable with the transformations of the nineteenth century, more local and national histories have not: there is an extensive literature documenting the expansion and intensification of agriculture, settlement, and empire that transformed environments throughout the world. And, the effects of this process on Britain have also been well documented. British economic historians have long understood the scale of commerce that brought global commodities into British homes and factories. More recently, they have also documented the integration of markets, particularly in wheat, making clear that Britain was institutionally integrated within a world ecology built on commodity production. Finally, after decades of debate on the "standard of living" of the British working class during the industrial revolution, historians have developed an anthropometric history of British bodies, tracking the changes in size, stature, and other biological indicators of health

[2] J. R. McNeill, *Something New Under the Sun: An Environmental History of the Twentieth-Century World* (New York: W. W. Norton & Company, 2001).

that occurred across the nineteenth century. Taken together, these bodies of literature show the creation of a global ecology of wheat, flour, and bread that transformed environments around the world and brought the products of those environments into British bodies.

In order to connect the expansion of commodity production and environmental transformations abroad with consumption, standards of living, and British bodies at home, it is necessary to consider the shift in biopolitical apparatuses governing Britain in the early modern period. At the most basic level, "Free Trade" was necessary to allow larger amounts of goods to circulate; but, Free Trade was not simply a matter of removing state intervention. Before Britain could become fully integrated into a world-ecology of wheat, a revision of what Foucault called "the permitted and the forbidden" was necessary.[3] There had to be, in other words, a biopolitical transformation bringing about a shift from the medieval and early modern anti-scarcity system to an apparatus of security.

The anti-scarcity system in place in early modern Britain included a broad range of regulations, statutes, and customs: the Corn Laws regulated the import and export of grain; statutes regulated the internal grain trade by prohibiting regrating, forstalling, and ingrossing, as well as by requiring merchants to make grain available to small purchasers at "just" prices in markets at specific times and places; a patchwork of feudal regulations on milling existed, including customary tolls and monopolies; the Assize of Bread tied wheat and bread prices to one another, and functioned as a sumptuary law, specifying the amount, quality, and price of bread; and the various Poor Laws made some provision for

[3] Michel Foucault, *Security, Territory, Population: Lectures at the Collège de France, 1977-1978*, ed. Michel Senellart, trans. Graham Burchell (New York: Picador, 2004), 45–6.

paupers.[4] All of these interventions attempted to ensure low prices, or, failing that, "fair" prices, and thereby ensure social stability. Underlying this system's attempt to ensure social stability was a fundamental moral position that the ideal relationship between the production and consumption of food should be as short and direct as possible, or, in environmental terms, that humans encounter nature directly through their labor. Best of all was a person consuming the products of their own labor, for it reflected the most direct relationship of all: "In the sweat of thy face shalt thou eat bread, till thou return unto the ground; for out of it wast thou taken: for dust thou art, and unto dust shalt thou return," the King James Bible intoned in Genesis 3:19, reflecting a long tradition of subsistence agriculture in western Eurasia, as well as illustrating a moral touchstone for early modern Britons. In the frequent absence or impracticality of such direct relationships, there should be as few intermediaries as possible. Anyone standing between the production and consumption of food was inherently suspect as they stood to profit personally from their position as a middleman. To address this potential problem, regulations on merchants and bakers operated in many cases to render them effectively public servants, removed from the full operation of the market. As C. R. Fay noted, in his account of the commercialization of milling: "In a matter so vital as the delivery of food, no autonomy, no rights against society were suffered."[5]

This anti-scarcity system began to break down in the late seventeenth and early eighteenth centuries as transportation and commercial networks began to merge local

[4] John Bohstedt, *The Politics of Provisions: Food Riots, Moral Economy, and Market Transition in England, C. 1550–1850* (Farnham, U.K.: Ashgate Publishing, Ltd., 2013); E. P. Thompson, "The Moral Economy of the English Crowd in the Eighteenth Century," *Past & Present*, no. 50 (February 1971): 76–136; Sidney Webb and Beatrice Webb, "The Assize of Bread," *The Economic Journal* 14, no. 54 (June 1, 1904): 196–218.
[5] C. R. Fay, "The Miller and the Baker: A Note on Commercial Transition, 1770-1837," *Cambridge Historical Journal* 1, no. 1 (1923): 85.

grain markets into a national one. Although this was a long process—there was no uniform "national loaf" of British bread until at least the late nineteenth century[6]—there was certainly more trade in grain from the late seventeenth century on.[7] Millers had never been as closely or as comprehensively regulated as other segments of the anti-scarcity system, and a set of capitalist millers and other "men of capital" were able to transform the milling industry into a commercial pursuit and to thereby expand the scale of the grain trade.[8] By the eighteenth century, corn dealers were operating at a larger scale, and commercial millers were buying wheat and selling flour for profit at whatever prices they could get.[9] The increasing scale of the grain trade began to push individual buyers, and especially the poor, out of the market. They could only afford to buy small amounts for their own consumption, but farmers preferred to sell in larger quantities to corn dealers and millers, often by sample. Selling to dealers before individual consumers and selling by sample were both technically illegal, and violated the existing anti-scarcity system, as evidenced by widespread complaints: Thompson notes a 1768 pamphlet, for example, in which the author regarded the farmer's attendance at the regulated local markets and provision of grain for small-scale purchases as "a material part of his duty; he should not be suffered to dispose of his goods elsewhere."[10]

Commercial millers, buying, grinding, and selling on their own accounts, made it progressively more difficult for local authorities to control the prices of provisions. At the same time, however, it is clear that the rapidly growing cities of eighteenth-century Britain

[6] E. J. T. Collins, "Dietary Change and Cereal Consumption in Britain in the Nineteenth Century," *The Agricultural History Review* 23, no. 2 (1975): 97–115. See also Chapters Four and Six.
[7] Karl Gunnar Persson, *Grain Markets in Europe, 1500-1900: Integration and Deregulation* (Cambridge: Cambridge University Press, 1999).
[8] Fay, "The Miller and Baker."
[9] Ibid., 85–87.
[10] Thompson, "The Moral Economy of the English Crowd in the Eighteenth Century," 87.

could not have been supplied every year from the farmers in their most immediate vicinity; a more robust grain trade was necessary for urban growth.[11] And, this was a period of increasingly rapid population growth and urbanization. Although historical reconstruction is a difficult task and estimates vary, the consensus holds that England and Wales had a combined population of somewhat over 5 million in 1700, and the urbanization rate was somewhere between 15% and 20%. By 1750, the population had reached about 5.75 million, and urbanization had ticked up to about 21%, and by 1800, England and Wales combined for about 8.7 million, and Great Britain (England, Wales, and Scotland) had topped 10 million. At that point, fully a quarter of the population lived in towns of more than 5,000 inhabitants.[12] This increasing urbanization is difficult to imagine with a flexible grain trade, and impossible to imagine without a growing one. As such, enforcement of restrictions in the grain trade whether by the state or the people tended to occur most in moments of crisis, at which point popular protests could reassert the older framework of the moral economy in surprisingly disciplined "riots."[13] Typical events involved crowds forcing farmers, millers, and bakers to provide custom at "fair" prices, often with the explicit support of local gentry.[14]

The politics of the anti-scarcity system, and their evolution into an apparatus of security, are evident in the direct action of food riots. Bohstedt argues that prior to the 1740s, rioters' primary target was the transportation of provisions as they attempted to

[11] Persson, *Grain Markets in Europe*; Roger Scola, *Feeding the Victorian City: The Food Supply of Manchester, 1770-1870* (Manchester, England: Manchester University Press, 1992).
[12] E. A. Wrigley, "Urban Growth and Agricultural Change: England and the Continent in the Early Modern Period," *Journal of Interdisciplinary History* XV, no. 4 (Spring 1985): 688; B. R. Mitchell, *British Historical Statistics* (Cambridge, U.K.: Cambridge University Press, 1988), 474–5; See also Wrigley's broader writings on the population history of Britain. E. A. Wrigley, *Poverty, Progress, and Population* (Cambridge, U.K.: Cambridge University Press, 2004).
[13] Bohstedt, *The Politics of Provisions*.
[14] Thompson, "The Moral Economy of the English Crowd in the Eighteenth Century," 87, 93–4, 107–15.

keep grain trade local and small scale, enforcing the old moral priority for a direct relationship between producers and consumers. In the 1740s, 1750s, and 1760s, however, rioters shifted their attention to markets, where they attempted to obtain price reductions and controls in an occasionally violent negotiation with local authorities.[15] It was at this point that the state began to shift toward a biopolitical apparatus of security. For the new apparatus of security, the low prices that the older anti-scarcity system attempted to preserve were no longer a goal; instead, high prices were seen as a positive benefit because they would stimulate greater production and greater exchange, helping to level out the uneven geography of abundance and scarcity. Higher prices overall meant, however, a level of "forced under-consumption" by the poorest in society. Hence, rioters attempted at this point to enforce the older norms of the politics of provisions with direct action on the focal point of prices, the markets.[16]

With the beginning of the shift from anti-scarcity to security apparatuses, Britain also shifted from being a net exporter of grain to a net importer. This shift is visible in legislation after 1765. Parliament first flipped their laws governing imports and exports. Previously, it was illegal to export when prices were above stated levels; the fear was that if prices were high and export allowed, it would exacerbate already-existing shortages, driving prices still higher. Parliament began at this point to impose heavy duties on imports if domestic prices were below a certain level. This prevented merchants from flooding the country with cheap imported grain, thereby keeping prices in the country fairly high, and protecting the rents of landowners while also stimulating greater production and

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[15] Bohstedt, *The Politics of Provisions*, 91–164.
[16] Foucault, *Security, Territory, Population: Lectures at the Collège de France, 1977-1978*, 42.

exchange.[17] At the same time, other Acts removed restrictions on engrossing, regrating, and forestalling, and import duties on grain were lowered, allowing more freedom of movement for grain. In this way, the price of grain was allowed to rise, while greater circulation of grain was permitted. The nineteenth-century removals of the other components of the anti-scarcity system, the Corn Laws and the Assize of Bread, built on this legislative foundation. In short, then, the British state began to rely increasingly on the market to set prices and supply provisions, and, in so doing, made it possible for Britain to tap into the materials produced as commodity frontiers expanded around the world.

The Great Specialization

Findlay and O'Rourke called the extension of commodity frontiers in the nineteenth century "The Great Specialization," and it entailed the creation of an extensive global division of labor, including a range of primary products from jute to beef to sugar to wheat.[18] This coincided with an enormous expansion of settlement and agriculture substantially (though not exclusively) effected through imperialism. Between 1800 and 1914, the lands under cultivation or pasturage increased about 75% globally, and to accomplish this change—to create a new world ecology—millions of non-agricultural peoples were expropriated and in some cases exterminated, forests were felled, mountains leveled, wetlands drained, grasslands plowed, rivers dammed and diverted, deserts irrigated, and land and water crossed with railways, telegraphs, and steamships.[19] What

[17] Paul Sharp, "'1846 and All That': The Rise and Fall of British Wheat Protection in the Nineteenth Century," *Agricultural History Review* 58, no. 1 (2010): 76–94.
[18] Ronald Findlay and Kevin H. O'Rourke, *Power and Plenty: Trade, War, and the World Economic in the Second Millennium* (Princeton: Princeton University Press, 2007), 365.
[19] Giovanni Federico, *Feeding the World: An Economic History of Agriculture, 1800-2000* (Princeton: Princeton University Press, 2005), 34–5.

Wilfred Malenbaum called the "wheat world" was not the largest part of the transformation of the Earth's surface (that likely goes to the very land-extensive pasturage), but wheat was among the largest by volume and the greatest in value, and was definitely the first to create fully integrated markets, in which a "world price" existed.[20]

The most extensive changes in global landscapes occurred on the frontiers of European and Neo-European empires.[21] In countries of European settlement outside Europe itself, the land under cultivation ballooned from 50.5 million acres in 1850 to 165.8 million acres in 1910.[22] The United States was the largest single example by far, growing from 45.7 million acres in 1850 to 140.4 million in 1910; the figure would be larger still if counting from 1800, for in the nineteenth century, the United States expanded from what was essentially a string of settlements along the eastern seaboard and its immediate littoral, all the way across the continent.[23] Similar expansions somewhat later and over more limited territory occurred in Canada, Australia, and Argentina.[24] Although much of this land was pasture, and only a fraction was given to wheat, the increase remains staggering. Further, wheat played a particularly important role in expanding frontiers, as it was frequently the most valuable product per unit of weight, and was already established as a hardy traveler, able

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[20] Findlay and O'Rourke, *Power and Plenty: Trade, War, and the World Economic in the Second Millennium*, 365; Steven C. Topik and Allen Wells, *Global Markets Transformed, 1870-1945* (Cambridge, Mass.: The Belknap Press of Harvard University Press, 2012), 116–60.

[21] On the concept of the "Neo-Europe," see Alfred W. Crosby, *Ecological Imperialism: The Biological Expansion of Europe, 900-1900* (Cambridge, U.K.: Cambridge University Press, 2004) See below.

[22] Federico, *Feeding the World*, 33–4.

[23] William Cronon, *Nature's Metropolis: Chicago and the Great West* (New York: W.W. Norton, 1991); R. Douglas Hurt, *American Agriculture: A Brief History* (West Lafayette, Ind.: Purdue University Press, 2002).

[24] Jeremy Adelman, *Frontier Development: Land, Labour, and Capital on the Wheatlands of Argentina and Canada, 1890-1914* (Oxford: Oxford University Press, 1994); Cameron Muir, *The Broken Promise of Agricultural Progress: An Environmental History* (Abingdon, U.K.: Routledge, 2014); Alan Shaw, "Colonial Settlement, 1788-1945," in *Agriculture in the Australian Economy.*, ed. Donald Birtall Williams (Sydney: Sydney University Press, 1990), 1–18; For an overview, see David B. Grigg, *The Agricultural Systems of the World: An Evolutionary Approach*, vol. 5 (Cambridge, U.K.: Cambridge University Press, 1974); Federico, *Feeding the World*.

to survive long journeys in ships' holds and (later) railway wars. It could thus bear the costs of long-distance transportation better.[25] The new lands brought under the plow varied in their fertility and long-term viability; considerable portions of the American Midwest, for example, turned out to be too dry for long-term cultivation.[26] Others, such as California, began with wheat but shifted to other crops as their agricultural economies and access to markets changed.[27] Still others, such as the northern states in the American Midwest, the Canadian prairies, the wheat lands of Australia, and portions of the Pampas of Argentina, remained significant wheat exporters through the Second World War and beyond.[28]

The frontier regions of the United States, Canada, Australia, and Argentina were what Alfred Crosby dubbed "Neo-Europes," lands far from Europe but with similar climates, and therefore amendable to "ecological imperialism" from European *portmanteaux biota*, the species that accompany particular groups of humans.[29] One Neo-Europe that produced little or no wheat for export was New Zealand (though it more than made up for that in wool, mutton, and butter, filling the same role as other Neo-European resource-producing peripheries[30]). Some environmental marginal Neo-European regions such as Uruguay, southern Brazil, and South Africa also produced little or no wheat as it was poorly suited to their particular climates. Overall, though, the larger portion of the

[25] C. Knick Harley, "Western Settlement and the Price of Wheat, 1872–1913," *The Journal of Economic History* 38, no. 04 (1978): 865–78.
[26] Donald Worster, *Dust Bowl: The Southern Plains in the 1930s* (New York: Oxford University Press, USA, 2004).
[27] Steven Stoll, *The Fruits of Natural Advantage: Making the Industrial Countryside in California* (Berkeley: University of California Press, 1998); David Igler, *Industrial Cowboys: Miller & Lux and the Transformation of the Far West, 1850-1920* (Berkeley: University of California Press, 2001).
[28] Malenbaum, *˜Theœ World Wheat Economy, 1885-1939*.
[29] Crosby, *Ecological Imperialism*.
[30] James Belich, *Making Peoples: A History of the New Zealanders, from Polynesian Settlement to the End of the Nineteenth Century* (Honolulu: University of Hawaii Press, 2001).

increase in wheat cultivation around the world took place in Neo-European regions at the frontiers of empire. Further, although not strictly a "Neo-Europe," Russia's expansion of wheat cultivation also fits this pattern. Russia's cultivated area increased from 82.5 million to 113.4 million acres in the second half of the nineteenth century, primarily as a result of settlement, commercialization, and railway development in the "Black Earth" region along the Volga River, and in the Ukraine.[31]

The expansion of cultivation occurred in part as a cause, and in part as an effect of an enormous wave of settlement premised on land seizure and supported by imperial states. John Weaver called this pattern the "Great Land Rush," and it stretched beyond the nineteenth century, beginning at least as early as 1650, and continuing in some areas well into the twentieth century. And, while this settlement was at times at the behest and under the aegis of empire, it was not always such. In some instances, the expansion of settlement was the result of *resistance to* national or imperial states; Weaver argued that the Great Land Rush resulted from "a tension, remarkable and fateful, between defiant private initiatives and the ordered, state-backed certainties of property rights."[32] Further, the expansion of the world wheat ecology and the wheat-flour-bread chains it created did not fit easily into the boundaries of particular empires. The world's largest exporter for much of the nineteenth century was the United States, effectively an empire in its own right, but tied commercially and ecologically to consumers in Europe, and particularly in Britain. And,

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[31] David Moon, *The Plough That Broke the Steppes: Agriculture and Environment on Russia's Grasslands, 1700-1914* (Oxford: Oxford University Press, 2013); David Moon, "Peasant Migration and the Settlement of Russia's Frontiers, 1550–1897," *The Historical Journal* 40, no. 04 (1997): 859–93; David Moon, *The Russian Peasantry 1600-1930: The World the Peasants Made* (Abingdon, U.K.: Routledge, 2014); Barry K. Goodwin and Thomas J. Grennes, "Tsarist Russia and the World Wheat Market," *Explorations in Economic History* 35, no. 4 (1998): 405–30; Peter Gatrell, *The Tsarist Economy, 1850-1917* (London: Batsford, 1986).
[32] John Weaver, *The Great Land Rush and the Making of the Modern World, 1650-1900* (Montreal and Ithaca, N.Y.: McGill-Queen's University Press, 2003), 5; James Belich, *Replenishing the Earth: The Settler Revolution and the Rise of the Angloworld* (Oxford: Oxford University Press, 2011).

some imperial expansions of wheat cultivation did not entail European settlement. The Government of India, for example, encouraged wheat exports to Britain in the late nineteenth century, in part through the construction of railways and canals.[33]

The expansion of the world ecology of wheat, flour, and bread also required what Daniel Headrick called the "Tentacles of Progress," the development of communications technologies and institutions, investments in them, and their proliferation around the world.[34] The overall effect of these developments was to dramatically reduce the cost of transport, and, ultimately, to achieve what economic historians call "market integration" by the end of the nineteenth century, if not significantly before. Chief among the technologies were those employing steam power, typically from fossil fuels (though wood continued to dominate in the United States well into the late nineteenth century), to transport goods directly: the railway and the steamship. The first commercial railway was constructed in Britain in 1830, linking the textile production center at Manchester to the port at Liverpool. By 1850, most of Europe and the settler colonies had some kind of embryonic railway infrastructure, but the growth by 1910 was exponential: Britain itself nearly quadrupled its railways, from 6,600 miles to over 23,000; European Russia grew from just 310 to nearly 35,000 miles; Canada from 66 to over 26,000; Argentina and Australia from none in 1850 to over 17,000 apiece by 1910; and the United States grew from an already-robust 9,000 miles to track to a staggering quarter of a million.[35] Steamships also proliferated after the

[33] David E Ludden, ed., *Agricultural Production and South Asian History*, 2nd ed (New Delhi: Oxford University Press, 2005).
[34] Chicago Daniel R. Headrick Professor of History Roosevelt University, *The Tentacles of Progress: Technology Transfer in the Age of Imperialism, 1850-1940: Technology Transfer in the Age of Imperialism, 1850-1940* (New York: Oxford University Press, USA, 1988).
[35] Kevin H. O'Rourke and Jeffrey G. Williamson, *Globalization and History: The Evolution of a Nineteenth-Century Atlantic Economy* (Cambridge, Mass.: MIT Press, 2001), 34–6.

development of more efficient compound engines in the 1860s, and played a growing role after 1880.[36]

But, although steam and fossil fuels have taken the bulk of historians' attention—and indeed represent a substantial appropriation of unpaid, accumulated work/energy from nature in the form of ancient sunlight and geology—they were necessary but not sufficient for the creation of a global wheat ecology. Improvements in sailing technology and ship construction, and greater knowledge of winds and currents helped cut travel times and maritime labor on long oceanic hauls enough to keep sail competitive with steam until the end of the nineteenth century.[37] Inland and coastal water transportation was also important in both Britain and Europe. The navigable length of inland waterways in Britain doubled from 1660 to 1760, and then tripled between 1760 and 1830.[38] This allowed the integration of a single British market in the eighteenth century, and the pattern across Europe was similar: the early integration of Europe-wide markets—led by grain—followed water far more than political borders.[39] Overseas, the construction of the Erie Canal from 1817 to 1825 turned Great Lakes ports like Buffalo into entrepôts and processing centers for American grain grown in the Ohio Valley, and which could then be exported consumed

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[36] Douglass North, "Ocean Freight Rates and Economic Development 1730-1913," *The Journal of Economic History* 18, no. 04 (1958): 542–3.
[37] Ibid., 541.
[38] Christian Petersen, *Bread and the British Economy, C. 1770-1870*, ed. Andrew Jenkins (Aldershot, Hants., England: Scolar Press, 1995), 152.
[39] David S. Jacks, "Intra-and International Commodity Market Integration in the Atlantic Economy, 1800–1913," *Explorations in Economic History* 42, no. 3 (2005): 381–413; David Chilosi et al., "Europe's Many Integrations: Geography and Grain Markets, 1620–1913," *Explorations in Economic History* 50, no. 1 (2013): 46–68.

in or exported via New York City[40]; the Suez Canal in 1869 effectively brought India thousands of miles closer to Europe and made it a viable supplier.[41]

In addition to the development of transportation infrastructure, it is also clear that there were institutional changes as well. The telegraph played a significant role in the global dissemination of information, allowing merchants to respond to opportunities more quickly.[42] However, the telegraph alone, like steam, was insufficient, for grain-trading firms were expanding their networks of agents and communication before the telegraph, and continued to develop them after. Morton Rothstein details the creation of much wider networks of merchant communication than ever before, with many trading houses stationing their agents in cities throughout the wheat world.[43] As early as 1825, merchants in New York had advantages over other American exporters because New York received more regular news from Britain via newly-established "packet" shipping lines; for these merchants, wheat and flour were a "fluctuating complement" for cotton-carrying ships making scheduled trips to Liverpool. For merchants whose primary goal was to have a full cargo hold in their ships, wheat could round out a relatively small cargo of cotton, allowing them to keep ships at sea more regularly.[44] Also important were the developments in standardized units of measure, both across Britain and between countries. British

[40] Morton Rothstein, "American Wheat and the British Market, 1860-1905" (PhD Dissertation, Cornell University, 1960), 18.
[41] Findlay and O'Rourke, *Power and Plenty: Trade, War, and the World Economic in the Second Millennium*, 380.
[42] Mette Ejrnæs and Karl Gunnar Persson, "The Gains from Improved Market Efficiency: Trade Before and After the Transatlantic Telegraph," *European Review of Economic History* 14, no. 3 (2010): 361–81.
[43] Morton Rothstein, "Centralizing Firms and Spreading Markets: The World of International Grain Traders, 1846-1914," Working Paper Series No. 47 (Business History Conference Annual Meeting, Atlanta, Georgia: Agricultural History Center, University of California, Davis, 1988); Dan Morgan, *Merchants of Grain*, Reprint (Bloomington, Ind.: iUniverse, 2000), http://agris.fao.org/agris-search/search.do?recordID=US19800491302.
[44] Rothstein, "American Wheat and the British Market," 18.

merchants developed a whole range of shipping and insurance policies in order to guard against the vagaries of long oceanic voyages.[45]

The overall result of the technological and institutional developments in global commerce in the nineteenth century was a significant reduction in the cost of transportation. Douglas North, in the original work on this topic, used the records of the international wheat trade as his primary source of data, and found astonishing drops in freight charges. Baltic wheat, from Danzig to London, dropped from 8.5s./qtr in 1816 to 3.04s./qtr in 1844. The transport cost for wheat from New York to Liverpool peaked in price at $.21/bushel in 1873, but by 1901 had dropped to just $.03/bushel.[46] Subsequent studies have found that shipping charges dropped for virtually all products, though wheat dropped most of all; in all, though, global freight rates dropped by about half from 1870 to 1913, on top of already significant reductions in the first half of the nineteenth century.[47]

Together, the institutional and technological developments of the nineteenth century, and the reductions in shipping costs they brought about, made possible a dramatic expansion of commodity frontiers through European imperialism.[48] The global wheat ecology was central to this, and underwent a significant transformation in the 1850s and 1860s. Rothstein argues that in those decades, there was a "transition from conditions under which relatively small shipments of [wheat] were made in response to scarcity prices to a situation where large-scale exports from all parts of the world were conducted

[45] Aashish Velkar, *Markets and Measurements in Nineteenth-Century Britain* (Cambridge, U.K.: Cambridge University Press, 2012).
[46] North, "Ocean Freight Rates and Economic Development 1730-1913," 544.
[47] Findlay and O'Rourke, *Power and Plenty: Trade, War, and the World Economic in the Second Millennium*, 382.
[48] Jeffrey Williamson argues that the reduced transportation costs and improved commercial institutions improved the terms of trade for eveyone, so that it made economic sense for peripheral farmer to specialize in exports to core consumers. "Globalization and the Great Divergence: Terms of Trade Booms, Volatility and the Poor Periphery, 1782–1913," *European Review of Economic History* 12, no. 3 (2008): 355–91.

with relatively little regard for price levels."[49] In other words, and in the technical language of later economic historians, the markets for wheat and flour integrated. After that point, prices obeyed—for the most part—the Law Of One Price, or LOOP. Essentially a single, global price came into being, so that the difference between the actual prices at any two places was only the cost of transportation. Sudden changes in price—"shocks" in the language of economics—in one place, perhaps due to a particularly large or small harvest, caused prices in other regions to respond as merchants shifted grain around the global market, looking for even narrow profits through arbitrage.[50]

The international wheat trade came to be dominated by Chicago and Liverpool, the main centers for grain collection, processing, and exchange. The financial and insurance centers of New York and London—also significant markets and redistribution points in themselves—played secondary roles. Behind them followed the regional collection centers such as Sydney, San Francisco, Odessa, and Buenos Aires. As the principal entrepôts for grain, Chicago and Liverpool were the points at which the grain trade became rapid and large-scale enough that futures markets developed: at Chicago in the 1850s and at Liverpool in the 1870s.[51] By that point, the "obstacle posed by distance to international specialization" had been reduced so much that cargoes of grain were not only regular, but they were nearly always sold well before they arrived in a particular port.[52] While historians have found evidence of co-movements of prices across the Atlantic in the eighteenth century, and the integration of markets around the world was not a linear

[49] Rothstein, "American Wheat and the British Market," 39.
[50] Mette Ejrnæs, Karl Gunnar Persson, and Søren Rich, "Feeding the British: Convergence and Market Efficiency in the Nineteenth-Century Grain Trade," *The Economic History Review*, New Series, 61, no. S1 (August 1, 2008): 156–64.
[51] Cronon, *Nature's Metropolis*; Rothstein, "American Wheat and the British Market," 142–98.
[52] North, "Ocean Freight Rates and Economic Development 1730-1913," 541–2.

process, it is clear that in the second half of the nineteenth century, truly global markets developed for a range of products, but wheat most of all.[53]

The Biopolitics of Security, Global Wheat, and Great Britain

Expanding cultivation at imperial frontiers, improved transportation and communication, and cheaper freight rates meant that Britain imported dramatically more wheat in the second half of the nineteenth century than at any point previously. From 1712 to 1765, Britain was a regular exporter of wheat, though intermittently and on a small scale; a fairly small group of highly capitalized London merchants employed buying agents in the wheat-growing regions of southern England, particularly Essex and Kent. They also established a set of resident factors in the largest import markets on the continent, including southern European ports and Amsterdam, the major entrepôt for trade from the North Sea, Germany, and the Baltic. This was a risky trade, and only those dealers with access to considerable finance, capable of working on small margins, and able to cushion their inevitable losses, could expect to succeed over the long term.[54]

However, even during its period as an exporter, and again after 1765, there were years when Britain imported considerable quantities. Sharp and Weisdorf argued that American farmers responded to very poor harvests in England with exports in 1728-9, 1739-40, 1755-6, and 1766-8. In part, this was possible because the center of wheat cultivation in North America, like the rest of European settlement, was very close to the coast. As such, it was cheap and easy to get cargoes from the farm to the ship, and then on

[53] Giovanni Federico, “When Did European Markets Integrate?,” *European Review of Economic History* 15, no. 1 (2011): 93–126; Paul Sharp and Jacob Weisdorf, “Globalization Revisited: Market Integration and the Wheat Trade between North America and Britain from the Eighteenth Century,” *Explorations in Economic History* 50, no. 1 (2013): 88–98.
[54] Rothstein, “American Wheat and the British Market,” 113–6.

their way across the Atlantic. Indeed, they suggested that the eastern coast of North America may have had some wheat that was "closer" than those portions of Britain and Ireland that were poorly served by canal and river transport.[55]

The wars of the Age of Revolution scrambled this nascent trans-Atlantic wheat ecology, utterly disintegrating markets during the American Revolution and the French Revolutionary and Napoleonic Wars. By the time peace and stability returned to the North Atlantic after 1815, American and Continental wheat prices had sunk, and British prices had risen to very high levels. It was those high, wartime prices and their associated rents that Parliament attempted to maintain with the Corn Laws. Still, the British population was growing, and prices were so high that it was a net importer despite the high duties. In the first half of the nineteenth century, with connections to North American wheat severed, British imports were largely made up of Polish and Prussian grain, much of it from along the Vistula River and shipped via Danzig; the Baltic Exchange in London became an early meeting place for merchants of eastern European grain, as well as other products, such as Russian tallow.[56] Rothstein argues that in the 1820s and 1830s, the London price was the determining factor in Baltic exports.[57] Up until the 1840s, however, despite the interactions between British, American, and European grain markets, the overall commerce was small. American merchants used wheat and flour as complements to their cotton or other cargoes, and shipments from the Baltic were nearly always single parcels in mixed cargoes.[58]

In 1846, the year that the Corn Laws were repealed, the North Atlantic Archipelago still provided at least three-quarters of Britain's wheat; indeed, even with the integration of

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[55] Sharp and Weisdorf, "Globalization Revisited," 89–91.
[56] Hugh Barty-King, *The Baltic Exchange, 1744-1994: Baltick Coffee House to Baltic Exchange 1744-1994* (London: Quiller Press, 1994).
[57] Rothstein, "American Wheat and the British Market," 121–2.
[58] Ibid., 128–9.

Britain's internal grain trade, the majority of Britons still got their food from less than 100 miles away.[59] After that point, imports expanded tremendously. By the outbreak of World War I in 1914, imports supplied more than four-fifths of Britain's bread. From fewer than 10,000 cwt. (hundredweight, 112 lbs.) in the early 1840s, over 16,000 cwt. entered the country in 1849, 1850, and 1851; the 20,000 cwt. mark was first broken in 1853, but after 1860 there were no years *under* 20,000. 1862 was an exceptional year, with over 41,000 cwt. of wheat making up for a poor harvest. During the disastrous harvest years of the 1870s, such a figure was unremarkable. By 1895, even the large numbers of the 1870s seemed small as imports reached 81,000 cwt. In the years immediately prior to World War I, 100,000 cwt. was common.[60] In less than seventy years, then, Britain's imports increased tenfold.

The much greater volume of imports was made possible only with the diversification of sources. Prussia and Poland, via the Baltic, remained the largest single source through the first half of the century, but a group of Anglo-Greek merchants began tapping into the growing wheat cultivation of southern Russia and Ukraine, via Odessa. Russian exports tripled between the 1820s and the 1850s as large estates, often with serf labor and easy water transport, were connected with British consumers. This southern route eclipsed the Baltic trade at some point in the 1850s,[61] and it continued to grow with the 1861 emancipation of serfs and the increasing commercialization of agriculture in the region, the construction of railways, and the development of steamship lines in the 1860s

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59 "[On the Proximity of Food Production to Consumption]," *The Economist*, March 23, 1850.

60 Mitchell, *British Historical Statistics*, 221–226.

61 Rothstein argues that the Black Sea trade overtook the Baltic as early as the 1850s; Ejrnæs et al. suggest it was somewhat later, not before 1860. Rothstein, "American Wheat and the British Market"; Ejrnæs, Persson, and Rich, "Feeding the British."

and 1870s. Russian exports tripled, from about 18 million bushels/year in the 1850s to nearly 60 million bushels/year in the 1870s.[62]

American grain returned in force to the British market in the 1850s, although the main supplier was California. There, the Gold Rush brought something like a quarter of a million Americans, Europeans, Mexicans, and Chinese to the new American state in less than five years. Relatively few of them found success in the gold fields, and many of them turned to agriculture in the Sacramento and San Joaquin Valleys. Several wet years combined with the bounty possible on previously uncultivated soil, and produced a "bonanza" of incredible harvests. Shipping by sail, 14,000 miles from San Francisco to Liverpool around Cape Horn, California supplied between one and three quarters of American wheat exports each year until the end of the nineteenth century.[63] So influential was California wheat that when Liverpool set up a futures market in the 1870s, it used California No. 1 as the basis for all transactions; deliveries had to be made in California No. 1 or its equivalent. And, Liverpool and San Francisco were the only two ports in the world to regularly use the cental, 100 lbs., as a standard unit of measurement (the commonly used measurement in Britain was the confusingly-named "hundredweight," or "cwt.," at 112 lbs.; American merchants counted in bushels of approximately 60 lbs.).[64]

Despite the growth of Russian and California wheat cultivation, the real breadbasket of Britain in the second half of the nineteenth century was the American Midwest. By the 1880s and 1890s, it provided about half of Britain's imports and, according to some

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[62] Rothstein, "American Wheat and the British Market," 38–9.
[63] Morton Rothstein, *The California Wheat Kings* (Davis CA: University of California Davis, 1987); James Gerber, "Gold Rushes and the Trans-Pacific Wheat Trade: California and Australia, 1848-1857," in *Pacific Centuries: Pacific and Pacific Rim History Since the Sixteenth Century*, ed. Dennis O. Flynn, Lionel Frost, and A. J. H. Latham (Abingdon, U.K.: Routledge, 1999), 125–51; Rodman Paul, "The Wheat Trade between California and the United Kingdom," *The Mississippi Valley Historical Review* 45, no. 3 (1958): 391–412.
[64] Rothstein, "American Wheat and the British Market," 143–4, 193.

analyses, Chicago actually exerted more influence on world grain prices than Liverpool.[65] After the political disruptions to the trans-Atlantic grain trade in the late eighteenth century, American exports were further hampered by the movement of the wheat frontier inland, away from easy water transportation. C. Knick Harley argued that the American frontier was essentially price frontier, a function of metropolitan wheat prices and transportation costs. Settlers—contrary to the popular mythology of the "frontier"—were not simply "rugged individualists" looking to escape the cities of the eastern United States or Europe and engaged in an ongoing encounter with a pristine nature, as Frederick Jackson Turner suggested in his famous "frontier thesis"[66]; rather, they were agents of those very cities, the leading edge of the emerging world ecology of wheat. When a profitable price for agricultural goods was possible in a given area, settlement would take place rapidly. The driving product for this process was wheat, for it offered the highest price for its weight. Thus, Harley identifies a series of bursts of western settlement in the United States, coinciding with local improvements in transportation infrastructure that reduced the cost of shipping, or with rises in prices in eastern markets.[67] The completion of the Erie Canal in 1825 created a wheat-exporting route from eastern Great Lakes ports, particularly Buffalo, down the Erie Canal and Hudson River to New York. This route, and the route down the Mississippi River to New Orleans, allowed the Ohio Valley states such as Illinois, Indiana, and Ohio to commence exports to Britain, especially during the disruption of Russian supplies during the Crimean War. The American Civil War and its aftermath were a significant disruption to this trade, but a major burst of railway building in the

[65] Ejrnæs, Persson, and Rich, "Feeding the British," 160.
[66] Frederick Jackson Turner, *The Significance of the Frontier in American History*, Reprint (London: Penguin, 2008).
[67] Harley, "Western Settlement and the Price of Wheat, 1872–1913," 227–31.

1870s and its associated rate wars allowed the price frontier to penetrate the prairie states of Minnesota, North and South Dakota, and Kansas. At that point, the American Midwest began to dominate and displace Russian supplies. By the 1880s and 1890s, North and South Dakota and Minnesota were firmly part of Britain's wheat ecology: 70% of grain grown there was wheat, and 85% of their wheat was exported, almost exclusively to Liverpool.[68]

As Britain's imports grew, the sources became more dynamic, shifting according to ecological events. A series of disastrous British harvests in 1873, 1875-7, and 1879-81 brought a massive influx of both American wheat.[69] Other years, the American, Russian, or other harvests traded off depending on their size. In the 1870s and 1880s, the United States was nearly always the leading supplier to Britain, but from 1888 to 1890, American exports dropped by half, from over 30,000 cwt./year to 14-17,000. Russian exports responded, growing from just 5,500 cwt. in 1887 to around 20,000 cwt./year from 1888 to 1890. By 1892, better harvests had returned the United States to its previous dominance: it supplied nearly 34,000 cwt. to just 4,400 from Russia.[70]

The sources of Britain's grain, and thus the emerging world ecology of wheat, continued to diversify in the late nineteenth and early twentieth centuries. The opening of the Suez Canal in 1867, railway construction, and Government of India policy brought India's wheat cultivators into Britain's wheat-flour-bread chain. Overall agricultural acreage there increased by 60% from 1860 to 1920, and much of that was in wheat.[71] In the

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[68] Rothstein, "American Wheat and the British Market," 64–9; Harley, "Western Settlement and the Price of Wheat, 1872–1913," 236–9.
[69] Rothstein, "American Wheat and the British Market," 156.
[70] Mitchell, *British Historical Statistics*, 195–7.
[71] Eric Stokes, *The Peasant and the Raj: Studies in Agrarian Society and Peasant Rebellion in Colonial India* (Cambridge, U.K.: Cambridge University Press, 1978); Ludden, *Agricultural Production and South Asian*

late 1870s and early 1880s, the Government of India sent hundreds of samples to London merchants and millers in an attempt to develop its market there.[72] In North America, railways brought the Canadian prairies into the world wheat ecology after about 1890. The same process unfolded at roughly the same time in Australia and Argentina.[73]

All this is not to say that conditions for farmers, either at the frontiers of empire or at its heart, were good. Indeed, Chris Otter argues that while Britain gained a level of food security through imports (though vulnerable in wartime), food *insecurity* was displaced onto peasant, imperial, and frontier communities.[74] There, the extension of markets, frequently without any kind of mitigating social policies, combined with poor harvests to cause famines. In the cases of the Irish potato famine and the many famines in India under British rule from the eighteenth to the twentieth centuries, an absolute lack of food was less the problem so much as the fact that peasant cultivators had little purchasing power. In a crop failure, prices rose beyond their ability to pay, with profound consequences in direct starvation, disease, and migration.[75] Similar outcomes followed in India, as British administration extended markets into the countryside while dismantling older anti-scarcity systems like public granaries and waterworks. When the failure of monsoons brought crop shortages and high prices, the relief measures were typically biopolitical in nature: public works like railways provided employment and food relief, combined with

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History; Ian Stone, *Canal Irrigation in British India: Perspectives on Technological Change in a Peasant Economy* (Cambridge, U.K.: Cambridge University Press, 1984).

[72] See Chapters Two and Four.

[73] Harley, "Western Settlement and the Price of Wheat, 1872–1913," 227.

[74] Christopher Otter, "Ecology, Security, Pathology: British Nutrition in World-Historical Context" (North American Conference of British Studies, Minneapolis, Minn., 2014); Christopher Otter, *The Vital State: Food Systems, Nutrition Transitions, and the Making of Industrial Britain* (Chicago: University of Chicago Press, Forthcoming); Avner Offer, *The First World War: An Agrarian Interpretation* (Oxford: Oxford University Press, 1989).

[75] Amartya Sen, *Poverty and Famines: An Essay on Entitlement and Deprivation* (Oxford: Oxford University Press, 1981); Cormac Ó Gráda, *Black '47 and Beyond: The Great Irish Famine in History, Economy, and Memory* (Princeton: Princeton University Press, 2000), 47.

market and work discipline in the short term, and in the long run often integrated distressed regions into wider networks of exchange, as adjuncts to the system of security established in Britain. These railways then served to conduct food away from areas with lower purchasing power, like India, and toward regions that could pay higher prices, like Britain.[76]

On the frontiers of North America, Australia, and Argentina, farmers were part of societies more fully integrated into the apparatus of security—as these societies were more fully commercialized and possessed no older anti-scarcity measures that needed dismantling—and individuals there typically had higher purchasing power. Thus, widespread food shortages were quite rare. Instead, frontier societies existed in an economy of exploitation, as they accepted very low wages and long hours in order to survive. For many, this was a situation they preferred over wage labor in the slums or impoverished countryside of Europe; as Avner Offer put it, many chose the "sod house" of the frontier, with all its hard work and discomfort, over the "manor house" of Britain or continental Europe.[77] The advantages were, of course, having no master and having the possibility of rising land values over time. Still, frontier farmers were fully dependent on railways, grain elevators, and merchants. And, the closer they were to the frontier, the more exposed they were to the power of those "middlemen," and the more they agitated against them. Agrarian unrest, as in the American "Granger" movement of the final decades

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[76] Otter, "Ecology, Security, Pathology: British Nutrition in World-Historical Context," 6; Mike Davis, *Late Victorian Holocausts: El Niño Famines and the Making of the Third World* (London: Verso, 2001).
[77] Offer, *The First World War: An Agrarian Interpretation*, 104–20.

of the nineteenth century, was a common feature of the expansion of commodity frontiers.[78]

There were also profound consequences for British farmers. Expansion of the commodity frontier overseas brought them into competition with American, Russian, Indian, Canadian, Australian, and Argentinian farmers in a single, global wheat ecology. Farmers outside Britain were typically much less productive per acre, but also had far lower rents, and had considerable stores of unpaid work/energy to tap: the accumulated nutrients in soils previously uncultivated, as well as family labor.[79] In this broader "wheat world," many British farmers could not compete without significant, and as a result, lands in Britain went out of cultivation. As prices fell, so too did rents and agricultural wages. Precisely how much is difficult to say, but common estimates are that Britain lost about a quarter of its wheat acreage, and Ireland as much as two-fifths.[80] These effects were not limited to Britain, but Britain was the only European state to continue policies of free trade; other European states adopted various protectionist measures from the late nineteenth century.[81]

British Bodies, Global Wheat, and the Standard of Living

The expansion of commodity frontiers for British wheat brought about a significant drop in wheat prices, or what O'Rourke called the "European Grain Invasion." This entailed

[78] Karl Gunnar Persson and Paul Sharp, "Winners and Losers from Globalization: Why Both European and US Farmers Were Angry in the Grain Invasion Era, 1870-1900" (Unpublished article, 2013), http://eh.net/eha/wp-content/uploads/2013/11/Sharp.pdf; Solon Justus Buck, *The Granger Movement: A Study of Agricultural Organization and Its Political, Economic and Social Manifestations, 1870-1880* (Cambridge, Mass.: Harvard University Press, 1913).
[79] Offer, *The First World War: An Agrarian Interpretation*, 93–120.
[80] Kevin H. O'Rourke, "The European Grain Invasion, 1870-1913," *The Journal of Economic History* 57, no. 4 (December 1, 1997): 785–6.
[81] Sharp, "'1846 and All That.'"

a rise in real wages for urban Britons, and a corresponding drop in rents for farmland and agricultural wages. In this way, the insecurity and exploitation of the commodity frontiers, whether of peasant communities brought into the market by force or frontier settlers expanding wheat cultivation by choice, led to increased food security for Britons. The "real" price of wheat fell 35.5% from 1870 to 1913, the largest price decline of any grain in Europe.[82] For consumers in Europe generally, and Britain in particular, then, this was a boon, making a substantial contribution to improving their real wages. And, it is here that one aspects of the world ecology of wheat has been hotly debated for decades, in the "standard of living" debate.

The "standard of living" debate asked whether or not the condition of the working classes improved in the early industrial revolution, traditionally dated from 1760 to 1820 (the reign of George III) but later expanded somewhat to 1750 to 1850. It arose because of an apparent paradox in British history: industrialization generated "modern" economic growth, an almost undisputed "Good Thing" to twentieth-century historians of all stripes, but first-hand accounts of industrialization told of filthy cities, long hours, starvation wages, and satanic mills. Indeed, it was during this moment of apparent growth and dynamism that the English (and in later historiography, British) working class was "made."[83] At stake was not merely an understanding of Britain's past, but the contest between capitalism and communism in the Cold War, and its practical application, Development Economics.[84]

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[82] O'Rourke, "The European Grain Invasion, 1870-1913," 781–5.

[83] E. P Thompson, *The Making of the English Working Class* (New York: Vintage Books, 1966); Anna Clark, *The Struggle for the Breeches: Gender and the Making of the British Working Class* (Berkeley: University of California Press, 1995).

[84] Walt Whitman Rostow, *The Stages of Economic Growth: A Non-Communist Manifesto* (Cambridge, U.K.: Cambridge University Press, 1990).

In the 1950s and 1960s, exchanges between Eric Hobsbawm and R. M. Hartwell focused on "real wages," the ratio of nominal wages to a cost-of-living index based on a hypothetical basket of consumer goods.[85] Subsequent studies were largely devoted to more and more robust wage and price series. By the 1970s and early 1980s, the most optimistic analyses suggested real wage gains that were substantial and rapid: 140% for workers from 1781 to 1851, with the majority of the gains coming after 1820.[86] However, after its apparent high-water mark in the early 1980s, the optimistic case fell apart. Earlier arguments for rapid growth in the early industrial revolution fell apart under scrutiny.[87] This presented substantial problems, for if the economy as a whole was not growing rapidly and no large-scale redistribution of wealth was visibly occurring, an increase in real wages for the working class became difficult to explain. A range of further studies of wages and prices revised the apparent growth downward, eroding the optimistic case. Indeed, recent estimates for real wage growth from 1750 to 1850 are quite modest, with some historians arguing that real wage growth from the 1780s to 1815 was practically nil, and that wages in 1850 were less than 30% higher than in 1780.[88]

In recent years, although the questions of wages and prices continue to occupy economic historians, the whole debate has come under critique in ways that are

[85] See, for example, the following: E. J. Hobsbawm, "The British Standard of Living 1790-1850," *The Economic History Review*, New Series, 10, no. 1 (January 1, 1957): 46–68; Eric J. Hobsbawm, "The Standard of Living during the Industrial Revolution: A Discussion," *The Economic History Review* 16, no. 1 (1963): 119–46; Robert M. Hartwell, "The Rising Standard of Living in England, 1800-1851," *The Economic History Review* 13, no. 3 (1961): 397–416; Ronald Max Hartwell, *The Industrial Revolution and Economic Growth* (London: Methuen, 1971); Arthur John Taylor, *The Standard of Living in Britain in the Industrial Revolution* (London: Methuen, 1975).

[86] Peter H. Lindert and Jeffrey G. Williamson, "English Workers' Living Standards During the Industrial Revolution: A New Look*," *The Economic History Review* 36, no. 1 (February 1, 1983): 1–25, doi:10.1111/j.1468-0289.1983.tb01221.x.

[87] Nicholas F. R. Crafts, *British Economic Growth during the Industrial Revolution* (Oxford: Clarendon Press, 1985).

[88] Charles H. Feinstein, "Pessimism Perpetuated: Real Wages and the Standard of Living in Britain during and after the Industrial Revolution," *The Journal of Economic History* 58, no. 03 (September 1998): 625–58.

particularly relevant for both the history of food and environmental history. A fundamental problem with economic history broadly is its reliance on quantitative data. From an environmental history perspective, it completely ignores the "nature" side of the human-nature binary; from a food history perspective, it reduces human life to the very barest of quantitative indicators. This promises a sort of mathematical objectivity, but at the cost of sacrificing the nuances of quality that shape individual humans' lives.[89] For all the promises that "real wages" offered to objective, quantitative certainty, they were unable to resolve the initial paradox that drove the debate: in a time of apparently increasing economic growth, why did contemporaries describe such misery? Real wage studies sidestepped the problem by reducing quality to quantity, or, as Jeffrey Williamson put it: "What would it take to bribe you to move to the dark satanic mill?" Framing the question in these terms, Williamson argued that since labor markets appeared to be relatively efficient and since cities continued to grow, wages must have been high enough to compensate for the "disamenities" of early industrial life, such as disease-causing air and water, poor and adulterated food, flimsy and crowded housing, and the profound social and dislocation that accompanied relocation into industrial cities. These, Williamson insisted contrary to considerable contemporary evidence, could have had "only the most trivial influence on trends in the quality of life for laborers in nineteenth-century Britain."[90]

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[89] Geoff Eley made this argument with respect to economic and social histories of Nazi Germany. See his *A Crooked Line: From Cultural History to the History of Society* (Ann Arbor: University of Michigan Press, 2005); See also James Scott's discussion of "high modernist ideology," which relies on a radical simplification of complex "local knowledge" in favor of simplified "universal knowledge." *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed* (New Haven: Yale University Press, 1998); For a historical example, see Timothy Mitchell, *Rule of Experts: Egypt, Techno-Politics, Modernity* (Berkeley: University of California Press, 2002).

[90] Jeffrey G. Williamson, "Urban Disamenities, Dark Satanic Mills, and the British Standard of Living Debate," *The Journal of Economic History* 41, no. 1 (March 1, 1981): 75, 80; Compare Williamson's dismissal of the quality of life in early industrial Britain to Engels's classic account. Friedrich Engels, *The Condition of the Working Class in England* (Oxford: Oxford University Press, 1993).

Beginning in the 1980s, several scholars began examining the human body as a means to address this particular problem. These scholars saw bodily metrics such as stature and mortality as "net measures" of the inputs and outputs of life; to assess human height over time, then, offered the possibility of a more holistic measure than real wages could provide.[91] A pioneering study by Floud et al. helped reverse the consensus on the standard of living, finding—though with a relatively small data set of military recruits—that heights increased from 1750 to 1820, but then declined until 1850 before rebounding slowly.[92] Subsequent studies assessed broader populations, infant mortality, and children's growth profiles, and nearly all the findings contradicted the prevailing optimistic view, based on real wages. These studies found that Britons from the middle of the eighteenth until the middle of the nineteenth were small by historical standards, achieved their full height later in life, lived shorter lives, and suffered from high infant mortality until at least the 1870s or 1880s.[93] Francesco Cinnirella put it bluntly in a review of the literature: "average nutritional status declined substantially" from 1740 to 1865, with partial recovery only for birth cohorts from 1805-9 and 1810-4.[94]

Initial anthropometric studies explained the deterioration of material standards they found as a matter of biological accounting: the demands made by long hours, disease,

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[91] Richard H. Steckel, "Stature and the Standard of Living," *Journal of Economic Literature*, 1995, 1903–40.
[92] Roderick Floud and et al, *Height, Health, and History: Nutritional Status in the United Kingdom, 1750-1980* (Cambridge: Cambridge University Press, 1990).
[93] John Komlos, "The Secular Trend in the Biological Standard of Living in the United Kingdom, 1730-1860," *The Economic History Review*, New Series, 46, no. 1 (February 1, 1993): 115–44; Paul Johnson and Stephen Nicholas, "Male and Female Living Standards in England and Wales, 1812-1867: Evidence from Criminal Height Records," *The Economic History Review* 48, no. 3 (1995): 470–81; Paul Huck, "Infant Mortality and Living Standards of English Workers During the Industrial Revolution," *The Journal of Economic History* 55, no. 3 (September 1, 1995): 528–50; Simon Szreter and Graham Mooney, "Urbanization, Mortality, and the Standard of Living Debate: New Estimates of the Expectation of Life at Birth in Nineteenth-Century British Cities," *The Economic History Review*, New Series, 51, no. 1 (February 1, 1998): 84–112; Wrigley, *Poverty, Progress, and Population*.
[94] Francesco Cinnirella, "Optimists or Pessimists? A Reconsideration of Nutritional Status in Britain, 1740–1865," *European Review of Economic History* 12, no. 3 (December 1, 2008): 325–54.

poor quality food, and so on, were too high for even improved wages to make good. However, the bodily nature of the data forced scholars to disaggregate data by age, gender, and class, and this exposed the fundamental inadequacy of real wage studies to that point. Simon Szreter and Graham Mooney, identifying the problem, explained that that existing scholarship was "unwittingly methodologically premised upon a patriarchal and economic definition of the problem, through its focus upon the study of adult male real wages as the most tractable sources for evidence with which to study the subject." Anthropometric studies thus concluded that, first, people felt the effects of industrialization based in part on their age and gender (in addition to class), and second, that "the 1830s and 1840s should not be viewed as the end, but, quite to the contrary, as the *beginning* of the serious debate over the impact of the industrial revolution on the standard of living of the British working class" (emphasis added).[95] Or, put another way, they argued that the question of the effects of industrialization on the British working classes could not be separated from Britons' bodies, and must take into account developments in the mid- and later nineteenth century, the very moment when Britain's food supply became truly global.

Conclusion

In sum, then, the expansion of the world ecology of wheat, whether under the aegis of British empire or on the frontiers of settler societies like the United States and Argentina, was directly connected to British bodies. This process brought about profound environmental change around the world, and it created a world ecology of wheat that

[95] Szreter and Mooney, "Urbanization, Mortality, and the Standard of Living Debate," 109–10; See also Derek Oddy, *From Plain Fare to Fusion Food: British Diet from the 1890s to the 1990s* (Woodbridge, Suffolk, U.K.: Boydell Press, 2003).

improved quantitative metrics for British bodies. It was not, however, a process as simple as all that. At a fundamental level, the globalization of Britain's wheat ecology involved the dismantling of the older moral economy, and its replacement with a market economy. It involved a shift from a society that cultivated its own food, and that dwelt in the countryside amongst this cultivation, to a society that increasing lived in cities and paid others to grow their food for them. In so far as the moral economy of early modern Britain provided a framework of moral value for wheat growers and bread consumers, it performed the vital function of structuring cultural meaning about bread, the most basic consumer good. The market economy, however, operated with no such framework of meaning other than price. A gap in meaning thus opened, between the production and consumption of food; the Cartesian binary's separation of the human and non-human realms was manifest in Britons' daily bread, for in the second half of the nineteenth century worldwide wheat producers and British bread consumers were radically separated. Into that gap in meaning stepped a whole new set of "middlemen," each possessing their own particular forms of knowledge necessary for the actual creation of a global wheat ecology. It is to the first of those "middlemen" we now turn: millers.

CHAPTER TWO

ROLLER MILLING AND THE OBLITERATION OF KNOWLEDGE

Despite growing imports, before the middle of the nineteenth century, the wheat ecology that fed Britain was mainly located in the Archipelago. While there were important exotic imports such as sugar and tea, the base of the British diet was still at that point domestic. Even within Britain, although there was an increasingly national market for wheat, the large majority of Britons still got their wheat from farmers within a hundred miles. Before mid-century, half of England's 14 million inhabitants were "rural" (in towns of less than 5,000), and agricultural employment was around 1.5 million at the time of the "Captain Swing" riots in 1830. The proportion of agricultural laborers and small, subsistence-farming peasants was higher in Scotland, and much higher in Ireland.[1] With this distribution of population and occupation, the great bulk of the people must have known very well where their wheat came from even if they did not actively participate in its production.

Millers scattered across the countryside milled this wheat into flour. Parliament abolished the traditional toll—a customary portion of the resulting flour, from a ninth to a thirtieth—in 1796, so all millers were paid in cash. Consumers who had some advantageous access to wheat as part of a customary allowance or payment in kind, and who baked their own bread, took their wheat to the mill and paid the toll themselves, but this was a relatively small portion of the population in the middle of the nineteenth century and dwindled to practically nothing by the end of the century. The rest of Britain's wheat was ground into flour either by commercial millers who then sold to bakers, or for bakers

[1] Eric Hobsbawm and George Rudé, *Captain Swing: A Social History of the Great English Agricultural Uprising of 1830* (New York: W. W. Norton & Company, 1968), 24.

who chose their wheat and paid a miller for the service. This was a necessary step in the wheat ecology, and individual mills were quite rare in nineteenth century Britain (though not wholly unknown); thus, virtually everyone dealt with millers in some way or another.[2] Millers have always played important roles as intermediaries between humans and their environments, rendering wheat palatable by physically transforming it into flour. In the anti-scarcity system that characterized Britain's food provision in the medieval and early modern period, millers were fairly circumscribed in their roles, typically limited to their customary tolls. They did play an important part in liberalizing Britain's internal grain trade as they took on roles as merchants, but as long as Britons fed themselves or were fed by nearby farmers, millers had little effect on what meanings people invested in their daily bread. They mediated between processes of production and consumption, but those processes were largely carried out by the same people, or by people in close proximity to one another. However, as the British state adopted a biopolitical apparatus of security through a liberalized trade in grain, and as Britain's wheat ecology grew in its spatial extent, farmers farther and farther away began to supply Britons with their wheat.[3] In the context of expanding commodity frontiers, the role of the miller changed and the importance of their intermediary role grew. In the first place, millers' expertise was necessary to process the wheat produced by a more extensive wheat ecology. Secondly, and more fundamentally, millers came to mediate not merely between the *processes* of production and consumption, but between the *people* and *places* that produced and consumed.

[2] Christian Petersen, *Bread and the British Economy, C. 1770-1870*, ed. Andrew Jenkins (Aldershot, Hants., England: Scolar Press, 1995), 50–2.
[3] See Chapter 1.

The liberal state dismantled the anti-security system and its attendant moral economy in the first half of the nineteenth century, a process culminating the repeal of the Corn Laws in 1846. The rapid growth of wheat imports following repeal presented a set of technical and economic challenges to British millers: they found the wheat they ground changing as its geographical sources changed, and they faced competition from increasing imports of fine flour from the United States, where Minneapolis developed into a major milling center. To stay in business, British millers had to meet the demand for whiter grades of flour, and they had to produce those grades of flour from different materials. In responding to these challenges, millers developed a trade press, national organizations, and new technologies, firms grew in size and in capital invested, and the industry began to concentrate in a few port towns. These developments were effectively biopolitical in nature, a reflection of millers' pivotal roles in the wheat ecology that connected global environments and British bodies through the market. Although millers received little direct assistance from the liberal state, they were indispensible to the "free" market in grain that was engineered and maintained by that same state. And, in developing their biopolitical expertise, millers reinforced the Cartesian binary that worked so hard to distinguish between humans and nature. In mediating between global environments and British bodies, millers received the commodity of "wheat," a commodity that was firmly on the "human" side of the Cartesian binary, but one that retained important connections to its particular environmental origins. But, millers passed along to bakers the commodity of "flour," a homogeneous commodity with far less connection to particular environments. Through their labor, they invested wheat, flour, and bread with meanings that reflected their position at the heart of the British food chain. They associated those materials with ideas of civilization and empire, with endorsements or condemnations of Free Trade, and they developed a body of expertise in the specific environments that produced wheat. This expertise enabled millers to process diverse and changeable wheat varieties into consistent, homogeneous flour. At the same time, they effectively masked the very meanings that they invested in flour. Instead of wheat's environmental origins or global political-economic salience, the flour they passed on to bakers carried only its baking characteristics: its strength, color, and flavor. Despite their unique vantage point in the British food chain, therefore, millers produced what amounted to a culinary empty canvas, onto which bakers could paint meanings divorced from the environmental origins of the materials.[4]

The milling industry has never played a large role in British historiography, though historians since the Second World War have told the story of milling's transformation several times. The histories that deal most with the technical changes in milling are best thought of as trade histories that see the story of milling as one of increasing technological innovation, with accompanying social, economic, and culinary benefits. John Storck and Walter Teague's 1952 *Flour for Man's Bread* and Herman Steen's 1963 *Flour Milling in America* deal primarily with American millers, although recognizing the international scope of the changes in both the wheat trade and milling technology; more recently, Glyn Jones's *The Millers* characterized the changes in British milling as "technological endeavor and industrial success."[5] By contrast, the agricultural historian Richard Perren's work on milling is more integrated with larger narratives of British history. He situates British

[4] See Chapters Four, Five, and Six.
[5] John Storck and Walter Dorwin Teague, *Flour for Man's Bread: A History of Milling* (Minneapolis: University of Minnesota Press, 1952); Herman Steen, *Flour Milling in America* (Minneapolis: T. S. Denison, 1963); Glyn Jones, *The Millers: A Story of Technological Endeavour and Industrial Success, 1870-2001* (Lancaster, U.K.: Carnegie Publishing, 2001).

milling within the historiography of industrialization, and argues that the milling industry changed radically from 1870 to 1914, and did so in ways at variance with the expectations of economic historians modeling the growth of industries. Although milling seemed a poor candidate for rapid innovations and increases in the size of firms in 1870, this did not prevent such changes.[6] This useful if thin historiography acknowledges the globalization of the wheat trade and the related contraction of British agriculture in the second half of the nineteenth century. However, all of these histories essentially begin when wheat reaches the mill, and end when the flour is shipped to market; none of them address the changing role that millers came to play in the wheat ecology broadly, or in the cultural relationships between Britons and the environments that produced their food. They situate millers' knowledge and expertise firmly on the "human" side of the human-nature boundary. None of these histories, therefore, recognize milling as an environmental phenomenon. Neither do they see milling as a biopolitical apparatus, despite its importance in facilitating the wider circulation of commodities within a growing capitalist world-ecology of wheat.

Milling and the Local Ecology

Before the middle of the nineteenth century, the British milling industry reflected the environment of Britain both materially and culturally. Mills processed primarily British-grown grain, and were thus more plentiful where sun, water, and soil combined in favorable variety to produce more grain. They relied on organic energy sources to drive their machinery, and were thus located where the topography made available wind or water power, generally hilltops or alongside rivers and streams. There was some incentive

[6] Richard Perren, "Structural Change and Market Growth in the Food Industry: Flour Milling in Britain, Europe, and America, 1850-1914," *Economic History Review*, New Series, 43, no. 3 (August 1990): 420–37.

to locate at intersections of exchange created by humans; market forces placed some mills in cities where both supplies of raw materials and consumers of the finished product were available. Overall, however, it was not until the 1870s that a wheat ecology spanning the world, industrial technologies, and the market reoriented the British milling industry away from the British environment, and toward global environments.

The standard technologies in the early nineteenth century were ancient in conception: a pair of circular millstones about four feet in diameter ground grain between them, and were powered by water or wind. A hole in the middle allowed the miller to load the grain, and grooves carved into the faces of these stones regulated the speed at which the meal traveled to the edges for collecting, and therefore the amount of grinding done to a stream of grain. Before the middle of the nineteenth century, millstones were the only method used for making flour, and the methods and equipment that British millers employed in the first half of the nineteenth century would have been recognizable to millers from antiquity. Roman querns were essentially miniature versions of what early nineteenth-century British millers employed, though powered by hand.[7] The power sources employed in the early nineteenth century were also ancient in origin. Donkeys and mules were used to turn millstones at least as early as the second century BCE, the Roman engineer Vitruvius and the Chinese engineer Master Huan both described undershot watermills (in which the water passes under the wheel) in the first century BCE, and by the early middle ages, Roman settlers in France had developed the more complex and more efficient overshot mill (in which the water passes over the wheel). By the twelfth century,

[7] Adam Lucas, *Wind, Water, Work: Ancient And Medieval Milling Technology* (BRILL, 2006), 20–22.

Europeans were employing both gearing mechanisms and wind to turn millstones.[8] Through the early modern period, engineers developed more elaborate and efficient mechanisms for transforming the motion of wind or water into moving machinery, particularly after metal parts were employed.

Powered as they were by organic sources, wind- and water-driven mills had little locational mobility. They could only operate where appropriate wind and water sources were. George Broomhall, a Liverpool grain merchant and founder of the trade journal *Milling*, claimed that in the late eighteenth century, there were at least fifteen or twenty windmills around Liverpool, with perhaps a few watermills. The year the Corn Laws were repealed, 1846, there were seven or eight steam powered mills in the area, though the "hill-top windmills still seem to have held their own." He recalled that at least as late as 1870, the majority of country mills surrounding Liverpool were still windmills, although by that time the "Migration to the Ports" of British milling was well underway.[9]

Although the stones used were ancient in conception, milling technology was by no means static to this point and it was not immune to the changes transforming the rest of British society in the late eighteenth and early nineteenth century. Millers began to apply steam power to mills in the late eighteenth century, part of the transition from organic power sources to mineral that accounted for so much industrial change.[10] The first steam-powered mills, however, were developed as adjuncts to wind- and waterpower. Early engineers thought that steam engines were not regular enough in their motion to drive the machinery directly, and so the first example in 1781 pumped water into a reservoir that

[8] Ibid., 32–51, 86.
[9] George Broomhall and John Hubback, *Corn Trade Memories, Recent and Remote* (Liverpool: Northern Pub. Co., 1930), 7–43.
[10] Petersen, *Bread and the British Economy*, 57–63; E. A. Wrigley, *Continuity, Chance and Change: The Character of the Industrial Revolution in England* (Cambridge, U.K.: Cambridge University Press, 1988).

drove a waterwheel.[11] In this way, the steam engine mitigated potential uncertainty of water flow, employing mineral energy to supplement organic. It was not until three years later, in 1784, that the Albion mills in London employed steam to drive the machinery itself, using two Boulton and Watt 50 horsepower engines before it was destroyed in a fire in 1791. Liverpool got its first steam-powered mill that same year, although it appears to have failed almost immediately. Richard Bennett and John Elton, the authors of a history of milling first published in 1898, claimed that there was no certain evidence of a steam-powered mill in Liverpool driving the machinery itself until 1817, when such a mill on Bridgewater Street burned to the ground.[12] By the middle of nineteenth century, British milling had begun to reflect the changing landscape of the industrial revolution, though it remained an industry oriented around processing the products of local environments.

In Britain's rural society before the nineteenth century, millers played a vital processing role, and their role in cultural reflected this. The anti-scarcity system of early modern Britain had an underlying moral foundation that prioritized a relationship between producers and consumers that was as direct as possible. Millers necessarily disrupted this relationship, and the anti-scarcity system of early modern Britain typically accommodated them by their commercial activities. Instead, they supplied a "closed" service to the estate or parish, an arrangement in which, as Petersen explained, a mill's franchise was "protected by right of property or by convention," it being the rule that one rural mill should not trespass on the territory of others.[13] Lucas notes a wide range of arrangements for the ownership, financing, operation, and maintenance of mills in late medieval and early

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[11] Storck and Teague, *Flour for Man's Bread: A History of Milling*, 193.
[12] Richard Bennett and John Elton, *History of Corn Milling, Vol. III: Feudal Laws and Customs* (London: Simpkin, Marshall, 1900), 284, 293–294.
[13] Petersen, *Bread and the British Economy*, 51.

modern Britain and Ireland, including communally owned, lordly, and monastic mills.[14] Millers were hardly objects of affection for rural populations; they necessarily stood between the production and consumption of food, and this could earn them scorn if they were seen to be abusing their position by taking an unfair toll. In some cases, even as late as the nineteenth century, mills retained centuries-old feudal rights of "soke," the right of the landlord to insist that all grain grown on his property (by his tenants) be brought to his mill, and to no other. In some parts of Scotland, mills could even have "abstracted mulcture"—a toll for any grain that might have been taken to a particular mill, but was taken elsewhere.[15] A popular complaint was that millers stole grain from honest farmers. A Somerset children's game involved catching a large moth called a "miller," and chanting "Miller! Miller! Dousty poll!/How many sacks of corn hast thou stole?"[16] The charge of stealing corn is indicative of the way that millers were an integrated part of a culture that was deeply involved with its own food production: it was the raw material *corn* that millers were accused of stealing, not the processed good *flour* or the finished article *bread*. The society that made such charges against millers was one that thought in terms of corn, not flour or bread.

The role of millers shifted slightly as the British state began to replace its older anti-scarcity system with the apparatuses of security. As transportation and commercial networks began to merge the local grain markets into a national one, millers played a crucial role in breaking down the old system. Although the development of a national

[14] Lucas, *Wind, Water, Work*, 165–76.
[15] Perren, "Structural Change and Market Growth in the Food Industry: Flour Milling in Britain, Europe, and America, 1850-1914," 422; Petersen, *Bread and the British Economy*, 51–2; Bennett and Elton, *History of Corn Milling, Vol. III: Feudal Laws and Customs*, vii.
[16] John Ashton, *The History of Bread: From Pre-Historic to Modern Times* (London: Religious Tract Society, 1904), 117.

market in wheat and flour was a long process—bread was produced locally until the twentieth century, and there was no uniform "national loaf" of bread until at least the late nineteenth century[17]—there was more trade in grain from the late seventeenth century on.[18] In this context, capitalist millers and other "men of capital" penetrated the milling industry and turned milling into a commercial pursuit. Unlike the comprehensive system of statutes and customs that regulated merchants and bakers, millers were never under the same level of scrutiny. In this situation, and with the possibility of considerable profits to investors, commercial millers developed in order to serve the nascent urban markets.[19] Under the Assize of Bread, a set of statutes from medieval times that set the price (or, more frequently, the size) of each loaf of bread based on the price of grain, bakers were instructed to bake a certain quantity of each of the various grades of bread, from brown to white. Limiting the amount of each quality of bread also made the Assize of Bread effectively a sumptuary law, as it attempted to limit the consumption of higher qualities of bread. In this system, the laws were written with the expectation that millers would act only as providers of a service, milling wheat purchased by the baker into meal. In medieval times, it was even left to bakers to "bolt" or sift the meal into various qualities of flour.

In the early eighteenth century, some millers and grain merchants began to purchase wheat on their own account and to grind and bolt whatever varieties of flour brought the most profit. This led them to produce more white flour, as it brought a higher price and produced more "offal," the removed bran which could be sold as animal feed.[20]

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[17] E. J. T. Collins, "Dietary Change and Cereal Consumption in Britain in the Nineteenth Century," *The Agricultural History Review* 23, no. 2 (1975): 97–115.
[18] Karl Gunnar Persson, *Grain Markets in Europe, 1500-1900: Integration and Deregulation* (Cambridge: Cambridge University Press, 1999).
[19] Petersen, *Bread and the British Economy*, 54–67.
[20] See Chapter Three.

This was effectively the thin edge of the wedge in the anti-scarcity system and its sumptuary aspects. From their position between wheat and bread in Britain's wheat, flour, and bread commodity chain, capitalist millers could effectively decouple the prices of wheat and bread. The state found it more and more difficult to regulate prices, and to enforce which people consumed which kind of bread, once millers became effectively grain merchants in their own right.[21] Further, as millers began to stand between production and consumption to a greater degree, there were shifts in the politics of the anti-scarcity system. W. Thwaites identified a key moment in this shift in Oxfordshire in the second half of the eighteenth century. There, rioters who had once agitated about high *grain* prices began instead to demand lower *bread* prices.[22]

And yet, despite the transformation of Britain's provisions system in the eighteenth century, it remained tied to an essentially local wheat ecology. Cities and towns were growing, but the bulk of the population remained rural and Britain did not become a majority urban nation until 1851. Agricultural employment was relatively low by European standards, but remained half or more of the laboring population until the last quarter of the eighteenth century; it was 41% in 1800, and 29% in 1841.[23] Connections to the countryside remained strong until at least the middle of the nineteenth century, for even if fewer Britons had grown up there, their parents and grandparents had, and cultural forms developed in an agrarian society retained a powerful hold over urban Britain. Further, Britain did not at that point import large amounts of wheat except in rare cases. An 1850 article from the *Economist* claimed that most Britons continued to be fed from within 100

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[21] See Chapter Three.
[22] W. Thwaites, "Dearth and the Marketing of Agricultural Produce: Oxfordshire C. 1750-1800," *The Agricultural History Review* 33, no. 2 (January 1, 1985): 121.
[23] Ronald Findlay and Kevin H. O'Rourke, *Power and Plenty: Trade, War, and the World Economic in the Second Millennium* (Princeton: Princeton University Press, 2007), 314.

miles. Rural districts consumed local produce, and London and the manufacturing centers were fed by the closest convenient corn-growing regions. Wiltshire, Somerset, and Dorset, for example, fed the coal- and iron-producing regions in south Wales.[24] Some imports did make their way into the country, particularly from eastern Europe and Russia via the Baltic.[25] From the 1830s, fine French and Hungarian flour came into Britain and were consumed in small quantities by the wealthy or added to British-grown flour in small amounts to lighten the texture of bread.[26] On the whole then, the British environment fed British bodies, and millers mediated between the processes of production and consumption within British society, and not between disaggregated producers and consumers. When the Corn Laws were repealed in 1846, Britain produced about three quarters of the wheat consumed in the country. By the beginning of World War I in 1914, that figure plummeted to less than one fifth.

The Pressures of a Global Food Chain

While Britain had a long history of importing wheat in fairly small amounts, those imports accelerated rapidly after 1850, as the world-ecology of wheat expanded its frontiers.[27] This was the concrete result of the implementation of biopolitical apparatuses of "security" in Britain. The apparatuses of security sought to ensure the circulation of materials between bodies and environments, and, in this case, that meant policies of Free Trade and the various interventions necessary to bring that about, both by the British state and its imperial adjuncts like Canada, India, and Australia, but also by other states involved

[24] "[On the Proximity of Food Production to Consumption]," *The Economist*, March 23, 1850.
[25] See Chapter One.
[26] Petersen, *Bread and the British Economy*, 50.
[27] See Chapter One.

in the expanding capitalist world-ecology, such as the United States, Russia, and Argentina. These biopolitical interventions involved supporting the development of transportation networks, the extension and integration of markets, frontier settlement, and liberal trade policies.[28]

The result of these policies across the second half of the nineteenth century was the particular variety of food security and *in*security described by David Nally and Chris Otter. A world-spanning wheat ecology connected to British bodies through commodity markets brought grain and bread prices down, and thereby increased real wages in Britain.[29] And, it reduced the variability in yield inherent in agriculture on a local scale, for it drew on a more diverse set of ecologies. This was immediately evident to the British milling community. Speaking to the National Association of British and Irish Millers (NABIM) in 1890, the American miller J. M. Case explained that Britain drew from "the whole wheat-growing world," "from Duluth to California, thence to Australia and New Zealand, thence to Africa, Egypt, India and Russia." With such a diverse array of environments, Case suggested that the milling community "can scarcely conceive of any one season in which some of these points will not offer favourable advantages for wheat supply."[30] In others words, with access to the world's harvests, there was always wheat for sale at good prices.

In addition to the benefits of a cheaper and more stable overall supply, foreign wheat varieties had characteristics that were desirable for British bakers. Wheat varieties and the flours produced from them are incredibly diverse. They were categorized according to their hardness, most important in milling; their strength, or the amount of

[28] See Introduction.
[29] See Chapter One.
[30] J. H. Chatterton, *Twelfth Annual Report of the National Association of British and Irish Millers* (London: George Berridge & Co., 1890), 56–7.

gluten they contained, vital for baking lighter, well-risen loaves; color; flavor; and moisture content. Wheat grown in Britain's relatively cool, damp climate was typically soft, white wheat, and low in gluten. These varieties of wheat were well suited for baking tender-crumbed biscuits and pastries, but did not have the gluten content to easily produce well-risen loaves of bread. The foreign wheat that increasingly made its way to London and Liverpool, however, was often significantly stronger, and therefore suited to baking higher, lighter loaves. This characteristic made some varieties of foreign flour particularly desirable for bakers. Hard red American wheat from the upper Midwest in particular was known for its incredible strength. John Kirkland, a master baker and author of a multi-volume baking textbook that ran to several editions, regarded it as the strongest flour available on the British market. Russian flour, sometimes named Odessa for the port from which it shipped, was also well regarded for its strength, and frequently preferred to American because of its lower price. Canadian wheat, particularly from Manitoba, was also known for its strength, while fine Hungarian flours had a long-standing reputation for excellence and strength, as well as a higher price.[31] Strength was not the only important characteristic, of course. California wheat, one of the earliest imports in great quantity, was exceptionally white in color.[32] Scottish and English wheats were very soft and weak, though prized for their flavor.[33] The availability of different kinds of flours meant that bakers could alter their flour choices to suit their products, blending stronger flours with softer, more

[31] John Kirkland, *The Modern Baker, Confectioner, and Caterer*, New and Revised Edition (London: Gresham Publishing Company, 1933), 59–61.
[32] Rodman Paul, "The Wheat Trade between California and the United Kingdom," *The Mississippi Valley Historical Review* 45, no. 3 (1958): 393.
[33] Kirkland, *The Modern Baker, Confectioner, and Caterer*, 55–56.

flavorful ones to produce higher and lighter loaves of desirable flavor. And, indeed, there is considerable evidence that bakers did this occasionally well before 1850.[34]

The same qualities that made foreign wheat so desirable for British bakers, however, also created difficulties for British millers. Each wheat variety was unique to its environmental origin, and they were often harder, drier, of a different color, and with a different set of impurities from English or Scottish wheat. These different characteristics needed to be treated differently. For one thing, drier wheats were more prone to combustion during milling, especially on millstones. Fires had long been a problem in mills, but dry foreign wheats compounded the danger and fire was a frequent topic of discussion among millers.[35] Harder varieties of wheat also presented particular technical problems to millers, because they could not be ground on stones without discoloring the flour.[36] Millstones employ the "sudden death" method of grinding, in which the wheat berries pass under the millstone, and are ground into the meal all at once. The meal is then sifted in a process called "bolting," to remove the offal, germ and bran. When grinding soft, British-grown wheat, the germ and bran tended to break into fairly large pieces that could be removed as "middlings," larger particles of starch with bran attached. The middlings could then be reground and rebolted to produce "seconds," lower-grade but still sellable flour. This method could produce about 25% of the grain's weight in white flour, another 50% of lower-quality but sellable flours, and 25% offal, not typically consumed by humans but still marketable as animal feed.[37] However, the germ and bran of hard wheats tended to shatter into pieces so small that they could not be removed by sifting. They thereby discolored the

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[34] See Chapter Four.
[35] J. H. Chatterton, *Ninth Annual Report of the National Association of British and Irish Millers* (London: George Berridge & Co., 1887), 26.
[36] Jones, *The Millers: A Story of Technological Endeavour and Industrial Success, 1870-2001*, 11.
[37] "History of the Decortication of Wheat," *The Miller*, October 2, 1876.

flour, reducing its market value.[38] Nutritionists studying the British diet had noted this at least as early as the 1850s, explaining that, "In wheats which are hard, the integuments separate with difficulty, and therefore the flour produced from these usually contains a greater proportion of adherent bran than do those flours produced from wheats which are soft, and which part with their epidermic coverings more readily."[39] One miller put the problem succinctly in 1876, lamenting that while "it would seem as if the wheats most desirable as mixtures … were those rich in gluten," the color of these wheats was a major problem, as "the bran and offals are so hard and brittle, and adhere so closely to the kernel, that when ground in the ordinary way it is practically impossible to keep them from getting ground into the flour."[40] This was a problem that had earlier confronted Hungarian and American millers, both of whom inhabited regions that grew almost exclusively hard wheat. Budapest and Minneapolis millers confronted and solved the problem of hard wheat in the decades before that problem arrived in London and Liverpool, and they began to export fine flours to Britain. These "patent" flours could be very white and very strong, and came with names such as the Minnesota-based Washburn Mill's "00" and "000" flours, Pillsbury's "Amazon," and the Hungarian Economo Mills' "Trieste AAAAA."[41] British millers thus faced two potential problems along with the benefits of global wheat supplies: different raw materials and competition from foreign millers.

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[38] Kirkland, *The Modern Baker, Confectioner, and Caterer*, 50–51.
[39] "Records of the Results of Microscopical and Chemical Analyses of the Solids and Fluids Consumed by All Classes of the Public: Bread and Its Adulterations," *The Lancet* 57, no. 1439 (March 29, 1851): 366–71.
[40] "Scientific and Practical Milling, No. IV," *The Miller*, February 12, 1876.
[41] William Jago, *A Text-Book of the Science and Art of Bread-Making: Including the Chemistry and Analytic and Practical Testing of Wheat, Flour, and Other Materials Employed in Baking* (London: Simpkin, Marshall, Hamilton, Kent, &co., 1895), 334.

Transforming the Milling Industry

At the base of the troubles facing British millers were two facts. First, with an expanding wheat ecology, the British milling industry ceased to reflect the geography of British food production. It needed to change to reflect the changing wheat ecology, or it would not survive in a competitive market. Second, the bakers who purchased flour demanded consistency and homogeneity in their products. The flour that millers produced had to be the same, no matter where the wheat came from, or they would lose their business. Squeezed between these two pressures, millers responded by revolutionizing their industry and creating what amounted to new biopolitical apparatuses: they created a trade press, adopted new technology, shifted the geographical distribution of mills, and developed a whole new set of technical expertise in the world's wheat. The state played little direct role in this, but these were forms of expertise sanctioned by the state, and they were necessary for the wider circulation of materials that "security" sought. By the eve of the First World War, milling in Britain reflected the new world-ecology of wheat far more than its older wheat ecology in Britain. In doing so, however, flour milling began to play a new role in mediating between humans and their environments. It ceased to mediate between merely the processes of production and consumption, and began to mediate between disaggregated producers and consumers. The people and places that produced wheat, and the people and places that consumed bread grew farther apart than ever before. In this way, then, when British millers physically transformed wheat into flour, they began to do so in such a way as to also transform the knowledge and meaning that accompanied those items.

The first reactions of British millers were to form a trade press and organize a national association. Corn merchants had exchanged information through several publications: the *Mark Lane Express* from at least the 1830s, the *Floating Cargo List* from 1854, and *Beerbohm's Corn Trade List* from 1869. *The Miller*, established in London in 1875 by William Dunham, was altogether different. The early issues of *The Miller* capture the state of the trade well as it struggled to cope with a rapidly changing world and to maintain its position in a lengthening food chain. Dunham, in an introductory editorial, explained the need for a dedicated milling press. He lamented the foreign sources of innovation in milling in the nineteenth century—chiefly Austro-Hungarian and American—and claimed that the principal aim of *The Miller* would be to foster inquiry and innovation.[42] He understood well the rapid changes in Britain's food supply and the technical challenges this posed, explaining that to be successful, a British miller needed to be "a scientific master, with a practical knowledge of the qualities of British and foreign wheat."[43] Here, Dunham captured the two elements around which the transformation of milling revolved: technological innovation, and knowledge of global wheat supplies. Or, put another way, the biopolitical expertise necessary for the operation of a world-ecology of wheat. Just three years later, at a meeting in the Corn Exchange Hotel on Mark Lane, the center of the London grain trade, a group of millers formed the National Association of British and Irish Millers (NABIM). Their first resolution echoed Dunham, explaining that due to the "great changes which are now in progress in the manufacture of flour, and in the machinery used for that

[42] "To Our Readers," *The Miller*, March 1, 1875.
[43] "Review of the State and Prospects of the Corn and Flour Trades," *The Miller*, March 1, 1875.

purpose," the time had come for an association that would promote milling's interests.[44] Both the creation of a trade press and NABIM's foundation thus suggested that the milling industry began to set itself in a position outside its traditional role in the rural community. Milling began to situate itself between not merely the processes of production and consumption within one society, but between disaggregated producers and consumers.

If the central technical problem facing millers was the challenge of grinding dry, hard wheat on millstones, the solution was to adopt rollers, which allow a much different method of milling: "high-grinding" or "gradual reduction," as opposed to "sudden death." Unlike stones, rollers allowed the miller to very gradually reduce the wheat by running it through rollers many times at different settings. The first few times through have the rollers far enough apart to just crack the grain's outer bran and husk, and are called "break" rolls. These separate the bran from the endosperm, the part that contains the starch, and produce middlings that can then be purified and slowly ground down into very white flour.[45] These methods were first developed in continental Europe, where Austrians and Hungarians working on hard, eastern European wheat found they could produce a small quantity of high-priced ultrafine flour using a gradual reduction process. After some experiments in the 1820s and 1830s, the first European roller mill was built in Budapest in 1839, the Walzmuhle.[46] Early adopters of rollers tended to use them for the first break only, in which the bran was removed from the kernel of wheat, and they relied on stones for the reduction of middlings and semolina into fine flour. Moreover, the early Hungarian mills, while capable of producing very fine flours, were not automated and relied on

[44] *Souvenir of the Millers' Congress, Paris, 1905* (Paris: The International Millers' Congress and the Annual Convention of the National Association of British and Irish Millers, 1905), 25–26.
[45] Oscar Oexele, "On Roller Mills, No. VII," *The Miller*, October 2, 1876.
[46] Bennett and Elton, *History of Corn Milling, Vol. III: Feudal Laws and Customs*, 303.

substantially more labor. This was largely effected by processing wheat in batches, with each batch progressing through several steps to produce about 30% very white flour, and a great deal of lower-quality flour.[47] Once roller milling had been developed in central Europe, American millers, particularly in Minneapolis, adopted and developed the technologies, automating them and dubbing their development "New Process Milling."[48] This increased the productivity of mills, allowing the production of greater quantities of white flour with much less labor, substituting water, wind, or mineral energy for human muscle.

The first roller plants appeared in Britain in the 1860s and 1870s, brought by German and Austrian immigrants like G. A. Buchholz, Oscar Oexele, and Henry Simon. Buchholz patented a "partial roller system" in 1862 that was very much like Hungarian systems using rollers for the "break stage" and then stones for the reduction of the middlings. He also included sieves between the rollers, to help reduce the bran the made it through to the next stage. His first installations were in the J. Fison & Co. mills in Ipswich in 1862, and the Albert Mills in Liverpool in 1868. With this system, Buchholz was able to get between 30 and 40% fine flour. Oexele, once employed at the Budapest Walzmuhle, set up several other roller mills, in Liverpool in 1868, and Newcastle and Glasgow by 1873.[49] Simon's system in the McDougall Bros. mills in Manchester, completed in 1878, was the first complete roller milling system to make no use of stones at all.[50] Simon went on to

[47] Ibid., 299; Jones, *The Millers: A Story of Technological Endeavour and Industrial Success, 1870-2001*, 22–3; Storck and Teague, *Flour for Man's Bread: A History of Milling*, 200–1; Perren, "Structural Change and Market Growth in the Food Industry: Flour Milling in Britain, Europe, and America, 1850-1914," 427–8.
[48] Storck and Teague, *Flour for Man's Bread: A History of Milling*, 213–22.
[49] Bennett and Elton, *History of Corn Milling, Vol. III: Feudal Laws and Customs*, 307.
[50] Perren, "Structural Change and Market Growth in the Food Industry: Flour Milling in Britain, Europe, and America, 1850-1914," 426; Jones, *The Millers: A Story of Technological Endeavour and Industrial Success, 1870-2001*, 11.

become the most successful of milling engineers in Britain, supplying the bulk of new roller milling systems by the turn of the century.[51] In 1889, Simon himself explained to a conference of mechanical engineers that "practically in less than ten years the machinery and methods of corn milling have been radically and entirely altered… in the mode of working, by the combination of roller mills with centrifugal dressers, purifiers, and rotary scalpers, and other machinery, so as to produce the best results in a mill working automatically on the principle of gradual reduction."[52] As Simon indicated, while rollers made the new system of high grinding and gradual reduction possible, this was only part of the innovation. Simon and his contemporaries developed a whole set of machines, integrated into a comprehensive milling system that could be automated, operate at high capacity, and handle a variety of wheats.

The grinding operation of the rollers, which included break operations done by fluted iron rollers and reduction operations done by smooth rollers, only accounted for one of three main elements of modern milling systems. The other operations were sieving and purifying. "Sieving" in milling systems includes scalping, grading, and dressing. After each break, the grain is "scalped" to separate the smaller pieces of starch from the bulkier parts that contain bran. Once scalped, the grain can be graded, or sorted according to size, which allows more precise grinding actions. Once sorted by size, the grain can be purified, in which the smallest pieces of bran are removed by passing a current of air through a falling stream of grain. The pieces of bran are less dense, and thus are pushed farther by the stream of air, into a separate chute. Dressing, or sifting flour through fine cloth, could be

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[51] Jones, *The Millers: A Story of Technological Endeavour and Industrial Success, 1870-2001*, 11, 83–100.
[52] Henry Simon, "On the Latest Development of Roller Flour Milling," in *Proceedings of the Institution Mechanical Engineers* (London: Institution of Mechanical Engineers, 1889), 148–149.

performed at several points in the process, but was often carried out last, to finish the flour. With this kind of milling system, millers could get a yield as high as 72% fine flour.[53] Finally, beyond the machinery that actually ground the grain was a whole suite of machinery for washing and drying the products before they even began the grinding process.

Roller milling machinery allowed British millers a great deal more precision in their processing of wheat, and it allowed them to extract a much higher proportion of fine flour. Milling Britain's soft, white wheat with stones was fairly effective although this method was capable of producing only a limited number of products. Eliza Acton, a cookery writer and advocate of social reforms, referred to stone-ground wheat as she explained in her 1857 *English Bread Book* that flour came in several varieties. The varieties of flour with all or most of the bran removed included "whites," the most expensive variety used only in cakes and fine pastries; "best households," were an "excellent" flour "used generally for bread-making"; "seconds," was a variety Acton characterized as "not very white" but the appropriate choice for those most interested in household economy. Beyond these were what we might call "brown" varieties: "wheat-meal," with the whole grain minus only the bran, coarsely ground; "whole-meal," with the entire grain including the bran ground fine enough for bread-making. In addition, millers produced bran and pollard, known as offal and sold as animal feed.[54] A typical yield of British wheat on millstones was about 25% fine

[53] Jones, *The Millers: A Story of Technological Endeavour and Industrial Success, 1870-2001*, 23.
[54] Eliza Acton, *The English Bread-Book for Domestic Use* (London: Longman, Brown, Green, Longmans, & Roberts, 1857), 87–89.

flour (fine in this case much less so than the ultrafine flours Hungarian millers produced), 50% lower grade flours, and 25% offals.[55]

With the adoption of rollers, a new set of terms emerged to describe the various grades of flour millers could extract. “Straight run” flours described those made when a miller ground wheat and extracted as much as possible under one grade; typically, a miller could extract upwards of 70% or even more straight run flour. If the miller chose to make two grades of 30% to 40% each, the better grade was a “patent,” and the lower grade “baker’s”—although not, confusingly, because bakers used it. A “long patent” referred to a better grade of flour comprising 50% or even 60% of the weight of the wheat, using more of the wheat than the usual “short patent.” Roller mill flour was also appreciably whiter, in part because the tiny particles of offal that were ground into flour by millstones were gone but also because millers developed washing machinery at the same time. One advantage to roller flour was that it kept longer, not having the tiny particles of oil that exist in the germ and bran, and that made their way into stone milled flour and could turn rancid over time. On the other hand, roller flour was known for its much weaker flavor, owing to the lack of the same.[56]

The transition from millstones to rollers as a result of Britain’s position in an expanding world-ecology of wheat was neither instant nor comprehensive, but it was real. A look at the program of the Second Convention of NABIM reveals the transition as it was underway in Glasgow in 1885. On the second day of the meeting, the confreres toured several Glasgow mills, many of which had recently adopted rollers for the express purpose

[55] “History of the Decortication of Wheat.”
[56] John Kirkland, *The Modern Baker, Confectioner, and Caterer: A Practical and Scientific Work for the Baking and Allied Trades* (London: Gresham, 1913), 52–55.

of grinding foreign wheat. The Craighall Mills had removed eighteen pairs of millstones in favor of roller plant, although two pairs of stones remained for occasional use. They dealt with a variety of wheats from around the world, including "Minnesota, Australian, Californian, Michigan, Canadian, Milwaukee, American red winter, Scotch, Indian, &c." The Centre Street Flour Mills, only twelve years old, had begun with seven pairs of stones, but had added a pair of smooth rolls. Like the Craighall Mills, they ground fine flour from "a general assortment of wheat, both home and foreign, but chiefly American." The Dale Street Mill employed a recently installed Simon system. The Dundas Flour Mills had switched to rollers in 1884, and claimed to be able to "sell in competition with the very best brands of Minneapolis flour," the commodity "most to be contended with." The Kingston Grain Mills claimed to be the first mill in Scotland to do away with stones completely, having adopted complete roller plants in 1881, while the Scotstoun Mill operated three different sets of mill technology on the same premises, and claimed to have been in operation for 300 years.[57] Certainly by the end of the century roller mills had come to dominate, and stone mills were reserved for special varieties and specific kinds of course-meal grinding, grinding corn for animal feed, or out of business. The Liverpool-published trade periodical *Milling* estimated that in 1901, only five percent of the country's flour came from stones.[58]

The change to roller milling systems and foreign flour also occasioned a shift in the geography of the milling industry, away from the grain-growing regions of Britain and locations with organic power sources, and toward ports with access to foreign wheat and mineral energy supplies. Perren, in his economic history of the milling industry, notes

[57] J. H. Chatterton, *Seventh Annual Report of the Transactions of the National Association of British and Irish Millers* (London: George Berridge & Co., 1885), 91–4.
[58] Cited in Perren, "Structural Change and Market Growth in the Food Industry: Flour Milling in Britain, Europe, and America, 1850-1914," 432.

censuses and maps of industry in Britain that revealed “no strong concentrations” of milling in 1850 or as even late as 1881. Grain was stored at regional centers and at seaports because of the nature of coastal transportation, and so these areas—in particular Liverpool—developed some concentration of mills, but “inland milling centers like Gloucester were as important as those at ports.”[59] Thereafter, milling began to concentrate in a few port cities: Liverpool, London, Bristol, Hull, and Glasgow. According to *Milling*, the region from Hull to York and the Bristol Channel ports each produced ten percent each of Britain’s flour, and Liverpool another thirteen percent.[60] In 1897, William Voller, a Gloucester mill manager and author, explained that in locating a modern roller mill, the two most important factors were availability of wheat supplies and proximity to a large population of consumers. If the miller planned to depend wholly on British wheat, his mill should be “of modest proportions,” and he would do well to remember that the wheat acreage of Britain was steadily declining. Voller assumed that the vast majority of mills in the future would be located in ports with access to foreign supplies. In that case, the real questions of mill location had to do with port quality, and the local position of the mill: closer to the water, or closer to rail links to urban populations.[61]

The shift of milling to reflect the new geography of global wheat supplies is clear in a closer look at one mill in particular, the W. Vernon & Sons’ mill at Birkenhead Dock in Liverpool. Opened in 1899, both the mill’s location and design reflected the changes in milling in the last half of the nineteenth century, as well as the broader changes in the British economy. The mill was located at Birkenhead Dock, a massive construction project

[59] Ibid., 422.
[60] *Milling*, February 23, 1901.
[61] William R. Voller, *Modern Flour Milling*, 3rd ed. (New York: D. Van Nostrand, 1897), 397–398.

that modernized Liverpool's port facilities to accommodate larger cargo ships. Such a location was possible in the first place because of the shift to mineral energy sources and the mobility it afforded to industry. Steam-powered mills had no need for wind or running water for power, and could locate instead at intersections created by human agency. Indeed, to actually build the foundation of the mill, a streambed was filled with an extensive system of concrete foundations.[62] The real advantage of Birkenhead Dock was its access to shipments of foreign grain, storage facilities, and railway networks within Britain. The Vernon mill was so large that multiple vessels could load or unload directly into the mill at once, and it could perform the same feat with railway carriages.[63] It was a mill located to process the products of global environments, much more so than the British environment.

The mill itself was an enormous investment of capital. Bennett and Elton's history of milling suggests that in the early nineteenth century, water or wind mills sold for £250 to £300; the Vernon mill "would seem to represent an outlay of over £200,000," orders of magnitude greater than older mills.[64] This is not surprising, given not only the costs of construction in its particular location, but also the machinery inside it. G. F. Zimmer, in a paper presented to the Second Convention of the National Association of British and Irish Millers in 1885, argued that millers should think of their mills as "flour factories," with "a place for every machine and every machine in its place."[65] The Vernon mill was truly a "flour factory," with two separate roller milling systems. Each system included a full suite of machinery connecting the storage silos to the packing warehouse, wheat "being taken

[62] Bennett and Elton, *History of Corn Milling, Vol. III: Feudal Laws and Customs*, 310.
[63] Ibid., 310–1.
[64] Ibid., 315.
[65] G. F. Zimmer, "A Few Words on Mill Buildings" (Second Convention of the National Association of British and Irish Millers, Glasgow, 1885).

entirely by automatic mixers and weighing machines direct to be treated as required by the screening, scouring, washing, and drying plants; thence to the rollers to be ground."[66] The automation allowed the mill a very large output, which Bennett calculated at 36,000 "packages" per week, with each package varying between 100 and 280lbs.

Categories of Knowledge for Millers

The technological revolution effected by British millers was only part of their reaction to the expanding wheat ecology, for their machinery was only useful in the context of their biopolitical expertise. In the decades after 1870, British millers occupied a position at the heart of the wheat ecology that supplied Britain with its daily bread. Their situation required deep expertise in the world's many kinds of wheat, and they mastered the specific physical and ecological characteristics of dozens of varieties in order to better process them. In this way, the technical expertise was a form of biopolitics; it involved little direct state intervention aside from facilitating Free Trade, but their knowledge and expertise was essential for the circulation of materials through human society. At the same time, their position also afforded them a unique vantage point, with a view of both the production and consumption ends of Britain's wheat, flour, and bread. From this vantage point, they invested the wheat and flour they handed with a variety of interlocking meanings that situated British millers with respect to the British empire, ideas of race and civilization, and Free Trade. Paradoxically, however, the very nature of milling as an intermediary link in a commodity chain meant that while few groups or individuals were as keenly aware of the ecological connections between global environments and British

[66] Bennett and Elton, *History of Corn Milling, Vol. III: Feudal Laws and Customs*, 313.

bodies, that expertise also served to separate producers and consumers. For all their knowledge of the global wheat ecology, millers had to produce flour that was consistent and homogeneous, whatever the particular sources of the wheat happened to be; the meanings they invested in wheat and flour, therefore, did not travel with those materials. Millers effectively created a culinary blank slate, onto which bakers could later paint (or bake) new meanings for consumers. In this way, the biopolitical expertise of millers actively reinforced the Cartesian binary, splitting humans from nature.

For millers, wheat cultivation and bread consumption were deeply connected to the existence and progress of civilization past and present, and thus central to a kind of original break between humans and a "savage" or "primitive" existence more closely associated with nature. They frequently assigned the British empire, and past and contemporary settler adjuncts Canada, Australia, and the United States, the dual tasks of increasing Britain's food supply and spreading civilization through wheat cultivation. This view of settlement and agriculture allowed millers to participate in the processes of empire and civilization, as they rendered wheat grown abroad fit for human consumption. At the same time, their position also led them to an ambiguous and changeable relationship with Free Trade. The creation of the global food chain relied on Free Trade and provided obvious benefits. However, there were drawbacks as well. Foreign flour imports threatened domestic milling and, worse, a global food chain could be vulnerable in wartime. These drawbacks led millers to support domestic agriculture as a safeguard against the dangers of a global food chain and to maintain social and economic stability in rural Britain.

British millers in the late nineteenth century regarded their profession as ancient and vital for a particular kind of civilization, one defined by cereal cultivation and bread consumption. This definition of civilization placed millers in a privileged position, at the heart of the relationships between humans and nature and with particular responsibility for ensuring and maintaining that separation. Sir John Ashton's 1904 *History of Bread* made this definition of civilization clear. In his discussion of "pre-historic bread," he equated cereal cultivation and bread consumption with the advent of civilization. He explained that archaeological sites from Swiss lakes provided evidence of a group of humans who ate bread, and who must therefore have been "the earliest known civilized inhabitants of Europe—by which I mean that they cultivated several kinds of cereals—wove cloth, made mats, baskets, fishing nets, and, besides, baked bread."[67] Bennett and Elton's 1898 *History of Corn Milling*—dedicated to NABIM—traced a direct line from the early cultivation of grain to the origins of civilization to the present day, with the critical role passing directly through millers. He claimed that corn milling was "Without doubt… the oldest continually conducted industry in the world… among the first fruits of man's inventive ingenuity." It was civilized humans' first occupation and advanced along with their technology, developing from hand power, to water and wind, and most recently to steam.[68] This particular definition of civilization as grain cultivation and bread consumption, with flour milling the crucial link between the two, helped millers situate themselves historically as agents of progress. In this view of the past, human civilization was defined by the relationship between humans and their environment, articulated through food and utterly dependent on the application of labor and expertise to render the products of nature fit for human consumption.

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[67] Ashton, *The History of Bread*, 13.
[68] Richard Bennett, *History of Corn Milling, Vol. I: Handstones, Slave and Cattle Mills* (New York: B. Franklin, 1964), vii.

This definition of civilization also suggested a boundary between those who cultivated wheat and ate bread, and those who did not; or, in other words, it placed different human groups into different positions relative to a certain version of the human-nature split. While this boundary in the first instance separated history from pre-history, it also had implications for the present, where it fit neatly into contemporary discourses of race and empire. Bradfield's textbook of milling opened by claiming that "Wheat has always held the premier place in the food economy of the most civilised races of the world… the most energetic, and we think we may add, the most intelligent races of mankind ever since the time of which we have record."[69] He thus connected the past to the present through wheat, flour, and bread. Julius Wihlfahrt, another well-known author on baking, explained of bread that it "is an outpost of civilization. Where bread is on the daily bill of fare, health, comfort and all that modernization implies are found."[70] In this way, millers understood the cultivation of wheat and consumption of bread to be essential to a version of civilization that was racially exclusive. Millers could thereby situate themselves not merely as members of a racially superior group, but as vital operatives in maintaining the very existence of that group.

If wheat, flour, and bread meant civilization, millers could interpret the advance of cereal cultivation in frontier regions as the march of progress. In 1876, a piece in *The Miller* described what a difference a century had made in the United States, where frontier expansion had made available more grain than anywhere else: in "1776… a gloomy, impenetrable wilderness stretched where now mile after mile of grain fields wave." The

[69] Edward Bradfield, *Wheat and the Flour Mill: A Handbook for Practical Flour Millers* (Liverpool: Northern Publishing Co., 1920), 1.
[70] Julius Emil Wihlfahrt, *A Treatise on Flour, Yeast, Fermentation and Baking: Together with Recipes for Bread and Cakes*, 3rd Ed. (The Fleischman Co., 1914), 4.

benefits of this transformation of the environment were social and economic stability, for "in those days a bad harvest meant a riot, and sometimes a revolution."[71] The expansion of European settlement abroad thus brought benefits to Britain, even when not under the jurisdiction of the empire. Canada offered the same benefits as well as a more direct link to Britain. There, a writer for *The Miller* claimed in 1879 that, "the great bulk of her population belongs to the British, in other words, the most industrious race in the world." The vast land there suggested that although Canada's prairies had largely gone uncultivated in 1879, Britons could expect that "in the future our American possession will prove an important element in our wheat supply."[72] A grain-producing empire thus filled the intertwined roles of provisioning Britain with the Staff of Life and expanding British civilization.

If the racial and civilizational meanings invested in wheat, flour, and bread helped millers situate themselves in society and in the expanding British food chain, they also functioned to allow the participation of other races, though on unequal terms. Millers occasionally attributed to wheat the characteristics of those who grew it. Indian wheat was universally known as being dirty and "ricey," with a particular smell imparted on the wheat by the use of animals to thresh the grain.[73] The early nutritionist Charles Graham, in discussing the character of British bread, noted that "Some objection has been made to the employment of too large a quantity of Indian wheats when mixed with our own, owing… to the aromatic flavour of bread that has too large a proportion of Indian wheat ground with

[71] "The American Wheat Crop," *The Miller*, August 7, 1876.
[72] "British North America as a Wheat Producer," *The Miller*, April 7, 1879.
[73] J. H. Chatterton, *Eleventh Annual Report of the National Association of British and Irish Millers* (London: George Berridge & Co., 1889), 44.

our English and other wheats."[74] Millers frequently assumed that Indian cultivators employed methods that were "crude in the extreme," and that "treading it out on a mud floor by oxen is still in vogue."[75] While an understanding of Indian wheat as dirty might have had some material consequences—suggesting particular methods in processing—millers often extended the association of wheat's characteristics with its cultivators into racial and moral realms. In a paper read to a council meeting of NABIM in 1892, G. M. Parkinson described methods of correctly blending wheat varieties, "till the golden grain of California need count it no dishonor to meet death side by side with the darkest skinned and once despised product of our Indian Empire, and the sweet plump berry of old England need fear no contamination of its virtues from contact with the ill-reputed wheat from the land of the Pharaohs."[76] In this way, millers' expertise at once reflected the unequal power relationships of race and empire, placing white cultivators above others, but also facilitating the participation of subordinate peoples in Britain's wheat ecology.

Wheat, flour, and bread enabled millers to situate themselves within British society and the empire, and within global grain markets as well. At times millers endorsed Free Trade, and at others they opposed it. If their understanding of their position in the British food chain led them to support the expansion of wheat cultivation abroad, their relationship to Free Trade led them to support wheat cultivation at home, as a safeguard against international competition and famine in wartime. The repeal of the Corn Laws in 1846 is taken as the moment at which Free Trade became a policy reality, and this opening of British markets to the world's grain was necessary to the development of a global wheat

[74] Charles Graham, "The Chemistry of Bread-Making," in *The Adulteration of Food: Conferences by the Institute of Chemistry* (London: Clowes, 1884), 99.
[75] Bradfield, *Wheat and the Flour Mill*, 25, 38–39.
[76] Hugh J. Sanderson, *Fourteenth Annual Report of the Transactions of the National Association of British and Irish Millers* (London: George Berridge & Co., 1892), 22.

ecology. Its benefits were manifest when Free Trade provided cheap and plentiful wheat, as it often did. In millers' eyes, these advantages suggested an equivalency in wheat-producing regions, a breaking-down of national and environmental boundaries. As an 1876 passage from *The Miller* described the emerging global food chain, claiming that "South Australia, California, even Chili [sic]—to say nothing of Pomerania, Wallachia, and the Delta of the Nile, are home counties, and their crops are as inevitably tribute to us those grown on the Bedford Level or the Vale of Evesham." Although such a situation was unprecedented in human history, these benefits made it seem a natural development. As the same piece continued, "a balance" was created among wheat-growing regions of the world, "the consequences of Nature having her own way and not being fettered by tariffs." At the fulcrum of this global balance of food and nature was Britain, where "foreign wheat supplies an excellent gauge of the world's weather and crops… brought to a common centre by the quickest and cheapest route."[77] Free Trade thus not only provided material benefits, but it located Britons at the center of a world ordained by Nature to focus the products of global environments on British markets. The benefits of lower prices and stability of overall supply were thus rendered the operation of Nature, something against which one could not argue, and about the potential drawbacks of which one should not complain.[78]

Free Trade was not always the millers' friend, however, because it exposed them to competition from abroad in the form of imported flour. This was most intense from the early 1880s, when the amount of flour imported reached one quarter that of wheat, one-fifth of overall imports overall. The crisis abated by the 1900s, when it fell permanently

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[77] "Free Trade in Corn," *The Miller*, May 1, 1876.

[78] This sentiment matches well with Polanyi's argument that liberals regarded Free Trade as the most "natural" mechanism through which to organize human relationships. Karl Polanyi, *The Great Transformation: The Political and Economic Origins of Our Times* (Boston: Beacon Press, 1957) See also Chapter Six.

below 15%, less than one-seventh of overall imports.[79] Millers saw this as an existential threat when it was at its worst in the late 1880s and early 1890s, and it dominated the discussion at NABIM conventions. In 1887, NABIM assembled a committee to investigate the "Present Depression" in milling. The committee's report concluded that while there had long been a trade in fine flour from central and eastern Europe, the situation had become critical due to "the construction in America of vast factories for the avowed purpose of supplying England and other countries, where no import duty exists, with flour." This, then, was the dark side of Free Trade: foreign businesses could access the British market, to the detriment of domestic industry. At the convention, a group of millers proposed a resolution supporting an import duty, a direct rejection on Free Trade. However, they were quickly overturned, and the resolution that passed was much more passive. They asked that "the products of foreign nations should bear the same proportion of Imperial and local taxation as our own."[80] Such a resolution betrayed the ambiguous views of millers to Free Trade, for they were cogently aware of both its benefits and its drawbacks.

Free Trade may have been a problem for millers because it exposed them to imported flour, but their vantage point at the heart of the British food chain suggested that the globalization of wheat supplies was a potential disaster for the nation because it exposed them to blockade and starvation in wartime. This was evident as early as the 1870s, when the acreage under wheat declined precipitously. From highs of nearly 3.7 million acres of wheat in 1868 and 1869, wheat acreage plunged to under 3 million in 1876, and stayed below 3 million after 1879.[81] *The Miller* noted these figures in 1877, and

[79] B. R. Mitchell, *British Historical Statistics* (Cambridge, U.K.: Cambridge University Press, 1988), 225–226.
[80] Chatterton, *Ninth Annual Report of the National Association of British and Irish Millers*, 113–128.
[81] Mitchell, *British Historical Statistics*, 186.

described the "apparently certain advent of a time when we shall be virtually dependent on foreign sources for our supply of cereals." This situation, the author claimed, amounted to potential disaster on two fronts. In wartime, "the whole nation would be to a considerable extent exposed to the attack of any continental power, for the successful diversion from our shores of any considerable portion of our cereal imports would of course plunge the nation into deepest distress." The situation was no better in peacetime, for "even a partial combination among foreign states for the purpose of lessening or withholding supplies would put this country under a pressure which might prove virtually irresistible."[82] John Ure, a Glasgow miller and chairman of the third NABIM convention in 1886, took a longer-term view of the problem, lamenting that Britain and Ireland had become dependent on foreigners for their food, while "we part freely with our coal and iron, products that are undoubtedly exhaustible."[83] These concerns came to a head in 1895, when NABIM passed a resolution expressing its "utmost concern at the decline of cereal crops," and that it "prays the Administration to take such steps as may commend themselves to arrest what is nothing less than a great and pressing national danger." By this, millers hoped to encourage subsidies or other encouragements for wheat growing in Britain. It was important for farmers to grow wheat, one argued, even if they had to be paid to do so.[84]

The scale of imported flour did fall off by the first decade of the twentieth century. Perren argues that this was not a result of increasing competitiveness of British milling, but because after that point, American population expanded to absorb the previously exported

[82] "The Diminished Wheat Growing Area in Great Britain," *The Miller*, March 5, 1877.
[83] J. H. Chatterton, *Eight Annual Report of the Transactions of the National Association of British and Irish Millers* (London: George Berridge & Co., 1886), 27–28.
[84] Hugh J. Sanderson, *Seventeenth Annual Report of the Transactions of the National Association of British and Irish Millers* (London: George Berridge & Co., 1897), 115–117.

surplus.[85] With the immediate danger of flour imports passed, however, British millers remained tepid in their support for Free Trade. After Joseph Chamberlain began his Tariff Reform campaign by proposing a duty on imported grain, one miller opined that opponents of Tariff Reform operated under the "free food delusion." A duty on imported grain, he argued, would allow the Government to reduce internal taxation, which would stimulate internal demand and thus increase work and wages generally. He claimed the solution to the problem of the "big and little loaf," a symbol frequently deployed to illustrate the benefits of cheaper grain prices, was "the big and little wage."[86] When the issue was restricted to imported flour, millers were unambiguously in support of tariffs even after American flour imports had fallen off. In 1909, the *Daily Express* ran a series of articles in which they solicited opinions from various trades on Tariff Reform. Their final installment of thirty-five dealt with milling, and found overwhelming support for a theoretical ten percent duty on imported flour. A letter from S. K. Keyes of Keyes' Daren Mills in Dartford put it plainly: "A duty of ten per cent on imported flour would give an enormous impetus to the milling trade of this country, and confer a benefit upon the community at large almost greater than the protection of any other of our industries."[87] While the benefits that Keyes saw accruing to the milling industry are obvious, the benefits that he saw for the rest of the country reflected the broader support of millers for domestic agriculture.

Promoting agriculture in Britain was attractive to millers for a variety of reasons, despite their frequent praise of global wheat supplies. In *The Miller*'s inaugural issue, Dunham himself pointed out that, "a good local supply of wheat is always an advantage to

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[85] Perren, "Structural Change and Market Growth in the Food Industry: Flour Milling in Britain, Europe, and America, 1850-1914," 431.
[86] "The Free Food Delusion," *The Miller*, May 1, 1905.
[87] "The Flour Milling Industry and Tariff Reform," *The Miller*, n.d.

millers, and makes them mostly independent of the demands of foreign importers during market fluctuation."[88] Beyond market stability, millers tended to side with the agricultural community, supporting cereal cultivation for the greater number of men it employed and the assumed social cohesion of rural society that it implied. One miller at an 1888 NABIM general meeting likened the nation to a body, and described agriculture as the "heart and lungs." If it were disrupted, he warned, "The dwellers in the towns, who had benefited by the cheap loaf, were constantly liable to see their bread taken from out of their mouths by the rush of starving laborers from the country… at best reducing their wages to starvation point."[89] NABIM passed an 1896 resolution that took these arguments a step further, invoking a divinely ordained agriculture to supply "sweet and pure grain" to the people, and to "restore the land now wholly or partially out of cultivation to the use designed by Providence, viz., to bring forth food for the people."[90] Despite the benefits of domestic cereal cultivation that millers cited, both national and international, Free Trade remained the rule in Britain until the formulation of Imperial Preference in 1932. [91]

More immediate means for supporting British agriculture needed to be operable within the context of Free Trade, and to this end British millers began supporting efforts to develop wheat cultivation in Britain and to thereby make it more competitive on the market. From the late 1890s, NABIM sponsored efforts to develop stronger varieties of wheat that could successfully be grown in Britain, and which would reduce their dependence on imports. The Home-Grown Wheat Committee was established in 1901 and

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[88] "To Our Readers."
[89] J. H. Chatterton, *Tenth Annual Report of the National Associationof British and Irish Millers* (London: George Berridge & Co., 1888), 26.
[90] Hugh J. Sanderson, *Eighteenth Annual Report of the Transactions of the National Association of British and Irish Millers* (London: George Berridge & Co., 1897), 93.
[91] Need citations on c. 1900 agricultural policy; certainly no subsidies.

continued its work until 1938. During that time, it developed strains of wheat that exhibited the milling and baking qualities of Canadian Hard Fyfe, a strong wheat originally from Manitoba.[92] While it took decades to develop this and the British state did not wholly support British cereal cultivation until the Second World War,[93] it nonetheless was an important intervention into the British food chain. It was one of the few means through which millers could mitigate the disadvantages of a global food chain, while navigating the narrows between Free Trade and the reluctance of the state to provide subsidies.[94]

Millers' position in the British food chain and their understandings of civilization, empire, and Free Trade encouraged them to support agriculture both at home and around the world, but it also required that they develop a deep expertise in the environments that produced wheat. Along with the meanings millers invested in wheat, flour, and bread which reflected their ideas of civilization and their position in the global grain trade, wheat remained part of an ecology, and brought with it important connections to its particular environmental origins. The successful handling and transformation of the world's wheat into marketable flour required the accumulation of deeper knowledge of global wheat varieties and environments than likely ever existed, for wheats are as different as their environments and no country had ever imported so much from such diverse origins. However, although this knowledge of global wheat environments was critical for millers, it existed only to shape flour's baking characteristics. The market for flour in Britain prioritized flour's price, strength, moisture, color and flavor. Some bakers before 1850 were attentive to the advantages of foreign wheat, and there was certainly a segment of

[92] E. N. Greer, "A Milling Character of Home-Grown Wheat," *The Journal of Agricultural Science* 39, no. 1 (1949): 125–27.
[93] Need WWII cites, see Howard paper.
[94] Christopher Otter, "Ecology, Security, Pathology: British Nutrition in World-Historical Context" (North American Conference of British Studies, Minneapolis, Minn., 2014).

bakers in the later nineteenth century that quite deliberately combined flours milled from single wheats in order to achieve their desired qualities in loaves.[95] However, millers stood a better chance of turning a profit if they could take advantage of their position to make their own mixtures. As long as they could keep their flour consistent, they might use whatever wheats they liked, allowing them to take advantage of the differences and changes in price among the varieties available. And, while many millers were probably not as good at this as they liked to think—bakers certainly complained of inconsistent flour from time to time—it nevertheless became the standard method for millers. This meant that when flour left British mills, all of millers' knowledge of its environmental origins and its role in global and domestic politics and economics remained with them. Whether wheat was homegrown or Free Trade, grown by Canadians or Indians, in hot or cold climates, in heavy clay soil or sandy loam, all that mattered when the flour left the mill was its strength, moisture, color, and flavor. Its material transformation from wheat to flour thus enabled transformations in its meaning as well, in ways that reinforced the separation of producers and consumers.

Understanding the highly variable characteristics of wheat varieties was vital for producing what the British flour market demanded: regular, consistent flour. The milling engineer and author Edward Bradfield explained that, "the one grade of flour for which bakers will accept no excuse, is the flour on which they cannot rely as being regular."[96] Flour that produced high and light loaves one week must not produce heavy and dense loaves the next. Bradfield explained that a miller must know the sort of trade he was attempting to serve, be it cakes, pastries, biscuits, or bakers' loaves, tailor the

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[95] See Chapter Four.
[96] Bradfield, *Wheat and the Flour Mill*, 68.

characteristics of the flour he milled to the demands of that particular trade, and to produce flour with the same characteristics consistently. That consistency was also the miller's biggest challenge, made difficult by the variability of the wheat supply that reached British ports, mills, bakeries, and ultimately British homes. Only through mastery of global wheat supplies could millers effectively use the varieties available to them to make profitable products. Bradfield explained that "the varieties available vary with the seasons, and there are often occasions when the wheats which are being depended upon to supply 'backbone' to the mixture are too high in price to be used."[97] In order for a miller to make a profit, therefore, he not only had to produce a consistent finished product but also had to do so with highly variable raw matierals.

Wheat varieties differed in their moisture content, hardness, gluten content, flavor, color, and the difficult-to-define "strength," which typically referred to the flour's capacity to produce a "bold, large-volumed, well-risen loaf"; it included the amount of the protein gluten, but also took into account the quality of that gluten. This could not be measured without baking, and also required the flour to absorb enough moisture during kneading.[98] To understand the different baking qualities of the world's wheats, William Jago, the foremost bread scientist in Britain in the late nineteenth century and required reading for apprentice millers, examined the chemical characteristics of a bewildering array of wheats available at one time or another in British markets: Britain itself provided wheats that were diverse enough among themselves to merit testing samples from Suffolk, Kent, Essex, Berkshire, and other counties, along with the very soft Rivetts, and Saxonska grown in both Scotland and southern England. Ports ringing the Pacific Ocean sent Walla Walla (Oregon),

[97] Ibid.
[98] Jago, *A Text-Book of the Science and Art of Bread-Making*, 299–300.

Californian, New Australian, and New Zealand "Growy," among other varieties. Indian varieties included New White Indian, Hard Calcutta, No. 1 and No. 2 Calcutta, No. 1 Bombay, Soft Red Bombay, Hard White Kurrachee, Red Kurrachee, White Jumblepore, No. 1 and No. 2 Club Calcutta. North American ports shipped No. 1 and No. 2 Minnesota Hard Spring, Red Fyfe Manitoba, No. 1 and No. 2 Winter American, No. 2 Chicago Spring, Milwaukee, Spring American, No. 1 American Hard Fyfe, and No. 1 Hard Canadian. Beyond these were the many types grown in Russia and Eastern Europe, which shipped either via the Black Sea or the Baltic Sea, and then less common varieties such a Persian and Egyptian.[99] Bradfield suggested that there could be as many as 1,000 varieties of wheat worldwide in the late 1910s, though British millers probably only needed to know about a hundred.[100]

All wheat is of course the product of a local ecology, and understanding those local ecologies was an important part of millers' technical knowledge. In explaining the wide variety of characteristics, experts of the late nineteenth and early twentieth centuries relied on a three-part explanation: soil, climate, and pedigree. These three factors operated in combination to explain the ability of some varieties to produce certain characteristics in certain environments, but not in others. If one were to transport "an acre of stiff English clay" to Manitoba and grow a strong, hard, spring wheat on it, changing only the soil, "the wheat when matured would be found to have modified its flinty hardness, and lost something of its strength as well."[101] Soil was, however, just one determinant, and growing a Manitoba spring wheat variety in Kent's milder, wetter climate would reveal that the wheat might have a "family likeness," but would not retain "its old reputation for strength."

[99] Ibid., 288–95.
[100] Bradfield, *Wheat and the Flour Mill*, 3.
[101] Voller, *Modern Flour Milling*, 11.

Indeed, sowing the resulting wheat in the same soil would ultimately obliterate the strain's original characteristics. Conversely, attempting to sow softer, weaker English wheat in Minnesota would not produce hard, strong wheat, because "the seed lacks that character necessary to success."[102] While this presented a puzzle for the British milling and baking trades, because they were unclear how particular varieties had come about and exactly what the relationships between wheat variety and environment were, it is certainly the case that British millers put a great deal of importance into the local environments that produced wheat.

In addition to the different characteristics of the wheats themselves and the relationships between grains and the environment in which they were grown, there were impurities that came with them. These were as unique as the environments that produced them. English wheats were traditionally known for being clean and relatively free of impurities, usually only 1-2%; Perren suggests that this was a result of relatively cheap agricultural labor, which could raise the value of wheat by cleaning it, although lower prices after 1870 made this less economical. Canadian and American wheats were somewhat dirtier, usually containing 2-4% impurities; Californian and Australian wheat were known for straw and oats in particular. Odessa wheat from southern Russia had many desirable properties, being hard and high in gluten, and frequently lower in price than other strong wheats. But, it was also high in impurities, with 6% common and as much as 12% in some particularly bad samples.[103] It was typically sown in fields after crops of

[102] Ibid., 11–2.
[103] Perren, "Structural Change and Market Growth in the Food Industry: Flour Milling in Britain, Europe, and America, 1850-1914," 431.

linseed, and therefore nearly always had linseed mixed in.[104] Its other impurities included dust and soil, cockle, rye, barley, and larger impurities. The larger impurities could be anything from cigarette butts to rivets and nails, although not, somewhat suspiciously, any coins; one miller claimed to have even found a quarter of a common red brick in sack of wheat. These impurities required a full suite of cleaning, including magnetic separators, sieves, air currents, washers and driers.[105]

The character of the world's wheat varieties was a central element of the body of knowledge that constituted British milling expertise. It featured prominently in the exams administered at the City and Guilds of London Institute of Advanced Technical Education, required for apprentice millers to become journeymen or foremen, managers, or teachers. These began in the early 1880s, at the same time milling technology was moving from stones to roller systems, and they typically began with a set of questions about the characteristics of different varieties of wheat. The 1883 Ordinary grade exam listed twenty-one varieties and asked the students to categorize each variety as "strong" or "weak," "harsh" or "mellow," and "coloury" or "dark." The Honours grade asked students to go one step further and indicate whether each variety was better suited to milling on stones or rollers.[106] The following year's exam asked students to name the impurities found in "California, Indian, Persian, No. 2 Spring American, Eygptian, and Taganrog Ghirka" varieties. It then noted that California wheat often tasted and smelled of "spice" or hay, and asked "from what does it arise and can it be removed? Is the taste and smell detrimental to

[104] Arthur Barker, *The British Corn Trade, From Earliest Times to the Present* (London: Sir Isaac Pitman & Sons, 1920), 83.
[105] Chatterton, *Eleventh Annual Report of the National Association of British and Irish Millers*, 20.
[106] Chatterton, *Seventh Annual Report of the Transactions of the National Association of British and Irish Millers*, 123–128.

flour?"[107] In the late nineteenth and early twentieth centuries, a deep level of expertise in the particular characteristics of global wheat supplies was required for British millers: their climates and soils, their impurities, their milling and baking characteristics.

The expertise in the global wheat ecology that millers accumulated paradoxically functioned to mask that very same knowledge, and thereby reinforced the Cartesian binary that separated humans from nature, and producers from consumers. Because the miller's product had to be consistent, no matter the source of supply, and one of the most important practical applications of knowledge of global wheat was to find and select substitutes in order to maintain the consistency of the flour. The 1888 Ordinary Grade exam put it bluntly: "You have been depending upon Duluth, Chicago, and Milwaukee spring wheats for the basis of strength; these failing, name your substitutes…"[108] Relying on only one source for wheat was particularly treacherous for British millers if that source was American wheat, because Minneapolis millers exported a great deal of flour as well. One miller at the 1887 convention of the NABIM complained that American mills sold their best flour and made their highest profits at home, which allowed them to dump their lower grade flour on the British market at rock-bottom prices. Another responded that many millers were foolish for educating their customers to prefer American wheats, and chided them for being "surprised when they were beaten in the competition with American flour."[109]

One of a miller's most important skills was blending wheat varieties to produce flours suited to particular markets. Cakes and biscuits required softer flours, while bread needed the all-important strength. The London market was known for demanding tall,

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[107] Ibid., 128–131.
[108] Chatterton, *Tenth Annual Report of the National Associationof British and Irish Millers*, 132.
[109] Chatterton, *Ninth Annual Report of the National Association of British and Irish Millers*, 134–135.

well-risen loaves, and the Irish market for very white flour that was baked into soda bread a quick bread using new forms of chemical leavening only recently developed.[110] The 1905 prize winner for the Honours Grade milling exam, Percy A. Amos of Rochdale, was asked to "Select suitable mixtures of wheat…to yield a straight grade flour of good colour, suitable for replacing Winter Patent" a variety usually made with substantial portions of American wheat and common in making the white loaves that were bakers' mainstays. He answered that he would combine Manitoba and Russian for strength, Indian and English for colour, Argentinian for whiteness, and Australian for "bloom."[111] Bradfield explained the process in detail in the late 1910s. He described a "typically cosmopolitan English mixture" as composed of the following:

20	Manitoba, No. 2
10	Russian
15	Karachi
5	No. 2 Club Calcuttas
20	Plates (Argentina)
20	English
10	Australian
100	

In this mixture, Bradfield's typical flour was cosmopolitan indeed, including wheat from every inhabited continent except Africa. As with Amos's answer, the Manitoban and

[110] Carolyn Cobbold, "Yeast, A Problem: The Rise of Alternative Bread Leavening Technologies in the 19th Century" (MA Thesis, Cambridge University, 2013).
[111] "'The Miller' Prizes," *The Miller*, August 7, 1905.

Russian wheats provided the majority of the strength. Bradfield further explained that the Club, Karachi, and Plate wheats also lent some strength. The English wheat improved the color and flavor, and helped "neutralise the tendency toward coarseness in the texture of the loaf," which often happened with Indian and Manitoba wheat. The Australian added "class" to the mixture and "bloom" to the flour. The Plate wheat he noted for its beautiful bloom and color, as well as its reputation for "working well in the mill." "From such a mixture," he claimed, "a high-class flour and a good length of patents well suited to bakers' breadmaking would be obtained."[112] In other words, such a selection of wheat would be reasonably priced and would yield a long patent (50-60%) of high-quality flour. If this was a flour for a typical London loaf, then Britons were truly fed by the world.

Conclusion

As the wheat ecology that connected global bodies to British environments changed, the milling industry changed as well. Before the middle of the nineteenth century, the miller was a constant—if often despised—figure in the local economy, an indispensible processor of largely local produce for largely local consumption. In this sense, while millers did mediate between humans and environments, these were largely the environments inhabited by those humans. They mediated between the processes of production and consumption, but those processes both occurred largely within the same society and the same environment. With a much longer, worldwide wheat ecology, millers took on new roles as mediators between producers and consumers on opposite sides of the world. In this role, millers invested wheat, flour, and bread with a variety of meanings that situated

[112] Bradfield, *Wheat and the Flour Mill*, 71–73.

themselves in British society, the empire, and global trade, while at the same time developing a set of technologies and expertise that functioned both to allow them to process global wheat into consistent and homogeneous flour, and to mask the very origins of the flour they produced. In this way, millers functioned to not only render wheat palatable, but also to transform its cultural meaning. They rendered it a blank slate, a commodity with no relationship to its origins and thus totally open for new meanings to be invested into it. Bakers had no need to know where a flour came from, so much as they needed to know if a flour was strong or weak, flavorful or dull, white or yellow. Milling the wheat into flour and transforming the products of nature into a manufactured good reoriented the way that flour registered in human understanding, and ultimately reinforced the Cartesian binary, generating a cultural distance between consumers and the environments that produced their daily bread, a distance just as important as the physical distance separating a consumer in Birmingham from a farmer outside Bismarck.

CHAPTER THREE

BODIES AND ENVIRONMENTS IN LONDON BAKERIES

Whether Britons purchased their wheat from an import merchant or grew their own, whether the miller took his customary toll or sold the finished article on the market, wheat and flour were not palatable—not properly *food*—until they were baked into bread. Baking is at the heart of relationships between bodies and environments, and was, like milling, an indispensible link in the commodity chain that comprised Britain's wheat ecology. Until at least 1700, and perhaps as late as 1800, domestic baking was the rule for the bulk of the population. For those baking at home, the anti-scarcity system effectively ended once they had their flour, for they were responsible for the last step of processing themselves. In this way, even domestic baking was a fundamental component of the anti-scarcity system's moral foundation, which prioritized a direct relationship between production and consumption. Provisions must be invested with meaning in order for them to count as actual *food*.[1] At a fundamental level, they must be brought from the realm of "nature," across the Cartesian binary, and into the realm of "human." Milling accomplishes this task to a certain extent, but does not result in a finished article that may grace a table, and thereby fit into the cultural realm of "food." Baking completes the process: the long and difficult labor involved invests wheat and flour with meaning, turning it both physically into bread and culturally into food. Performing the task at home, then, was a key part of feeding oneself. It is no surprise that baking bread was long regarded a housewife's duty, a necessary component of household economy, even when it was probably easier to buy

[1] Claude Lévi-Strauss, *The Raw and the Cooked: An Introduction to a Science of Mythology*, trans. Claude Weightman and John Weightman (New York: Pimlico, 1969).

bread from the baker.[2] With the nature of wheat and milling techniques in early modern Britain, the bulk of the population ate fairly dark, dense loaves until some point in the nineteenth century.[3] But, long after commercially baked white bread became the norm for virtually all Britons, a "home-baked loaf" was assumed to be darker in color and denser in texture. Many bakers in fact supplied exactly that kind of loaf for those that preferred it, right alongside their usual white loaves, indicating the long association between home baking and dark, dense bread.[4]

But, even in the medieval period, in the cities and towns, people either chose or had to rely on commercial bakers. Those bakers were potential "middlemen," standing between the production and consumption of food. As such, they were regulated by an extension of the anti-scarcity system called the Assize of Bread. Dating back to at least the thirteenth century, and perhaps even the twelfth, the Assize of Bread enforced the ideal of the direct relationship between production and consumption by tying the prices of wheat and bread together. It recognized that some populations were unable to bake for themselves, but proceeded on the assumption that any middlemen were inherently suspect. It thus limited the role of the market in the baking trade, ensuring that bakers could not collude to raise prices, but also that baking would be remunerative enough that there would be no shortage of bread. At the same time, it also performed sumptuary functions, for pegging the price of

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[2] See, for example, Eliza Acton, *The English Bread-Book for Domestic Use* (London: Longman, Brown, Green, Longmans, & Roberts, 1857); Christian Petersen argues that baker's bread was probably more economical than home-baking, because of the baker's greater economy in fuel and greater skill; the baker also assumed the risk of ruined batches. *Bread and the British Economy, C. 1770-1870*, ed. Andrew Jenkins (Aldershot, Hants., England: Scolar Press, 1995), 44–50.

[3] Michael Nelson, "Social-Class Trends in British Diet, 1860-1900," in *Food, Diet, and Economic Change Past and Present*, ed. Catherine Geissler and Derek J. Oddy (Leicester, U.K.: Leicester University Press, 1993); Petersen, *Bread and the British Economy*.

[4] *The Guide to Trade: The Baker; Including Bread and Fancy Baking with Numerous Receipts* (London: Charles Knight and Co., 1841), 31.

bread to wheat also entailed mandating particular qualities of bread. Bakers were thus expected to bake certain qualities of bread, and to bake those qualities in certain proportions. In this way, the anti-scarcity system attempted to maintain the social order in every way: it worked to keep prices appropriate—low for the brown bread of the common people and higher for the white bread consumed by elites—ensure a steady supply, and make allowance for the fact that shortages would occur, but only when the local harvest failed for reasons beyond human control.

This anti-scarcity system began to break down in the eighteenth century, thanks to an increase in scale of the grain and milling trades and their commercialization, plus the pressures of population growth and war with France. At the same time, commercial baking spread from the cities and towns to the countryside, and consumers across the archipelago developed a taste for whiter, wheaten bread. The British state attempted to maintain the anti-scarcity system through much of the eighteenth century, amending the Assize many times, particularly during war-caused disruptions, but it became increasingly unworkable. At root, the problem was that milling was essentially unregulated, meaning that millers could grind flour in whatever manner they found most profitable, and thus the prices of wheat and bread were not necessarily linked.[5] In the context of new ideas of liberal political economy, Parliament ultimately dismantled the anti-scarcity system in the early nineteenth century, replacing it with the apparatus of security: the market. In its practical application to baking, security meant repealing the Assize of Bread; this happened in the metropolis in 1815, and throughout the kingdom by 1836. At that point, the baking trade was thrown open to the market, ending the role of the state in maintaining the ideal of a

[5] C. R. Fay, "The Miller and the Baker: A Note on Commercial Transition, 1770-1837," *Cambridge Historical Journal* 1, no. 1 (1923): 85–91.

direct relationship between production and consumption, even though for many, the moral superiority of that ideal remained.

The market, however, quickly demonstrated that it could not provide true "security"—the circulation of materials necessary for the health of the population—on its own. The deregulation of the baking trade, combined with rapid population growth and urbanization, generated a three-pronged crisis by the middle of the nineteenth century, in which both the individualized bodies of bakers and the aggregated population of bread consumers were at risk: the price of bread fell, but did so through a reduction in quality, a dramatic increase in the exploitation of bakers, and the almost universal adulteration of bread. The journeymen bakers of London brought these problems before Parliament in the late 1840s, but at that point, the state played relatively little role in regulating cities and food supply; responsible officials assumed that the market was a sufficient apparatus to ensure the circulation of healthy food, as they did with water and public health.[6] But, by the 1850s and 1860s, as public health crises deepened, the medical profession changed, taking on a bigger role in regulating public health as a means to both ensure their own status and bring benefit to their society.[7] Physicians and medical researchers across the nineteenth century attempting to understand the role of food in health developed the field of chemical physiology, which understood bodies and environments as universal, abstract, and mutually constitutive categories engaged in an ongoing exchange of chemicals.[8] At the same time, British medical professionals led the sanitary movement, which sought to

[6] Christopher Hamlin, *Public Health and Social Justice in the Age of Chadwick: Britain, 1800-1854* (Cambridge, England: Cambridge University Press, 1998).
[7] Dorothy Porter, *Health, Civilization, and the State: A History of Public Health from Ancient to Modern Times* (New York: Routledge, 1999); M. Jeanne Peterson, *The Medical Profession in Mid-Victorian London* (Berkeley: University of California Press, 1978); Ivan Waddington, *The Medical Profession in the Industrial Revolution* (Dublin: Gill and Macmillan, 1984).
[8] See Chapter Five.

reform Britain's toxic industrial cities. From the intersection of these two discourses, chemical physiology and sanitation, a major study of adulteration brought the issue of food safety to the center of political discourse. It was at this point that the British medical profession and the British state were compelled to act, intervening in the food supply to discipline the bodies of bakers, the environments of bakeries, and the loaves of bread themselves.[9]

The biopolitical apparatus of security, through the free market, made possible a wheat ecology that connected British bodies to increasingly distant environments. The very same apparatus also generated crisis in Britain's urban bakeries, which became sites of impurity and danger. In response to this crisis, the state deployed another axis of biopolitical power: discipline. Medical inspectors extended a disciplinary gaze into the country's bakeries, the bodies of bakers, and into bread itself. There, they found serious problems: the bodies and environments in London's subterranean bakeries were far too intimately connected, literally creating and defining each other. Discipline, as a form of knowledge and a technology of power, was itself part of the Cartesian binary; in placing bodies in perceptual grids and hierarchies, it insisted on their utter separation from the non-human world. In the metropolis's subterranean bakeries, bodies and environments were mutually constitutive, and therefore mutually contaminating—and, they threatened to pass that contamination on to the bread-eating public. Disciplining the environments of these bakeries and the bread they produced therefore became a fundamental concern of the state. In this way, the apparatus of security, while intended to allow the market to

[9] E. J. T. Collins, "Food Adulteration and Food Safety in Britain in the 19th and Early 20th Centuries," *Food Policy* 18 (1993): 95–109; Michael French and Jim Phillips, *Cheated Not Poisoned? Food Regulation in the United Kingdom, 1875-1938* (Manchester, U.K.: Manchester University Press, 2000).

regulate food supplies with as little direct state intervention as possible, actually generated new interventions.

The interventions of medical experts were quite similar to those of millers in their cultural operation. In both cases, the market-based apparatus of security require and generated increasing interventions between the production and consumption of food, so that direct knowledge of food's origins became increasingly rare for consumers. In the old anti-scarcity system, no forms of knowledge or expertise external to the producers and consumers were necessary, for it was assumed that an individual's labor, the truest articulation of the direct relationship between production and consumption, was "knowledge" enough; although it was increasingly rare for individuals or families to actually grow their own food, the assumption of the direct relationship, and the reality of a largely rural Britain in which people were close to food production if not actually involved in it, meant that in practice expert regulation of food was unnecessary. Dismantling that anti-scarcity system and replacing it with the apparatuses of security meant, however, that the original ideal of a direct relationship became truly impossible. At that point, the only forms of knowledge about food available for both the state and consumers were those supplied by the market: prices. In this way, a kind of gap in the knowledge necessary to make food palatable and meaningful opened up; there was no longer any pretense toward a direct relationship between production and consumption, but the market was insufficient. In the crisis of metropolitan bread in the middle of the nineteenth century, it became clear that intermediaries were not only permitted, but also necessary. A new variety of intermediary brought medical, technical, and scientific expertise to bear on the problem of food, standing between production and consumption not as a middleman, but as an agent of the apparatus of security, as an expert who sought to ensure the circulation of materials necessary for the population. In this way, a set of biopolitical experts stepped into the gap in knowledge and meaning of food that had opened up with the implementation of the apparatus of security.

Regulating Bread in the Anti-Scarcity System

In the anti-scarcity system of medieval and early modern Britain, with its prioritization of direct relationships between production and consumption, commercial baking was a limited if vital component. For the bulk of the population before 1700, and perhaps even before 1800, home baking was the rule. For these families, the anti-scarcity system was most important for ensuring that they could either grow their own food, or, failing that, that they could purchase wheat or flour at fair prices, directly from farmers whenever possible. Regulations and customs of the internal grain trade required farmers and grain merchants to offer grain for sale to individual consumers in small amounts in specified places and at specified times. Only after the general public had the opportunity to purchase their necessary supplies were farmers permitted to sell their surpluses to licensed grain merchants or commercial millers. Further, to prevent manipulation of the market, farmers and grain merchants alike were prohibited from any transactions that suggested they might profit by acting as middlemen in the provisions trade: sales of grain still in the field or by sample were forbidden, as they might lead to speculation. Similarly forbidden were practices that might manipulate the market by holding back supplies of flooding the market with them: engrossing, regrating, and forestalling were all illegal.[10] For the home-baking population in the anti-scarcity system, the only intermediary between them and the farmers who produced their food was the local miller. And, in the medieval and early modern period, the miller was mainly a tradesman who worked for a customary toll; in some places, mills operated under the right of "soke," which gave a mill financed by the local lord a monopoly on all the custom in the domain. Millers' positions between production and consumption earned them the scorn of the local population, because they threatened the ideal of the direct relationship between food production and consumption.[11] But, on the whole, that ideal remained for the most part a reality.

In cities and towns, London especially, home baking gave way to commercial baking much earlier than in the countryside, and in those situations, the baking trade was regulated by the Assize of Bread. The inelasticity of bread's demand and the lack of alternatives meant that bakers might abuse their position, colluding to raise prices; at the same time, should baking not be a viable trade, bakers might close their ovens. Both cases jeopardized the food supply and social stability of the town. First enacted in the thirteenth century, the Assize of Bread tied the price of bread to the price of wheat: magistrates set the size and price of loaves, varying one or the other as the price of wheat changed, with a fixed "allowance" included to cover the bakers' costs and provide a modest wage. The Assize also operated as a sumptuary law, for connecting the price of wheat and bread also necessarily included mandating standard qualities of bread. The Assize recognized dozens of varieties, from "Wastel," a fine, white bread with the highest price, to "Cocket," "French,"

[10] E. P. Thompson, "The Moral Economy of the English Crowd in the Eighteenth Century," *Past & Present*, no. 50 (February 1971): 78–84.
[11] See Chapter Two.

"Ranger," and "Bread Treet," each with specifications as to quality, ingredients, methods, and price. Over time, these categories were simplified, reduced to "White," "Wheaten" or "Household," with specific relationships between them in both weight and price.[12] Under the Assize, bakers in medieval and early modern Britain were essentially public servants, operating not for profit but to provide vital services for customary fees, much as millers did. Aside from prices, bakers were largely self-governing, with minimal state intervention. Corporate bodies representing bakers existed in larger towns throughout Britain; the Worshipful Company of Bakers of London, the largest, was incorporated certainly by the thirteenth century, and perhaps as early as the twelfth. The Company was responsible for regulating retailing, labor, and quality through an internal court empowered to punish bakers publicly and financially, a system that seems to have worked to the satisfaction of both the bakers and the City of London. Through at least the seventeenth century, the Company enforced its regulations effectively enough that the City made almost no attempts to intervene in the trade, aside from setting the Assize.[13]

The eighteenth-century commercialization of milling and the grain trade undermined Britain's anti-scarcity system, in part by circumventing its sumptuary aspects. In this way, the commercialization of milling and the grain trade was connected to the proliferation of commercially baked white bread around the kingdom. Under the Assize of Bread, bakers were expected to bake not only particular qualities and to sell them at set prices; they were also expected to bake specific proportions of each quality, thereby restricting the amount of finer bread. Millers were largely unregulated in this system's

[12] James Davis, "Baking for the Common Good: A Reassessment of the Assize of Bread in Medieval England," *The Economic History Review* 57, no. 3 (August 1, 2004): 465–502.
[13] Sylvia Thrupp, *A Short History of the Worshipful Company of Bakers* (Croydon, U.K.: Galleon, 1933), 40–55.

early formulation, however, because initially they did not actually separate the meal into different varieties of flour; they merely reduced the grain to meal, and it was up to the baker to "bolt" or sift the meal into the required varieties. Commercial millers, however, bought wheat, and ground, sifted, and sold it as flour in whatever manner generated the greatest profit. They made a greater profit from whiter flour, both in the higher price of the final product, and in the greater amount of offal produced, which could be sold as animal feed. As such, commercial millers tended to ignore the proportions of flour nominally mandated by the Assize, and instead supplied the cities—London in particular—with as much white flour as possible.[14]

The greater supply of white flour to urban markets seems to have generated or at least facilitated more widespread demand for whiter bread, although it is difficult to precisely reconstruct patterns of consumption. Eighteenth-century accounts typically stressed the poor's "extravagant" and "wasteful" preference for white, wheaten bread—expressions of disgust at the poor eating above their station and violating the sumptuary aspect of the Assize of Bread—but recent scholarship has established a more nuanced picture: demand for white, wheaten bread certainly existed from at least the middle of the eighteenth century and most prominently so in London; but on a national scale, the actual displacement of other grains in favor of wheat, and of brown bread in favor of white, was a slower process, working out from the middle of the eighteenth century through the

[14] Hugh Seymour Tremenheere, "Report Addressed to Her Majesty's Principal Secretary of State for the Home Department, Relative to the Grievances Complained of by the Journeymen Bakers; with Appendix of Evidence," Command Papers, No. 3027 (London: House of Commons, 1862), 49; Karl Gunnar Persson, *Grain Markets in Europe, 1500-1900: Integration and Deregulation* (Cambridge: Cambridge University Press, 1999); John M. Orbell, "The Corn Milling Industry, 1750-1820," in *Studies in Capital Formation in the United Kingdom: 1750-1920*, ed. C. H. Feinstein and Sidney Pollard (Oxford: Oxford University Press, 1988); John M. Orbell, "The Corn Milling Industry in the Industrial Revolution, 1750-1830" (PhD thesis, Univeristy of Nottingham, 1977); Sidney Webb and Beatrice Webb, "The Assize of Bread," *The Economic Journal* 14, no. 54 (June 1, 1904): 201.

nineteenth. Both Drummond and Burnett argued that early in the eighteenth century, a preference emerged among fashionable London society for white, wheaten bread. This preference reached provincial towns like Norwich by the middle of the century, and "by the time of Waterloo the object of every baker was to produce the whitest possible loaf."[15] Certainly a variety of late-eighteenth-century elites commented on the poor's preference for white bread: Drummond cited Hogarth's 1784 observation that Londoners demanded bread as "white as any curd"; in 1795 Edmund Burke condemned the poor for aping their betters with their demand for white, wheaten bread, noting the "known difficulty of contenting them with any thing but bread made of the finest flour"; and Frederick Morton Eden's 1797 description of the state of the poor suggested that even the worst off sought the whitest bread available and would refuse otherwise.[16]

Despite the hand-wringing of elites, the actual consumption of white, wheaten bread across the country was probably lower than they feared. In the 1770s, Arthur Young noted laborers in northern England whose provisions included rye bread, the rye-wheat mixture maslin, or simply "various kinds" in addition to wheaten bread; certainly, before that time, non-wheat and brown breads were common among the poor everywhere.[17] In the most comprehensive study of bread to date, Petersen argues that the white, wheaten loaf came to dominate British consumption during the century from 1770 to 1870. Demand was an

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[15] J. C. Drummond, Anne Wilbraham, and Dorothy F. Hollingsworth, *The Englishman's Food: A History of Five Centuries of English Diet* (London: Pimlico, 1991), 186–7; John Burnett, *Plenty and Want: A Social History of Diet in England from 1815 to the Present Day* (London: Scolar Press, 1979), 2.
[16] Drummond, Wilbraham, and Hollingsworth, *The Englishman's Food*, 187; Edmund Burke, *Thoughts and Details on Scarcity, Originally Presented to the Right Hon. William Pitt* (London: F. and C. Rivington, 1800), 5; Frederick Morton Eden, *The State of the Poor, Or, An History of the Labouring Classes in England, from the Conquest to the Present...*, vol. I (London: Printed by J. Davis for B. & J. White, 1797), 250.
[17] Arthur Young, *A Six Months Tour through the North of England: Containing an Account of the Present State of Agriculture, Manufactures and Population, in Several Counties of This Kingdom*, vol. II (London: W. Strahan, 1770), 210, 232, 501.

important part of this process: by 1800, the insistence on white, wheaten bread was "notorious in London, where even at the height of dearth, in 1800, it was well observed that the poorer the district the finer the bread," although such demand—never mind the supply—was far from universal outside the metropolis. Petersen also argues that white bread was the most cost efficient food available, even if nominally more expensive than other staple starches and despite the anxiety it generated among elites.[18] E. J. T. Collins's study of grain consumption in the nineteenth century roughly agrees with Petersen's argument, although he places the full ascendance of white, wheaten bread somewhat later: he found that wheaten bread, while preferred, only became the standard across the entire kingdom relatively late in the nineteenth century, toward the end of the Petersen's time frame and definitely not at any point in the eighteenth. Michael Nelson makes the same case in his survey of British diets in the second half of the nineteenth century, arguing that brown bread was the dominant food of the British working classes until at least 1860, and that white bread was not universal until 1900.[19] Thus, while London in particular demanded white bread, and also larger towns to an increasing extent after 1750, consumers may not have always gotten what they wanted. Still, the perception of such demand and the metropolis's dominance in matters of bread policy were enough to influence bread provision and regulation across the country.

Alongside the trend toward whiter bread was the decline of home baking from the middle of the eighteenth century. While bought bread had always been common in the towns—hence the urban origins of the Assize of Bread—commercial baking spread across

[18] Petersen, *Bread and the British Economy*, 4, 15–29.

[19] Young, *A Six Months Tour through the North of England*, II:210, 232, 501; E. J. T. Collins, "Dietary Change and Cereal Consumption in Britain in the Nineteenth Century," *The Agricultural History Review* 23, no. 2 (1975): 97–115; Nelson, "Social-Class Trends in British Diet, 1860-1900," 104–5.

the countryside from the mid-eighteenth century. A 1774 House of Commons Select Committee found that outside London, about half of England and Wales relied on commercial bakers.[20] W. Thwaites argues that, in Oxfordshire in the second half of the eighteenth century, complaints shifted from the price of wheat to the price of bread, suggesting that home baking was giving way to commercial baking.[21] By the 1860s, the physician and nutritionist Edward Smith found that just one-fifth of rural residents went wholly without bought bread, and half ate mostly bought bread.[22] Home baking remained more common in areas with low fuel prices, illustrating the mechanism driving the commercialization of baking: bakers' bread was an economical choice.[23] With the development of wider internal trade networks and commercial milling, the baker could get better materials at lower prices thanks to his or, more rarely, her[24], purchases in bulk; a larger scale of operations afforded greater economy in the use of fuel; and skill and experience made ruined batches less likely. The economy of commercial production combined with the opportunity cost in the time- and labor-intensive activity of baking at home meant that once Britons were losing the customary access to fuel and grain they had

[20] "Report from the Committee Appointed to Consider of the Methods Practiced in Making Flour from Wheat; Etc.," Sessional Papers (London: House of Commons, 1774), 65.
[21] W. Thwaites, "Dearth and the Marketing of Agricultural Produce: Oxfordshire C. 1750-1800," *The Agricultural History Review* 33, no. 2 (January 1, 1985): 119–31.
[22] Edward Smith, "Sixth Report of the Medical Officer of the Privy Council. Appendix No. 6, Report on the Food of the Poorer Labouring Classes in England," Command Papers; Reports of Commissioners (London: House of Commons, 1864), 230.
[23] David Zylberberg, "Potatoes, Broths and Wheaten Bread: Fuel Prices and Yorkshire Regional Diets, 1790-1830" (Anglo-American Confernce of Historians, London, 2013).
[24] Petersen notes a remarkable prevalence of women bakers in several parts of northern England, Westmoreland and Yorkshire especially, perhaps connected to manufacturing employment opportunities for men. Petersen, *Bread and the British Economy*, 83.

enjoyed in the medieval period, the growth of commercial baking was not surprising, despite contemporary moralizing about the poor's laziness or extravagance.[25]

The commercialization of milling and the grain trade, in part a result of the development of transportation infrastructure, disrupted the anti-scarcity system in place since medieval times, but it did not immediately replace it with the apparatus of security. Further, it occurred in the geopolitical context of the Anglo-French wars of the eighteenth century. The growth of Britain's population in the eighteenth century and the preference for wheat over barley, rye, and oats, made clear after about 1750 that imports would necessary in dearth years. In the context of mercantilism, any import of grain, particularly from France, was seen as a problematic drain of bullion to a rival power.[26] War also meant that domestic shortages could not easily be made good by imports, and thus prices could rise to unacceptable levels. The combined circumstances of disruption of the anti-scarcity system and eighteenth-century geopolitics prompted a series of legislative responses to the problem of provisions. These aimed to manage potential shortages and high prices by restricting consumer choices; to the original goal of "fair" bread prices was added reducing dependence on imports by making the most of domestic wheat supplies. This began with the 1709 revival and "modernization" of the Assize. Prior to that point, the original, medieval language remained unchanged, though a series of amendments and qualifying laws existed. It was thus an out-of-date, occasionally poorly understood, and unevenly enforced measure.[27] The 1709 Act simplified the kinds of bread bakers were allowed to

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[25] Ibid., 45–9; A good example of criticisms of poorer Britons purchasing their bread is William Cobbett, *Cottage Economy; Containing Information Relative to the Brewing of Beer, Making of Bread, Keeping of Cows...*, 17th ed. (London, 1850).
[26] See, for example, Lars Magnusson, ed., *Mercantilist Theory and Practice: The History of British Mercantilism* (London: Pickering & Chatto, 2008).
[27] Webb and Webb, "The Assize of Bread," 200–2.

bake, denoting all loaf bread as White (the finest quality), Wheaten, and Household (the lowest quality). This Act standardized the weights of loaves to be baked, as Peck (sixteen pounds), Half-Peck, Quarter Peck (or quartern, the four-pound loaf that was the most common article of trade), and Half-Quartern. Local authorities gained the power to vary the bakers' allowances to compensate for differences in the costs of supplies, and to set the Assize by either wheat or flour, although it assumed that there would be a fixed relationship between the prices of wheat and flour, an assumption that was not borne out by later developments. The 1709 Act, therefore, was the first major legislation in Britain recognizing that the anti-scarcity system was breaking down, and that it was being replaced—even if unintentionally—by the apparatuses of security, in the form of commerce in wheat, flour, and bread.[28]

In the following century, despite Parliament's best efforts, the old anti-scarcity system proved increasingly difficult to maintain in the face of growing commercialization of wheat, flour, and bread, as well as ongoing war with France. Acts in 1735, 1757, 1771-3, 1796-7, 1801, 1805, and 1813 attempted to deal with various aspects of bread, particularly during wartime. This stream of legislation culminated in the repeal of the Assize in London in 1815, and nationally in 1836. Parliament acknowledged the public's preference for white bread in the war-driven dearth of 1757, and sought to reduce the consumption of "wasteful" White and Wheaten bread by prohibiting the old "White" category and replacing it with an improved "Wheaten" loaf, set to be 25% more expensive than the Household loaf. In a repricing scheme set with this act, bakers received a higher allowance for Wheaten bread and a lower one for Household bread, though in practice bakers baked as much

[28] Petersen, *Bread and the British Economy*, 19, 54–56, 99.

Wheaten bread as possible, often ignoring Household.[29] Other Acts adjusted bakers' allowances and sought to obligate bakers to sell only day-old bread, on the grounds that people would eat less if it were served cold. By the early nineteenth century, it was clear that the Assize was no longer an effective means of regulating the price of bread, largely because milling remained outside its purview. With milling unregulated, the price and quality of bread consumed was simply not up to bakers, for millers could grind and dress whatever varieties they preferred; as their profits were higher from whiter flour, they naturally neglected browner flour. One option open to the British state, then, was to develop and enforce much more rigorous regulations on milling, but this ran against the intellectual currents of the early liberal political economists like Smith, Malthus, and (later) Ricardo. Outside of regulating milling, the only real mechanism to manipulate the price of bread was to squeeze or enlarge bakers by altering their allowance. And, in the context of the years from the 1770s through the early nineteenth century, which saw the prices of wheat rise almost constantly, altering the bakers' allowances provided negligible benefits.[30]

Beyond the difficulty of managing an increasingly complex wheat, flour, and bread system, the growth of "Undersellers" from the eighteenth century provided evidence that the anti-scarcity system had become not merely unworkable, but perhaps unnecessary. The Assize of Bread had never mandated *minimum* prices, only maximum, so it did not violate the law to sell under the Assize price; it only violated the customs of bakers. Millers and corn merchants began to set up journeymen bakers on commission, supplying them with

[29] Ibid., 100–103.
[30] The literature on wheat and bread prices is vast; one early source that chronicled the steady rise of wheat prices through the late eighteenth century is William Playfair, *A Letter on Our Agricultural Distresses, Their Causes and Remedies: Accompanied with Tables and Copper-Plate Charts Showing and Comparing the Prices of Wheat, Bread, and Labour from 1565 to 1821* (London: W. Sams, 1821).

flour cheap enough that they could sell under the Assize price.[31] For millers and merchants, the arrangement was a means to dispose of surplus or poor quality flour; to many bakers, it amounted to a kind of debt bondage that ultimately led to the exploitation and degeneration of the trade.[32]Another class of bakers, able to pay cash for flour rather than relying on credit, could also get flour cheap enough to sell under the Assize price. Further, by refusing their own customers credit and delivery, both of which were traditionally part of the bakers' service, some bakers could charge 1d. per quartern loaf or more under the "full-priced" bakers, and still take home enhanced profits (the late-eighteenth-century quartern loaf ranged from 6d. to 9d. or more in times of crisis). This practice first became widespread in the 1780s. By 1815, about 150 of London's 1700 assized bakers were undersellers, and many of them were doing multiple batches per day, suggesting that they might have accounted for up to 30% of the city's trade.[33]

Repeal emerged as an attractive option in 1815 in light of the development of underselling, though it was not necessarily the work of a more liberal Parliament, since it was repealed the same year that a new set of Corn Laws was passed.[34] Instead, it seems that many Parliamentarians genuinely believed—or at least hoped—that the trade would get into the hands of "persons of capital," who would improve its efficiency, perhaps mechanize the process, and reduce labor costs.[35] As such, an Act in 1815 abolished the

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[31] John Burnett, "The Baking Industry in the Nineteenth Century," *Business History* 5, no. 2 (1963): 100; Thrupp, *A Short History of the Worshipful Company of Bakers*, 27–9.
[32] George Read, *A Brief History of the Bread Baking Trade, from the Earliest Period to the Present Time...* (London: George Biggs, 1848), 15–6.
[33] Petersen, *Bread and the British Economy*, 72, 105–6.
[34] Webb and Webb, "The Assize of Bread"; Petersen, *Bread and the British Economy*; Fay, "The Miller and Baker."
[35] Tremenheere, "Report on the Grievances of the Journeymen Bakers," xiii.

Assize in London and mandated only that bread be sold by weight, a customary requirement that usually meant bread would be sold in 4 lb. or 2 lb. units.

The Problems of Bread and Security

Despite Parliament's hopes for a revolution in the trade, however, baking had been and remained a small-scale industry. Almost all bakeries employed just a few hands aside from the master, and baked fewer than 20 sacks of flour per week (three or fewer per day, every day but Sunday). More than any other cause, the persistent fragmentation of the trade came down to the product itself: it was perishable, and best consumed within two days of baking. Many poorer Britons preferred warm, "new" bread, and along with tea, freshly baked bread comprised their only warm meals during the week. In a world without the ability to rapidly distribute bread over distances beyond a short walk, bakers had to be distributed among the population. Petersen calculates that a baker doing one sack per day, with a master, a journeyman, and perhaps a boy helping, would produce about 350 lbs. of bread per day, enough to support just 600 individuals at 4 lbs. each per week. Data from Southampton from 1783 to 1861 show that this is about what obtained: there, the baker density remained in the band of from 1:395 to 1:636.[36] In addition, bakers' ovens were frequently used by city dwellers that could not afford fuel or had no room for ovens. Many bakers opened on Sundays explicitly for this purpose.[37]

The results of a repealed Assize and reduced regulation overall, along with stiff competition and the urban public's demand for white bread, were three inter-related developments that combined to produce a state of crisis in the urban (and especially

[36] Petersen, *Bread and the British Economy*, 68.
[37] Tremenheere, "Report on the Grievances of the Journeymen Bakers," 22, 28.

metropolitan) baking trade by the middle of the nineteenth century. First, without the regulating influence of the Assize and its allowance, bakers began to compete on price, not on quality, and the proportion of "undersellers" ballooned. From an 1815 figure of about 8-10% of bakers in London producing perhaps as much as 30% of the metropolis's bread, by the middle of the nineteenth century undersellers accounted for a full 75% of bakers. "Full-priced" bakers (a customary term, since after 1815 there was no set price) were restricted largely to the West End and other wealthier enclaves, while as many as one in six London bakers were "cutters," underselling even the undersellers. With miniscule profits from such cut-rate competition, there was little capital for larger bakers: manual labor, fragmentation, and small scale continued to be the norm. Bakeries most frequently consisted of one oven installed in the basement of a house, with little in the way of capital improvements.[38]

Second, the hours worked, particularly in London, grew much longer. Bakers were frequently loathe to double their output to two batches per day, as this required doubling their custom, but it appears that this is exactly what happened in London. In part, this was made possible by the growth of chandler's shops, very low-priced retailers selling a wide variety of goods, including cut-rate bread, and who thereby provided an outlet for bakers to produce a second batch of bread per day. Petersen's sackage estimates and census data suggest that bakers went to two batches per day, because the number of bakery workers per capita fell, although bread consumption itself did not; as such, each bakery worker must have been producing more bread, particularly after 1800.[39] The baker George Read's 1848 pamphlet provides an explanation for what this process might have looked like from the perspective of the bakers themselves. He describes an increase in the hours expected of

[38] Ibid., 23, 92–4.
[39] Petersen, *Bread and the British Economy*, 71.

bakers' men brought about particularly by the bakers who had been set up in business by commercial millers and corn merchants. He explained that workmen had once stayed late on occasion, helping to produce an extra batch in exchange for a dinner or some other extra payment. This system had begun with friends and acquaintances helping one another, but "gradually grew into a custom, and was at last enforced as a right."[40] Longer hours, slim profit margins, and the small scale of the trade meant that bakers found themselves working in worse and worse conditions, a fact that became central to state interventions in the trade after 1850.

The third result of the removal of the Assize and the public's demand for white bread was the proliferation of adulteration. Collins calls the period from 1815 to 1860, from the repeal of the London Assize to the passage of the first act regulating food quality, the "golden age" for adulteration[41]; P. Mathias, in his classic *Retailing Revolution*, attributed the mid-nineteenth century deterioration of food quality to "low money wages translated against high costs in the distributive system and a failure of the distributive trades to advance as fast as urban populations."[42] In other words, poor but rapidly growing urban populations and an unregulated trade with very slim profit margins combined to produce a situation in which bakers had to scrape out a profit by any means necessary. The preferred means was alum, an astringent and bleaching agent, used to whiten flour. Employed properly, it could turn poor quality flour into white bread, and even unsellable flour into a sellable loaf. Given the lack of regulation and surveillance between 1815 and the *Lancet*'s investigations in the 1850s, is difficult to know how quickly adulteration spread. The

[40] Read, *A Brief History of the Baking Trade*, 15–16.
[41] Collins, "Food Adulteration and Food Safety in Britain in the 19th and Early 20th Centuries," 95.
[42] Peter Mathias, *Retailing Revolution: A History of Multiple Retailing in the Food Trades Ased upon the Allied Suppliers Group of Companies* (London: Longmans, 1967).

physician Frederick Accum wrote several pamphlets in the 1820s, asserting that virtually all foods consumed in the metropolis were adulterated, bread among them. He claimed that, given the "degree of whiteness rendered indispensible by the caprice of the consumers in London," adulteration must have been widespread, because there simply was not enough high quality to flour to produce so much "white" bread without resort to fraud.[43] An 1841 *Guide to the Trade* describing the bakers' process of producing bread called alum "indispensible." The author noted that the usual practice was to include about eight ounces of bakers' "stuff," a three-to-one mixture of salt and alum, with each 280 lb. sack of flour. This worked out to about two ounces of alum per 85 to 90 loaves, an amount small enough that the *Guide*'s author thought it negligible. The bakers all ate it, he noted, and the people who baked their own bread for a time came back to the baker sooner or later.[44] Petersen actually goes so far as to suggest that alum effected what Parliament had been trying to accomplish for decades, which was the full utilization of British wheat supplies. They had tried to carry this out by forcing people to eat browner bread, but found that difficult if not impossible due to the public's great "prejudice" against it. Alum, by making a great deal of lower-quality flour sellable as fine white or Wheaten bread, and by making some unsellable flour sellable as Household bread, achieved the same outcome.[45]

Repealing the Assize also meant a legislative rejection of the moral ideal behind the anti-scarcity system, that of a direct relationship between food's production and consumption. Culturally, however, the ideal of the direct relationship remained, and many

[43] Friedrich Christian Accum, *A Treatise on the Adulterations of Food, and Culinary Poisons Exhibiting the Fraudulent Sophistications of Bread, Beer, Wine, Spiritous Liqour, Tea, Coffee, Cream, Confectionary, Vinegar, Mustard, Pepper, Cheese, Olive Oil, Pickles, and Other Articles Employed in Domestic Economy and Methods of Detecting Them* (London: J. Mallett, 1820), 132–3.
[44] *The Guide to Trade: The Baker; Including Bread and Fancy Baking with Numerous Receipts*, 31–34.
[45] Petersen, *Bread and the British Economy*, 119–20.

commentators lamenting the state of bread or the baking trade blamed different elements of the commercialization of food production. Frederick Accum's treatises on food in the 1820s rendered adulteration a moral problem, the result of the "eager and insatiable thirst for gain" among "unprincipled dealers" of food.[46] Among those "unprincipled dealers" he implicitly included metropolitan bakers, "obliged to suit the caprice" of their customers and provide white bread, more pleasing to the eye but less nutritious that brown bread.[47] In this way, the moral failure of the market was the fault of both bakers and consumers; consumers were immoral for demanding white bread, which was above their station, while bakers were equally bad for facilitating and meeting that demand. George Read's 1848 account of the distressed state of the baking trade identified the problem as "the millers," who, "(contrary to the ancient usage and custom) had stepped in between the grower of corn and the baker, and become the principal person who supplied them, and the public with flour." According to Read, the unregulated millers began to make too much white flour, creating a public taste for it that was unsustainable without adulteration. They also reduced bakers to dependence on them, taking the profits of both milling and baking at the bakers' and the public's expense.[48] While Read and the bakers were themselves "middlemen" according to the old moral economy, even they privileged the ideal of the direct relationship between production and consumption, identifying any additional middlemen as problems.

[46] Accum, *A Treatise on the Adulterations of Food*, iv.
[47] Friedrich Christian Accum, *A Treatise on the Art of Making Good and Wholesome Bread of Wheat, Oats, Rye, Barley, and Other Farinaceous Grain Exhibiting the Alimentary Properties and Chemical Constitution of Different Kinds of Bread Corn, and of the Various Substitutes Used for Bread, in Different Parts of the World* (London: Thomas Boys, 1821), 23–4.
[48] Read, *A Brief History of the Baking Trade*, 15.

After the repeal of the Assize, the baking trade entered a period of crisis as both working conditions and products deteriorated. In response to these conditions, the journeymen bakers of London petitioned Parliament for intervention in their trade in 1848. It brought little concrete action at the time, revealing a biopolitical landscape that did not sanction intervention into food supplies as such.[49] The House of Commons Sanitary Commission heard evidence from Dr. William Guy, professor of Forensic Medicine at King's College, who explained that he made a habit of asking his patients about their conditions of work and its effects on their health. He learned that bakers worked particularly long hours in particularly bad conditions, and he went on to survey over a hundred individuals. From them he confirmed the bakers' claims of incredibly long hours, but also found that their work environments were appalling, leading to unusually high rates of illness, especially respiratory problems. Guy reported to the Sanitary Commission that they almost universally suffered from chest problems ranging from colds and coughs, to inflammation and asthma, to spitting up blood, a characteristic sign of tuberculosis. The causes of this abysmal state of health, he explained, were environmental: London's bakeries, in the cellars beneath shops, were in "a very unwholesome state; very close, very dirty, very damp, and very offensive." There, the "long hours of work, great muscular efforts, exposure to heat, the inhalation of the particles of flour, and the close underground places in which they work" combined to destroy the workers' health. The environments of London bakeries and the journeymen's bodies were mutually constitutive in this case, for it was the long hours in such environments that made the men "ignorant and indifferent," sick, immoral, and dirty, and thereby reinforced the state of their workplace. One baker's wife complained of the

[49] Tremenheere, "Report on the Grievances of the Journeymen Bakers," v.

difficulty of getting the men to change their clothes before falling asleep, while Guy commented on their habits of spending free time in public houses, not "in a manner likely to recruit their strength, preserve their health, or improve their morals." The men's exhaustion and poor health generated carelessness and waste, for as Guy explained, "coals are burnt out for want of attention; flour is spilt on the ground; fragments of dough are thrown about, kicked in a corner and burnt in the oven; and the bread itself is sometimes spoiled; over-work and waste in this, as in other trades, are cause and effect."[50]

Guy's testimony recognized relationships between bodies and environments, but not in a way that required public health intervention. Instead, the problem of filthy environments and sick bodies manifested in waste and inefficiency, and was therefore essentially a problem that the market could solve on its own, without further intervention. He acknowledged that it was possible for the unhealthy environments of London bakeries to be harmful to the bread but neither he nor the questioners from the Sanitary Commission emphasized consumer safety. At this point, the Sanitary Commission saw the bakery only as a workplace, and not as an element of a wheat ecology with relevance to the health of the population as a whole, and that connected bodies to environments. Asked about the condition of bakeries, Guy described their filth in detail, reporting that in one instance, he "found the soil-pipe within a foot of the trough in which the bread is made; the pipe in a very unsound state, and the flour in danger of being moistened by its contents." The baker who accompanied him confirmed that he had in the past "seen the sewage flowing into the trough." The air of such establishments was "offensive," and in an "extremely impure state," and he even claimed that the "bread we eat absorbs" this

[50] "Copy of the Evidence Given by Dr. Guy Before the Sanitary Commission in Reference to the Persons Employed in the Baking Trade," Sessional Papers, No. 362 (London: House of Commons, 1848), v.

atmosphere. But, having identified a potential source of impurity in the bread, he stopped. Immediately after his revelation that the atmosphere of the bakeries could affect the bread and thus perhaps the consumers, both he and the Commission returned their attention to the bodies and morals of the bakers, hoping to enact sanitary reforms that would preserve their lives and "surround them with comforts."[51] Guy's and the Commission's concern with waste, and the suggestion that bread might be "spoiled" by filthy bakeries and unhealthy environments illustrated the way that, in 1848, they operated under the assumption that the market was sufficient to regulate food's safety and purity because consumers would not buy "spoiled" bread. The ideal of the direct relationship no longer underlay legislation at that point, but to Guy and the Sanitary Commission, the market—the core of the apparatus of security—was sufficient.

Biopolitical Interventions in Bakers' Bodies and Loaves of Bread

Just a few years after Guy's testimony before the Sanitary Commission revealed the limits of biopolitical intervention in the late 1840s, the *Lancet's* landmark investigation of Britain's food supplies began a process that expanded the role of the state in regulating the relationships between bodies, populations, and environments. In this process, the health of the aggregated, bread-consuming population, the bodies of the bakers themselves, the environments of bakeries, and the loaves of bread themselves came under the biopolitical gaze of the state and the British medical profession. Ostensibly, the 1851 Analytical Sanitary Commission, chaired by the microscopist Arthur Hill Hassall and published over several months in the *Lancet*, exposed widespread adulteration in London's food supply.

[51] Ibid., 3–6.

Some adulterants were merely fraudulent, such as watered down milk or margarine mixed with butter, while others were outright harmful, such as arsenic and lead in candy. The 1851 Commission generated public outcry in metropolitan and provincial newspapers, a wider investigation by the *Lancet* into provincial food supplies, and Parliamentary Commissions that responded with important legislation: the Food and Drugs Act in 1860, which permitted the appointment of professional analysts to survey the purity of foods; the 1872 Adulteration of Food, Drink and Drugs Act which more clearly defined adulteration; and the much more robust 1875 Sale of Food and Drugs Act, which required local government agencies to appoint analysts to survey and maintain purity in consumer products. The 1875 Act remained the overarching legislative framework of Britain's food regulation until after the Second World War.

Historians of food, public health, and state regulation have long noted the importance of the *Lancet*'s investigation, and the subsequent legislation that ultimately constructed a regulatory framework around commerce in consumables. John Burnett argues that the investigation "compelled public recognition of an urgent social problem," an essential step toward pure food, in which medical and scientific expertise acted in the public interest to guarantee pure food. In the case of bread, the development of pure food legislation was an astounding success: after discovering bread almost universally adulterated with alum in the 1850s, that figure declined to about half by 1872, and by 1892 the Local Government Board could guarantee the purity of the nation's bread supply "with truth and some satisfaction."[52] E. J. T. Collins, and Michael French and Jim Phillips all situated the growth of medical and scientific surveillance and food purity legislation within

[52] Burnett, *Plenty and Want*, 190–213.

more institutional contexts, arguing that the case of food fit well with the patterns of regulation established in other areas of Victorian society: public crises generated permissive legislation, which was proved insufficient by later crises, which in turn generated mandatory regulation.[53] More recently, Erika Rappaport saw the *Lancet*'s investigation and the mid-Victorian crisis of food purity in a global context, but with decidedly local results. With more and more of Britons' food and drink coming from distant and unknowable sources, the adulteration scandal highlighted the mysterious origins of tea in particular, and led to its domestication by retailers, who developed pre-packaged, branded teas as a means to supply information to consumers.[54]

While the existing literature has therefore noted the importance of the Analytical Sanitary Commission for Britons' diets, their institutional regulation, and their cultural meanings, when viewed through a biopolitical lens and with regard to bread in particular, the Commission takes on new significance: it was the moment at which the biopolitical apparatuses that regulated food, and thereby the connections between British bodies and both local and global environments, expanded. The market, the preferred apparatus of security, created connections between Britons and increasingly widespread environments; it also generated crisis in the baking industry. But, crucially, it fully severed the connections between the production and consumption of food. While markets had operated to supply food in Britain since medieval times, they had been smaller in scale and remained at least partially under the control of an anti-scarcity system that prioritized, and thereby maintained to some extent, the moral ideal of a direct relationship between production and

[53] Collins, "Food Adulteration and Food Safety in Britain in the 19th and Early 20th Centuries"; French and Phillips, *Cheated Not Poisoned?*
[54] Erika Rappaport, "Packaging China: Foreign Articles and Dangerous Tastes in the Mid-Victorian Tea Party," in *The Making of the Consumer: Knowledge, Power and Identity in the Modern World*, ed. Frank Trentmann (Oxford: Berg, 2006).

consumption. The repeal of the Assize of Bread and the deregulation of the baking industry finally dispensed with that moral ideal in legislation, but in so doing it opened up a gap in the knowledge of food available to both the state and consumers. Medical, technical, and scientific expertise began to fill this gap; the experts who inspected bakeries, bakers' bodies, and the bread itself, were "middlemen" of a sort—but in the new biopolitical landscape of food, those kinds of middlemen were not only permitted, they were absolutely necessary.

The Analytical Sanitary Commission stepped into the knowledge gap between production and consumption from a position at the intersection of two disciplinary discourses: the development of chemical physiology, and the sanitary movement. From this intersection, biopolitical discourse constructed bodies and environments in relation to one another at both local and universal scales. Researchers across Europe, North America, and European colonies in the nineteenth century pursued an understanding of human physiology through chemistry. In their laboratories and clinics, and in the pages of their medical journals and reports, they rendered environments and bodies as abstract, homogeneous categories of production and consumption. The German chemist Justus von Liebig published his highly influential *Animal Chemistry* in 1840 (it was translated into English almost immediately) and placed the study of nutrition and physiology on a firmly chemical basis. In this context, food became the vehicle through which the correct chemicals were transmitted from environments to bodies, part of an organic, continuous cycle of chemical exchange operating on a universal scale.[55] In this way, chemical physiology stood at the intersection of security and discipline: it sought to manage the

[55] See Chapter Two.

health of an aggregated population, but accessed that population through a clinical gaze upon individual bodies. The medical "problems" of food in this scheme were twofold: first, at a theoretical level, was identifying the "best" food. And second, at a more practical level, was ensuring that appropriate substances made it into the human body while inappropriate ones stayed out. Doctors in the nineteenth century identified wheaten bread as the single best food, or at least the greater part of the best diet; the problem of purity, on the other hand, was not one that existed in their laboratories or chemical equations. It emerged medically only in the extension of a disciplinary gaze into the food supplies of real populations, a circumstance in which the abstractions of laboratories, clinics, calorimeters, and chemical equations broke down.

At the same time, the sanitary movement of Victorian Britain saw the issues of purity and contamination as central to both individual well-being and national prosperity. Focused on the medical and moral problems of industrial cities, the sanitary movement saw cities as places of filth, disease, and immorality, and found solutions in the removal of waste and the provision of clean water and air. In this way, the sanitary movement was very much an apparatus of security, for it was most concerned with facilitating the proper circulation of materials necessary for the health of an aggregated population. In this case, rather than ensuring that food was available through the market, the sanitary movement sought to conduct wastes away from the population and to avoid contamination.[56] The Analytical Sanitary Commission, by combining elements of both chemical physiology and the sanitary movement, extended a biopolitical gaze onto the country's food supply, and thereby brought global views of the relationships between bodies and environments to a

[56] Hamlin, *Public Health and Social Justice in the Age of Chadwick*.

local level. This gaze generated interventions into Britain's food supply that included not merely regulating the purity of the bread itself, but also, ultimately, the disciplining of the environments that produced it. Clinical medicine was a fundamental component of the Cartesian binary, placing individualized bodies into perceptual grids and hierarchies, and thereby insisting on their absolute separation from environments. Extending a biopolitical gaze into London's bakeries revealed the mutually constitutive nature of bodies and environments there: subterranean air, water, and vermin intermingled with the ignorance, ill-health, and filth of bakers' bodies. The body-environment relations that doctors and medical inspectors found in London bakeries were mutually constitutive and thereby mutually contaminating; they thereby threatened to contaminate the country's bread supply and thus the health of the aggregated population. The solution, then, was to discipline those spaces, the bodies of the bakers, and the bread itself.

Hassall and the other members of the Analytical Sanitary Commission situated themselves within the new field of chemical physiology through their chemical evaluations of bread, which went beyond simply examining the loaves for purity. Testing and publishing the amount of gluten, starch, and mineral matters in flour, the *Lancet* researchers took the results obtained from their own analysis and fit them into the registers provided by the growing body of food analysis. Their report cited a pair of French researchers who surveyed flour and bread, and established chemical norms for different varieties of flour: Dumas, for example, claimed that a generic "Wheat-Flour" contained 10% water, 10.96% gluten, 71.49% starch, 4.72% sugar, and 3.32% dextrine; "Odessa Flour (Flinty)," or hard, contained somewhat more water and gluten, but substantially less starch, while the chemical proportions of "Odessa flour (soft)" were between the generic wheat-flour and the hard Odessa. The report also cited Saussure, whose analysis reported 20% gluten, a very high proportion for any variety.[57] Contemporary chemical research understood nitrogen-rich gluten to be a particularly valuable—indeed, some argued the only true—nutrient, and thus these evaluations were not trivial. They established the environmental and nutritional specificity of wheat and flour. However, the Commission's analysis of bread operated in much the same way as contemporary nutritional research: despite acknowledging the nutritional significance of wheat and flour's origin, when they analyzed the bread itself those origins were ignored. Their analysis always imagined a homogeneous, abstract, ideal four-pound loaf that was pure or impure, fraudulent or fair. In this way, then, the Commission operated within the intellectual world of contemporary chemical physiology, in which a focus on the exchange of chemicals rendered bodies and environments essentially homogeneous, abstract, and universal categories.

The Analytical Sanitary Commission also situated itself as a continuation of ongoing sanitary efforts in Britain's cities, particularly those dealing with water and air. In its first statement of the Commission's activity, the *Lancet* noted that although Boards and Commissions existed to ensure "uncontaminated air and pure water," "unadulterated Food, the bone and muscle of the body" remained without state or medical guarantee. To address this, the commission aimed to survey London's food based on laboratory experiment: "the microscope and test-tube… will be our constant companions," Hassall assured readers.[58] With their extension of such a fine-grained disciplinary gaze into the metropolis's food, the Commission found itself confronted with the concrete spaces in which the abstracted

[57] "Records of the Results of Microscopical and Chemical Analyses of the Solids and Fluids Consumed by All Classes of the Public: Bread and Its Adulterations," *The Lancet* 57, no. 1439 (March 29, 1851): 366–71.
[58] "Records of the Results of Microscopical and Chemical Analyses of the Solids and Fluids Consumed by All Classes of the Public," *The Lancet* 57, no. 1427 (January 4, 1851): 20.

notions of bodies and environments articulated by chemical physiology broke down: London's subterranean bakeries.

The results of their investigations excused millers and grain merchants—a departure from the eighteenth century, in which millers and merchants were morally and legally suspect middlemen—while implicitly identifying bakeries as the site for adulteration and impurity in London's bread. In the initial round of testing, all but one of the samples of flour tested was pure; the one exception was mold, an indication of poor quality but not an intentional, malicious adulterant. From these findings, the Commission concluded that "millers and corn-dealers are somewhat maligned, and that, as a rule at least, the housekeeper may use the flour she purchases, either for puddings or bread, without any great misgivings as to its genuineness." Such results endorsed a global wheat ecology broadly, and in the specific political milieu of 1851, Free Trade. Their samples included French and American flour, both of which were pure, although neither at this point constituted a large portion of the calories consumed in Britain. Still, in explaining the overall purity of flour, the report suggested that, "we are, to some extent, no doubt, indebted to free trade, which by reducing the price of flour, has removed much of the inducement to its adulteration."[59] Later tests did find adulterated flour, but never to the extent of bread.

In their initial round of tests, twenty-four out of twenty-four samples of bread from around the metropolis were described as made "with alum," "with much alum," or "with a

[59] "Records of the Results of Microscopical and Chemical Analyses of the Solids and Fluids Consumed by All Classes of the Public: Bread and Its Adulterations (Continued)," *The Lancet* 57, no. 1440 (April 5, 1851): 386–87.

considerable quantity of alum."[60] Although the Commission did not examine the bakeries themselves, and therefore located no explicit violations of purity within those spaces, the guilt of bakers was implicit in the results. Moreover, their reports established the importance of medical intervention in food purity by providing clinical descriptions of alum's effects on bodies. In the 1820s, Accum's accounts of adulteration had omitted specific descriptions of the health dangers of alum, but the 1851 Commission explained that alum was "probably" harmful to plants, caused phthisis in horses if used "in too great quantities," and its immediate topical effect was astringent. When ingested, it "causes dryness of the mouth and throat, somewhat increases thirst, checks the secretions of the alimentary canal, and thereby diminishes the frequency and increases the consistency of the stools." For these results, the Commission cited Wibmer, who had conducted a series of experiments on himself, consuming three grains dissolved in five drachms of water,[61] several times each day. When taking larger amounts, Wibner claimed that the alum produced "nausea, vomiting, griping, purging, and even an inflammatory condition of the intestinal canal," while other physicians claimed that it produced "passive haemorrahages and mucous discharges," irritation of the lung and coughs, and even acidic urine.[62]

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[60] "Records of the Results of Microscopical and Chemical Analyses of the Solids and Fluids Consumed by All Classes of the Public: Bread and Its Adulterations (Concluded)," *The Lancet* 57, no. 1441 (April 12, 1851): 423–4.

[61] "Grains" are a now largely archaic measurement that, from the 1824 Weights and Measures Act, were 1/7000 of a pound, or approximately .065 grams. "A drachm" (or dram) is 1/16 oz., and thus the amounts Dr. Wibner ingested were very small indeed. Assuming that 2 oz. of alum were added to a standard 280 lb. sack of flour, which baked about 90 four pound loaves (see below), this meant that .022 oz. of alum, or .624g, was present in each loaf. Assuming also that an individual ate one pound of bread per day, this meant each person was ingesting about .156g gram of alum each day. Dr. Wibner's ingestion of .065g several times a day was thus probably—very roughly—in line with a common consumption of alum by individuals living on the bread produced by London bakers. Certainly there were cases in which loaves were found with a very large amount of alum, although these were rare.

[62] "Records of the Results of Microscopical and Chemical Analyses of the Solids and Fluids Consumed by All Classes of the Public: Bread and Its Adulterations (Concluded)."

From their foundation of chemical analysis and clinical research, the *Lancet*'s reports staked a claim for a much broader medical intervention into the country's food supplies by identifying potential issues of fraud along with more explicit dangers to human health. Through their analysis of purity, the Commission situated themselves as experts not merely on human bodies, but as medical and scientific regulators of the market; in this way, they stood at the intersection of discipline and security. Concerned with the aggregate health of the population and with the proper functioning of the apparatus of security—the market—they brought disciplinary power to bear on food, subjecting individual loaves of bread to a clinical gaze. They found that much of the bread sold around the metropolis was under weight. This was a matter of water absorbed, in addition to the types of flour used, and thus offered the potential for fraudulent—though not harmful—adulteration. Potatoes and rice-flour were problems not because they were harmful in themselves, but because they were less nutritious articles than wheat. In the case of rice, which absorbed more water, "the customer is cheated of a certain amount of nutritious wheat farina, the place of which is supplied by water"; for potatoes, the customer was cheated because the potatoes "are made to take the place of an article very much more nutritious."[63] The Commission argued that the medical profession needed to systematically intervene in order to protect a public that could not protect themselves, a clear shift from the older ideal of the direct relationship between food's production and consumption, with its assumption of knowledge through individual experience, and from Guy's testimony three years before the Commission, in which he implied that consumers could judge for themselves the quality of their bread.

[63] Ibid., 421.

The results of the 1851 Commission generated a public discourse about adulteration and food safety that was more medically and scientifically oriented than ever before. In this discourse, the presence of alum in bread was a problem, but did not occupy public attention in the same way that more dastardly adulterants like arsenic and lead in candy and tea did.[64] Nevertheless, metropolitan and provincial newspapers began to publish reports of adulteration in bread far more frequently, both reproducing the *Lancet*'s accounts and publicizing local cases.[65] There followed other investigations by the *Lancet* in the 1850s that established adulteration's prevalence outside London,[66] two Parliamentary select committees on adulteration,[67] and an increased attention to alum by the medical community. Much of this discourse reinforced the fundamental conclusions of the 1851 report: wheat and flour were more pure than bread; bakeries, therefore, were the real sources of contamination in Britons' daily bread. John Snow, most famous for his work identifying the source of cholera in a London water pump, argued in an 1857 piece in the *Lancet* that alum was a cause of rickets in metropolitan children. He, like the Commission in 1851, located the problem in bakeries, arguing that families in northern England continued to bake their own bread because of the lower fuel prices. Because of their home-baked bread, rickets was less common in the North. In the rest of the country nearly all families

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[64] Burnett, *Plenty and Want*, 190–200.
[65] "Bread and Its Adulterations," *Reynold's Advertiser*, April 20, 1851; "Adulteration of Bread with Alum," *Lloyd's Weekly Newspaper*, June 21, 1857.
[66] The Commission began its provincial investigations with Birmingham; Manchester and Liverpool followed within a few months. "Records of the Results of Microscopical and Chemical Analyses of the Solids and Fluids Consumed by All Classes of the Public: Report on the Condition of the Food Sold in Birmingham," *The Lancet* 69, no. 1756 (April 25, 1857): 436–37.
[67] William Scholefield, "First Report from the Select Committee on Adulteration of Food &c.; with Minutes of Evidence and Appendix," Reports of Committees, 432 (London: House of Commons, 1855); William Scholefield, "Second Report from the Select Committee on Adulteration of Food &c.; Together with the Proceedings of the Committee and Minutes of Evidence," Reports of Committees, 480 & 480-I (London: House of Commons, 1855); William Scholefield, "Report from the Select Committee on Adulteration of Food &c.; Together with the Proceedings of the Committee, Minutes of Evidence, Appendix and Index," Reports of Committees, 379 (London: House of Commons, 1856).

bought their bread from bakers, who, he claimed, "so far as I have examined, all put alum in their bread." As the 1851 Commission did, he excused millers and grain merchants and placed blame squarely on the baking trade, explaining, "I have never examined a specimen of flour which contained alum, or a specimen of baker's bread which did not contain it."[68] Snow's solution to this problem was state intervention, a solution that became increasingly common in public and professional discussions of adulteration.

The first law for preventing, and not merely punishing, adulteration was the 1860 Adulteration of Food and Drinks Act, a permissive measure that allowed but did not require local authorities to appoint public analysts to guarantee the purity of bread and other foods. The permissive nature of the act meant that many local authorities did not implement it, instead continuing to rely on the market to police itself. Indeed, in the twelve years the Act was in force, just seven public analysts were appointed across Britain, and only one of those examined more than a few samples. The 1872 Adulteration of Food, Drink and Drugs Act clarified adulterants and added drugs to the legislation, but it was essentially an amendment of the 1860 Act, and not an especially robust revision. The 1860 and 1872 Acts contained no provision for funding the expense of the tests, and with local government agencies not obligated to carry out the exams, the actual sampling of goods was frequently left to individual tradesmen or companies. Purity and genuineness became more common advertising claims, synonymous with quality, and the Act could be used to reinforce a seller or manufacturer's claim to quality.[69] Even then, however, the analyst himself could be suspect. In 1873, a group of master bakers from Shoreditch sought to distinguish themselves from the local undersellers by having the purity of their bread verified by the

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[68] John Snow, "On the Adulteration of Bread as a Cause of Rickets," *The Lancet* 70, no. 1766 (July 4, 1857): 4–5.
[69] Burnett, *Plenty and Want*, 199–200.

local public analyst. They submitted several loaves for examination, some of them pure, and some of them deliberately adulterated, but their analyst found them all pure, drawing the ire and contempt of the bakers.[70]

Doctors and sanitary-minded reformers commenting on the subject argued that the 1860 act was grossly inadequate, and campaigned for more stringent regulations, and indeed for broad medical surveillance of the market. An 1863 Sub-Committee of the Manchester and Salford Sanitary Commission was tasked with adulteration, and examined a variety of samples from around greater Manchester. Finding none of the flour and much of the bread adulterated, the committee's report repeated the conclusions of earlier investigators that bakers were the problem, but also supported much stronger intervention. An independent analyst was insufficient, the report's author claimed, for it "throws the care of its food on the public itself," an arrangement already shown to be inadequate to guarantee public health. A specially appointed inspector, charged with surveying all food produced and sold could serve as "both be the eye and the hand" of medical intervention, thereby ensuring pure food for the population.[71] Here, less than fifteen years after Guy's report to the Sanitary Commission in 1849, was a public articulation of a new role for the medical profession: the ideal of the direct relationship was long gone, and the market had proved insufficient because the public could most definitely not look after itself; medical expertise was therefore necessary to fill the gap in knowledge between production and consumption in order to ensure the safety and purity of food.

[70] T. Stevenson, "The Adulteration of Bread," *British Medical Journal* 2, no. 674 (November 29, 1873): 647–48.
[71] Manchester and Salford Sanitary Association and R. Angus Smith, *Report of the Sub-Committee upon the Adulteration of Food* (Manchester: Powlson & Sons, 1863).

By the early 1870s, it was obvious that adulteration remained common, if perhaps slightly more subtle than it had been twenty or even just ten years before. A House of Commons Select Committee investigation in 1874 found that the 1860 and 1872 Acts had hardly been enforced by local authorities, who had frequently simply ignored the law. "Even where a competent analyst has been established," the Committee's report explained, "if the local authority does not associate a special investigator with him, or does not insist upon the police or other recognised officials performing the duties of inspectors, the Act remains a dead letter."[72] Amid continuing public pressure, Parliament passed a more robust Act mandating regulation, and this likely contributed to reducing adulteration in many foods by the end of the century. Indeed, by the early 1890s, the Local Government Board reported that the adulteration rate in bread was below 1%.[73] The purity of bread measured in chemical terms was not, however, the last word in the biopolitical surveillance of bread. Beginning in 1851, the Analytical Sanitary Commission had brought bread under surveillance in a way that also brought the environment of the bakeries themselves within a disciplinary gaze, and which thereby reconstructed the relationships between bodies and environments. And it was in London's bakeries that, after 1851, factory inspectors, sanitary reformers, medical officers, and physicians began to view bodies and environments as mutually constitutive at the most local level, and in ways that threatened the health of the nation.

Bodies and Environments in London Bakeries

[72] "Report from the Select Committee on Adulteration of Food Act (1872)," C. 262 (London: House of Commons, 1874), iii.
[73] "Twenty-First Annual Report of the Local Government Board 1891-92," C. 6745 (London: House of Commons, 1892), cxli; "Twenty-Second Annual Report of the Local Government Board 1892-93," C.7180 (London: House of Commons, 1894), cxlii.

In April, 1861, Secretary of State Sir George Lewis asked the Factory Inspector, Hugh Tremenheere, to revisit the complaints of London's journeymen bakers from 1848, the same complaints that Guy had been questioned about at that time. The resulting investigation and report took place within the context of the discourse on adulteration and was far larger and more comprehensive than Guy's questioning, ultimately generating disciplinary surveillance and intervention in the country's bakeries. In reference to Guy's 1848 testimony, Tremenheere noted that "The facts were then not disputed, and it appears from the evidence appended to this Report that they remain substantially the same." However, at the time of his report in 1863, he claimed that "it would be desirable that the provisions of the Act 'for preventing the adulteration of articles of food,' &c. (23 & 24 Vict. c. 84) should be made more effectual."[74] Thus, he recommended systematic regulation and inspection of bakeries, measures that he argued would make bakeries better places to work, but that would also produce better, healthier bread.

Tremenheere's 1862-3 investigation and report articulates a dramatic extension of a disciplinary gaze into bread. While building from the foundation laid by the *Lancet* in 1851, the later report differed in two significant ways. First, Tremenheere was not a doctor. As the Factory Inspector, his nominal responsibility was to survey places of work as such, regulating them in terms of the health and safety of those laboring there. However, the biopolitical discourse of purity in food established in 1851 informed his endeavor. Medical expertise was necessary for guaranteeing the purity of food as it related to both fairness in the market and the health of the population, and this discourse encouraged Tremenheere and his panel of witnesses to extend the aegis of "Factory Inspection" to include a broader

[74] Tremenheere, "Report on the Grievances of the Journeymen Bakers," v–vi.

intervention into the health of the population at large. Second, the combination of a biopolitical discourse demanding health through medical surveillance of food, and a mandate to examine bakeries as workplaces revealed a new, mutually constitutive complex of bodies and environments in London's subterranean bakeries. Bakeries were rendered environments of filth, both defining and defined by the bodies that inhabited them. The bakers became simultaneously products and producers of their environments: through long hours in filthy conditions, the men became ill, immoral, and careless; they thereby contributed to environments of filth, and in turn to contaminated bread. For Tremenheere, unlike for Guy, bakeries became threats not merely to the bodies of the bakers themselves, but threats to the public's food supply and in need of disciplinary intervention. In this way, bread was not merely an article of consumption, but a site for the construction of bodies and environments, and for state intervention.

Tremenheere's nominal responsibility was to survey the bakeries of London as places of work, in order to ascertain the need for state intervention. Beyond confirming the extremely long hours, his overwhelming finding was that they were dirty, although the evidence he collected from expert witnesses along with his own visits to bakeries around the metropolis combined to paint a picture of something more than simply dirty workplaces. The bakeries constituted an environment of pollution, filth, and impurity, defined by the airs and waters within it, but also by the organisms residing therein, vermin as well as the bakers themselves. John Bennett, the secretary of the London Operative Bakers Association, attributed the filth to "imperfect sewage, bad ventilation, and neglect."[75] In an account that would have shocked sanitary inspectors whose central

[75] Ibid., 31.

concern was usually water, Benjamin Snow, a 23-year-old employed in contract bakeries that sold large batches to hospitals, workhouses, prisons, and other institutions, described the bakeries located near the river. In cellars under houses, their floors were "covered several inches deep in water at every tide"; when it rained heavily or during a spring tide, it could be a foot or more.[76] Tremenheere's own inspection of bakeries identified one in which the atmosphere was particularly noxious, especially close to the already-low ceiling, only six and a half feet high. There, he found "rafters black with sulphur and flour-dust, and hanging thickly with cobwebs in all directions."[77] The organisms within the bakeries were just as bad as the airs and waters, with pests ubiquitous. H. W. Nevill, the owner of the largest single baking establishment in the metropolis, claimed that many bakeries were "infested with rats, beetles, cockroaches, &c.," while Tremenheere described one bakery in which the boards for making the bread had "ants and cockroaches and other creeping things" running over them.[78] William Peacock, a longtime London baker, testified that he had worked in bakeries so "infested with vermin, such as black beetles," that "you could gather a quart pot full in ten minutes."[79] The bakers' bodies were frequently covered in lice; William Frances, of the Holborn Union Workhouse described one man infested to such a "disgusting extent, that I wonder he could sleep at all."[80] But, while the vermin that inhabited the bakeries were problems, the greatest problem was often found in the bodies of the bakers themselves.

As Guy had described fifteen years earlier, the long hours spent in filthy, poorly ventilated, vermin-infested bakeries had profound effects on the bakers, rendering them

[76] Ibid., 36.
[77] Ibid., 110.
[78] Ibid., 44, 110.
[79] Ibid., 33.
[80] Ibid., 54.

unhealthy, immoral, and careless. In this way, the bodies of the bakers and the environments of the bakeries were mutually constitutive, shaping one another. Henry Webb, a 35-year-old baker from Devonshire who had spent 17 years in London, described the deterioration of his health from his time in the trade: "I have greatly lost weight since I came to London. I was a strong man… the first bad effect produced upon me was from the flour dust getting into my lungs, and the close atmosphere in which I have always worked."[81] Webb's testimony was typical, and he extended his claims, explaining that the long hours and difficult conditions led to immorality and carelessness. London bakers, he claimed, were "the most ignorant of any class of labouring men," largely due to their long hours and poor conditions. "Let loose" on Saturday evenings, the men drank and smoked, while on Sundays they "lie about, mostly without cleaning themselves."[82] The conditions of the trade made it impossible for the bakers to have a proper domestic life. Claridge, of the Surrey House of Correction, argued that the long hours and dismal conditions meant that the journeyman baker had "no home comforts," and thereby "experiences none of the comforts which help the commonest labourer on in his toils." On the few occasions when a man had some free time, he had "no place but the public house… no place to keep a suit of clothes in which to appear on a Sunday." In total, his condition was so bad that "he loses all self respect, all hope, and feels that he has but little to live for."[83] Bennett located much of the problem in the practice of journeymen being lodged in the bakeries themselves. This left them with no real home, no distinct domestic space; sleeping places were in basements, under stairs, or upon the work boards themselves, their only bedding "the sacks laid on the

[81] Ibid., 37.
[82] Ibid., 40.
[83] Ibid., 69.

boards." This "naturally leads … to great immoralities," with master bakers preferring to hire unmarried men, and with journeymen finding it difficult to get married themselves.[84]

Because their bodies were defined as polluted, ill, and immoral, the bakers themselves became a threat to the bread at the same time that the bakery was a threat to their bodies. Contact between the bread and the bodies of the bakers was a recurring theme throughout Tremenheere's report. In its most obvious articulation, the problem of bodies touching bread is that those bodies were often diseased. Mr. Dawson, of the Wandsworth and Clapham Union Workhouse identified the problem: "numbers of journeymen have diseases of various kinds, skin diseases, and many the itch, and their habits are often very dirty." "They must all come into contact with the dough," he shuddered, "They," in this case, including not merely the bakers, but a whole complex of filth that included the bakers' bodies, the diseases they carried, and the filth and contamination of their work environments.[85] Diseases aside, the inherent filth of the bakers' bodies is evident in the obsession that Tremenheere and his witnesses exhibited with bodily substances coming into contact with the dough, particularly perspiration. In the poorly ventilated environments of bakeries, with large ovens blazing nearly all the time, the men not surprisingly sweated a great deal, particularly when exerting themselves in making dough. To Tremenheere and his witnesses, this sweat was inherently impure. The director of the Lambeth workhouse made the connection between human touch and impurity clear: "It is impossible to avoid a great deal of dirty impurity getting into the bread by hand-kneading," he explained. "No hand-kneaded bread is ever made without a

[84] Ibid., 28.
[85] Ibid., 64.

certain amount of perspiration getting into it, and sometimes in hot weather a great deal."[86] The veteran baker Peacock noted that some men sweated a great deal, and their hands and arms are too covered in flour to wipe their faces. As a result, the sweat frequently dripped from their faces into the dough. He noted that some bakers even kneaded with their feet, and confessed to doing it himself a few times, unknown to his master.[87] Contact between bodies and bread was an unavoidable part of the business, necessary for profit even in ways that appeared disgusting. One witness claimed that it was universal practice for the men to wash the flour and sweat that accumulated on their arms into pails of water. This water was then used in the next batch of bread. In the tight business of London baking, the half-penny saved in this way was something that "no careful master" could allow to be lost.[88] Even under the best conditions, a nominally sanitary bakery was a problem due to bodily contact with the bread. Claridge explained that although country bakeries were usually "above ground and more clean and airy," their bread remained a source of contamination through bodily contact: "there must always be… the perspiration getting into the bread, and always will be as long as the dough is kneaded by hand."[89]

Overall, then, London bakeries were subterranean, damp, close, and filthy, inhabited by vermin; long hours in them imparted those unsanitary characteristics upon the bakers themselves, whose poor health, immorality, and fecklessness perpetuated the poor state of bakeries. This complex of bodily and environmental filth could only produce unhealthy bread, with detrimental effects that extended well beyond the bakery or the baker himself. John Bennett, Tremenheere's first and most prolific witness, articulated the problem in its

[86] Ibid., 53.
[87] Ibid., 34.
[88] Ibid., 39.
[89] Ibid., 68.

totality. With the filthy state of the bakeries, "the bread must, during the process of fermentation, get impregnated with the noxious gases that surround it." Bread, environment, and bodies of the bakers were connected in multiple ways: "The dirty, close, and unhealthy places of work have a direct tendency to produce unwholesome bread in another way; for they incapacitate a man from paying proper attention to the most critical parts of the process of bread-making," the fermentation. If this process is not carefully attended to and is allowed to progress too long, it will produce "sour," unwholesome bread. Bennett, moreso than many other witnesses, explicitly connected the problem of filthy bakeries to public health. He noted that even sour bread "is eaten by somebody; if not by the usual customers, by people living in a poorer neighborhood; and, being unwholesome, it must have influence in producing disease, especially among the young and delicate."[90]

Here, then, was the extension of biopolitical surveillance well beyond the adulteration that was the focal point of the 1851 Commission. The investigations into adulteration and food purity had suggested that bakeries were a problem, but 1863 confirmed that, finding them a greater problem than any had imagined. The legislative response, an 1863 Act for the Regulation and Inspection of Bakehouses, set about remedying the problem by instituting disciplinary mechanisms on the bakeries. Prior to 1863, the only legislation covering bread and baking was the 1836 Sale of Bread Act, which had repealed the Assize and mandated only that bread be sold by weight.[91] The 1863 Act, on the other hand, regarded the bakeries themselves as environments of contamination in need of disciplinary reform. It was also an act regulating labor, for it prohibited night work

[90] Ibid., 32.
[91] John Devonald Fletcher, *The Weights and Measures Acts 1878 to 1904: Being Only Those Sections of the Acts Which Regulate the Use and Possession of Weights and Measures for Trade* (London: Sherratt & Hughes, 1908).

by persons under 18, but its underlying purpose was to discipline bakeries. It mandated that all bakeries be maintained in a "cleanly state, and shall be provided with proper means for effectual ventilation, and be free from effluvia, arising from any drain, privy, or other nuisance." This required, among other measures, that all interior walls to be painted every seven years, or limewashed every six months. The Act attempted to separate the spaces of work and dwelling, prohibiting the lodging of men in any space on the same subterranean level as the baking, unless the spaces were clearly designated. The Act required partitions extending from floor to ceiling, and glazed windows of specific sizes: at least nine superficial feet, with half of that area able to open for ventilation. Finally, the 1863 Act provided for fines and enforcement, empowering "local authorities" to enter any bakery at any time during baking. Indeed, the £20 penalty for denying entry was four times the penalty for violations of the Act's statutes.[92]

The 1863 Act to regulate bakeries was not immediately successful: the small scale and fragmented nature of the metropolitan baking trade made effective surveillance difficult, and the trade certainly resisted. Bakeries were included in the 1878 and 1883 Factory and Workshops Acts with the same sanitary, biopolitical intentions. The 1883 act required greater ventilation, prohibited any toilet, water-closet, or privy from communicating directly with the bakery, and forbade any drain pipe carrying "foecal or sewage matter" from having an opening in the bakery.[93] In 1889, the *Lancet* appointed a Special Sanitary Commission to investigate bakery environments that, to the medical community, remained health problems despite several decades of disciplinary legislation.

[92] *A Compendious Abstract of the Public General Acts of the United Kingdom of Great Britain and Ireland* (London: E.B. Ince, 1862), 65–6.
[93] Great Britain, *The Public General Acts of the United Kingdom of Great Britain and Ireland* (proprietors of The law journal reports by Edward Bret Ince, 1883), 288–9.

The bread supply of a large town, the Commission's report explained, was "fraught with so many complications and difficulties that sanitary precautions are apt to be neglected, and what we call the 'staff of life' may become a cause of death." In other words, disciplinary expertise was necessary to protect the public from the uncertainty generated by the apparatus of security, which used the market to ensure the circulation of materials through society. Scientific and medical experts saw themselves as providing knowledge vital to the optimal operation of the market and public health. The dangers inherent in the bread remained much as they had in the 1860s, although the conditions had no doubt improved. One bakery was clean and well-ventilated, bringing it within the letter of the law, although "it was obvious that there were many bugs climbing around the walls." Another had a dirty water closet and a broken dustbin, not inside the bakery as might have been expected in the 1860s, but now just outside the bakery in a small court. These bakeries remained "altogether nasty"; "not contrary to the letter of the law, [but] certainly not in keeping with its spirit and object."[94] The actual "success" of biopolitical surveillance was ambiguous, and perhaps impossible because the problem was not simply "dirty" bakeries, but the asymmetry of knowledge between food's production and consumption.

Whatever the "success" of the acts regulating bakeries and adulteration, however, by the 1860s at the latest, bread had clearly become an object of biopolitical surveillance, a process that imposed disciplinary regulations on bakeries, bakers, and the bread itself. It was, as one doctor wrote, absolutely necessary that bread be "a cheap, clean, nutritious, and digestible" product, an outcome that could only be achieved with the "intelligence and

[94] "Report of the Lancet: Special Sanitary Commission on Bakeries and Bread-Making," *The Lancet* 134, no. 3457 (November 30, 1889): 1140–42.

activity of the leaders and teachers in the sciences of sanitation and of political economy."[95] It was within this context of biopolitical surveillance that the amount of imported wheat increased dramatically after 1870, and biopolitics provided a set of overlapping views of the relationships between bodies and environments that informed Britons' incorporation of global wheat supplies into their diets. Chemical physiology developed in laboratories across Europe, suggesting an abstract relationship between bodies and environments as categories of production and consumption engaged in a constant cycle of chemical exchange[96]; those abstractions broke down in London's bakeries under disciplinary surveillance and intervention. State-sponsored medical interventions, then, focused not on wheat's origins but instead on the bodies and environments that baked bread.

[95] Ibid.
[96] See Chapter Five.

CHAPTER FOUR

SCIENTIFIC BAKING AND WHITE BREAD

"Scientific baking" emerged in the 1870s, brought together developments in botany, chemistry, and bacteriology—what the history of science Robert Bud called "zymotechnology"[1]—with the practical concerns of bakers, and resulted in whiter, lighter textured, more highly risen bread. It was a response to two stimuli: the implementation of disciplinary surveillance by the British state, and the globalization of Britain's wheat ecology. While scientific baking was never compulsory, it was a biopolitical discourse, for it sat at the pivot between discipline—the medical, state-sponsored inspections of bakeries in response to the crisis of adulteration and filth in the middle of the nineteenth century—and security—the replacement of the medieval and early modern anti-scarcity system with the market, through the adoption of Free Trade policies.

Through the 1860s, British baking, like milling, essentially reflected the local wheat ecology that fed the country: bakers got their materials from relatively close by, often with close relationships to specific millers and in some cases even growing their own yeast inside the bakery. Further, the knowledge they deployed was itself "local."[2] It was the result of many hours of labor as apprentices, and was often described as something embodied in the bakers themselves, possessing a sort of tactile quality. True knowledge of baking could only come, bakers argued, through practical experience and physical contact with wheat, flour, and bread, in working bakeries with "practical" methods. This resulted in bread that was quite "local" as well, and its character varied considerably across the country. This was

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[1] Robert Bud, *The Uses of Life: A History of Biotechnology* (Cambridge, England: Cambridge University Press, 1993).

[2] See James Scott's discussion of "local" as opposed to "universal" knowledge. *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed* (New Haven: Yale University Press, 1998).

the baking industry that entered a period of crisis after the dismantling of the anti-scarcity system, and that came under disciplinary surveillance in the 1860s.[3]

By the 1870s, however, British baking began to reflect the nascent global wheat ecology. Bakers got their materials from increasingly greater distances, assisted in substantial part by developments in milling.[4] Some bakers developed their own expertise in foreign wheats, mixing flours from particular regions in specific combinations depending on their applications; many more came to rely on millers for their mixtures. Bakers also adopted new forms of yeast, nearly all of which were industrially manufactured and many of which were imported. Along with new materials, bakers began developing new forms of expertise that both responded to disciplinary surveillance, and that drew upon the universal knowledge promised by science. In some ways, this new expertise mirrored and complemented that of millers. But, unlike millers, bakers were under the pressure of disciplinary surveillance from the 1860s. As a result, they adopted some of the language of that surveillance, attempting to improve the sanitary conditions of their bakeries and the purity of their bread. More broadly, developments in botany, chemistry, and bacteriology gave them the intellectual tools to think of their materials and their environments in new ways. While many bakers no doubt continued their traditions of "local" knowledge through apprenticeships, practical experience, and "embodied" expertise, many others began to adopt a scientific discourse of baking that claimed to operate through universal laws, that was applicable everywhere, and that could be—and indeed needed to be—learned through textbooks, microscopes, and laboratories, with the guidance of a new class of experts.

[3] See Chapter Three.
[4] See Chapter Two.

In its shift to reflect the new global wheat ecology rather than Britain's older local wheat ecology, baking began to play a role similar to and complementary to that of milling. After 1870, millers developed the technical expertise necessary to mill many kinds of foreign wheats. In so doing, they created flour that was essentially an origin-less, homogeneous commodity: when millers were successful, the quality and baking characteristics of flour remained constant, even as the actual environmental origins of the wheat changed from year to year as weather, harvests, and other factors dictated.[5] But, consumers purchased less and less flour on their own, as domestic baking declined in the eighteenth century. By the middle of the nineteenth century, it was still practiced only in a minority of households, and generally only in rural areas or where fuel prices were low. As such, bakers were necessary mediators between humans and environments, turning flour—an intermediary product made from wheat, the direct product of environments—into the foundational food "bread." The new global wheat ecology meant that the sources of Britons' daily bread were farther away than ever, and knowledge of those sources was increasingly difficult to come by. While millers blended the world's various wheats into consistent, homogeneous flour, effectively obliterating knowledge of its origins, bakers reinvested that flour with knowledge and meaning necessary for consumers. And, with new foreign wheat and roller-milled flour to work with, industrially manufactured yeast, and scientific knowledge of fermentation, the character of British bread changed. The darker, denser loaves of the eighteenth and early nineteenth century were replaced with whiter, lighter-textured, and more highly-risen bread. The "proper white bread" that George

[5] See Chapter Two.

Orwell's character Winston Smith, in his dystopian novel *1984,* craved was (and remains), therefore the product of biopolitical apparatuses.

Bakers' Priorities: Yield, Color, and Flavor

In its most basic sense, baking is the combination of flour with water to form dough, a matrix of the flour's protein and starch infused with water. Leavened bread requires the addition of some kind of chemical or biological agent to charge that dough with gas; yeast has been the standard in Western Europe since Classical Antiquity, though chemical leavening supplemented it in the nineteenth century. Once charged with gas, the now-leavened dough is baked. Baking solidifies the gas-charged starch-protein matrix, while forming a harder crust on the outside, thus giving leavened bread its characteristically light and porous interior texture with a harder, chewier crust. Behind this apparently simple definition of bread, however, is a constellation of elements that make it a difficult article to produce consistently. The various ingredients can be combined in many different ways—all at once, as in the "straight dough" method, or in stages called "ferments" or "sponges." The ingredients themselves are highly variable, with many different varieties of yeast. Yeast can be roughly broken down into two categories: the byproducts of alcohol production, such as brewers' and distillers' yeast, and what nineteenth-century British bakers called "patent" yeasts, products made by the baker in the bakery itself, and which included English malt and hop yeasts and Scottish barms. Flour is also, as British millers knew very well, itself quite variable depending on the characteristics of the wheat, the environment in which it was grown, and the manner in which it is milled into flour. In addition, even if the materials themselves are consistent, flour, yeast, dough, and bread are dynamic objects. Never static, flour can be spoiled by water, heat, or pests from microorganisms to mice; yeast are living organisms whose life and utility to the baker depend on the careful management of their environment and food; dough and bread are prone to over- or under-fermentation, over- or under-baking, drying out, and spoiling. The weather both inside and outside the bakery can have a profound effect on the quality of the bread, with hot days encouraging over-fermentation and cold days preventing adequate fermentation. Baking bread is, in short, a difficult and delicate operation. Any number of things can go wrong, and the baker's task is to manage the uncertainty of the materials, the organisms, and the environments necessary to produce the article the market demanded.

Just what consumers demanded varied substantially across Britain, and some areas were known for their peculiar preferences. Charles Dickens claimed in 1852 that the bread-eaters of Birmingham liked "their old-fashioned bitter bread," and considered London bread insipid. Tastes were a two-way street, however, as "The Londoners, for their part, make faces at the bitterness of Birmingham bread."[6] Overall, there were two broad divisions that bakers had to account for. First was in color: the cities, London especially, ate white bread, while the countryside ate considerably more brown bread. The metropolis was long known for its insistence on whiteness, dating back to at least the eighteenth century.[7] Many bakers, millers, and corn merchants remarked that any bread that was not as white as possible simply would not sell in London. The London baker John Wake explained in 1814 the difference between country and city bread, claiming that London consumers "are so very particular… we must make all handsome loaves for the people, or

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[6] Charles Dickens, "The Miller and His Men," *Household Words*, 1852, 419.
[7] See Chapters Three and Six.

they will not have it."[8] In 1828, the baker John White, author of an extensive *Treatise on the Art of Baking*, agreed that white bread was preferred to brown by urban Britons, and warned against varieties of wheat that would make only a "black" loaf.[9] The 1841 *Guide to Trade* argued that it was Londoners' insistence on whiteness that brought about the nearly universal use of the bleaching agent alum among metropolitan bakers.[10] Flour mills using millstones produced a limited amount of truly white flour, and as such bakers had to find some way to make whiter bread with second-class flour.[11] In 1862, a London baker named Robertson told the committee investigating journeymen bakers that "The people of London would not eat the common household bread" found throughout much of the rest of the kingdom, for its was too brown; another witness claimed London bakers consistently over-fermented their sponges and doughs (see below) in order to produce lighter colored bread.[12] Country bread, on the other hand, was darker in color. Matthew Wood, a City of London Alderman, noted in 1814 that he preferred "country bread," though it was not so white as the usual London standard. J. G. Jones, a London flour merchant, suggested at least a partial explanation for this in 1814 when he told the committee investigating the Assize of Bread that many districts shipped their best—that is, whitest—flour to London and the other towns, where it brought higher prices; the darker flour that remained was consumed

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[8] Thomas Frankland Lewis, "Report from the Committee on Laws Relating to the Manufacture, Sale, and Assize of Bread," Reports of Committees, 186 (London: House of Commons, 1815), 23, 43.
[9] John White, *A Treatise on the Art of Baking, with a Preliminary Introduction, Shewing the Various Productions... with a Number of Valuable Receipts, Original and Selected for the Baker and Domestic Circle* (Edinburgh: Anderson and Bryce, 1828), 130.
[10] For a more substantial discussion of alum in bread and its important role in adulteration scandals in the middle of the nineteenth century, see Chapter Three.
[11] *The Guide to Trade: The Baker; Including Bread and Fancy Baking with Numerous Receipts* (London: Charles Knight and Co., 1841), 35–6 See also Chapter Two.
[12] Hugh Seymour Tremenheere, "Second Report Addressed to Her Majesty's Principal Secretary of State for the Home Department, Relative to the Grievances Complained of by the Journeyman Bakers," Command Papers, No. 3091 (London: House of Commons, 1863), 80.

locally.[13] Many bakers made some version of "home-baked" bread, and in all cases it was browner than the usual loaf of commerce.[14]

The second major division in British bread was flavor. Southern England, and London in particular, demanded sweeter bread, while northern England and especially Scotland preferred sour bread. Sweetness and sourness were not, however, simple categories, for there were different types, particularly of sourness; moreover, one of the most common problems in bread was unwanted sourness due to over-fermentation or bad yeast. To southern bakers, sweetness was a signifier of the baker's success, and sourness of his or her failure. White's 1828 *Treatise* is full of advice on how to achieve the desired "natural sweetness" of bread and avoid sourness: proper selection of flour, good quality brewers' yeast when available, long experience in the various processes of baking, and close attention to one's work. Indeed, producing sweet bread was the overriding objective of his instructions. In the 1860s, several of Hugh Tremenheere's witnesses also indicated that avoiding sourness was their primary concern. The baker William Peacock testified that the long hours he and his fellow journeymen worked were in part to constantly monitor the fermentation process and so avoid sour bread. Gilbert Crerar, another baker, explained the differences in flavor between the high-quality, full-priced bakers in the West End and the low-quality, underselling bakers in the East End. They used different kinds of yeast, he asserted; the East End bakers used cheap patent yeasts while the West End bakers used more expensive brewers' yeasts. The high-quality and higher-priced brewers' yeast produced bread that was always sweet and would remain so, but the cheap patent yeasts

[13] Lewis, "Report on the Assize of Bread," 14, 18, 34, 52–3.
[14] White, *A Treatise on the Art of Baking*, 234–5.

were more likely to produce a sour loaf, and their bread turned sour after a day or two even when made well.[15]

In contrast to the broad preference for sweeter bread in southern England, northern England and Scotland developed a taste for sour bread. This was not the same kind of sourness produced by some variety of yeast or fermentation failure, but one produced by the particular barms used by Scottish bakers (what are called sourdough starters today). John White claimed that this had come about because Scottish bakers were at some point in the past unable to get sufficient quantities and quality of brewers' yeast. At this point, the brewers' yeast that bakers had been using "became very unfit" and "the supply ran very short, and even when one could get a gallon of it, it was very low quality." In response, Scottish bakers developed flour barms, a form of home-made yeast that used only hops, flour, and water, allowed to ferment on its own. This method gave Scottish bakers a measure of control over their fermentation supplies, though White claimed that its characteristically sour flavor first generated considerable resistance from consumers. After some time, they grew accustomed to it, and by the nineteenth century preferred sour bread in the same way that southerners preferred sweet bread. Whether White's story was apocryphal or not—and some elements, such as a baker's apprentice who traveled all the way to London looking for yeast, obviously were—it was certainly agreed by all in the nineteenth century that northern and southern bread were different: one was sour, and the other sweet.[16]

In addition to the flavor and color, which varied across the country, there were three other inter-related qualities that concerned both bakers and their customers: the lightness

[15] Tremenheere, "Second Report on Journeyman Bakers," 33, 36, 104.
[16] White, *A Treatise on the Art of Baking*, 197–204.

and porosity of the bread, the yield of loaves from a sack of flour, and a flour's working qualities. Whatever their preferences for flavor, customers nearly always wanted bread that was lighter and more porous in texture; bakers always sought to avoid "heavy" or "damp" loaves. This lightness in the loaf was, perhaps paradoxically, a result of a flour's capacity to absorb more water, a quality that itself led to a higher yield of loaves per sack. Bread and flour were always sold by weight: flour in 280 lb. sacks, and bread in four-pound "quartern" loaves or their equivalents. Making bread of course involved adding water to the flour, as well as yeast and salt, but the amount of water in proportion to flour varied according to the quality of the flour and the skill of the baker. The baker wanted the flour to absorb as much water as possible, making as many loaves as possible. With the tiny profit margins in the baking trade, a few loaves could be the difference between profit and loss. The Assize of Bread long assumed that twenty peck (16 lb.) or eighty quartern (4 lb., "quarter-peck") loaves could be produced by a 280 lb. sack of flour, and that number remained the standard for metropolitan bakers in the first half of the nineteenth century.[17] Theoretically, this suggested that a sack of flour needed to produce 320 lbs. of bread. However, dough and bread are dynamic objects: the dough contains living yeast, constantly metabolizing, reproducing, and thereby altering the dough it inhabits, while bread is a perishable food, liable to over-drying and becoming stale, and vulnerable to molds and other pests. For bakers obligated to sell four-pound loaves, the changeable nature of bread made it a difficult commodity to work with. Depending on the quality of the flour and the heat of the oven, dough lost a variable proportion of its weight through evaporation during baking. Moreover, once the bread was removed from the oven, it continued to lose weight

[17] Lewis, "Report on the Assize of Bread," 7.

as it dried. Because much bread was sold twelve, twenty-four, or even thirty-six hours after baking and had to be weighed at the point of sale, bakers had to produce loaves heavy enough to meet the weight requirements well after their removal from the oven. As such, a 280 lb. sack of flour needed to produce not merely the 320 lbs. of bread that technically constituted 80 quartern loaves; 340 to 360 lbs. of bread needed to come out of the oven, indicating a net addition after baking of at least sixty pounds of water, about six gallons. Of course, much of the water added to make the dough evaporated during baking, and so much more than six gallons was needed. John Bennett claimed in 1862 that good quality flour would absorb nearly sixteen gallons to the 280 lb. sack.[18]

The capacity to absorb more water was a function of two things: the amount of moisture already present in a flour, and the "strength" or "hardness," a combination of the amount of gluten and that gluten's ability to absorb moisture. Different flours absorbed different amounts of water, and thereby produced different yields of bread. Early in the nineteenth century, the usual yields were just above eighty quartern loaves per sack: the London baker Thomas Gray claimed the usual yield was eighty quartern loaves; some particularly high quality flours might produce a few more, but "no man can make more than eighty or eighty-one Quartern Loaves, averaging the whole year round."[19] Others involved in the trade gave wider ranges of the possible yields of various flours. John Wake, a baker at Norton Falgate, identified a usual range between seventy-nine and eighty-two; he doubted that a baker could produce an average of eighty-three over any length of time, and said that he had never known a baker to make as high as eighty-five. C. Lance, a London flour merchant, claimed that, when baked properly, the best flour would easily produce

[18] Tremenheere, "Second Report on Journeyman Bakers," 25.
[19] Lewis, "Report on the Assize of Bread," 52–3.

eighty-four loaves. If a baker were to bake very near the minimum weight of four pounds—thereby risking a fine for selling bread underweight—he might even bake eighty-six.[20] By the 1860s, standards had risen: John Bennett claimed that good quality flour would produce ninety-one loaves, and the Stratford baker W. McCash claimed that hand-kneading produced as many as ninety-five loaves, and his new mixing machine increased that to a hundred.[21]

Flour with the capacity to absorb more water and produce more loaves per sack made individual loaves with less flour than otherwise. These flours nearly always had higher gluten contents than less absorbent flours, and thus created a more elastic dough; with less flour overall and a more elastic dough, these "strong" flours could capture more gas during the fermentation process, creating a dough with more tiny, gas-filled holes, and thus producing lighter-textured, more porous loaves overall. Bakers referred to these characteristics as the working qualities of the flour, although precisely what this entailed is difficult to reconstruct. Understanding the working of flour relied on a deep tactile knowledge acquired only through experience; however, they were quite real to bakers, who frequently commented on them. John Wake described the difference between better and worse quality flours in terms of their "spring." Poorer flours "would not hang together," and loaves might split when they were removed from the oven.[22] John White described higher-quality flours as "free," or "good working."[23] On the other hand, poor quality wheats and flours were described as "cold in hand," baking loaves that were "heavy and dead."[24] In all, then, bakers faced a set of challenges: they needed to produce bread of the appropriate

[20] Ibid., 30–3, 40–3.
[21] Tremenheere, "Second Report on Journeyman Bakers," 25, 59.
[22] Lewis, "Report on the Assize of Bread," 42–3.
[23] White, *A Treatise on the Art of Baking*, 131.
[24] Lewis, "Report on the Assize of Bread," 38–9.

color and flavor, while making that bread as light and porous as possible, and producing as many loaves as possible.

Baking and the Local Environment

Bakers' knowledge and skill, and their position in Britain's wheat ecology, remained profoundly "local" in important ways until at least the 1870s. First, it dealt primarily with local environments, in terms of the flour and yeast supplies and in the management of the environments in bakeries. The great bulk of their wheat was British, and their flour typically came from millers nearby. Yeast came either from local producers of alcohol or, particularly in Scotland, bakers produced their own yeast, right in their bakeries. Second, it was knowledge essentially embodied in the bakers themselves: acquired through long apprenticeships and much practice, it resided in the baker him- or herself, the product of thousands of loaves baked by hand. Indeed it was at times spoken of as having a particularly tactile quality. In this way, bakers—like millers—before 1870 did mediate between the processes of production and consumption, but did so essentially within the same society.

Rarely written down, baking expertise was passed on orally. As such, the sources available for understanding this body of skilled knowledge are sparse. Before the 1870s and the proliferation of new forms of baking knowledge at that point, thorough descriptions of bakers' methods and their understandings of their work are few and far between. A handful of parliamentary reports on relevant topics, on the Assize of Bread in the 1810s and on journeyman bakers in the 1860s, and a pair of what are essentially trade publications must provide the rest: the baker John White's 1828 Treatise on the Art of

Baking, and the 1841 Guide to Trade. Nevertheless, despite this relatively narrow base of sources, clear patterns do emerge, enough so to illustrate the environmental dimensions of baking before 1870 and their inherently local nature.

Before the middle of the nineteenth century, and to a diminishing but still important degree from 1846 to 1870, flour supplies were largely local. Merchants, millers, and bakers who spoke before Parliament in the 1810s were familiar with supplies from Essex, Kent, Suffolk, Norfolk, Dorsetshire, Sussex, Lincolnshire, Yorkshire, and the Cleveland district, and even noted small amounts of Scottish and Irish wheat. There were also corn merchants who specialized in foreign wheats, and the baker John White, in his 1828 *Treatise on the Art of Baking*, was very familiar with both foreign and domestic varieties.[25] London was the demographic center of gravity for the archipelago, and it attracted imports from across northern Europe, and even as far as away as North America. However, these imports were fairly small overall.[26] R. Wilson, a London corn factor specializing in foreign wheats, explained that flours from distant ports were "in very small proportion to the consumption; the chief supply for the consumption of London is from in and about London, and perhaps twenty miles round."[27] Despite the predominance of local supplies, there was a wide variety of flours available, and their selection was an important matter for bakers.

Among British flours, southern English varieties were almost universally preferred, at least among London bakers. The highest priced wheats and flours found on the London market were nearly always from southern England, and Kent and Essex in particular. These varieties were generally three shillings per quarter higher in price than Norfolk and Suffolk

[25] Lewis, *Report on the Assize of Bread*, 22–3, 33–4, 37–9; White, *A Treatise on the Art of Baking*, 135–9. For more on the British grain trade in the nineteenth century, both before and after its globalization, see the Introduction.
[26] On the grain trade, see Chapter One.
[27] Lewis, "Report on the Assize of Bread," 39.

wheat, and ten shillings per quarter above "northern" wheat, described as anything from Lynn to Hull and beyond.[28] The higher prices for southern English wheat reflected their superior flavor, strength, and color in comparison to northern wheat. Thomas Gray far preferred flour from Essex and Kent, and explained that northern flour did not "answer his purpose," for it was frequently not "of a colour that is saleable," and "it is so soft, it will not make eighty Quartern loaves."[29] Among foreign wheats, the London corn merchant R. Wilson claimed Dantzic—wheat shipped from the port of Danzig, grown in Poland and shipped to market along the Vistula river—was typically the highest priced, though some American varieties occasionally brought prices as high.[30] John White claimed that Dantzic had "a celebrated name" but distinguished between Dantzic and Pomeranian, and argued that Pomeranian was just as good but less well known.[31] The main advantage of foreign wheat was its dryness, which allowed it to absorb more water than British flours; this also made them valuable in mixtures with better British flours.[32] Indeed, mixing flours was an important strategy for bakers, and one that White considered a vital skill. It enabled the baker to reduce costs by incorporating a proportion of cheaper, lower-quality flour into his bread. The flour merchant George Phare, for example, explained that the high-quality, full-priced bakers of London never used northern English flour alone. They could, however, use them in a mixture with higher-quality varieties.[33] White echoed Phare's point, warning that

[28] Ibid., 22–3, 38–9.
[29] Ibid., 52–3.
[30] Ibid., 22–3, 38–9.
[31] White, *A Treatise on the Art of Baking*, 195.
[32] Lewis, "Report on the Assize of Bread," 34.
[33] Ibid., 49.

several varieties of wheat, including some imported varieties from Russia and Pomerania, were useable only when mixed with higher-quality British flours.[34]

In selecting their wheats and flours, bakers recognized environmental differences in their choices, but their knowledge of British wheat differed substantially from their knowledge of foreign wheat. Bakers' knowledge of British wheat included the particular nature of quite specific localities and their methods of cultivation. John White wrote extensively on this topic, and although it is unlikely that many other bakers had his particular depth of knowledge—or opinions—about the particular relationships between wheat cultivation and bread baking, his views do make clear that such knowledge existed and was available to bakers. He distinguished between winter- and spring-sown wheat, the character of the soil, the manures used, and the position of the wheat in a farmer's rotation of crops. Within this set of variables was a nearly infinite range of possible qualities: winter wheat was superior to spring, that grown with moss or seaweed manure was poor, while that grown on heavy black clay or following grass or potatoes was merely indifferent. The best flour came from wheat grown on light or sandy soils, or in a rotation following beans, peas, or oats.[35] That bakers actually deployed this kind of knowledge in making choices is distinctly possible, although few likely had the extensive knowledge of British agriculture that White did. Nevertheless, bakers do seem to have made a point out of knowing something about the origins of the wheat they purchased. When asked after the causes of northern flour's inferiority, the London baker John Wake explained that he knew this

[34] White, *A Treatise on the Art of Baking*, 135–7.
[35] Ibid., 131.

because his father had been a miller in Berwick-on-Tweed, and he had always said that it came from the "coldness of the land."[36]

It is also clear that bakers developed longstanding relationships with particular country millers; because of their location in the countryside and away from large grain markets, country millers necessarily ground the wheat grown in their immediate vicinity. As such, their supplies were likely relatively consistent, coming from farmers on the same land and very likely the same cultivation methods. Buying directly from the same millers was thus a way to avoid the environmental uncertainty inherent in wheat and flour. Thomas Gray, for example, bought directly from millers in Colchester, the largest town in Essex, while John Wake bought directly from millers in the countryside around London, rarely dealing with merchants. He identified the benefit of avoiding merchants' commissions in explaining his preferences, but also alluded to the consistency available by dealing with the same millers year after year. He never dealt in samples, he claimed, because flour might "look very good to the eye, and yet not be good in baking." Avoiding samples suggests that he knew his millers well enough to trust them.[37] A. E. Saunders, a Wiltshire miller who spoke to a Parliamentary committee in 1812, described the wheat and flour markets in Bath. While it was a smaller flour market by far than London, his description does provide insight into the relationships between millers and bakers. "Persons who are known carry no samples; we sell to the baker, describing it as wheaten or standard," he explained. Only "strangers" attending the market bothered to carry

[36] Lewis, "Report on the Assize of Bread," 52–3.
[37] Ibid., 40–2, 52.

samples.[38] It is not unlikely, then, that Wake's relationships to the millers around London was similar to that between Saunders and the Bath bakers: actors at two different points in Britain's wheat ecology who had established long-standing relationships with one another in order to mitigate the environmental variability inherent in any ecology.

In contrast to the detailed environmental and agricultural knowledge bakers acted on in selecting British flour, they chose foreign flour based on different criteria. While the quality of the soil and methods of cultivation influenced choices of British flour, bakers had no such information available for foreign flour. Moreover, while foreign flour was a tempting purchase for British bakers due to its cheapness and dryness, it was even more unpredictable in its quality due to that lack of knowledge of it origins. White commented at length on foreign wheats, explaining that despite Dantzic's frequently good reputation, the great majority of wheat was grown nowhere in the vicinity of Danzig itself, instead coming from hundreds of miles up the Vistula river. On its trip to the port, it rode for days at a time on open barges, exposed to sun, wind, and rain. On reaching the port, it was loaded onto ships bound for Britain, at which point it sat in holds where it could sprout, mildew, or ferment. When the weather permitted, he warned, the crews of these vessels opened the hatches to ventilate the holds, at which point "a smock[sic] will issue from the hold, as if the vessel was on fire, accompanied by a most intolerable stench." It was these sorts of concerns, and the lack of knowledge about foreign wheat that suggested to White that domestic wheat was by far the better purchase. "Those who are not acquainted with

[38] Thomas Frankland Lewis, "(Country Bakers.) Minutes of Evidence Taken before the Committee on the Bill to Alter Two Acts... so Far as Relates to the Price and Assize of Bread," Reports of Committees, 259 (London: House of Commons, 1813), 6.

foreign grain should be cautious of purchasing it," he warned, especially at a higher price, for its quality was always uncertain.[39]

After the choice of flour, yeast was the most important material for bakers, playing important roles in aerating the bread and providing flavor. Like flour, yeast in the nineteenth century was also a product of the local environment. Bakers relied on essentially two kinds: brewers' yeast, a byproduct of local brewing industries, and "patent" yeasts, a variety of yeasts which bakers maintained themselves. Associations between brewing beer and baking bread were recorded at least as early as the third millennium BCE in the *Epic of Gilgamesh*[40]; in northern Europe, baking and brewing using shared yeasts had taken place since at least the Middle Ages.[41] Bakers working under the Assize of Bread either regularly purchased yeast or were expected to do so, for their "allowance," the costs of materials accounted for the Assize price, included yeast; in medieval Britain, this was most likely purchased from local domestic brewers.[42] The industrialization of porter production in London in the eighteenth century made possible a larger trade in brewers' yeast, and Peter Mathias, in his history of the English brewing industry, credits Matthew Felton with the earliest industrial production of a dried and compressed version of brewers' yeast, specifically for bakers. In 1796, Felton began collecting yeast from industrial porter breweries, either skimming it off the top of brewing tuns as the wort (the liquid mixture of grain, malt, and hops from which beer is made) fermented, or draining it from bungholes on the sides and then collecting it in butts (runoff collectors added for this

[39] White, *A Treatise on the Art of Baking*, 139.
[40] Anon. and Andrew George, *The Epic of Gilgamesh*, Rev. (New York: Penguin Classics, 2003).
[41] Richard W. Unger, *Beer in the Middle Ages and the Renaissance* (Philadelphia: University of Pennsylvania Press, 2004).
[42] James Davis, "Baking for the Common Good: A Reassessment of the Assize of Bread in Medieval England," *The Economic History Review* 57, no. 3 (August 1, 2004): 465–502; Judith M. Bennett, *Ale, Beer and Brewsters in England: Women's Work in a Changing World, 1300-1600* (Oxford: Oxford University Press, 1996).

purpose). He then pumped the yeasty, frothy mixture he collected at high pressure through heavy worsted or sailcloth to filter it, and then dried it under pressure to produce a concentrated, dried yeast product that kept well, could be transported easily, and was concentrated in its leavening power.[43]

Many southern bakers preferred brewers' yeast because of the flavor it added to bread. When it was high quality and used properly, it made possible the sweet bread that southerners preferred. Gilbert Crerar, a London baker, claimed in 1862 that brewers' yeast gave bread a "sweeter… nicer flavour," and with less risk of a sour fermentation.[44] Brewers' yeast was also notoriously unreliable, however, and bakers complained of it being both too strong and too weak. In 1814, John Wake complained that brewers' yeast had risen in price dramatically in recent years, and "when we get it, it is nearly all water," suggesting a diluted product inadequate to add flavor and aerate dough. The baker John Moxey, on the other hand, agreed that the quality of brewers' yeast could be "scandalous," but complained of a product particularly apt to fail in warm weather. This suggested a product too strong in its capacity to ferment.[45] John White agreed, complaining that the yeast produced by industrial porter breweries was "too high wrought… to be of much use." This indicated yeast with too strong a flavor and too likely to over-ferment and turn sour; he preferred the weaker yeasts used in less alcoholic "small beers."[46] Part of the problem was likely the yeast dealers themselves, who were notorious for both diluting their product and "sophisticating" it, adding foreign materials to improve its appearance although those

[43] Peter Mathias, *The Brewing Industry in England, 1700-1830* (Cambridge, U.K.: Cambridge University Press, 1959), 48–9.
[44] Hugh Seymour Tremenheere, "Report Addressed to Her Majesty's Principal Secretary of State for the Home Department, Relative to the Grievances Complained of by the Journeymen Bakers; with Appendix of Evidence," Command Papers, No. 3027 (London: House of Commons, 1862), 36.
[45] Lewis, "Report on the Assize of Bread," 40, 43, 78.
[46] White, *A Treatise on the Art of Baking*, 197.

materials did not help its fermenting qualities and were at times toxic.[47] It seems likely that, as with metropolitan bakers who developed longstanding relationships with millers to ensure consistent flour, some bakers did the same with brewers. Thomas Grey, a higher-priced London baker, remarked that brewers' yeast was "as cheap now as it was twenty years ago," and "as good in quality." He, unlike many other commentators on the topic, described his long history with a pair of breweries near his bakery: one on Tottenham Court Road and, and another on Oxford Street, whose owners he evidently knew well.[48]

Brewers' yeast, while frequently preferred, was unreliable enough that many bakers—including nearly all of them in Scotland—used some variety of "patent" yeast, what bakers speaking to the Select Committee on the Adulteration of Food Act in 1872 described as that which "bakers make themselves by brewing malt and hops."[49] Called "barms" in Scotland, patent yeasts ranged from very simple pastes of water and flour to more elaborate, multi-stage preparations involving hops- or wormwood-infused water, malt, sugar, potatoes, flour, and sometimes even honey or ginger. They were in some cases produced by bakers themselves, right in their own bakeries, but in other cases by larger companies specializing in the patent yeast trade.[50] They varied considerably according to their purpose: in Scotland, they provided the leavening and flavor for their more sour bread, while London bakers frequently used them to provide additional bulk.[51]

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[47] Frederick T. Vine, *Practical Bread-Making: A Useful Guide for All in the Trade*, 2nd ed. (London: Office of the "Baker and Confectioner," 1900), 17–8.
[48] Lewis, "Report on the Assize of Bread," 40, 43, 78.
[49] Clare Sewell Read, "Report from the Select Committee on Adulteration of Food Act (1872)" (House of Commons, 1874), 193.
[50] White, *A Treatise on the Art of Baking*, 201–3; Read, "Report from the Select Committee on Adulteration of Food Act (1872)," 193.
[51] Tremenheere, "Report on the Grievances of the Journeymen Bakers," 36.

In addition to selecting materials, the core of a baker's skill lay in his or her ability to actually make the dough and bread. This required more than merely combining the ingredients and putting them into the oven; it was a practical management of materials, fermentation, and environment in order to produce loaves that were light and porous in texture and appropriately flavored for their particular market. Baking was, moreover, a process that reflected local environments: sources of flour and yeast were largely local, but aside from the materials, the management of the environment within the bakery itself was a vital element of the baker's skill. The weather outside and conditions inside the bakery had important effects on the manner in which fermentation proceeded, and a baker had to be able to adapt methods to accommodate changes in flour, yeast, or weather, all while producing the article in demand by local bread consumers. With the variable kind and quality of flour and yeast at the bakers' disposal, and the particular preferences of British consumers, two methods dominated: "sponges" and "ferments." These methods, in turn, played important roles in determining that nature of the work that bakers actually performed. They were time-consuming, and were to a considerable extent why bakers worked such long hours, and frequently worked through the night.

The simplest method of making dough was the "off-hand" or "straight dough" method, in which all the ingredients were combined at once, and the resulting dough allowed to "prove," a term that indicates dough allowed to rest in a state of fermentation. This method, however simple, did not make the light and porous loaves customers preferred.[52] To produce those, most bakers in England used some variety of "sponge." A sponge separated a portion of the fermentation from the rest of the process, and it was

[52] White, *A Treatise on the Art of Baking*, 226.

categorized according to how much water was used in each step. "Quarter" sponges used a quarter to a third of the water a baker expected to use in the whole batch, "half" sponges used half or more, and "whole" sponges used all or nearly all of it. Sponges could also be made "thick" or "thin," sometimes also called "tight" or "loose," according to the proportions of water and flour combined at each stage. For example, a thin quarter sponge involved mixing the barm or yeast with up to one third of the water, and then with just enough flour to form a thin paste. Once the initial mixture of flour, water, and yeast showed signs of sufficient fermentation, the baker moved on to the next step, either adding more flour and water to continue fermentation for a second stage, or making the dough itself by combining the sponge with the remaining flour and water, as well as the salt. Some bakers left their dough to "prove" for some time before kneading, weighing, and shaping the loaves, while others preferred to allow it to prove after kneading. In any case, making bread with sponges, especially the longer quarter sponges, could be quite lengthy. The first stage alone took up to six hours, and the whole process from eighteen to twenty-four, depending on the quality of the materials, the weather, and the speed and attention of the bakers.[53] Bennett described long quarter sponges used in Scotland, where he first learned the trade, in which the first steps alone were twelve or even fourteen hours long.[54]

Sponges performed two important functions for bakers: they made better bread, and they helped bakers reduce risks. Bakers did not begin to describe yeast in microbial terms until at least the 1870s (see below), but they had long recognized that certain processes could increase the fermenting power of small amounts or weak samples of yeast.

[53] Ibid., 229–30; *The Guide to Trade: The Baker; Including Bread and Fancy Baking with Numerous Receipts*, 37–41.
[54] Tremenheere, "Second Report on Journeyman Bakers," 26.

Sponges were one of these processes, and when carried out successfully they produced the lighter and more porous loaves consumers sought. A sponge allowed the yeast to strengthen, and bakers monitored its progress by tracking its rise and fall in the fermentation tub or by spreading a thin layer of dry flour over the top and waiting for bubbles to break through. Only when it showed evidence of the proper fermentation was a sponge taken up for the later stages in the bread-making process. However, they could easily go bad, producing sour or bitter flavors particularly in warm weather, or fermenting too slowly in cold weather. Bakers needed to monitor them constantly, and be ready to take them up at a moment's notice. Though this increased the amount of labor required, it also served as a means of mitigating risk. With the threat of bad yeast ever-present, it was difficult for a baker to know if the yeast would ferment properly under any circumstances. By mixing it with only a portion of the flour, the baker risked less material at one time. Once the fermentation had proceeded appropriately, the rest of the flour could be incorporated into the dough and baked into bread.

In addition to sponges, bakers also used "ferments," a more concentrated form of a sponge. They used substantially less water than even the smallest quarter sponges, usually only a few pints as against several gallons in sponges, and combined some form of yeast with a nutrient-rich mixture that could include flour, malt, or a "fruit" of potatoes. Only after the yeast in the ferment had risen and fallen several times was the solution used to make a sponge. As with long sponges, ferments were slow, and could easily take well over twenty-four hours. If done correctly, they could increase the aerating ability of weak yeast without generating a sour flavor, and were thus perfect for London bakers. Indeed, Bennett claimed that the yeasts used in London in the 1860s would not work sufficiently without the aid of ferments. In Scotland, by contrast, bakers did not use ferments; there, the long quarter and half sponges using barms produced the sour flavored bread preferred by Scottish consumers.[55]

Sponges and ferments were delicate operations, highly sensitive to different materials and especially to local environmental conditions. As such, bakers needed to constantly respond to the particular development of their fermentation, and to adapt their methods to meet changing conditions. One baker in London's Limehouse district explained in 1862 that, "our material is such that we cannot work by the clock. The state of the dough varies with the weather." Because of this, bakers had to pay close attention to the progress of fermentation, and a batch could be lost if not taken up at the right moment. Another baker described staying awake with ferments and sponges all night, keeping a ferment cool in the summer and keeping another warm on a frosty night. Had he not been there to monitor the bakery environment to suit the fermentation, either "the sponge would have worked itself too much" and produced sour bread, or the sponge would have worked too light and produced bread "not as light as it should be."[56] White advised thin sponges in the summer, and a thick sponge, which would better "retain the heat," in the winter. Thicker sponges, he claimed, needed greater heat that thin sponges to reach the same state of fermentation in a set amount of time; however, they ran the risk of acquiring "too great a strength before it drops" in the summer, and needed to be attended to with cold water in order to remain "sweet." Without the proper attention, a thick sponge could over-ferment, rendering the bread "very heavy and damp." Similarly, quarter sponges took the most time, but could produce good bread even if the baker was working with weak barm or yeast. Half

[55] Ibid., 24–26.
[56] Tremenheere, "Report on the Grievances of the Journeymen Bakers," 80, 101–2.

sponges took four to six hours less than quarter sponges, but required more salt and a greater amount of barm or yeast. Whole sponges were the fastest, and could be ready in as little as seven to eight hours, but required the very best materials.[57]

Although bakers adapted their methods to meet the changing conditions of the local environments in their bakeries, one change that bakers do not seem to have made was to alter their methods to maximize the benefits or minimize the risks of foreign flour. While they did prefer drier foreign flours because they could absorb more water, the existing sources make no mention of any actual alterations in method; it appears that bakers simply adjusted the proportion of water to flour and carried on with their usual methods. When bakers did discuss changing methods to accommodate variable flour, it turned on the problems common to British wheat. Among the most common was "sprung" wheat, wheat that was caught by rain partway through its harvest. Wet weather at the wrong moment could lead to the wheat malting slightly, making its flour unsuitable for baking. This problem was at the heart of Thomas Hardy's depiction of the English grain trade in his 1886 novel *The Mayor of Casterbridge*, and the character Farfrae developed a (fictional) technique for salvaging "sprung" wheat.[58] In 1863, H. W. Neville, the owner of the largest baking establishment in London, suggested a solution to this problem, arguing that "a good deal of flour [from sprung wheat] could not be made into bread without the addition of a small quantity of alum, or a small quantity of bean or pea meal."[59] White gave a more thorough account of his solution to this problem. He recommended adding half to a full quarter of oats to nine quarters of sprung wheat flour. It should be then given a "very ripe

[57] White, *A Treatise on the Art of Baking*, 231–2.
[58] Thomas Hardy, *The Mayor of Casterbridge* (New York: Signet Classics, 1962).
[59] Tremenheere, "Second Report on Journeyman Bakers."

spunge [sic],” so that the fermentation was allowed to progress a great deal. Due to the chemical changes in the wheat when it sprung, “there [was] little danger of making sour bread.” The dough was then made with less water and more salt than usual, the loaves given a double proof before baking in an extra hot oven, and on their removal they were laid on their edges and allowed to cool. This, White claimed, would produce a loaf that was a little damp but still sellable.[60]

In several ways, then, baking in Britain before 1870 reflected Britain’s local wheat ecology. The bulk of wheat supplies were British, the flour was milled nearby, and yeast was from local producers or produced within the bakery itself. Bakers were careful in their management of the environment within the bakery, monitoring the temperature in particular as it played such an important role in fermentation. In addition, bakers’ knowledge of their trade was also a form of “local” knowledge: it was craft-based, learned by hand, rarely written down, and some bakers even denied any universal or scientific principles to it. This knowledge was intimately connected to local environments: bakers made choices about the wheat and flour they used based on its environmental origins, including the character of the soil and the methods of agriculture used. They developed long-standing relationships with millers and brewers in order to ensure consistency of supplies, and knew how to deal with the particular inconsistencies that were most common in British wheat. The local character of their knowledge of supplies is particularly evident in comparison to their knowledge of foreign supplies: while for British wheat, bakers were attentive to the soil and agricultural methods that produced it, for foreign wheat they discussed only the mode of transit and the dangers therein. Like millers, bakers played an

[60] White, *A Treatise on the Art of Baking*, 249.

important role in mediating between British bodies and the environments that fed them, but before 1870 these were largely British environments.

The Development of Scientific Baking

A series of developments combined to create a discourse of "scientific baking" from about 1870. This transformed baking, changed bakers' understandings of the processes they took part in, the methods they employed, and ultimately the bread they baked. Scientific baking occurred in the context of the new disciplinary surveillance of baking from the 1860s; it included new research in the chemistry of brewing and baking, increasingly global wheat supplies and scientific research into the nature of those supplies, and the development of a technical discourse specific to baking, in which the object was to improve the character of bread and baking through the application of chemistry and biology. Scientific baking was a biopolitical discourse, a means through which the biological processes of human existence were regulated, and it operated along two axes. It was concerned on the one hand with security, ensuring the circulation of materials through society; in this sense, it was an active attempt to better manage the increasingly global wheat ecology in which Britons were enmeshed. On the other hand, it deployed disciplinary techniques in its use of clinical and laboratory science, its insistence on a disciplinary gaze—often with microscopes and other tools for peering deeply into its objects of study—that regulated and disciplined the environments of bakeries and the bread produced therein.

In the 1880s, a new technical literature articulated this discourse, the newly formed National Association of Master Bakers and Confectioners provided institutional support for it, and new technical education programs helped make it a reality for many bakers. A clear watershed moment is difficult to identify for the changes in baking, and indeed, many bakers no doubt carried on much as they had before, taking little interest in the chemistry of bread-making or new sponging techniques. Still, it is clear that the baking industry was changing from the 1870s, and with greater speed in the 1880s. Given the various developments that combined to transform baking, a rough break can be identified about 1870. Before that date, baking was more or less as it was early in the nineteenth century: a reflection of primarily local environments, in the wheat and flour, the yeast, and the state of the bakery. Moreover, the knowledge that bakers used was itself largely "local": unsystematic, rarely written down, based on the experience of individual bakers, and to an extent embodied in the bakers themselves. After 1870, baking began to reflect global as well as local environments, bakers' knowledge became more systematic, more reliant on the universal principles of chemistry and biology, propagated through journals and technical education. Bakers began to employ new forms of industrially manufactured yeast and globally sourced wheat and flour, and some scientists and bakers began to make careers for themselves by specializing in the science of baking.

The textual elements of scientific baking—journals, textbooks, and technical education—grew out of earlier developments in several related fields: research in the chemical changes occurring in malting and fermentation, particularly in alcohol production, and agricultural research relating to wheat and flour. Together, these related fields of research provided the foundation for the scientific investigation of baking for the sake of improving bread by the late 1870s. Malting, the deliberate germination of grain to convert the starch inside into sugar, was used in the manufacture of alcohol since at least the

Middle Ages, particularly in beer and Scotch whiskey.[61] In 1833, the French chemists Anselme Payen and Jean-Francois Persoz were the first to identify the chemical changes that occur in the malting process, in which starch breaks down into dextrin and sugar; they identified a substance they believed caused this change and called it "diastase." Diastase provided one of the earliest avenues of scientific investigation into baking. William Odling, a Professor of Practical Chemistry at Guy's Hospital in London, gave a paper on the chemistry of baking in 1858, in which he described diastasic action and argued that it was this chemical action in wheat harvested in wet weather that made bread turn brown, not simply the presence of bran in the flour. For Odling in 1858, however, as for the medical community broadly, the main concern with bread was adulteration, and thus identifying one of the causes of brown bread made it theoretically possible to avoid it and thereby avoid the use of alum to whiten it. While he described the chemical changes occurring in flour during its baking and fermentation, his point was to address the ongoing adulteration crisis at the time, and this was the only point of his paper taken up in the subsequent discussion.[62] By the 1870s, research into malting became more practically oriented when scientists working for brewers took it up. Cornelius O'Sullivan, a researcher working for Burton-on-Trent breweries, noted the influences of temperature and pressure on diastasic action, useful information for manipulating malted barley, one of the basic ingredients of beer.[63] By the late 1870s and early 1880s, this more practical knowledge became available for bakers.

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[61] Margaret C. Storrie, "The Scotch Whiskey Industry," *Transactions and Papers of the Institute of British Geographers*, no. 31 (December 1962): 97–114.
[62] William Odling, "On Some Points in the Chemistry of Bread Making," *Journal of the Society of Arts* 6, no. 281 (April 9, 1858): 318–30.
[63] Koushik Seetharaman and Eric Bertoft, "Perspectives on the History of Research on Starch Part II: On the Discovery of the Constitution of Diastase," *Starch - Stärke* 64, no. 10 (October 1, 2012): 765–69.

In addition to the chemical changes occurring in flour and bread during the baking process, scientists also developed new knowledge of yeast and fermentation. Chemists had long recognized that fermentation was involved the breaking down of sugar and the production of carbon dioxide and alcohol, or other products such as lactic acid or acetic acid (vinegar), depending on the variety of fermentation. Their explanations of why these changes occurred tended to turn on the belief in an "active principle" in yeast or other ferments, which generated chemical change under the proper circumstances. When a ferment came into contact with flour, in imparted this active principle to the flour, beginning the fermentation process.[64] Louis Pasteur is generally credited with being the first to apply germ theories not only to disease, but he is also notable for his work on fermentation. He was instrumental in helping effect a shift in understandings of fermentation from chemical or physical to biological and physiological. However, he was certainly not the first to investigate yeast, and in fact he built on an existing foundation of research. In the 1820s and 1830s, researchers began to use microscopes to examine yeast, and the French physicist and engineer Charles Cagniard de la Tour identified yeast as single-celled organisms in 1837. That same decade, the German physiologist Theodor Schwann connected the growth of the "sugar fungus," as he called yeast, with the chemical changes observed in fermentation. He argued that fermentation was the "decomposition that occurs when the sugar-fungus uses sugar and nitrogenous substances for growth, during which, those elements not so used are preferentially converted to alcohol."[65] Schwann's biological explanation for fermentation as the effects of yeast metabolism met

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[64] Odling, "On Some Points in the Chemistry of Bread Making," 319.
[65] James A. Barnett, "A History of Research on Yeasts 1: Work by Chemists and Biologists 1789-1850," *Yeast* 14, no. 16 (December 1998): 1441–4.

considerable resistance from contemporary experts in chemical physiology, including Justus von Liebig, F. Wöhler, and J. J. Brezelius, all chemists known for their work in plant and animal physiology.[66] However, in a series of experiments from 1855 to 1875, Pasteur demonstrated conclusively that fermentation was a biological process involving the metabolism of sugars in must and wort (the unfermented solutions of either grapes or grain which form the basis of wine and beer) by yeast cells.[67]

Pasteur's work was no doubt important in the context of the history of scientific knowledge, but it became important for brewers and bakers because an understanding of yeast and fermentation as the result of a microorganism's metabolism made it possible to imagine new ways of controlling or manipulating fermentation, long held to be a difficult, unpredictable action, and with good reason. Older understandings of yeast and fermentation provided little mechanism through which the baker or brewer could control the different kinds of fermentations, and which could produce either the carbon dioxide and alcohol and bakers wanted, or lactic acid and sour flavors, ruining the bread (according to the taste of one's customers). Scientists working for brewers began to identify particular species of yeasts they found useful and others that they found harmful, and this made possible the cultivation of pure strains from single cells, aided by the microscope. Horace T. Brown, called the "Doyen of Brewing," began to use microscopes to control the brewing processes at English breweries in Burton-on-Trent in 1871[68]; later known as the founder of "carbohydrate chemistry," the German physiologist Emil Fischer applied some of Pasteur's findings to Dortmund breweries in 1876. Between 1879 and 1883, Emil Christian Hansen

[66] For more on physiology, see Chapter Five.
[67] James A. Barnett, "A History of Research on Yeasts 2: Louis Pasteur and His Contemporaries, 1850-1880," *Yeast* 16, no. 8 (June 2000): 756–8.
[68] Neil Morgan, "The Development of Biochemistry in England through Botany and the Brewing Industry (1870-1890)," *History and Philosophy of the Life Sciences* 2, no. 1 (January 1, 1980): 156.

developed methods of growing pure yeast strains from single cells while working at the Carlsberg Laboratory in Copenhagen.[69] These early examples of what the historian of science Robert Bud calls "zymotechnology," the study and application of processes of life, were vital for improving brewing processes: before the late nineteenth century, breweries routinely lost a fifth or more of their batches to problems in fermentation, and in 1866 a particularly catastrophic series of failed brewings resulted from bad yeast in all the Burton breweries.[70] Microscopical controls reduced that failure rate, producing a much more consistent product. Hansen's methods in particular were so effective that brewing batches from pure strains became standard industry practice within just a few years.[71]

Because of the connections between brewing and baking, developments in the brewing trade necessarily affected bakers, in two interconnected ways. First, as brewers and then distillers began to improve their yeast management techniques, they gained the ability to produce larger quantities of higher-quality yeasts. This led to the emergence of a new product for bakers, distillers' yeast. Often called German, French, or compressed yeast, depending on its origins, it was both more powerful and more reliable than brewers' or patent yeasts. It is unclear when distillers' yeast first appeared in Britain, but the *British Miller and Baker* claimed in 1886 that while some Manchester bakers still used a potato ferment, that practice was "fast dying out"; instead, "Compressed yeast is employed almost entirely to the exclusion of other kinds."[72] The official history of the National Association of Master Bakers and Confectioners listed bakers' reliance on imported distillers' yeast as an

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[69] E. M. Sigsworth, "Science and the Brewing Industry, 1850-1900," *The Economic History Review* 17, no. 3 (January 1, 1965): 537; James A. Barnett and Frieder W. Lichetenthaler, "A History of Research of Yeasts 3: Emil Fischer, Eduard Buchnet and the Contemporaries, 1880-1900," *Yeast* 18, no. 4 (March 2001): 363–6, 373.
[70] Sigsworth, "Science and the Brewing Industry, 1850-1900," 539–42.
[71] Bud, *The Uses of Life: A History of Biotechnology*, 7.
[72] William Jago, "Technological Examination in Bread-Making," *The British Miller and Baker*, August 2, 1886.

important topic in the early formation of their association in 1887; in 1893, the Netherlands Yeast and Spirit Company invited the confreres at the annual National Association meeting to Delft to tour their yeast factory.[73] William Jago toured the Encore Yeast manufactory in Lille in 1895, and wrote a lengthy description of it, making explicit the connections between science and industry. He suggested that compressed yeast was the "yeast of the future" because it was more regular and consistent in its quality, and "steady and trustworthy" in its action. Its high quality, he explained, was due to their manufacture being "entrusted to men who bring the highest skill that practical experience and science can furnish."[74]

In addition to changing yeast supplies for British bakers, there was a transfer of knowledge from brewing to baking in both malting and fermentation. Some of the earliest practical scientific studies of bread and baking came from research in brewing. Charles Graham, a chemist at the University of London, gave a series of lectures on the chemistry of brewing beginning in late 1873. In these lectures, he described diastasic actions and fermentation as they related to the chemical changes occurring during the various stages of the brewing process.[75] Although he acknowledged that Liebig's chemical view of fermentation remained popular among some researchers, he adopted a largely biological explanation for the fermenting powers of yeast. He described different forms of fermentation that could result from bacteria living under different conditions, and suggested means through which their metabolism could be manipulated to the brewers'

[73] *Twenty-One Years History of the National Association of Master Bakers and Confectioners* (National Association of Master Bakers & Confectioners, 1908), 10, 41.
[74] William Jago, *A Text-Book of the Science and Art of Bread-Making: Including the Chemistry and Analytic and Practical Testing of Wheat, Flour, and Other Materials Employed in Baking* (London: Simpkin, Marshall, Hamilton, Kent, &co., 1895), 245–6.
[75] Charles Graham, "Cantor Lectures: On the Chemistry of Brewing," *The Journal of the Society of Arts* 22, no. 1106 (January 30, 1874): 173–200.

benefit.[76] In 1879, he extended his analysis to bread with a similar series of lectures on the "Chemistry of Bread-Making."[77] Almost exactly a decade later, William Jago—perhaps the single most important bread scientist of the late nineteenth and early twentieth centuries—called Graham's 1879 lectures the "foundations of modern scientific bread-making."[78] Graham's papers from the 1879 meetings of the Society of Arts were not fully reprinted in the usual manner, though their subtitles indicate an examination of baking that mirrored his earlier examination of brewing. In 1884, he published a full monograph on the chemistry of bread making, and gave a paper on the subject at the International Health Exhibition in London. In this paper, aimed explicitly at "practical" bakers, he combined new understandings of both diastasic action and fermentation with new knowledge on the chemical composition of global wheat supplies to make some of the first scientific recommendations for adopting new methods of baking necessary in a global wheat ecology.[79]

Studies of wheat, flour, and bread were nothing new by the time Graham commented on them in 1884. The Italian chemist Baccaria identified gluten and starch in the eighteenth century, and when J. H. Gilbert and John Bennet Lawes published an extensive study of the chemical composition of wheat, flour, and bread in 1858, they cited a robust literature, particularly among French chemists and physiologists.[80] Before the

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[76] Charles Graham, "The Chemistry of Brewing, Lecture V," *Journal for the Society of Arts* 22, no. 1110 (February 27, 1874): 297–302.
[77] W. H. Preece, "Journal of the Society for Arts, Vol. 27, No. 1407," *The Journal of the Society of Arts* 27, no. 1407 (November 7, 1879): 1001–8.
[78] William Jago, "Modern Developments in Bread-Making, Lecture I, November 23, 1889," *Journal for the Society of Arts* 38, no. 1936 (n.d.): 83.
[79] Charles Graham, "A Lecture on the Chemistry of Bread-Making," in *The Health Exhibition Literature*, vol. VI. Health in Diet (Internation Health Exhibition, London: Clowe and Sons, 1884), 83–110.
[80] John Bennet Lawes and J. H. Gilbert, "On Some Points in the Composition of Wheat-Grain, Its Products in the Mill, and Bread," *Quarterly Journal of the Chemical Society of London* 10, no. 1 (January 1858): 1–2.

1870s, however, these studies were largely local in orientation, and dealt with nutrition or agriculture, not baking. Odling's paper on the chemistry of bread, for example, compared the proportions of gluten and starch (nitrogenous and non-nitrogenous components) of four different samples of wheat, but he made no reference to their particular origin. Instead, he indicated only a general quality, and suggested that the quality was substantially influenced by the wetness or dryness of the weather at harvest, a particularly British concern with wheat.[81] Doctors studying nutrition in the middle of the nineteenth century were of course quite concerned with the chemical composition of foods, and indeed wheat's higher proportion of nitrogen-rich gluten made it appear to be a better food than other staples, such as rice or potatoes. However, while doctors noted the variable quantities of nitrogen—and therefore gluten—in wheat, they made no mentions of the baking process, and were concerned only with the body's chemical inputs and outputs.[82]

The most comprehensive scientific investigation of wheat, flour, and bread before the 1870s was Gilbert and Lawes's 1858 paper. They initially intended it to deal with "the character of varieties, especially in relation to their adaptation, and the qualities they develop, under the influence of broader distinctions as to locality, altitude, and varying climatic circumstances generally." Their hope was a survey of wheat as an environmentally specific product, carried out in "a journey through the chief corn growing districts of Europe, commending at the northernmost point at which wheat is grown successfully." The revolutions of 1848 disrupted their plans, and they were unable to obtain the range of samples necessary through the Great Exhibition of 1851. By 1858 they had only been able

[81] Odling, "On Some Points in the Chemistry of Bread Making," 319.
[82] The examples of this are numerous, but one particularly clear example is Robert Dundas Thomson, "On the Laws of Dieting," *The Lancet* 50, no. 1246 (July 17, 1847): 74. See also Chapter Five.

to analyze the variation of wheat's chemical composition on their own test farm. There, as part of a landmark study on agricultural chemistry, they planted wheat on several plots continuously from 1843. Some of the plots received no manures, others chemical manures, and still others the traditional farmyard manure. In this investigation, they identified variations according to the weather, but the study as a whole remained local in character, dealing only with British growing conditions. They were able to expand their analysis by citing French researchers and thanks to the work of a Mr. Constable of Brighton; with this information, Gilbert and Lawes were able to compile a table of the relative proportions of gluten of the varieties of wheat then available on the British market. They identified the higher gluten contents of wheats grown in warmer weather, and noted that bakers used imported wheats to strengthen relatively weak domestic flours. This suggests that, as John White had suggested in the 1820s, bakers knew something of the foreign wheat and flour available to them and could effectively combine it with domestic flours to produce better bread or lower their costs. At their core, though, Gilbert and Lawes were agricultural chemists seeking to connect the elements in soil, food, and bodies; they made little comment on the actual methods of bakers, and no attempt to recommend particular methods.[83]

By the 1870s, the influx of foreign wheat into Britain made a more systematic investigation necessary for bakers, a problem already noted for millers.[84] The impetus for the first investigation with particular reference to baking came from the empire. Hoping to increase India's wheat exports to Britain, the Government of India shipped more than a

[83] Lawes and Gilbert, "On Some Points in the Composition of Wheat-Grain, Its Products in the Mill, and Bread," 2, 5–24, 48–53.
[84] See Chapter Two.

thousand samples of wheat to Britain in 1879, where a committee under Dr. Forbes Watson was charged with assessing their suitability for the British market. The samples compared favorably with British wheat, and with Dantzic, Australian, Californian, Canadian, and several varieties from the American Midwest.[85] In order for Indian wheat to actually find a market in Britain, it needed to be capable of appearing in a marketable form, and that meant it needed to be assessed not merely as wheat, but as milled flour and baked bread. In an 1882 expansion of the original study, the McDougall Brothers, London millers, carried out extensive milling and baking tests on samples of five thousand pounds each, evaluating each variety's yield of flour on both roller and stone mills, its yield of bread, and the bread's flavor, color, and character. They used a much smaller number of samples than the original investigation, but their choices are revealing, providing a snapshot of the rapidly growing wheat supply chain in the early 1880s. In addition to eight varieties of Indian wheat, they tested English, Australian, New Zealand, Californian, American winter and spring, Russian winter and spring, and two Egyptian varieties.[86] In other words, then, they used the varieties then most commonly found on the British market, varieties that reflected the expanding wheat ecology.

Their study was the first comprehensive investigation of how global wheat might supply the British market, and with two particular findings it articulated a particular geography of bread for the first time. The first was that English flour was best in flavor. The McDougalls assessed each loaf on a numeric scale of flavor, with 10 as "the standard of fair average quality of London Households Bread made from London Flour, Households, and Whites in equal proportions." Their sample English loaf scored a 13, the highest on the

[85] John Forbes Watson, *Report on Indian Wheat* (London: HMSO, 1879), 1–4.
[86] McDougall Brothers, "(East India.) Further Papers on Indian Wheat," C.3710 (London: HMSO, 1883), 25.

chart. Australian, New Zealand, Californian, and American winter loaves came in at 12, while no Indian loaf was above 9; one Egyptian loaf was as low as 4, described as a degree below even a sample itself said to possess "no good points."[87] But if English wheat was the best in flavor, it was near worst in yield. The McDougalls weighed the amount of bread produced by each 280 lb. sack of flour, and found that the English sample produced a mere 352 lbs. This was theoretically enough for 87 loaves, a good return by the standards of the old Assize, but in reality bakers had to include enough extra weight for a loaf to weigh four pounds even after drying for 24 to 48 hours. As such, their English sample likely produced only 80 to 82 loaves, a yield typical of bakers in the first half of the nineteenth century. In contrast, some Indian varieties produced as much as 370 lbs. of bread, enough for four or more additional loaves per sack.[88] Given the thin profit margins of the trade, those four loaves could make a night's labor worthwhile. The difference in yield was a result of two things: the moisture in the flour and the amount of gluten. Drier flours could, naturally, absorb more water than flours that arrived at the bakery already having absorbed moisture. Likewise, flours with more gluten could absorb more water and bake higher, lighter loaves, thanks to the additional structural support provided by the protein. None of this was new to British bakers or the McDougalls: they identified Russian Saxonska wheat as "invaluable for mixing with weaker ones to add strength to the flour," due to its high gluten content, double that of their English sample.[89] Their report is a watershed moment in the history of Britain's wheat, flour, and bread, however, because it articulated systematically and comprehensively what many bakers had already known through their

[87] Ibid.
[88] Ibid.
[89] Ibid., 27–8.

labor. It also provided a more systematic justification for the mixing that British bakers were likely already doing: using English wheat to give bread a good flavor, using drier and stronger imported varieties to increase their yields, and using cheaper varieties to bring down their costs.

By the early 1880s, the intellectual components of scientific baking were in place: new understandings of the chemistry of baking, including malting and fermentation, and new knowledge of the character of wheat and flour produced in the emerging global wheat ecology. Together, they suggested that science could transform baking from an antiquated, craft-based, guild-organized trade into a modern, scientific industry. Actual change, however, needed sites for the articulation of a new discourse of scientific baking, institutional support, and practical means of training new bakers. The first of these elements was the development of a new kind of trade publication in baking. The very first articulations of new knowledge relevant to baking appeared in the first milling publications of the 1870s. By this point, foreign wheats and their processing presented a pressing issue for British millers, and by extension for bakers. Thus, while early milling publications were certainly focused on milling, they were also relevant to bakers. Early issues of *The Miller* included a survey of the British baking trade, and they encouraged millers to align their products with bakers' needs, remarking that the millers were "beholden" to the bakers, their customers.[90] As such, understanding the qualities of flour bakers desired was critical, and discussions of qualities of flour such as strength, color, and "bloom" were common.

Publications aimed specifically at bakers and with an explicitly scientific agenda appeared in the early 1880s. Prior to that point, baking publications were almost

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[90] "The Present Condition of the Baking Trade.--No. 3," *The Miller*, May 3, 1875.

exclusively focused on laboring conditions and organization. *The Staff of Life*, for example, was first published in 1866, and identified its object as the "Physical, Mental, Moral, and Social elevation of the great body of operatives, whom we claim to represent." To achieve such comprehensive goals, the paper aimed to help bakers organize to abolish night work and secure twelve-hour days, increased wages, and Sundays off.[91] By the 1880s the focus of baking publications shifted to practical methods articulated in a scientific discourse. These began with the studies in the chemistry of baking carried out by Charles Graham noted above, and continued in monographs on the subject by Graham in 1884 and William Jago in 1886.[92] Graham, as noted above, was an early researcher in the chemistry of brewing, while Jago began his career in inorganic chemistry.[93] In both cases, scientists who had previously worked in other fields began to apply their expertise directly to the practical manufacture of bread. At the same time Graham's and Jago's monographs appeared, a new kind of baking periodical oriented around scientific baking appeared. These periodicals regularly featured articles on topics such as the "Scientific Basis of Cookery."[94] They also began to publish sample technological examinations that dealt with questions about the chemistry of malting, fermentation, and baking, and the composition of various flours.[95]

The new baking publications made explicit their endorsement of scientific knowledge over the older, craft-based forms of knowledge on which baking had previously

[91] "To Our Readers," *The Staff of Life. A Bakers' Journal*, September 29, 1866.
[92] William Jago, *The Chemistry of Wheat, Flour and Bread, and Technology of Breadmaking* (Brighton: William Jago, 1886).
[93] William Jago, *Inorganic Chemistry, Theoretical and Practical: An Elementary Text-Book* (London: Longmans, Green and Co., 1881).
[94] "The Scientific Basis of Cookery," *The British and Foreign Confectioner*, April 1, 1884.
[95] William Jago, "Technological Examination of Bread-Making," *The British and Foreign Confectioner*, November 1, 1884; Jago, "Technological Examination in Bread-Making."

been based. An 1886 article in *The British Miller and Baker* made evident the development of a new discourse when it claimed that

> The days of slavish adherence to mere tradition and to a blind obstinate plan—we cannot call it method—of doing everything on borrowed experience, copied… but not understood, are happily over, and the era of intelligence, of progress, and of general enlightenment has very fairly commenced.[96]

The piece continued, praising the importance of theoretical knowledge for practical baking skills. In 1903, John Kirkland—under whom the National School of Baking at the London Borough Polytechnic was formed in 1899—opened a series of baking lectures in Ayrshire by claiming that baking was "not a lost, but a new art," reinvented by the application of science. "Has not bread-making its roots in the past?" he asked rhetorically, answering "No! There has been evolution, but the scientific basis sought for in the present is breaking away from all the traditions of the past." Our ancestors "happened upon leavening" by chance, "while we may abide by it with our eyes open and minds alert."[97] He explicitly endorsed theoretical, classroom education as an indispensible adjunct to baking practice, a far cry from John White's 1828 insistence that baking could only be learned "at the trough, the table, or the oven mouth," and never from a book or laboratory.[98]

An important moment in the development of scientific baking was the formation of the National Association of Master Bakers and Confectioners of Great Britain and Ireland in 1887. The first national trade organization for baking—a decade after the National Association of British and Irish Millers—the NA was a new kind of labor organization. Unlike earlier, local organizations, the NA was much less concerned with organizing for

[96] "Millers and Bakers as Readers and Thinkers," *The British Miller and Baker*, September 1, 1886.
[97] A. Kirkland, *Studies for the Bakehouse: Being Lectures Delivered to the Ayrshire Class* (London: "The Baker and Confectioner," Ltd., 1903), 12–13.
[98] White, *A Treatise on the Art of Baking*, vi.

shorter hours, and much more concerned with the pursuit of national political influence. Formed in 1887 on the initiative of the Birmingham Master Bakers' Association, their initial objectives were to advocate for improvements in the "laws and customs of the Baking Trade of the United Kingdom" so that the "social status of the whole trade could thereby be raised." The promise of better baking offered by science was alluring, and the organization made explicit their support for scientific baking from the beginning. Their meetings always included the reading of research papers on topics such as flour blending, machinery and techniques for baking, and the history of leaven. The NA quickly formed alliances with the new trade publications, and the *British and Foreign Confectioner* became its official organ. By 1889, their meetings included an Examination Committee that judged essays on theoretical and practical aspects of bread making. Their prizes again reflected their support for scientific baking: first prize was a microscope.[99]

Finally, with scientific baking articulated in new publications and supported by the NA, new technical training programs served to disseminate it to new generations of bakers. As early as 1890, NA members discussed the need for a technical institute to train bakers, and sought a way to provide "a systematic course of training in theoretical and practical bakehouse work; the practical use of the microscope; testing and examination of different varieties of flour and yeast; and the study of various methods of breadmaking in operation in different districts." They also hoped to include annual lectures on the chemistry of bread by eminent scientists, a practical commercial course including checking produce, bakery accounting, and bread delivery, as well as regular reports on "condition and value of

[99] *Twenty-One Years History of the National Association of Master Bakers and Confectioners*, 19–20.

various classes and qualities of flour produced throughout the world."[100] This scheme proved too ambitious for the NA to undertake itself, but the new Borough Polytechnic Institute in South London began classes in baking in 1894, and in 1899 established a National School of Baking under the leadership of John Kirkland.[101] While these training programs were far too small to displace the older apprentice-based modes of training that had sustained the trade to that point immediately, they do illustrate the ways that scientific baking was a discourse based on the universal tenets of science. The knowledge it offered was neither specific to a particular place, nor embodied in the baker him- or herself, nor acquired only through decades of labor. Instead, it was universal, systematic, and abstract, theoretically available to any student who could grasp the universal principles of chemistry and biology in a classroom or from a book.

Global Wheat and Global Baking

Scientific baking provided practical benefits to bakers, giving them a body of knowledge for dealing with the new varieties of flour and yeast that were available in the new global wheat ecology. With changing flour and yeast supplies, it is likely that many bakers changed their methods as well; whether they developed new methods simply based on trial and error or through the new baking publications, National Association meetings, or technical classes is difficult to know, but it is certainly the case that scientific baking proliferated as a discourse. Publications in scientific baking grew rapidly from the 1870s, and began to make specific recommendations for how to deal with global flour supplies in the early 1880s. Charles Graham's 1884 paper at the International Health Exhibition in

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[100] Ibid., 24–5.
[101] Owen Simmons, *The Book of Bread*, 1903, 58–9.

London made some of the earliest recommendations for applying science to baking. After a thorough explanation of the chemical changes observed in diastasic action and fermentation, and a discussion of the physical and chemical characteristics of yeast and flour, including microscopical diagrams of yeast cells and wheat grains, Graham then gave an account of London baking. He described the sponge and dough process very much as John Bennett had described it to Hugh Tremenheere in 1862, when the latter led a Parliamentary investigation of the conditions of journeymen bakers. Graham, however, considering the changes that occurred in the process and the different varieties of flour available, and suggested not only that bakers should combine environmentally specific flours, but that different flours should be employed at different points in the bread-making process. He conducted a series of experiments with Messrs. Hill, Bishopgate bakers, and Mr. Dunham, the founder of *The Miller*, in which hard American flour was used for the sponge stage, and soft Norfolk flour used in the doughing stage. This allowed the tough gluten of the American flour to mellow in the fermentation process, while preserving what strength the Norfolk flour offered. The loaves baked in this manner were far superior in their rising and color, compared to those in which either only one variety of flour was used or in which the two varieties were mixed at the outset.[102]

This essential pattern, in which hard flours were used in the ferment and sponge stages, and soft flours were used in the dough, became a standard method for incorporating geographically diverse flours into bread. Shortly after Graham's paper, trade publications made the same recommendations: the *Baker & Foreign Confectioner* suggested strong

[102] Graham, "A Lecture on the Chemistry of Bread-Making," 105–8.

Minnesota flour in the sponge, and mild, dry California flour in the dough.[103] The most thorough account of the various methods and materials available to bakers, and the best ways of combining them, was William Jago's 1895 *Text-Book of the Science and Art of Bread-Making.* He surveyed methods, from off-hand or straight doughs, in which the ingredients were all combined at once, to ferments and sponges of varying lengths, and argued that each system had its particular role to play in transforming the heterogeneous products of a global wheat ecology into marketable bread. At times, this required bakers to know the specifics of global flour supplies and to choose and combine specific flours for particular purposes. He advocated "ferment and dough" methods for crusty and tin bread in the south of England, and argued that for this product, geographically specific, and fairly soft flours were necessary: spring American varieties were useful, but "Russians seem to suit this method of bread-making better than the spring Americans, owing to their glutens mellowing down more rapidly." Some bakers, he noted, used exclusively English flours with this method, while others relied on winter Americans or Hungarian flours. A second method he described was the Scottish "Flour Barm, Sponge, and Dough," producing "the well-known and close-packed 'Scotch Brick'… a high and comparatively narrow loaf, prepared from tough, hard flour of the highest class." This method also required different flours at different stages, and he—following the broad recommendations outlined by Graham in the 1880s—advised "strong patents or straight grades from Duluth or Russian wheats" in the sponges, and "winter Americans or softer, but still tough, home-milled flours" in the doughs.[104]

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[103] "Californian Flour," *The British and Foreign Confectioner*, June 1, 1884.
[104] Jago, *A Text-Book of the Science and Art of Bread-Making*, 344–8.

At the same time that scientific baking found roles for different flours, British millers were attempting to combine wheats to produce mixtures suitable for bakers. This resulted in a contest of sorts between millers and bakers, each attempting to control knowledge of flour's origins because doing so offered greater possibilities for adding value by the most economical combinations. Millers sought to develop mixtures that were consistent in their baking characteristics but that used the cheapest wheats possible; at the same time, many bakers preferred to do their own mixing, and complaints about millers were common. At times, bakers' complaints were simply that millers could not produce consistent flours from the wide variety of wheats available. An article in the *Baker and Foreign Confectioner*, for example, complained of the "excessive" blending of wheats in 1884. The article reminisced fondly for days gone by, in which "The corn grew around the mill where it was ground, and it was all of one kind, and the baker knew what he was dealing with." While this may have been a particularly rosy view of the past, certainly in line with the anti-scarcity ideal of a direct relationship between production and consumption, it does match to some extent the strategies of bakers in the early nineteenth century, who had longstanding arrangements with particular country millers (see above). By the 1880s, however, "the flour a baker gets is often blended from wheat which comes from all the ends of the earth, and never hardly does he get two loads alike." The solution, according to the *Baker and Foreign Confectioner*, was for the millers to grind single wheats and allow the baker to do the mixing, which was "clearly his business and not the miller's."[105] Certainly, the milling community at the time would have disagreed, given the

[105] "Bakers' Profits," *The British and Foreign Confectioner*, April 1, 1884.

amount of effort they put into knowing global wheat supplies for the express purpose of combining them.

While some bakers clearly used single-wheat flours in ways that maximized their characteristics to produce the highest quality loaves, all bakers faced a certain calculus in which they had to balance the price of materials with the amount of labor required. Because of this, flours that allowed bakers to use less labor-intensive methods could produce better profits, and it is clear that some bakers adopted blended flours because they could simplify baking methods. Jago described the advantages of off-hand doughs, for example, which he argued were best with "strong patent flours," especially "Strong London households." These were flours blended by London millers, and when successful, they were examples of flour with consistent characteristics made from variable supplies of wheat. Jago explained that these flours used in an off-hand doughing system could produce loaves "very red and fiery in the crust," not the best in color but with the large advantage that they took just six hours to prepare.[106] The blended wheats millers offered thus provided the option to sacrifice color and appearance for economy of labor and simplicity of production. In combination with stronger and more reliable yeast, and perhaps with the improved skills of millers, it appears that methods requiring just a single variety of flour became more popular late in the nineteenth century.[107] The *British Baker* reprinted an article from *Milling* in 1900, which noted that long sponges were particularly well suited for the hard foreign wheats that arrived in great amounts from the 1870s. But, despite this, the article claimed that bakers were by that point beginning to turn to shorter sponges. "Quick

[106] Jago, *A Text-Book of the Science and Art of Bread-Making*, 344–6.
[107] Robert Wells, *The New System of Making Bread: A Concise and Practical Treatise on Bread and How the Make It* (Manchester, U.K.: Abel Heywood & Son, 1903), 36.

sponging and doughing are finding more and more favour with bakers in England," the article explained, in substantial part because of the availability of stronger yeast. "With a short system of fermentation such as this," the author explained, "British milled flours, and, above all, flours containing a large portion of English wheat, ought to enjoy considerable favour." In other words, a single flour with the right combination of wheats could produce sellable loaves baked in the most efficient manner.[108] Certainly, this was something that the readers of *Milling* wanted to hear, but its reproduction in the *British Baker* suggests that it was relevant to bakers as well.

Beyond the practical benefits of adjusting their methods to accommodate the different varieties of flour available, scientific baking also gave bakers a means to engage with and to some extent control the biopolitical surveillance that had existed since the 1860s. A major strand of scientific baking turned on sanitation and the management of the bakery environment, but scientific baking's deployment of microbiology gave sanitation a new meaning in the 1870s and 1880s. The focus on microbes, in yeast but also throughout the bakery, shifted the defining characteristics of the bakery environment away from the bodies of the bakers and toward the ubiquitous microscopic life forms. In the first place, friendly microbes had to be well cared for, and this was one of the earliest elements of scientific baking articulated. Bakers began regularly using ingredients in their ferments and sponges that were specifically designed to produce healthy yeast. Owen Simmons, for example, emphasized the need for a "perfect yeast food" in a ferment or sponge, and described it in chemical terms: an appropriate proportion of carbohydrate, preferable

[108] "The Rehabilitation of British Flour," *The British Baker*, May 25, 1900.

glucose and maltose, along with nitrogen-rich proteids, and phosphorus, potassium, magnesium, calcium, and sulphur.[109]

The management of yeast and other microbes was not simply a matter of microbiotic metabolism; it was also a matter of managing the environment inside the bakeries. The older concern with the cleanliness—and morality—of the men and women working in bakeries was joined by measures to control microbial populations. Robert Wells, in his 1903 manual *The New System of Baking*, prioritized cleanliness in the bakery, and argued that sourness in bread—that old foe of bakers—was due most often to "carelessness and want of cleanliness." "If a bakehouse is not kept clean, and is not regularly whitewashed," he argued, "the atmosphere becomes contaminated with germs, which enter into sponges, doughs, barms, &c… They are as contagious as a fever, and it is as difficult a thing to expel them from a bakehouse as it is easy for them to enter one."[110] Kirkland, writing in the *British Baker*, explained that when the sponge was fermenting, it was in danger of contamination from water, dust, and even the flour itself: "The soil of foreign lands" and the "dank matter of musty holds" might accompany the wheat into the mill, and even remain with the flour, he warned. He recommended "cleanly harvested wheat," with storage facilities situated "on heights, open to air and sun—Nature's most active micro-killers." He wanted bakeries similarly situated, so that they might be truly hygienic, "Built in the region of pure air, roomy, well-ventilated, and flooded with the sun."

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109 Simmons, *The Book of Bread*, 46.
110 Wells, *The New System of Making Bread: A Concise and Practical Treatise on Bread and How the Make It*, 30–1.

In such circumstances, he claimed, "We have then some of the first conditions of pure bread."[111]

The concerns of working bodies, microbes, and the environment within the bakery were best articulated in the model bakeries that began to appear by the end of the century. Although many bakers were adopting machines, large factories for bread making were rare; on the whole, baking continued to take place in fairly small quarters. The *British Baker* complained in 1898 that most London bakeries were hot, "dingy, cramped, and uninviting," but "frequent inspection kept them clean."[112] Nevertheless, with the development of scientific baking, some writers did begin to imagine new kinds of perfect, "modern" bakeries. The *British Baker* described a model bread factory that was the very antithesis of the mid-Victorian subterranean bakery that Tremenheere had discovered. This factory was multistory, and combined scientific baking with a more sanitized and disciplined management of laboring bodies. On the top flour was the flour sifting and mixing room in which "every bit of foreign matter is taken from the flour," further purifying even "the cleanest and best flour." From there, the flour was mixed into dough, not by "brawny men, who knead and maul it till they puff with exhaustion"; instead, "in the perfectly equipped establishment the kneading is done by machinery." Workmen did handle the dough, but in the model bakery these workmen were more disciplined, fitted out in "square white caps," and surrounded by "notices… to the effect that a pin found on their person… will subject them to immediate discharge, and that no person will be allowed to carry tobacco into the bakery in any form."[113] In this way, model bakeries, and by extension scientific baking

[111] A. Kirkland, "The Bread of Commerce," *The British Baker*, March 25, 1898.
[112] "London Bakeries," *The British Baker*, March 18, 1898.
[113] Ibid.

itself, attempted to obviate the biopolitical interventions of medical professionals by policing themselves, adopting the very same language of discipline.

Aside from the practical benefits scientific baking offered, and the ability to control or at least influence the biopolitics of bread, scientific baking also gave bakers a new way to view themselves and their trade. From medieval and early modern times, bakers had been identified by the privileges accorded to their guilds. As was the case with millers, global wheat supplies, national organization, and scientific methods gave bakers a much broader perspective on themselves and their place in the world. And, as with millers again, they began to situate themselves as expert mediators between British bodies and global environments, playing a vital role in the health and prosperity of the British nation, and in maintaining the strength of the empire and its civilizing mission.

Bakers had long described their history in ways that suggested a privileged position for their trade; many pamphlets and textbooks on baking began with a history that put baking at the center of human civilization broadly and British history in particular. These histories typically drew direct connections between modern baking in Britain and ancient Egyptians, Jews, Greeks, and Romans, in some cases going back to Neolithic times.[114] They frequently noted bakers' position in ancient Rome, where they enjoyed the benefits of the College of Bakers, a guild-like organization that kept baking within certain families, guaranteed them a living, and even allowed some bakers to become senators.[115] Writers also frequently gave baking a specifically Anglo-Saxon history, often beginning with the fable of Alfred the Great's burned cakes. The ninth-century King of Wessex and the only

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[114] John Ashton, *The History of Bread: From Pre-Historic to Modern Times* (London: Religious Tract Society, 1904), 13.

[115] George Read, *A Brief History of the Bread Baking Trade, from the Earliest Period to the Present Time...* (London: George Biggs, 1848), 13.

English king to earn the moniker "Great," Alfred took refuge with a peasant's wife who, unaware of his royalty, left him to watch cakes baking on the hearth. Lost in thought about the dire situation of his kingdom in its ongoing wars against Viking invaders, Alfred did not turn the cakes properly, and let them burn, earning him a scolding.[116] The *Guide to Trade* took a more linguistic approach to putting bread at the heart of British history, describing the Anglo-Saxon origins of the words bread, from "brayed grain," dough, from "dorv" or "whetted," and loaf, from "hlif-ian" meaning "to raise up."[117]

Putting baking at the heart of British history was not an apolitical rhetorical move, however, and nearly all accounts of the trade's history followed by describing the trade's privileged position in early modern Britain. The main pieces of evidence for this were the Assize of Bread, which guaranteed bakers a measure of protection from competition, and a decree from Henry VIII which insisted that "No man, for using the mysteries or science of baking, brewing, surveying, or writing, shall be interpreted as a handicraft," a designation that bestowed greater privileges on bakers.[118] These histories of baking, while placing baking at the center of the historical development of civilization, did little to bring baking's privileged role into the present, instead concluding that baking had fallen due to its exposure to the marketplace, the avarice of millers and grain merchants, and the foolish preferences of consumers.[119] In this way, histories of baking frequently articulated baking's role in an anti-scarcity system, in which the preservation of a the direct connection production and consumption was the moral ideal; bakers saw themselves as playing a vital role in preserving that connection, and lamented the present situation, in which the

[116] Ibid., 4; Ashton, *The History of Bread*, 84.
[117] *The Guide to Trade: The Baker; Including Bread and Fancy Baking with Numerous Receipts*, 9–10.
[118] Ibid., 13.
[119] Read, *A Brief History of the Baking Trade*, 14–17.

merchants and millers (as well as the bakers themselves) stood between producers and consumers.

The development of a global wheat ecology and the biopolitical apparatus that supported it, however, suggested a wider possible role for bakers. Instead of limiting their concerns to local environments in Britain or the long-gone traditional privileges of their trade, bakers began to actively endorse the globalization of wheat, often on imperial or racial grounds. The *Baker & Confectioner*, for example, had no problem with imported flour from Canada and India in 1879, endorsing the growth of imports from the two imperial territories on the grounds that "national interdependence" could be beneficial. It was appropriate in Canada and India because they were linked by the "common heritage of the race."[120] Many bakers at the very least saw imported flour as necessary. An 1884 article in the *Baker & Foreign Confectioner* gave an unsympathetic account of a boycott of foreign flour organized by the Dublin bakers. The author argued that relying on domestic flour only assured that either the bread would deteriorate in quality or the bakers would go bankrupt.[121] Some bakers went so far as to condemn British farmers for continuing the grow grain in the face of American imports. "Cousin Jonathan beats us in corn-growing and the sooner that fact is knocked into the head of the British farmer the better it will be for him," the *Baker and Confectioner* argued in 1892. Once they understood that wheat would not be profitable in competition with foreign imports, the author reasoned, British farmers could switch to more profitable pursuits such as fruit or poultry.[122]

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[120] "India as a Wheat Field," *The Baker and Confectioner*, October 6, 1879.
[121] "Bakers' Profits."
[122] "American Versus European Corn-Growing," *The Baker and Confectioner*, n.d., September 13, 1892 edition.

Once bakers began to situate themselves in broader national, imperial, and global contexts, they began to endorse their own positions on the grounds of national efficiency, particularly in the wake of imperial crises in the late 1890s, including particularly the Boer War.[123] The *British Baker* in 1898 wanted bakers to view themselves as citizens with clear roles to play in the health of nation. "Bread-eaters are almost invariably healthy and strong," the *British Baker* claimed; "Nothing makes up to a growing child for the loss of its thick bread and butter."[124] In discussing the role of bakers in the nation's and empire's health, the same publication described wheat, corn, and rye, as "the principal breadstuffs of the civilised world," and bread as the "staff of life," which, "when well made and of proper material, a very stout and reliable staff it is." For the great bulk of the population, the article continued, "in bread lies their vital force. Transformed in the human economy, it is the great lever which moves the world."[125]

Conclusion

By the close of the nineteenth century, then, British bakers adopted a biopolitical discourse of scientific baking, based on the apparently universal principles of science. This new discourse matched their practice, as they abandoned the "local" practices and forms of knowledge that had served them well until about 1870. At that point, however, the combination of disciplinary surveillance, a global wheat ecology, and a free market in bread drove them to adapt both their methods and their expertise—which they did, comprehensively. Bakers learned to deploy the products of a global wheat ecology, to use

[123] Dane Keith Kennedy, *Britain and Empire, 1880-1945* (Harlow: Longman, 2002).
[124] "The Bakers as Citizens," *The British Baker*, n.d., sec. April 22, 1898.
[125] "Whole-Wheat Bread," *The British Baker*, July 22, 1898.

new forms of industrially produced yeast, and to situate themselves within British and imperial society as experts, in much the same ways that millers did. And, this biopolitical discourse of scientific baking, combined with roller-milled flour and foreign wheat, this resulted in ever-whiter bread.

CHAPTER FIVE

NATURE AND NUTRITION

After the British state dismantled the medieval and early modern anti-scarcity system, with its moral ideal of a direction relationship between production and consumption, and replaced it with a biopolitical system of security based on the market, the origins of their daily bread became more difficult for most Britons to discern. The farmers who grew their wheat became more distant and more varied[1]; millers developed the technical expertise necessary to produce consistent, homogeneous flour from highly variable global wheat supplies[2]; and bakers learned to produce whiter, more highly risen, and more consistent bread from those same supplies.[3] Moreover, from 1851, Britain was a majority urban nation and most individuals were simply less involved in food production than in the past.[4] These developments combined to substantially restrict consumers' direct access to knowledge of the origins of their food supplies. Knowledge of food is, however, absolutely necessary, for all food must be meaningful in some way in order to fit into a society's cultural registers.[5] In a world of largely local food supplies, with an anti-scarcity system that governed the production and distribution of food by prioritizing as direct as possible a relationship between production and consumption, the underlying assumption was that the labor and experience of production itself was knowledge enough. In a society in which individuals and families largely produce their own food, the knowledge of

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[1] See Chapter One.
[2] See Chapter Two.
[3] See Chapter Four.
[4] For an overview of changing cooking practices in relation to urbanization, see Andrea Broomfield, *Food and Cooking in Victorian England: A History* (Westport, Conn.: Praeger, 2007).
[5] This is a central premise of anthropological studies of food, established in the works in Mary Douglas and Jack Goody. For a recent interdisciplinary overview of the topic, see Carole Counihan and Penny van Esterik, eds., *Food and Culture: A Reader*, Second Edition (New York: Routledge, 2008).

consumption is deeply tied to food's production and to labor. In that case, other forms of knowledge are not necessary (though they certainly may exist). However, when a food supply becomes global and a population becomes urban, that fundamental unity between food's production and consumption is ruptured. Grain merchants, millers, and bakers had existed long before the globalization of Britain's wheat ecology, but in the context of the new world wheat ecology, they combined to effectively disaggregate production and consumption. And, without ready access to knowledge of and meaning derived from food's origins and production, there was effectively a gap in the knowledge required to make food meaningful and palatable. Into this gap stepped new experts: merchants, millers, and bakers to an extent, but also the physicians and medical inspectors who brought a disciplinary gaze to bear on the filthy bakeries and adulterated bread that had resulted from the deregulation of the baking industry.[6] The problems of adulterated bread and filthy bakeries that came to light in the 1850s and 1860s illustrate this gap in knowledge.

Another form of knowledge that developed simultaneously with the globalization of Britain's food supply, and that helped fill the gap between production and consumption, was chemical physiology, and in particular medical knowledge of nutrition. Physicians, philosophers, and scientists had long considered food's role in health, but the chemical nomenclature developed in the late eighteenth century provided a new language for this investigation. This led to vigorous debates among doctors and scientists about the nature of food, the operation of the body, and precisely what minimum and optimal diets were. From the publication of Justus Liebig's 1842 *Animal Chemistry*, which articulated the first comprehensive theory of chemical physiology, until the first decade of the twentieth

[6] See Chapter Three.

century, medical research used quantitative chemistry to describe the materials necessary to allow muscular action, maintain bodily heat, and grow and maintain tissue. Liebig's views privileged nitrogen-rich protein as the only truly nutritive constituent in food, a position that other researchers challenged in subsequent decades. What Harmke Kamminga and Andrew Cunningham call a "broad consensus" emerged by the 1890s, and held that energy was the most useful descriptor of food's value to the human body and that the main macronutrients—fats, carbohydrates, and proteins—were interchangeable in terms of energy provision, but that a minimum amount protein was necessary for health.[7] Research into micronutrients upset this consensus in the years before World War I. The identification of vitamins, from the German doctor Casimir Funk's 1912 term "vitamines" or "vital amines," dominated nutrition research from the 1920s, while leaving largely undisturbed physiologists' understanding of the importance of energy in food. The period from the early nineteenth century's adoption of chemical nomenclature until the discovery of vitamins on the eve of the First World War is thus a useful period for studying the history of nutrition, defined by the ascendance of and contests around chemical physiology.

The new knowledge of chemical physiology articulated and reinforced the Cartesian binary, the cultural and intellectual separation of humans and nature that, according to Jason Moore, underpins both the Scientific Revolution and the development of modern capitalism. Ancient and medieval ideas of health had made clear connections between human bodies and the environments in which they existed, seeing ill health as some form of imbalance in the particular, local relationship between a body and its environment; in

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[7] Harmke Kamminga and Andrew Cunningham, "Introduction," in *The Science and Culture of Nutrition, 1840-1940* (Amsterdam: Rodopi, 1995), 9.

these schemes, food was a primary aspect of those body-environment relationships.[8] In this way, medieval ideas of nutrition mirrored the anti-scarcity systems that governed food's production and consumption, for both prioritized a direct relationship between humans and their immediate environments through food. Chemical physiology, however, severed those particular and local relationships between bodies and environments. It reduced food and nutrition to a set of abstract, universal, chemical (and later thermodynamic) exchanges: nutrition and health were no longer the result of particular connections between bodies and environments, but instead the product of the universal laws of chemistry. Doctors, physiologists, and other researchers began to see bodies and environments as universal, distinct, internally homogeneous categories engaged in a continuous and complementary chemical exchange through respiration and food. Individual bodies and specific landscapes were not identical, but doctors and scientists expected each to operate according to the universal laws of chemistry, and to participate in continuous chemical exchange, with all operations reduced to quantifiable chemical reactions. Plants, they believed, transformed elements too simple for animal use into the more complex compounds that animals needed. Animals, in turn, obtained these complex compounds by consuming plants or other animals, and metabolizing them. They excreted simpler substances that, after a period of decay and decomposition, were available for plants, thereby renewing the cycle. The medicalization of "food" thus situated it as one part

[8] Roy Porter, *The Greatest Benefit to Mankind: A Medical History of Humanity from Antiquity to the Present* (London: Harper Collins, 1997), 56–8.

of the chemical exchange between bodies and environments, a homogeneous category composed only of complex compounds in forms more or less useful for humans.[9]

This new form of knowledge was (and remains to this day) biopolitical. Like milling and baking, it facilitated the organization of food production through the market. And, like the disciplinary inspections of bakeries, it provided a body of expertise useful for managing the biological existence of the population. Identifying the best food or combination of foods to ensure health for individuals and populations was a question of fundamental biopolitical importance for doctors, physiologists, and administrators, as well as for British consumers in the second half of the nineteenth century. Although their understandings of how bodies actually absorbed or used nutrients changed considerably from 1840 to 1914, a strictly chemical understanding of nutrition led doctors to consistently endorse white, wheaten bread as the ideal food, or the greater part of the ideal diet (usually alongside protein-rich foods such as meat or cheese). If the fundamental nature of relationships between bodies and environments was the exchange of chemicals in food, respiration, and waste, then, doctors reasoned, white bread was the most efficient way to accomplish this task. In this way, the medicalization of bread endorsed cereal agriculture, for only the cultivated field could provide the chemical elements and energy in suitable form to maintain the vital chemical exchanges between humans and nature. Moreover, because bread—like all foods—was viewed simply a package of useful chemical compounds, it made little difference from a medical perspective if the wheat comprising one's daily bread came from near or far. From a nutritional standpoint, environments were essentially homogeneous, all

[9] This view of human relationships to nature is very similar to the radically simplified, "high-modernist" views of nature and society James Scott describes. And, like the views of nature that Scott describes, it was a view that was useful to institutions because it offered clearly "legible" registers for understanding complex phenomena. See *Seeing Like a State : How Certain Schemes to Improve the Human Condition Have Failed* (New Haven: Yale University Press, 1998).

producing greater or fewer nutrients for human consumption. And, to the extent that wheats from beyond Britain's shores appeared chemically superior, and allowed for whiter bread, chemical physiology actively endorsed the globalization of Britain's wheat ecology.

In this way, the medical profession functioned within Britain's wheat ecology in a similar way to that of millers and bakers. Each group contributed to the material and cultural construction of a loaf of bread that was homogeneous and without origin beyond its most proximate point of distribution. Millers performed this operation by producing homogeneous flour from increasingly diverse global wheat supplies, ensuring that Britons' daily bread remained consistent despite global environmental variability. Bakers performed the same operation of flour, turning it into the well-risen white bread that consumers demanded. Doctors, in turn, performed this operation by providing medical expertise that imagined bodies, environments, and foods as abstracted, homogeneous categories whose relationships could be beneficially scaled up. Nineteenth-century physiology, therefore, provided to both the state and to consumers an occasionally-explicit but always implicit endorsement of what was without doubt a novel relationship between humans and nature: the emerging world wheat ecology.

Biopolitics and Nutrition

For many decades, histories of science and medicine took as their object the description of "progress" through "rational, scientific enquiry." These histories treated scientific and medical knowledge as essentially disembodied truths awaiting discovery by the investigator who most skillfully performed such inquiry. The truths thus revealed were then available for the next step of research, each of which brought scientific and medical knowledge step by step up to contemporary understandings of the universe. Knowledge that did not "contribute" to understandings current to the authors was treated as misfortune or error, attributed to incompetence or superstition, or simply ignored altogether. Histories of nutritional science are surprisingly rare, but those that exist fit easily into this historiography: European, American, and colonial doctors and scientists combined to produce our contemporary, scientifically articulated, medically endorsed, state-sanctioned and institutionalized understanding of the human body and its operation.[10] Karl Guggenheim's *Nutrition and Nutritional Diseases: The Evolution of Concepts*, for example, is a thorough and well-researched narrative of clinical and laboratory research that led to the understandings of nutrition current in the late twentieth century. He located the origins of these understandings in the seventeenth century, the point he characterized as "the dividing line between the Middle Ages and the modern world." It was at this moment that, thanks to the scientific revolution, scientists were encouraged to accept "observation and experimentation as a method of elucidating the laws of nature," so that, for the first time since the Classical world, "attempts were again made to explain natural phenomena on a rational basis." In Guggenheim's narrative, typical of this style of history, nineteenth-century doctors were important for their development of chemical physiology and then the energy-based conception of food embodied in the calorie; twentieth-century doctors contributed the "newer knowledge of nutrition" by identifying the importance of micronutrients and the operations of metabolism at a cellular level.[11]

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[10] In this way, the science of nutrition remains a biopolitical apparatus even today.
[11] Karl Guggenheim, *Nurition and Nutritional Diseases: The Evolution of Concepts* (Lexington, Mass.: Collamore, 1981), 43; the phrase is from Elmer Verner McCollum, *The Newer Knowledge of Nutrition* (Macmillan Company, 1922); For more recent works with the same approach, see Lee McDowell, *Vitamin History, the Early Years* (Sarasota: First Edition Design, 2013) and Frances Rachel Frankenburg, *Vitamin discoveries and disasters: history, science, and controversies* (Santa Barbara, Calif.: Praeger/ABC-CLIO, 2009).

This approach provides a great deal of information and describes in abstract terms how doctors and scientists arrived at their current knowledge. However, the teleology underlying such an approach elides the overwhelming majority of doctors, patients, and indeed the rest of society, who played very little role in such research. The broader social, cultural, and political contexts of medical research and practice are effectively ignored, and the few great men deemed to have made a worthwhile contribution are described as though they worked in laboratories and clinics whose only elements were evidence and logic.

More recent histories of science and medicine have treated the subject not as an uncomplicated and abstracted body of knowledge, but as a social, cultural, and political phenomenon. These approaches have encouraged historians to re-examine medicine in terms of patients, the state, and the medical profession.[12] The last generation of historians has produced studies revealing not only the changing nature of medical practice, but also the social, cultural, and political salience of medicine and related ideas of the body. In recent accounts of nutrition in the nineteenth and twentieth centuries, historians have similarly expanded their focus, investigating the "production of scientific knowledge about nutrition and the social and political valuations that have entered into the promotion and application of such knowledge."[13] This has led to productive discussions of the application of nutritional science in cookery instruction and in the provision for dependent populations in workhouses, in barracks and on ships, as well as medicine's role in the

[12] The classic study is Michel Foucault, *The Birth of the Clinic: An Archaeology of Medical Perception*, trans. A. M. Sheridan Smith (New York: Vintage Books, 1994); For a recent overview of shifts in the historiography of medicine, see Dorothy Porter, *Health, Civilization, and the State: A History of Public Health from Ancient to Modern Times* (Abingdon, U.K.: Routledge, 1999).

[13] Kamminga and Cunningham, "Introduction," 1; David Smith takes a similar approach in his work, David Smith, ed., "Introduction," in *Nutrition in Britain: Science, Scientists, and Politics in the Twentieth Century* (London and New York: Routledge, 1997).

often-problematic rendering and political articulations of hunger.[14] Nor have recent histories neglected the intellectual history of research in nutrition, and there have been useful explorations of nutrition's historical situation within social, cultural, and political contexts, through doctors' changing views of the importance of protein, or their use of the "human motor" as a central metaphor underlying medical understandings of the body and its representations in nineteenth and twentieth-century policy.[15] The anthropologist Nancy Chen has expanded the boundaries of cultural and intellectual studies of nutrition by suggesting that food and medicine should be considered as a "continuum, rather than as two separate arenas," arguing that the boundaries between food and medicine are culturally specific. She notes further that food and medicine generate the "boundaries of the social being as well as the individual body" through the profound cultural meanings they carry: every culture has specific though often unstated rules regarding who may eat what, when, and with whom, rules that instantiate some of the most basic structures of society, culture, and politics.[16] Chen's argument does not deal specifically with environments, but it is useful in that regard, for all food is a product of particular material and cultural relationships between humans and nature. Situating medicine along a continuum with food suggests the extent to which medical knowledge performs similar functions, and indeed that health is, at its core, a question of a body's relationship to its environment. If food and medicine help to maintain the boundaries of the social being and

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[14] Yuriko Akiyama, *Feeding the Nation: Nutrition and Health in Britain before World War One* (London: Tauris Academic Studies, 2008); James Vernon, *Hunger: A Modern History* (London: The Belknap Press of Harvard University Press, 2007).

[15] Kenneth J Carpenter, *Protein and Energy: A Study of Changing Ideas in Nutrition* (Cambridge, U.K.: Cambridge University Press, 1994); Anson Rabinbach, *The Human Motor: Energy, Fatigue, and the Origins of Modernity* (New York: Basic Books, 1990).

[16] Nancy N. Chen, *Food, Medicine, and the Quest for Good Health: Nutrition, Medicine, and Culture* (New York: Columbia University Press, 2009), xi, 3–5.

the individual body, they must also therefore instantiate and maintain the boundaries between bodies and environments, between humans and nature.[17]

Historians have examined the relationships between environments and health, in both material and cultural terms. A particularly rich body of literature identifies the connections between urban environments and disease through the sanitary movement, airborne pollution, and water.[18] To the extent that historians have studied nutrition in relation to environments and health, it has been to establish the importance of larger, more varied, and more stable food supplies for human wellbeing. Thomas McKeown's classic work on the growth of population from the eighteenth century forward was instrumental in critiquing narratives of medical progress by attributing this growth to improved nutrition and environmental conditions, and not medical discoveries.[19] Similarly, scholars reconstructing historical biometrics have demonstrated that there have been substantial though not linear changes in height in the last three centuries, changes they attribute to food supplies.[20] However, the connections between health and environments located in these histories have largely overlooked the ways that, in the nineteenth century, the environments with which bodies had material and cultural relationships were not necessarily their most immediate ones. Indeed, by the end of the nineteenth century,

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[17] For a discussion of the culturally constructed boudnaries between humans and nature, see Raymond Williams, "Ideas of Nature," in *Culture and Materialism: Selected Essays* (London: Verso, 2005), 68–85; "The Trouble with Wilderness; Or, Getting Back to the Wrong Nature," in *Uncommon Ground: Toward Reinventing Nature* (New York: W.W. Norton & Co, 1995), 69–90.
[18] Christopher Hamlin, *Public Health and Social Justice in the Age of Chadwick: Britain, 1800-1854* (Cambridge, England: Cambridge University Press, 1998); Peter Thorsheim, *Inventing Pollution: Coal, Smoke, and Culture in Britain since 1800* (Athens, Ohio: Ohio University Press, 2006); Christopher Hamlin, *A Science of Impurity: Water Analysis in Nineteenth Century Britain* (Berkeley: University of California Press, 1990); Dale H Porter, *The Thames Embankment: Environment, Technology, and Society in Victorian London* (Akron, Ohio: University of Akron Press, 1998).
[19] Thomas McKeown, *The Modern Rise of Population* (London: Edward Arnold, 1976).
[20] Roderick Floud and et al, *The Changing Body: Health, Nutrition, and Human Development in the Western World since 1700* (Cambridge, U.K.: Cambridge University Press, 2011) See Chapter One for an extensive overview of this literature.

British bodies relied on wheat-growing environments around the world substantially more than those within their own country, and certainly more than any wheat field in their immediate vicinity; or, put another way, British bodies existed in as part of a global wheat ecology.[21]

In this way, the bulk of scholarship in the history of medicine, and certainly all of it in the history of nutrition, reinforces Moore's concept of the Cartesian binary, the broad pattern of forms of knowledge, cultural meaning, and political power that draws a sharp line between the human and non-human realms.[22] It operates in much the same way that the bulk of scholarship in the history of food does: rather than seeing humans as part of an ecology along with their food (and other resources besides), historians of nutrition have treated only the "human" side of the human-nature binary, considering only the things that have already been rendered as "food," and thereby seeing bodies essentially in isolation to environments.[23]

But, as with other aspects of the Cartesian binary, the knowledge of nutrition is also biopolitical in nature: it is part of the set of broader governmental, disciplinary, and regulatory practices that emerged in the eighteenth century, and that made the management of life the object of political power.[24] Biopolitics operates along multiple axes of power running through society: one axis turns on the disciplining of individualized bodies, while another works to secure the biological existence of aggregated populations. In his seminal work *The History of Sexuality*, Foucault argued that sexuality occupied a

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[21] See Chapter One.
[22] Jason Moore, *Capitalism in the Web of Life: Ecology and the Accumulation of Capital* (London: Verso Books, 2015) For a full discussion of the term, see the Introduction.
[23] For the history of food, economic history, agrarian history, and their relationships to environmental history, see the Introduction.
[24] Michel Foucault, *The History of Sexuality, Volume 1: An Introduction*, trans. Robert Hurley (New York: Vintage Books, 1990), 139.

privileged position at the intersection of those two axes: sexuality was an apparatus of power both "tied to the disciplines of the [individualized] body," and "applied to the regulation of [aggregated] populations."[25] The study of nutrition stands at that same intersection. Central to biopolitical government was reliance on scientific expertise, which offered insight into the essential nature of humans and their relationships to the non-human world, and therefore guidance for good government. Particularly in the context of nineteenth-century liberalism that sought to govern according to the inherent "naturalness" of the market, nutrition instantiated the "particular relationships of power and knowledge, of government and science" at the core of biopolitics. It was through nutrition, among other apparatuses, that "the population as a collection of subjects is replaced by the population as a set of natural phenomena."[26] It extended a medicalizing gaze into individual articles of food and into bodies, prescribing a norm for bodies and their relationships to food. At the same time, it offered a way to regulate the consumption of an entire population in relation to the environments that produced food, observing an empirical norm and constructing apparatuses to regulate and safeguard that norm. In these ways, the science of nutrition was a vital element of the expanding wheat ecology in the second half of the nineteenth century. It provided both an endorsement of that expansion, rendering "natural" and unproblematic global wheat production.

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[25] Ibid., 145.
[26] Michel Foucault, *Security, Territory, Population: Lectures at the Collège de France, 1977-1978*, ed. Michel Senellart, trans. Graham Burchell (New York: Picador, 2004), 351–2.

Nature and Nutrition

Ideas of nutrition and health in the medieval and early modern period had their origins in Classical Greek and Roman writers, stretching back to Aristotle, Hippocrates, and Galen, who attributed to the body a "vital heat" fed by food as oil fed the flame in a lamp. These Classical writers espoused humoral theories of the body, which held that health was a matter of maintaining an appropriate balance between four fluids: blood, phlegm, yellow bile, and black bile. Each fluid was associated with a season (autumn, winter, and so on), an element (earth, air, etc.), an organ, a temperament, and a combination of qualities of heat and moisture. Blood, for example, was warm and wet, and associated with spring, air, the heart, and—for individuals in whom it was a dominant humor—sanguinity. Phlegm, on the other hand, was cold and wet, and associated with winter, water, the brain, and phlegmatic temperaments. Humoral theories of health and nutrition were fundamentally particular and local. Each individual had their own particular humoral constitution, and each individual's humors were associated with local environmental conditions. Illness resulted from imbalances in these humors, whether as a result of some internal cause—a blockage in the flow of humors, say—or an external cause—a change in the local environmental conditions that upset the body.[27]

Humoral medicine saw food as a key component of health, in that food articulated a major component of the relationship between a body and its immediate environment. Foods fit into the humoral system because all edible items were characterized as hot, cold, dry, or moist; they were thus vital tools in maintaining and restoring an individual's proper humoral balance. But, because each individual's humoral composition was unique, there

[27] Porter, *The Greatest Benefit to Mankind: A Medical History of Humanity from Antiquity to the Present*, 56–8.

was no single optimal diet, applicable to all humans. Each person needed a diet that matched his or her particular constitution. Further, humoral theories of health mirrored the anti-scarcity systems that governed food in the medieval and early modern periods in a crucial way: both humoral medicine and anti-scarcity systems prioritized relationships between humans and their environments that were as direct as possible. For anti-scarcity systems, that relationship was articulated in labor, so that ideally, people would produce and consume their own food. For humoral medicine, health was a matter of the body's harmony in relation to its most immediate environment, maintained in significant measure through food. From their roots in Classical Antiquity, these ideas persisted through the medieval period, and indeed can even be found as late as the nineteenth century.[28]

By the seventeenth century, doctors and researchers were beginning to approach food in different ways. Most accounts of the history of "modern" nutrition begin with the Italian scientist Santorio. In 1614, he spent time in a chair attached to a scale and was thus able to weigh the inputs and outputs of his own body. He found that while he consumed on average eight pounds in food and drink per day, he excreted only about three pounds. Thus, his body consumed an additional five pounds, but paradoxically remained a constant weight. The disappearance of this five pounds he attributed to "insensible perspiration," which he argued was due to the breakdown of bodily tissue each day, which was then excreted through the skin.[29] Santorio's method set an agenda for the medical investigation of food, and from that point forward, a major strand of medical research involved attempting to understand and balance the body's material inputs and outputs.

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[28] G. E. R Lloyd, *In the Grip of Disease: Studies in the Greek Imagination* (Oxford: Oxford University Press, 2003); Ken Albala, *Eating Right in the Renaissance* (Berkeley: University of California Press, 2002); Carpenter, *Protein and Energy*, 1–2.

[29] Carpenter, *Protein and Energy*, 2; Guggenheim, *Nutrition and Nutritional Diseases*, 44–5.

In the seventeenth and early eighteenth century, the dominant explanations of how food served nutritive purposes were essentially mechanical. William Harvey's description of blood's circulation in 1628 provided a mechanism to explain the turnover of bodily tissues, and a variety of natural philosophers, scientists, and physicians used this knowledge to explain how the body processed food. René Descartes claimed in his 1637 *Discourse on Method* that the constant exposure of nutrients in the blood to the heat of the heart gradually rendered those nutrients the "stuff" of tissue, at which point they would form part of the body. Walter Charleton, a founding member of the Royal Society and author of the 1659 *Natural History of Nutrition, Life and Voluntary Motion*, explained that animal heat "dissolves, dispenses, or consumes" the particles of food in the bloodstream, while food also provided fuel for the vital flame. Moreover, he argued that food contained one essential nutritive substance suitable for all applications within the body.[30] Later researchers like the Dutch physician Hermann Boerhaave and Edinburgh Medical School lecturer Andrew Pictairn described the body as "an engine," in which disease resulted from the obstruction of circulation, and animal heat resulted from the friction and abrasion of the blood's circulation.[31]

In the last decades of the eighteenth century, scientists developed a new language through which to describe matter and quantitatively assess changes in it, a shift in nomenclature and methods now described as the "chemical revolution."[cite] Although debate is ongoing as to precisely how revolutionary this change was, an obviously pivotal moment was the French scientist Antoine Lavoirsier's description of oxygen, carbon, hydrogen, and nitrogen in a series of experiments and publications from 1772 to 1789. His

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[30] Carpenter, *Protein and Energy*, 3–5.
[31] Ibid., 5–6.

theory of oxygen displaced Stahl's earlier theory of phlogiston in the air. Stahl's phlogiston theory held that phenomena such as combustion, respiration, or calcification were based on the removal of phlogiston from the air. Lavoisier provided a very different theory: the element oxygen existed as one component of the air, and was capable of reacting with other substances in a variety of ways, generating combustion, respiration, or calcification. His work suggested that there was a set of universal terms that could describe matter far more precisely and quantitatively than before. It was immediately influential, and has been described as a fundamental change in the most basic concepts through which scientists understood, described, and investigated the world.[32] It had particular importance for the study of nutrition. Focusing on the role of oxygen, Lavoisier concluded that "respiration is therefore combustion, admittedly very slow," an insight with important implications for the study of food and human bodies.[33] He argued that both processes involved identical chemical reactions between oxygen and other compounds, an argument that suggested that universal laws, articulated in chemistry, governed the universe, both within the body and without. Thus, universal explanations were now possible for how the body absorbed and processed food, how it grew, moved, and remained warm, along with corresponding claims about the optimal relationship between humans and nature. Although it did not happen immediately, these universal explanations for how the body operated and how it related to environments provided the basis for a new understanding of physiology that ultimately displaced the local and particular understandings of nutrition and health that humoral medicine suggested.

[32] Paul Thagard, "The Conceptual Structure of the Chemical Revolution," *Philosophy of Science* 57, no. 2 (June 1990): 183–209; Arthur Donovan, "Introduction," *Osiris* 4 (January 1, 1988): 4–12.
[33] Guggenheim, *Nutrition and Nutritional Diseases*, 52–4.

Despite his death in French Revolutionary violence in 1793, Lavoisier's influence on the field was evident in the following decades, particularly among French researchers. Scientists in the early eighteenth century had noted fundamental differences between plant matter, which fermented and gave off acidic, vinegary liquids when left out, and animal matter, which putrefied and gave off alkali liquids under the same circumstances. They questioned whether the body could use both animal and plant matter to grow or replenish its own tissues, or if bodies required specifically animal matter for those purposes. The development of chemistry gave them the ability to describe the elements making up these tissues more precisely, and they quickly identified animal matter as being, on the whole, more nitrogenous than plant matter. These and other insights suggested to doctors that there were three basic divisions of food: there were nitrogenous animal matters, first called "protein" by the Dutch chemist G. J. Mulder in 1838 but also variously called albuminoids or albuminous substances. There were also the carbon-heavy fats and starches. Fats, also referred to as "oleaginous" matters or "hydro-carbons," contained relatively more hydrogen than the starches, which were called "saccharinic" matters or "carbo-hydrates." Chemistry also gave researchers the ability to describe the body's outputs in the same language. Doctors understood that bodies exhaled carbon dioxide from the lungs ("fixed air" as Lavoisier called it), and secreted nitrogen-rich urea in urine. In light of the nitrogen content of food and its presence in urea, in 1816 Francois Magendie fed dogs diets that were particularly poor in nitrogen, as a means to assess the necessity of that element in diets. His results seemed to suggest that it was indeed necessary for animals, because his subjects quickly sickened and died on diets of sugar, olive oil, and other nitrogen-poor items. Jean-Baptiste Boussingault's work in the 1830s extended Magendie's conclusions: he took nitrogen to be the only truly nutritive element, and calculated the equivalent values of various foods on exactly that basis.

Justus von Liebig and the Chemical Theory of Life

By the 1840s, doctors and scientists across Europe were pursuing a broadly similar research agenda in physiology, in which they attempted to reconcile the various inputs and outputs of the human body—food, water, and breath went in, and feces, urine, exhaled breath, heat, and motion were produced—through the language of chemistry. Chemistry's laws promised universal explanations as no other discourse had; Justus Liebig's 1842 *Tierchemie in ihrer Anwendung auf die Physiologie und Pathologie*, translated into English the following year as *Animal Chemistry*, was the first work to apply chemical laws to physiology in a comprehensive way. He approached the problem of physiology by noting that while knowledge of anatomy had substantially increased in the previous century, physicians were still at a loss to explain the functions of the various organs they described. Chemistry was the solution, he claimed, explaining that, "The most beautiful and elevated problem for the human intellect, the discovery of the laws of vitality, … cannot even be imagined without an accurate knowledge of chemical forces…"[34] Framed in this manner, Liebig's work was essentially a chemical theory of life itself.

Liebig's publication was an instant success across Europe, and it dominated physiological research for at least the next two decades and remained influential even longer. He described a model of nutrition in which there were two important categories of food, each playing a different role in the human body. Nitrogenous foods (what we now

[34] Justus Liebig, *Animal Chemistry; Or, Organic Chemistry in Its Application to Physiology and Pathology.*, trans. William Gregory (London: Taylor and Walton, 1842).

know as proteins), he argued, were alone responsible for allowing muscular work and for building tissue. He claimed that muscles performed work by breaking themselves down, and that the waste products from this action were excreted by the body as nitrogen-rich urea. Nitrogenous foods thus replenished the nitrogen lost in this manner, performing a simultaneous function of allowing muscular work and building tissue. This earned them the title "flesh-formers," a term that they kept into the twentieth century. On the other hand, non-nitrogenous foods (fats and carbohydrates), he argued, produced only bodily heat through their oxidation.[35] Liebig claimed that the amount of heat generated by the oxidation of one's food and respiration was strictly determined by the nature of the reactions occurring. The fact that human bodies in all climates remained the same temperature suggested, therefore, some of the differences in human diets, and the occurrence of some illnesses. Cold weather required more food because it required the oxidation of more carbon and hydrogen to maintain body heat. Warmer climates therefore required less food. As such, he explained, "The Englishman in Jamaica sees with regret the disappearance of his appetite," a situation he attempts to remedy with spicy and stimulating food. This enables him to eat his usual amount, but "the whole of the carbon thus introduced into the system is not consumed," and ultimately "disease of some kind, therefore, ensues."[36] A century earlier, doctors had identified different diets with the climatic influence on the body's humors, but by the nineteenth century it was a universal, quantifiable chemistry that provided explanations for health and sickness in relation to diet.

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[35] Ibid., 1–20.
[36] Ibid., 24.

Liebig's arguments divided life into two fundamentally different categories—plants and animals—based on the particular chemical reactions that sustained each. The continued existence of life, moreover, was premised on a set of harmonious chemical exchanges between those two different classes of organisms, and, indeed, the earth itself. This was immediately visible in the air surrounding all terrestrial organisms. In *Animal Chemistry*, Liebig argued that investigations of plants had established that "the growth and development of vegetables depends on the elimination of oxygen, which is separated from the component parts of their nourishment," while "the life of animals exhibits itself in the continual absorption of the oxygen of the air." In other words, plants and animals created the atmosphere necessary for each other. This exchange included more complex materials, and Liebig argued that plants created complex chemical compounds out of simple ones, and that animals broke down those same complex compounds, excreting simpler ones. Animals needed the "highly organized atoms" that made up other organisms. However, parts of an "organized being" could not serve as nutriment to plants until they had been broken down by putrefaction and decay into simpler materials, fit for plant absorption from the soil. Once broken-down materials were absorbed and reconstituted by plants, they once again became the highly organized atoms necessary for animal life in a cycle of perpetual chemical exchange not unlike plant and animal respiration.[37]

The idea that plants and animals existed in a harmonious relationship was not new, but Lavoisier's chemical nomenclature and Liebig's theory of nutrition combined to provide and reinforce that idea's scientific, quantifiable foundation. This understanding of the relationship between plants and animals both predated and long outlasted his

[37] Ibid., 1–2.

influence. William Bird Herapath, in an 1863 address to the British Medical Association, described the vast amounts of carbon dioxide exhaled by humans each day (then called carbonic acid), and noted that this gas would accumulate to poisonous levels in large cities, were it not for the constant motion of the atmosphere. Instead of presenting a danger, however, he explained that "Our beautiful green pastures and fields of ripening corn, our delightful hedge-rows and princely avenues of aristocratic oaks and ancestral elms, purify the atmosphere of that carbonic acid, of which the plebian artisan has equally contributed his share alike with the noble and peer..."[38] Thus, human bodies were held to a set of universal laws of chemistry, each operating in precisely the same way. Collectively, they were a category of consumption of oxygen and food, generating carbon dioxide as a by-product of their existence whether "artisan… noble or peer." Because plants performed the opposite operation, transforming carbon dioxide and elements in the soil into the "organized tissues" that humans needed for nutriment, as well as the oxygen they needed to breathe, the cultivated, human-shaped landscape was most suited to human existence. Only the cultivated landscape could perform *both* operations, since an uncultivated landscape could not provide nearly as much food—organized atoms—for humans. In this way, the relatively new science of chemistry reinforced the material relationship between humans and nature that had been dominant in the West since antiquity: cereal agriculture.

Liebig's theory, with a strict separation between the "nutritive," or "flesh-forming," nitrogenous foods, and the "calorifiant," non-nitrogenous foods, was the dominant interpretation of nutrition and physiology in the 1840s, but it came under assualt from other researchers almost immediately. The French chemist and physicist V. Regnault, and

[38] William Bird Herapath, "The Address On Chemistry In Its Relation To Medicine And Its Collateral Sciences," *The British Medical Journal* 2, no. 137 (August 15, 1863): 171.

the German scientists Bidder and Schmidt, for example, performed a variety of experiments with the most elaborate instruments yet developed for measuring oxygen consumed and carbon dioxide produced by animals, providing more precise understandings of the chemical exchanges between bodies and environments.[39] Edward Smith, an English doctor most famous for his roles in Parliamentary commissions investigating prisons and working-class dietaries in the 1860s, conducted what one historian called "the first systematic inquiry into respiration and metabolic response of the human to muscular exercise." His experiments involved both prisoners and himself walking on a treadwheel, a rotating step-like device similar to the wheel on a paddle steamer. They existed in Victorian prisons as a means to obligate prisoners to perform some kind of physical labor, and prisoners were usually assigned to walk on them for fifteen minutes at a time, with equal rest periods, for several hours every other day.[40] Smith examined the inputs and outputs of his own and prisoners' bodies on both work days and rest days. Liebig's theory predicted that the increased muscular work would also increase the urea excreted, but Smith found no such relationship between work and urea. Instead, he found that work increased the amount of carbon dioxide expelled, results that suggested, but did not confirm, that muscles were acquiring energy from non-nitrogenous foods.[41] A few years later, two Swiss professors, Adolf Eugen Flick and F. Johannes Wislicenus, tested Liebig's theories by ascending a nearby mountain while eating only non-nitrogenous, carbohydrate-heavy fats and starches. They concluded that nitrogenous foods could not be the only source of muscular energy, because they had consumed only non-nitrogenous food but nevertheless

[39] Guggenheim, *Nutrition and Nutritional Diseases*, 68–69.
[40] Treadwheels were quite similar in purpose to crank machines, also deployed in prisons. See Chapter Six.
[41] Guggenheim, *Nutrition and Nutritional Diseases*, 69–73.

were not exhausted after their ascent of the Falhorn. Therefore, the non-nitrogenous foods they had consumed for the previous 31 hours must have sustained their muscular activity.[42]

With the acknowledged problems of Liebig's work, the questions of how precisely the body operated and what constituted the optimal diet remained open. Carl von Voit, a German chemist and student of Liebig, and T. L. Bischoff worked with a massive respiratory chamber constructed in the 1860s at enormous expense and funded by King Maximillian II of Bavaria. This chamber was large enough to experiment on humans, and contained a bed and stationary bicycle, allowing them to take a full account of the inputs and outputs of the human body in states of both work and rest. Prior to this, observations had been made for short times, and typically measured either the respiratory activity or the food and wastes of a body, but not both over an extended period. Their results further suggested that Liebig's strict delineation between nitrogenous and non-nitrogenous food materials was not useful. Instead, they distinguished simply between foods that deposited materials in the body, and foods that did not.[43] Voit, continuing experiments on Munich working men, regarded protein as the most essential nutritive substance. He saw it as a necessary physical replacement for material lost by the body, arguing that protein requirements were proportional to muscle mass. In 1875, he proposed a dietary standard of 118 grams of protein per day for an adult male undertaking daily physical labor, along with 56 grams of fat and 500 grams of carbohydrate.[44] Other researchers in Germany and the United States disputed his results, finding it possible to live in health on diets with substantially less

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[42] Ibid., 75–6.
[43] Ibid., 118–121.
[44] Carpenter, *Protein and Energy*, 89.

protein per day. Still, any debate about the amount of protein required continued along the lines established by Liebig: researchers assumed that the fundamental questions of nutrition were the relative amounts of nitrogen, carbon, and heat evolved from oxidation. This notion was not fully displaced until the widespread adoption of a thermodynamic, heat- and energy-based physiology in the late nineteenth and early twentieth century.

The general application of a standard of energy to diet did not occur until at least the end of the nineteenth century. As early as the 1840s, the same decade that Liebig published his theory of nutrition, researchers across Europe began to develop the ideas that we now know as the "law of conservation of energy," ideas that eventually enabled researchers to explain why the experimental results obtained by Smith, Wick, and Wislicenus did not support Liebig's theory. Prior to that point, there was no unified theory of "energy" (also known as "force" in the nineteenth century) as something that could be expressed as heat, motion, or otherwise. Instead, heat had previously been regarded as a material substance, an "elastic, uncreateable, indestructible, measurable fluid." This began to change in the 1840s when the English scientist J. P. Joule established a quantitative equivalence in work and heat with his paper "Über die Erhaltung der Kraft (On the Conversation of Energy)," which established the mathematical principles of the conservation of energy. Similarly, the German physician J. R. Mayer developed the idea of the "calorie," a unit of heat needed to raise the temperature of one kilogram of water by one degree Celcius, and equivalent to the energy needed to raise that same kilogram of water 425 meters.[45] The work of these two researchers in particular began to suggest an alternative to Liebig's notion of physiology, with its strict division between nitrogenous

[45] Guggenheim, *Nutrition and Nutritional Diseases*, 59–67.

and non-nitrogenous foods, useful only for motion and tissue on the one hand, and animal heat on the other. By the 1870s, new understandings of energy and the experiments of the previous generation of doctors suggested that nitrogen was not necessary for muscular contraction; in other words, any kind of food could fuel the body's activity, although many regarded proteins as essential for building tissues.

If, in theory, the knowledge of energy existed to provide a thermodynamic explanation of nutrition in the 1840s, doctors still had no mechanism to explain how something as amorphous as "energy" could generate muscular movement and not simply heat. The French physiologist Claude Bernard is often credited with a substantial discovery in this area when he identified the liver as a source of sugar as early as 1849. He identified what we now know as glycogen, a form of sugar that serves as an energy storage mechanism, allowing the distribution of a useful form of fuel to cells throughout the body. Bernard suggested that the blood constituted an "internal environment" which created and maintained the conditions necessary for the life of the cell, and ultimately for the organism.[46] However, while Bernard suggested a kind of "indirect nutrition," in which the body was able to process its foods into the many different kinds of materials necessary for its maintenance, his work was little noticed until the twentieth century. Researchers in the nineteenth century tended to assume that the body had to consume substances that were essentially like its own substances. The German physiologist Max Rubner, a student of Voit, published a series of papers between 1878 and 1883 and offered an alternative around which a broad consensus formed. He established that the law of conservation of energy obtained within animal bodies, and that therefore the caloric value of food was a useful and

[46] Ibid., 128.

universal metric of its nutritional value. He rejected protein as simply replacement tissue, and instead viewed the body as a thermodynamic engine. He presented experimental evidence for a new physiological law, the isodynamic law, which stated that proteins, fats, and carbohydrates were mutually interchangeable in the body according to their caloric equivalents. It was only with his his 1902 synthesis, *Die Gesetze des Energieverbrauchs bei der Ernährung*, or *The Laws of Energy Conservation in Nutrition*, that a clear demonstration existed of the ability of the body to use nearly any food for energy. [47]

Rubner's understandings of the human body had substantial differences from Liebig's, more than half a century earlier, but they shared vital similarities. Rubner, like Liebig, sought chemical explanations for the operation of the body, and hence placed bodies into a category governed by universal laws. He opened his 1902 treatise by explaining that, "The most important task of research lies in pursuing natural phenomena to such an extent that it becomes possible to deduce unified laws from a variety of processes," echoing Liebig's words from a half-century earlier.[48] Moreover, while his work did represent a conceptual shift in how the body used food to maintain itself and produce work, Rubner, as others before him, continued to view the human body as essentially a category of food consumption, articulated in a chemical language, albeit now the more flexible one of caloric energy rather than the older view of simply nitrogen, carbon, and oxygen.

The transition from Liebig's and Voit's understandings of nutrition rooted in nitrogen and carbon to Rubner's thermodynamic understanding represented a conceptual shift in doctors' understandings of the fundamentals of physiology. While a consensus did

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[47] Graham Lusk, "Contributions to the Science of Nutrition," *Science* 76, no. 1963 (August 12, 1932): 130; Corinna Treitel, "Max Rubner and the Biopolitics of Rational Nutrition," *Central European History* 41, no. 1 (January 1, 2008): 3; William Chambers, "Max Rubner," *The Journal of Nutrition* 48 (1952): xix.
[48] Max Rubner, *The Laws of Energy Consumption in Nutrition*, trans. Allan Marikoff and Alex Sandri-White (Elsevier, 2012), 1.

coalesce around Rubner's thermodynamic ideas, this consensus was soon disrupted by research into elements necessary for health, although only in very small quantities. The history of vitamins, as these micronutrients came to be known, is often discussed in terms of deficiency diseases such as rickets, beriberi, and most particularly scurvy.[49] Doctors had recognized the prophylactic or therapeutic value of certain foods in relation to diseases like scurvy, but the idea that tiny amounts of difficult to identify and difficult to measure substances could secure health was not intuitive. Certainly doctors had previously identified elements in food that were not strictly nitrogen and carbon. Edmund Parkes, an army physician and author of the 1864 *Manual of Practical Hygeine*, certainly regarded the "salts" that could be identified along with proteins, fats, and carbohydrates in foods as "essential," although the had no specific mechanism to explain why.[50] Similarly, Henry Thompson's 1880 treatise *Food and Feeding*, reprinted in more a dozen editions into the twentieth century, identified in both food and the human body, "oxygen, carbon, hydrogen, nitrogen, phosphorus, sulphur, chlorine, fluorine, silicon, calcium, potassium, sodium, magnesium, iron, manganese, copper, as well as lithium and lead in unmeasuable amounts." Recognizing the composition of the skeleton, Thompson referred to calcium and phosphorus as "bone-forming" nutrients.[51]

Scurvy, rickets, beriberi, and other diseases related to diet were typically explained not as deficiencies, but as the result of contamination in the food or the environment. Sailors' scurvy, for example, was often attributed to the foul air inside ships' holds, or to

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[49] There is a substantial literature on vitamins, which fit neatly into a narrative of discovery for nutrition, because they are clearly identifiable substances with real therapeutic value. See Frances Rachel Frankenburg, *Vitamin discoveries and disasters: history, science, and controversies* (Santa Barbara, Calif.: Praeger/ABC-CLIO, 2009) and Lee McDowell, *Vitamin History, the Early Years* (Sarasota: First Edition Design, 2013).
[50] Edmund A. Parkes, *A Manual of Practical Hygiene*, ed. F. S. B. Francois de Chaumont, Seventh Edition (London: Churchill, 1887), 237.
[51] Sir Henry Thompson, *Food and Feeding*, First (London: F. Warne & Co., 1880), 8, 63.

excessive moisture in the atmosphere at sea.[52] Moreover, when diet was identified as a culprit, it was explained in the language of macronutrients familiar to nineteenth-century researchers. For example, one doctor argued that the Japanese navy had eliminated beriberi among its sailors (what we now describe as a vitamin B deficiency) by increasing its protein content, replacing white rice with bread, peas, beef, fish, and miso (fermented soybean).[53] The Polish chemist Casimir Funk is often credited with discovering "vital amines" in 1912, when he asserted that there were a set of organic compounds, all "amines" (indicating a particular chemical structure), which prevented scurvy, pellagra, beriberi, and rickets. These compounds, he claimed were necessary only in very small amounts, and were dubbed "vitamins" when it was realized that they were not all strictly "amines." Research for the next several decades (beyond the temporal scope of this paper) focused on identifying and then synthesizing these compounds.

Constructing Bodies and Environments

From the adoption of chemical nomenclature and the universal laws first articulated by Lavoisier in the late eighteenth century, through Liebig's interventions in the 1840s, and through the thermodynamic ideas of nutrition adopted in the late nineteenth and early twentieth century, the "modern" ideas of nutrition served to articulate and reinforce the Cartesian binary, the split between humans and nature at the heart of Western culture. The adoption of chemical nomenclature was paradoxical: it suggested that bodies and environments, or humans, animals, plants, and the rest of the environment, were all

[52] Kenneth J. Carpenter, *The History of Scurvy and Vitamin C* (Cambridge, U.K.: Cambridge University Press, 1986).
[53] Carpenter, *Protein and Energy*, 121; See also Carpenter's fuller study of beriberi, *Beriberi, White Rice, and Vitamin B a Disease, a Cause, and a Cure* (Berkeley: University of California Press, 2000).

composed of the same things; as Lavoisier argued, “respiration is… combustion, admittedly very slow.”[54] However, at the very same time that it suggested the universal applicability of chemistry, studies of nutrition from Lavoisier and Liebieg through the thermodynamic understandings in the early twentieth century concluded that animal bodies operated in a fundamentally different way than plants and the rest of the environment. Bodies required highly organized compounds, which they broke down to generate life; plants and the rest of the environment, however, took simple elements and built them up into more complex ones. In this way, bodies and environments were two distinct, internally homogeneous categories engaged in a continuous and complementary chemical exchange governed by universal laws and reducible to abstract chemical reactions. This was a profound departure from the older humoral views of bodies and environments, which saw the relationships between bodies and environments as particular and local.

This fundamental separation of bodies and environments inherent in ideas of physiology since Lavoisier is evident in the ways that doctors’ understandings of which chemical or thermodynamic elements were required to maintain health were, for the most part, beyond their understanding of the actual mechanisms by which such elements performed this function. Because of this fact, in the medical investigation of nutrition and digestion, the body often functioned as a kind of black box that took in nutrients, expelled waste, and generated heat, motion, and tissue, though how precisely it performed these functions remained a mystery. Dr. George Ross, in an 1844 description of the processes of digestion and nutrition, explained that while “the mouth has been styled the organ of mastication; the stomach the organ of chylification; ...when these distinctions acquired

[54] Guggenheim, *Nutrition and Nutritional Diseases*, 52–4.

importance, no physiologist was able to inform us upon what ground he established them; or, if correct, in these local ascriptions, he would have been perplexed to tell us the mode in which these organs performed their functions."[55] The body was essentially a category of thing that absorbed certain chemicals via the alimentary tract. Dr. T. Lauder Brunton, in a lecture to the Medical Society of London in 1885, described the body as "a cylindrical box, through the center of which runs a tube open at both ends, but not communicating with the cavity of the box. Anything in this tube is outside the box, just as anything inside the intestines in outside the organism."[56] For doctors, then, bodies and environments were fundamentally different categories although how precisely they operated remained an open question.

Absent a consensus as to how bodies actually absorbed, used, and expelled food, doctors frequently fell back to metaphors of the body as an engine.[57] While such metaphors had been popular in the seventeenth and eighteenth centuries, before the chemical revolution and Liebig, they continued to appear in the second half of the nineteenth century, after Liebig's theories had fallen out of favor. The Rev. S. Haughton, a professor at Trinity College, Dublin, explained in a lecture on food and the body that the various organs of the body "resemble the piston, the beam, and the fly-wheel of the steam-engine, and, like them, only transmit or store up the force communicated by the steam in one case, and by the products of the food conveyed by the blood in the other case."[58] Haughton's point contains an implicit rejection of Liebig, who assumed that muscles operated by consuming

[55] George Ross, "An Analytical Inquiry into the Nature of the Processes of Digestion and Nutrition," *The Lancet* 41, no. 1063 (January 13, 1844): 506.
[56] T. Lauder Brunton, "Abstract of Lettsomian Lectures of Disorders of Digestion, Their Consequences and Treatment," *The Lancet* 125, no. 3203 (January 10, 1885): 53.
[57] Rabinbach, *The Human Motor*.
[58] S. Haughton, "On The Relation Of Food To Work Done By The Body; And Its Bearing Upon Medical Practice," *The British Medical Journal* 2, no. 398 (August 15, 1868): 163.

their own materials. Henry Thompson's use of the engine metaphor was particularly thorough. He opened his 1880 book-length survey of physiology and foods by describing the component parts of a locomotive's operation: material structure, fuel, water, and waste products. He then described the body in the same way, comparing the coal and coke of a locomotive to the food eaten each day. Chemistry remained the language of legibility for him, as he noted that both coal and food were oxidized, though at different rates, and with the energy thus released deployed in different ways.[59]

The metaphor of the engine gave doctors a way to describe food in terms of heat or energy transmitted from nature into the body, where it could be stored and deployed as needed to produce work.[60] This was a flexible and durable metaphor. When doctors' research built from the accepted premise of food and energy toward the additional need for "accessory food factors," their description of the engine simply became more specific. In a series of lectures on digestion in 1882, the professor of physiology Arthur Gamgee explained that "The food of an animal is like fuel to an engine, but it differs in one respect--namely, that an engine may be supplied with almost any kind of fuel that will not be destructive to the engine, while the food of an animal must answer to certain very precise requirements." Gamgee's point suggested the central issues for nineteenth-century doctors: the problems doctors were actually able to address were less a matter of what took place within the body—the "cylindrical box" Brunton described—and more ensuring that the correct materials made it inside or remained outside. This boiled down to the fundamentally biopolitical (and ecological) tasks of identifying and prescribing an optimal diet.

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[59] Thompson, *Food and Feeding*, 1880, 1–3.
[60] Rabinbach, *The Human Motor*.

The Best Food for the Best People

In their ongoing investigations of nutrition, above all in their attempts to determine the best diet, doctors operated under a set of assumptions about food, bodies, and health that had necessary—but often unacknowledged—implications for broader human social relationships, and human relationships to nature. Whatever particular understanding of nutrition was dominant—whether it was Liebig's, Voit's, or Rubner's—chemical physiology suggested that white, wheaten bread was the ideal food, or at least the greater part of the ideal diet. Doctors saw only the chemicals that made up food that entered the body, and the chemicals in the waste that left it. Drawing on their metaphors of engines, white bread seemed to be a more efficient food as it produced less bodily waste and therefore appeared to be more fully absorbed. In this way, doctors endorsed cereal agriculture and bread consumption as the ideal relationship between humans and nature; and, to the extent that a global wheat ecology made possible whiter bread, they further endorsed the expansion of wheat cultivation across the globe. This is visible both in the ways that they described diets and in the ways they conducted their investigations.

Doctors surveying the diets of their patients, their societies, and the peoples of the world frequently compared the nutritional values of the staples that comprised them. Applying their chemical understandings and analysis to different foods led to the conclusion, shared by virtually every Western medical professional in the second half of the nineteenth century, that wheaten bread was the best food, or at least the greater part of the best diet. Wheat's higher gluten content was frequently their main justification for preferring it. Gluten, the protein found in wheat (as well as barley and rye, but in highest proportion in wheat) enables bread to form bubbles around the gases generated by leaven. It is a nitrogenous substance, and thus constituted a "flesh-former" to nineteenth-century scientists. Dr. Friedrich Knapp, a German physiologist whose work was published in German in 1847, and then translated into English and well-received in the British medical press, explained that "barbarous nations which live entirely on flesh" received too much nitrogen, here referred to as "blood-forming matter," while "the poorer classes amongst us are obliged to live upon... potatoes, which are one-half poorer in blood-forming constituents..." than bread. Living on potatoes was "unnatural in the extreme," and such people existed "on the edge of a fearful precipice," whose dietary deficiencies manifested in "imperfect bodily strength, and unsoundness of health;... increased mortality and shortness of life;... [and] want of energy,... a kind of stupidity and want of interest in everything but what concerns the merest animal interests." "A people in this state," he concluded, were "always ripe for rebellion, and ready to join in every insurrection."[61] Writing in 1848, Knapp's words referred directly to the working class Europeans who engaged in widespread revolutionary activity that year, as well as to Irish peasants who starved during the Famine. In both cases, Knapp implied, the problem was not industrial poverty or exploitative land distribution, but food and, ultimately, the chemical relationships between humans and nature. Only wheaten bread, supplemented with a little meat or cheese, provided the optimal balance of nutrients for healthy bodies, stable politics, and productive populations.

Similarly, twenty-five years later, Dr. Edward Smith, an English nutritionist who made a name for himself with studies on the diets of prisoners, out-of-work factory

[61] Knapp, "The Law of Nutrition in Animals," trans. John Brown, *The Lancet* 52, no. 1308 (September 23, 1848): 344.

workers, and himself, explained in his 1873 book *Foods*, that wheat was "the most important vegetable production of temperate climates... upon which the life of man in these regions mainly depends." It was "produced abundantly, and cheaply; is easily ground and refined, is readily and thoroughly cooked, has a mild flavour which is universally agreeable, and contains nearly all the essential elements of nutrition. It is preferable to any of the other great vegetable products on which men chiefly live, since it is a far more agreeable food than maize, and a more nutritious food than rice. It is probable that the health and mental and bodily vigour of the inhabitants of temperate climes are more attributable to this food than to any other single cause."[62] Henry Thompson's 1880 survey of foods "naturally" gave first consideration to the cereals, wheat chief among them. Wheat, he explained, was preferred to other grains because it was more easily processed, yielding a greater amount of fine, white flour "readily made into a light and spongy bread," best for bodily absorption. Most importantly, "The chemical constituents of the wheat grain are likewise so proportioned as to render this food well fitted for the general sustenance of man, both as regards its flesh-forming and heat and force-producing character."[63] His work was enormously popular, and went through more than a dozen editions. The eleventh edition, published in 1901, placed wheaten bread in a historical, and indeed civilizational context. He explained that wheat took first place in the cereals, "containing nearly all the elements necessary to life," something which ancient humans had recognized because wheat "had been distinguished, in the form of bread, as the 'staff of life,' long before the physiological demonstration of the fact had been attained."[64] It was, in other words, not

[62] Edward Smith, *Foods* (New York: Appleton & Co., 1873), 171–2.
[63] Thompson, *Food and Feeding*, 1880, 60.
[64] Henry Thompson, *Food and Feeding*, 11th; ed. (London: Frederick Warne & Co., 1901), 43.

merely the best food, but the food that had, through the development of agriculture, made certain humans civilized.

If wheaten bread was the best staple, then white bread seemed to be the best kind of bread. Traditionally, physicians fit the varieties of bread consumed into moral and economic categories that matched the realities of early modern life: the rich preferred white bread, and physicians understood this as a result of their relatively sedentary lifestyle and refined tastes. Conversely, the working populations consumed cheaper brown bread, and physicians explained this as a reflection of their coarser nature. Liebig's chemical physiology, however, put the question on new ground. If all that mattered was the exchange of chemicals between bodies and environments, then white bread emerged as a superior food, for it produced less waste and therefore appeared to be more fully absorbed by the body. In his 1863 survey of out-of-work factory workers in Lancashire, Smith noted with concern that among families that ate brown bread, the individuals had too frequent bowel movements. "Frequent dejection," he wrote, "carries off nutritive material. Bran, husk of oatmeal, and shells of peas carry off food." Drawing on some of his studies of prisoners, he explained that on diets of brown bread, prisoners passed 10 oz. or more of feces per day, two and a half times what a person on white bread passed in "ordinary life."[65] Thompson expanded on the reasoning in his 1880 book *Food and Feeding*. He acknowledged that the germ, bran, and husk of wheat could be shown to have "mineral salts" not found elsewhere. But, he argued,

[65] Edward Smith, "Fifth Report of the Medical Officer of the Privy Council. Appendix V: Report on the Nourishment of Distressed Operatives," Reports of Commissioners, 161 vol. XXV (London: House of Commons, 1863), 321.

it must not be thought that whole-meal bread or any other kind of brown bread does actually furnish more nutriment than white bread. It may be, and often is, richer in nutrients, but the presence of numerous rough, branny fragments so stimulates the action of the intestines, that the material is hurried along the digestive tract without that complete digestion and absorption of its nutritive matters which white bread undergoes.[66]

If white, wheaten bread was the best food available, then cereal agriculture was therefore the best possible relationship between humans and nature. Any examination of wheat or bread was also an implicit examination of the environments that produced them. In the same way that doctors assumed all bodies operated according to a set of universal, chemical laws of physiology, they made a similar set of assumptions about wheat, and this allowed them to offer broad endorsements for an expanding wheat ecology. They saw wheat as an embodiment of the relationship between humans and environments, whereby nitrogen and carbon were rendered chemically available for human bodies by a particular ecology. Because all bread and therefore all wheat could be rendered legible in the same chemical language, it mattered little in an abstract sense where the wheat came from. However, wheats from different parts of the world were (and remain) very different from one another, and in ways that were chemically relevant: wheats grown in Britain tended to be "soft" wheats, containing less gluten and therefore less nitrogenous, flesh-forming matter, while much of the wheat grown elsewhere, particularly the in United States, Canada, and Russia, were "hard" wheats, which contained more gluten. These differences were vital to British millers and bakers, and they contributed to the revolution in British milling in which steel rollers replaced millstones from the 1870s forward, when large

[66] Thompson, *Food and Feeding*, 1880, 68.

imports of hard foreign wheat began to substantially alter the composition of Britain's wheat supply. The characteristics of British bread also changed as roller-milled hard wheat allowed loaves that were whiter and lighter overall.[67] The chemical significance of both global wheat supplies and different kinds of bread were not lost on doctors and other researchers: their language of chemical physiology and their understandings of the relationships between human bodies and environments drove their discourse about food in general and bread in particular, a discourse that functioned to endorse the globalization of Britain's wheat supplies.

Robert Dundas Thompson, a lecturer in practical chemistry at the University of Glasgow, applied Liebig's ideas to bread and other foods soon after the publication of *Animal Chemistry*. In so doing, he illustrated how the chemical composition of food registered with doctors, and that it did so in ways that made explicit and implicit connections between humans and their environments, connections that existed in the context of Free Trade, and therefore the system of market-based security adopted by the British state after 1846. After presenting a set of charts illustrating the "nutritive" and "calorifiant" contents of different grains and other staples, he explored the implications of this information for both individual and national diets. He argued that "equilibrium" existed "between the wants of the body and the constitution of the food," but that this equilibrium could be disturbed by "meteorological factors" in a country, suggesting that it was cereal agriculture on a national scale that first constructed this equilibrium between people and their local environment. Agriculture was, therefore, a kind of natural state, the normative relationship between a people and their environment, although it was one

[67] On the different varieties of wheat and its role in flour milling, see Chapters One and Two; on bread, see Chapter Four.

subject to natural uncertainty. Chemical physiology could combine with the international grain trade to combat that uncertainty, which could manifest as disequilibrium on a national level and as nutritional imbalance on an individual level. "By different mixtures of one kind of flour which contains a small quantity of nutritive constituents, with another which is richer in that material," the equilibrium may be restored; thus, he argued, English wheat "is inferior to that of the continent of Europe and America," but could be improved with the addition of foreign flour. He noted that "mixing one-third of Canadian flour with two-thirds of maize, we form a very good bread, and if we mix equal parts of flour and oatmeal, or barley, or peasemeal, a very palatable bread is obtained by this mixture."[68] Writing in 1847, just a year after the repeal of the Corn Laws, Thomson laid bare the biopolitical implications of market-based security and an expanding wheat ecology on human bodies.

As Britain's wheat ecology globalized in fact and not merely in potential, doctors continued to note the chemical and hence nutritive differences among global wheats. In response to the physical differences between these wheats and the practical need for consistent, homogeneous flours, millers from the 1870s developed technical expertise in global wheat supplies—and hence global wheat environments—that allowed them to effectively obliterate the origins of wheat in the process of milling it into flour.[69] From the 1870s, doctors in Britain began to perform the same fundamental operation, consistently acknowledging the nutritional variation among worldwide wheats, and then equally consistently ignoring that variation in their analysis of bread. The London physician F. W. Pavy's 1881 edition of his *Treatise on Food and Dietetics* (his first edition was 1874)

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[68] Robert Dundas Thomson, "On the Laws of Dieting," *The Lancet* 50, no. 1246 (July 17, 1847): 47.
[69] See Chapter 2.

illustrates this. His chapter on plant-based foods made clear that wheats from different parts of the world had different characteristics, and he charted the nitrogen, starch, dextrin, cellulose, fatty and mineral matters, finding considerable differences: "Hard wheat" from Venezuela contained twice the nitrogenous matter as "Tuzelle," a soft, white French wheat. These differences, moreover, he linked specifically to environmental conditions, explaining that hard wheat, that richest in gluten, "is produced in the warm countries of the south, and upon the most fertile soils." Nevertheless, in his analysis of flour, he indicated a narrower range of chemical composition. He referred to figures produced by Letheby, which gave 10.8 percent nitrogenous matter, and other figures by Payen, which gave 14.45 percent. His analysis of bread referred only to Letheby, who claimed that bread contained 8.1 percent nitrogenous matter.[70] Through this analysis, then, the possible nutritional variation in wheat, flour, and bread was progressively obliterated, resulting in an abstracted, homogeneous category "bread," the optimal fuel for the equally homogeneous category "human body." Professor Charles Graham, a chemist specializing in bread-making, performed a similar maneuver in his paper on that topic at the 1884 International Health Exhibition in London. He explained that the cereals were "undoubtedly the most valuable of all the fruits of the earth," and he commented at length upon the recent expansion and diversification of British wheat supplies. He noted that wheats varied in their protein content according to their origin and the year's climate, and explained that while millers had formerly been obliged to use "the wheats as they could find them in their own country… we now have excellent wheats from the United States, from Canada, from the Black Sea, from Australia… from India and Persia." However, managing this variety was a

[70] F. W. Pavy, *A Treatise on Food and Dietetics, Physiologically and Therapeutically Considered*, 2nd ed. (New York: William Wood, 1881), 145–8.

task for the miller and baker and not the doctor: when Graham turned his attention to the process of bread-making, all the acknowledged variety of the world's wheats collapsed into the abstract, originless, 280-lb. "sack of flour" on which he based his analysis.[71]

The majority of medical articles, books, and dietary surveys referred simply to "bread" as an item of food, with no indication of the possibility of variation in either the bread or the wheat. Edward Smith, whom we have already met, in his 1863 report to Parliament on the diets of unemployed Lancashire cotton workers, surveyed the diets of dozens of families. His meticulous charts made no distinctions between the different kinds of bread people ate, much less the origins of wheat, although that did not stop him from deploying the chemical precision that marked rigorous medical investigation in the mid-nineteenth century. In calculating the cost and nutritional intakes of individuals and families, he calculated that bread contained precisely 1968 grains of carbon and 94 grains of nitrogen per pound, at a cost of 1 ½ d.[72] Flour he calculated at 2656 grains of carbon and 126 grains of nitrogen per pound, at a cost of 1 ¾ d., slightly more nutrient dense than bread because of the water mixed with flour to make dough, but equally anonymous in its origins and homogeneous, nutritional characteristics, and legible only as a package of nutrients. Edmund Parkes's *Manual of Practical Hygiene* contained extensive charts of the values of foods, rendered in nitrogen, carbon, hydrogen, sulphur, and "salts," and listed dozens of different products. However, his only entry for bread was simply "Bread, white wheaten, average quality."[73] Thomas Oliver, a Univeristy of Durham professor of physiology, conducted a series of working-class dietary surveys and published them in *The*

[71] Charles Graham, "The Chemistry of Bread-Making," in *The Adulteration of Food: Conferences by the Institute of Chemistry* (London: Clowes, 1884).
[72] "Grains" are a now largely defunct measurement originally based on individual seeds of grain; now about 64.8 mg.
[73] Parkes, *A Manual of Practical Hygiene*, 243.

Lancet as "The Diet of Toil." In the several dozen dietaries that he reproduced in his article, he lists only "bread," and assigns it a nutritive value of 117 grams of carbon and 55 grams of nitrogen per pound. He makes no mentions of the character of the bread, or whether or not it might have any nutritive value outside carbon and nitrogen.[74]

Conclusion

Ultimately, medical knowledge, much like the technical expertise developed by millers and bakers at the same time, served to articulate and reinforce the Cartesian binary, and thereby to facilitate and endorse the globalization of Britain's wheat ecology. Chemical physiology provided doctors with a way to describe the relationships between bodies and environments, humans and nature, that operated according to universal laws and that understood environments and bodies as universal categories of production and consumption, operating in a continuous chemical exchange. In this scheme, food in general and the loaf of bread in particular functioned as a third abstraction, a category of thing connecting environments to bodies by transmitting chemical nutrients in edible form. White, wheaten bread was almost universally regarded as the ideal connection between bodies and environments, and because of the assumed homogeneity of all three of those categories, the relationships between humans and nature could be beneficially scaled up: a global wheat ecology could thus be understood as simply chemical transfer on a larger scale, and not a novel historical development. Medical and scientific knowledge did not, however, simply flow from clinics and laboratories, medical journals and conferences, to the state, industry, or other interests in British society. Instead, it provided one discursive

[74] Thomas Oliver, "The Diet of Toil. 1," *The Lancet* 145, no. 3748 (June 29, 1895): 1630.

reservoir among others on which people and institutions could draw in their attempts to manage British food.

CHAPTER SIX:

THE STAFF OF LIFE AND THE BREAD OF IDLENESS

The bread in Britons' homes may have been grown in the field down the road, or across the sea; milled for a customary toll on ancient millstones, or by professional millers in a highly-capitalized port city mill on modern steel rollers; baked in the home or by a professional baker. Whatever the case, the single most important element for consumers was its color: white or brown. In the early modern anti-scarcity system, with its local wheat, flour, and bread ecologies, its moral ideal of direct relationships between producers and consumers, its millstones, and its home-baking or small-scale and "local" baking, the amount of truly white bread was fairly limited. And, the Assize of Bread, one of the central aspects of the anti-scarcity system, functioned as a sumptuary law by mandating how much of each kind of bread a baker might produce. The expansion of Britain's wheat ecology to a global scale, and the array of biopolitical discourses that developed to facilitate this expansion, meant that in a liberal, market-based system, far more white bread was available than before: Britons had access to foreign wheats that were stronger, and thus baked lighter and more porous loaves; millers adopted steel rollers, allowing them to produce greater quantities of white flour; and bakers developed new techniques that produced more highly risen loaves.[1]

Britain's industrialization, urbanization, and outsourcing of its food supply through the creation of a wheat ecology also meant that the old moral ideal of a direct relationship between food's production and consumption no longer served to structure the cultural meanings of food. Production and consumption were disaggregated, not merely through a

[1] See Chapters Two, Three, and Four.

division of labor within society, but through a global division of labor and environments. A gap in meaning thus opened up in Britons' bread: where bread had once meant simply "work," the only meaning that the market-based system of security provided was price. Millers, bakers, and physicians stepped into this gap, investing wheat, flour, and bread with meanings as they carried out their roles within the global wheat ecology.

For many working Britons, those meanings were less relevant than their everyday experience with bread. And for many, that everyday experience was one of unremitting toil, with long hours, low wages, and the threat of the workhouse (or even the prison) looming. The liberal state institutionalized hunger as a central element of a system of coercive discipline to compel participation in the labor market and bread was at the heart of it. It is through the deployment of bread as a disciplinary instrument that its meanings for working Britons are most evident: brown bread became the bread of discipline, and white bread the bread of freedom.

Certainly, there were elites writing about the insistence of the poor on white, wheaten bread in the late eighteenth century, and some scholars of agricultural history in the first half of the nineteenth century followed this lead and concluded that the bulk of the population ate white, wheaten bread by the early nineteenth century.[2] E. J. T. Collins argued in 1975, however, that it was by no means clear that wheat consumption was uniform in the nineteenth century. Rather, he argued that in 1800 "a still very substantial proportion of the population of England and Wales, and almost a majority if the population of Great Britain, lived on the 'lesser-grains,' barley, oats, pulse, and rye; … a uniform national

[2] G. E. Fussell, "Population and Wheat Production in the Eighteenth Century," *History Teachers' Miscellany* VII, no. 5 (1929): 65–68; W. Ashley, *The Bread of Our Forefathers: An Inquiry in Economic History,* (Oxford: The Clarendon press, 1928); Collins (see below) points out that Percival placed the full transition to wheat about 1830. John Percival, *Wheat in Great Britain* (London: Gerald Duckworth, 1948), 614–7.

pattern of cereal-eating became a reality" only after 1900. Further, he suggested that through much of the nineteenth century, "the cross-price-income elasticity of demand for cereal was positive"; in other words, consumers varied their cereal consumption based on their income, purchasing whiter or more wheaten bread when they could, but also falling back to brown bread, barley, oats, or other staples when necessary.

By 1900, the bulk of the population had shifted to white, wheaten bread, but had also broadened its diet—to a limited extent—beyond bread.[3] Michael Nelson found this pattern in his 1993 study of social-class trends in British diets from 1860 to 1900. He argued that the working classes ate some sort of brown bread in 1860, while the middle class ate white bread; by 1900, white bread was practically universal. Moreover, 1860 was the peak in cereal grain consumption as a proportion of total diet. At that point, working-class Britons consumed from 8 to 13 lbs. of bread per week, while by 1900 the average had dropped to 6 lbs. In its place were more meat, cheese, fish, and other protein sources, made cheaper and more affordable by cheap imports and rising real wages.[4] Derek Oddy's synthetic treatment of British diets from the 1890s to the 1990s confirmed these findings with respect to bread, though he also noted that the urbanization of Britain meant that access to sources of food from outside the market dropped: it was impossible to glean or gather wild edibles in the cities, few urban residents had access to garden plots or allotments, and their cramped homes offered little space for cooking, and certainly not

[3] E. J. T. Collins, "Dietary Change and Cereal Consumption in Britain in the Nineteenth Century," *The Agricultural History Review* 23, no. 2 (1975): 97–8.
[4] Michael Nelson, "Social-Class Trends in British Diet, 1860-1900," in *Food, Diet, and Economic Change Past and Present*, ed. Catherine Geissler and Derek J. Oddy (Leicester, U.K.: Leicester University Press, 1993), 104–5.

enough for the long-term storage of large amounts of seasonally-gathered and processed food.[5]

While working-class diets improved over this period, there remained a major gap between working and middle- and upper-class diets. In the second half of the nineteenth century, an increasingly urban British working-class lived on what Oddy characterized as a fairly narrow diet of "plain fare," a diet of bread, potatoes, pork, and a few other major staples such as tea and sugar. Their access to and ability to purchase these items did increase, but the diets themselves remained quite narrow. Middle- and upper-class Britons could afford far more elaborate meals, and the gap between the simple, narrow diets of the bulk of the population, and the elaborate and varied feasts of those higher up the socio-economic ladder persisted until at least 1939 when a full program of wartime rationing performed a durable "leveling" of national diets.[6]

Beyond these quantitative assessments of bread's place in the British diet, historians have paid scant attention to bread's cultural significance. It appears in British historiography only as an adjunct to political struggles: Paul Pickering and Alex Tyrrell's *The People's Bread*, for example, does recognize the importance of bread as a symbol in the movement to repeal the Corn Laws, but their study is ultimately a matter of the Anti-Corn Law League.[7] At a fundamental level, their study does not recognize bread as a material object, ingested into British bodies and thereby connecting Britons to environments in a global wheat ecology, and invested with cultural significance. Frank Trentmann's *Free Trade Nation* performs essentially the same task with respect to the 1906 general election.

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[5] Derek Oddy, *From Plain Fare to Fusion Food: British Diet from the 1890s to the 1990s* (Woodbridge, Suffolk, U.K.: Boydell Press, 2003), 3–15.
[6] Ibid., x.
[7] Paul Pickering, *The People's Bread: A History of the Anti-Corn Law League* (London: Leicester Univ. Press, 2000).

He too sees bread as a symbol of political struggle in the late nineteenth and early twentieth centuries.[8]

In these two bodies of literature, then, are two components of bread's history: its material nature and its cultural significance. Because these two elements do not intersect in these two bodies of literature, the real significance of bread has not been addressed; certainly its environmental dimensions are not considered. And yet, this was arguably the single most important object for Victorian Britons, and the single most important environmental relationship. Underlying the existing scholarship on bread and food has been a question essentially unasked: why did Britons prefer white bread? And what did white bread *mean*? Existing studies of the shift from brown to white simply assume that the working classes sought to imitate those above them in the social and economic hierarchy, or that it simply tastes better. Petersen takes a more functionalist perspective, using contemporary nutritional knowledge to argue that working class Britons chose white bread whenever they could because it was a rational choice, providing more caloric value for the money.[9] As his study is essentially economic, the cultural meaning of bread is simply not addressed. And yet, the people of Victorian Britain knew their bread as intimately as anything in their lives, and its presence and characteristics were central aspects of their existence. And for them, the color of bread was inextricably bound up in the institutions that governed their lives. With the passage of the New Poor Law in 1834, brown bread became an instrument of the state; while with the repeal of the Corn Laws in 1846, whiter bread became the product of the market. Exactly who one was, and how successful one

[8] Frank Trentmann, *Free Trade Nation: Commerce, Consumption, and Civil Society in Modern Britain* (Oxford: Oxford University Press, 2008).
[9] Christian Petersen, *Bread and the British Economy, C. 1770-1870*, ed. Andrew Jenkins (Aldershot, Hants., England: Scolar Press, 1995), 125–46.

might be was bound up in whether one ate white or brown bread. And access to white or brown bread was, ultimately, a question of ecology and the biopolitics that governed it.

White Bread and Brown Bread

The descriptions of diets of both urban and rural Britons in the nineteenth century follow to some extent the quantitative data gathered by Collins, Nelson, and Oddy, but they also complicate it. More than anything else, they make clear the environmental dimensions of diet: rural Britons were more a part of the older moral economy, which assigned virtue to direct relationships between the production and consumption of food, and continued to participate in local, non-market wheat and food ecologies after urban Britons had shifted to a regional and then global wheat ecology organized by the market. As a result, rural residents ate wheat less often, and their bread was typically darker and denser. The rural working population, for example, was much more likely to obtain their bread by gleaning. In 1904, as the Conservative Party under Joseph Chamberlain attempted to reintroduce import duties, the Liberal publishing company of Thomas Fisher Unwin collected a set of letters from around Britain detailing life in the 1830s and 1840s, before the repeal of the Corn Laws. W. H. Moss, who grew in Bournbrook, near Birmingham, wrote that as a child in the 1830s and 1840s, his family was often able to obtain wheat only from gleaning, and then had to bring the already-sprouted grains to the mill for grinding. This produced a loaf that "was nearly black."[10]

These recollections of the "Hungry Forties" were clearly intended to paint the period before 1846 in the most negative possible light, and they cannot be considered an

[10] *Hungry Forties: Life Under the Bread Tax; Descriptive Letters and Other Testimonies from Contemporary Witnesses* (London: T. Fisher Unwin, 1904), 69–70.

accurate sample at all; however, they do reveal that there was to some extent a pattern of darker, less wheaten bread in the countryside before 1860. These letters virtually all describe the lowest segments of the laboring population, but that population continued to live on a range of staples including potatoes, turnips, and beans; what bread they ate was only partially wheaten at best, dark in color, and dense or soggy in texture. Many of the writers describe purchasing only the lowest qualities of meal, such as "tailing corn," "sharps," "toppings," or other forms of rough meal, often considered unfit for human consumption.[11] This, not surprisingly, produced only the lowest qualities of bread. A former postman recalled that in his youth, "We mostly lived on bread, but 'twasn't bread like 'ee get now; 'twas that heavy and doughy 'ee could pull strings of it out of your mouth."[12] In some cases, the grains available to the rural poor were of such low quality that they would not bake into loaves at all. In those cases, people resorted to "'peel' or 'griddle' cakes, …for when they attempted to make it into loaves, to bake in an oven, only an outside crust could be obtained of a firm consistency, the inside mass remained or became soft and pappy, and would, if thrown on a wall, bespatter it and stick like mud."[13] Thomas Mitchell, who grew up in Wandsworth in the 1840s, wrote that the quality of grain and flour available to them was so low that "The bread came from the oven in flat cakes. Upon keeping one day, a slice when cut, if pulled apart, was as though cobwebby, the colour then black, and it stank."[14] While this evidence is not conclusive in itself, it does reveal that for the lowest echelons of the rural working population, white, wheaten bread remained out of reach at mid-century.

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[11] Ibid., 73, 123, 133.
[12] Ibid., 26–9.
[13] Ibid., 93–4.
[14] Ibid., 138.

The pattern of higher-income Britons choosing wheaten bread over other options, or of lower-income people resorting to non-wheaten choices, is evident in the towns as well. People's Charter author William Lovett's memoirs include an account of his childhood poverty in Penzance in the early nineteenth century; he and his grandmother survived on the few shillings per week he earned in wages, plus what little his grandmother could earn in the fishing season. As a result, their diet was primarily barley bread, though he noted that fishermen commonly took a wheaten loaf to sea with them. Whether there is some material advantage to this—if a wheaten loaf held up under the damp conditions on a fishing vessel, for example—Lovett does not say. But, fishermen going off to work had more income than the unskilled, poorly paid, and casually-employed Lovett and his grandmother. As a result, wheaten bread was a possibility for them while it was not for Lovett.[15] The social investigator and journalist Edwin Waugh found the same pattern among urban and rural Lancashire in 1855. He walked from Bury to Rochdale, and stopped at a cottage along the way, where he was offered—in a country Lancashire dialect—"cowd mheyt" and "hard brade"; that is, an oatcake. The cottage's matriarch asked where he came from, and when he replied that he was from Manchester, she exclaimed, "Fro Manchester! Whau then, yo'd'n rayther ha' loaf-brade, aw'll uphowd yo." Here, the higher incomes of Manchester residents led the woman to assume that he, like other Mancunians, preferred wheaten bread, as they very likely chose that more frequently. Waugh, however, reveled in the "wholesome," "homely feast" she offered, and refused the wheaten bread.[16]

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[15] William Lovett, *The Life and Struggles of William Lovett: In His Pursuit of Bread, Knowledge and Freedom: With Some Short Account of the Different Associations He Belonged to and of the Opinions He Entertained* (London: Trübner & Co., 1876), 13.
[16] Edwin Waugh, *Sketches of Lancashire Life and Localities* (London: Whitaker, 1855), 13.

By the 1860s, the consumption of white bread was becoming more general in England as imports began to increase significantly. Edward Smith, a physician who first made his name investigating the dietaries of out-of-work cotton textile workers in Lancashire in 1862, conducted a broader investigation of the diets of the "lowest-fed classes" for the Privy Council in 1864. Tasked with describing the diets of working families, and not the wholly destitute, he surveyed agricultural laborers across England, Wales, Scotland, and Ireland. These families still existed to varying degrees within the older moral economy. Smith found that it was very difficult to ascertain the precise incomes of most rural families, for most of them obtained some form of "allowance" or other non-market benefit along with their pay. These included patches of ground on which to grow potatoes, free housing, or a monthly supply of wheat or barley directly from their employer or at a discounted rate.[17] Nevertheless, while many of these families must necessarily have eaten brown or barley bread, Smith found that they purchased white bread from the baker or white flour in order to bake their own as much as possible. 30% of the families he surveyed purchased bakers' bread as a "principal" article of their breadstuffs, while 50% bought it as an adjunct to their own baking. Of the 70% that bought flour to bake into bread, virtually all of them bought "seconds" flour; just one family regularly used wholemeal brown flour.[18]

Smith's findings for Scotland, Ireland, and Wales indicate that the consumption of wheaten bread was more limited outside England. In Scotland, 90% of the rural families Smith interviewed consumed oatmeal as a staple, and none of them bought bread regularly, though 30% did as an adjunct. 62% of the families used some amount of wheaten flour, but

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[17] Edward Smith, "Sixth Report of the Medical Officer of the Privy Council. Appendix No. 6, Report on the Food of the Poorer Labouring Classes in England," Command Papers, No. 3416 (London: House of Commons, 1864), 235–6.

[18] Ibid., 239.

this could be as little as 2.75 lbs. per adult per week, and in the Highlands it was just used by just 10% of families. Where it was used, wheaten flour was almost certainly combined with barley or some other grain. Indeed, he found no families that baked their flour into loaf bread, instead preferring "small, flat cakes called scones or bannocks." Although Smith did not make this particular inference, it is likely the case that a mixed flour with only some wheat but more barley, rye, and/or oats would not have baked into particularly appetizing loaves in any case. Certainly some of the English families noted above abandoned attempts at loaf bread owing to the poor quality of flour, and similar dynamics likely obtained for Scottish families.[19] His findings were similar in Ireland. There, just 3% of the families he examined used wheaten flour as a principal article of their diets, and while 68% of families consumed *some* wheat regularly, the average was just 2.5 lbs. per adult per week. Just a quarter of families bought bread at all, and most consumed potatoes, barley, and maize as their principal staples, not wheat.[20] Welsh families nearly all baked at home, and many combined barley with their wheaten flour or, because they received wheat as an "allowance" along with their labor, used low-quality wheat that was quite brown.[21]

In addition to his investigations of agricultural laborers noted above, Smith also examined several urban populations in 1864. These consisted of "town populations," grouped by trade: silk weavers and throwsters, needlewomen, kid glovers, stocking and glove weavers, and shoemakers, spread throughout the country: Spitalfields, Bethnal Green, Coventry, Macclesfield, Yeovil, Stafford and Northampton, a range of villages and hamlets in Derbyshire, as well as rural residents from across England, Wales, Scotland, and

[19] Ibid., 277.
[20] Ibid., 284–9.
[21] Ibid., 267.

Ireland. Among these populations, what mattered most was the rate of pay and the steadiness of the work, for those allowed people to purchase their preferred foods. But, it was certainly the case that these English families ate considerably more white, wheaten bakers' bread than other Britons. The kid-glove stitchers of Yeovil, for example, Smith found to be an unhealthy and underfed group; they purchased their bread from bakers in every case, and consumed a weekly average of 8.75 lbs. per person, along with 5.25 lbs. of potatoes. Stocking and glove weavers, living in a collection of small villages and hamlets across Derbyshire and the Midlands, were significantly better off; and, they averaged 11.9 lbs. of bread per person per week, and 4 lbs. of potatoes. Every weaving family Smith surveyed baked at least some of their own bread, and, like rural laborers at the time, used "seconds" flour, which Smith called "white."[cite]

The dramatic increase in imported flour from the 1870s forward, and the adoption of roller mills in the 1880s, meant that white flour, and therefore white bread, became truly available for all. Eighteenth-century writers such as Arthur Young and Thomas Eden noted with some disdain that laborers ate white bread when they could, and occasionally went so far as to insist upon it.[22] Certainly bakers had long discussed the demand for white bread. John White, a London baker, wrote in 1828 that it was vital to avoid bread that was "heavy," "damp," or "black," and that instead loaves needed to be "sweet" and "light." He condemned the effects of the bleaching agent alum, explaining that it imparted an "artificial whiteness" which soon "leaves the bread as it grows cold, and in twelve hours' time the bread is stale, it gets black and cracked all round." Despite this, however, he felt compelled to use it because of Londoners' insistence on white bread. They "will not have [bread] with

[22] See Chapter Three.

the natural colour in it," he lamented, and without alum, "the public will not eat your bread."[23] This pattern obtained for at least several decades: the process described by the 1841 *Guide to Trade* was the same, and was clearly the case in 1851 when the *Lancet* carried out its extensive surveys of adulteration in food, and found every bakers' loaf to contain alum.[24]

British millers adopted rollers in the 1880s for several reasons. They had long sought to produce the whitest flour possible, as it brought a higher price, and produced more bran, which was also a sellable commodity as animal feed. Ultimately, though, it came down to what bakers wanted. *The Miller* put it bluntly in 1876, declaring that "there is a constant and increasing demand among bakers for white and strong flour," a demand that could only be met by adopting rollers.[25] Further, as Britain's wheat ecology globalized, the increased imports of harder, drier wheat from environments outside Britain were difficult to grind into white flour on millstones, since their harder and darker bran tended to shatter and discolor the meal. British millers also feared competition from the United States. Millers in Minneapolis developed some of the first integrated roller milling systems as early as the 1860s, and began sending large amounts of flour to Britain.[26] As the British milling industry worked to develop its technical expertise, however, the demand for white bread, and therefore white flour, was a topic of constant comment. President Ure, at a meeting of the National Association of British and Irish Millers (NABIM) in 1886, made the relationship between roller milling and demand for white flour clear: "it must be

[23] John White, *A Treatise on the Art of Baking, with a Preliminary Introduction, Shewing the Various Productions... with a Number of Valuable Receipts, Original and Selected for the Baker and Domestic Circle* (Edinburgh: Anderson and Bryce, 1828), 234–41.
[24] See Chapter Five.
[25] "History of the Decortication of Wheat," *The Miller*, October 2, 1876.
[26] See Chapter Two.

acknowledged," he explained, "by those who have to engage in the modern competition—some would say craze—for whiteness," that rollers were essential.[27] Henry Simon, a milling engineer substantially responsible for the development of roller milling systems in Britain, gave a paper to the Society of Mechanical Engineers in 1889, on the recent developments in that field. Following his paper, one member of audience commented that "he had found man did as a rule select the product offered from the roller mill in preference to that offered from the stone mill."[28] At the same session, the President of the Society noted that all agreed that, "the industrious classes are as anxious as the wealthier to have their flour as white as it could be got."[29]

By the late nineteenth and early twentieth centuries, white bread was practically ubiquitous. Among the 1904 correspondents who described their lives in 1840s, there were many who compared the bread of their childhood with what they ate later in life. In all cases, they regarded the bread of the late nineteenth and early twentieth century as far superior to the bread they ate as children. W. C. Moss, who grew up in Bournbrook, near Birmingham, recalled that as a child in the 1830s and 1840s, his family was often able to obtain wheat only from gleaning, and then had to bring the already-sprouted grains to the mill for grinding. This produced a loaf that "was nearly black," which he was "quite sure" the workingmen of 1904 would never have touched.[30] Another writer in the same volume said that in his childhood in East Anglia, "A really good piece of bread, such as we now get always in abundance, was then a luxury and a treat to the poor—greater than roast beef is

[27] J. H. Chatterton, *Eight Annual Report of the Transactions of the National Association of British and Irish Millers* (London: George Berridge & Co., 1886), 135?
[28] Henry Simon, "On the Latest Development of Roller Flour Milling," in *Proceedings of the Institution Mechanical Engineers* (London: Institution of Mechanical Engineers, 1889), 180.
[29] Ibid., 190.
[30] *Hungry Forties*, 69–70.

today."[31] One writer, under the pseudonym "A Hampshire Hog," made perfectly clear the advantages in quality of bread available with a global wheat ecology: "In Protection days a bad harvest not only meant dear bread, but bad bread. There was no dry foreign wheat to fall back upon, and we had to put up with our own."[32] In this way, then, the repeal of the Corn Laws and the globalization of Britain's wheat ecology bought—or at least were perceived by some members of the working classes to have brought—considerable material benefit to the their diets.

Bourgeois reformers often saw the matter differently. In 1898, the British empire went to war against the Boers in South Africa, and in a burst of imperial exuberance, large numbers of Britons attempted to join the army. A substantial portion—perhaps as high as half—were turned away because of ill health. This prompted considerable hand wringing by political leaders and social reformers, for an unhealthy and possibly "degenerate" population was, they believed, an existential threat. As a result, the House of Commons ordered a special committee to investigate the crisis of "degeneration" in 1904. Along with examinations of working-class labor, housing, and urban environments, this committee looked at diets. They found that the working classes ate almost exclusively white bread. The physician Robert Hutchinson, asked about the matter by the committee, replied that, "If I were asked to state the chief fault in the diet of the working classes of this country, I should say it is the excessive use of tea and bread."[33] There are real doubts as to precisely what proportion of working-class recruits were turned away, and working-class diets were at that point probably as good or better than they had been at any point in the previous

[31] Ibid., 93–4.
[32] Ibid., 143.
[33] Almeric Fitz Roy, "Report of the Inter-Departmental Committee on Physical Deterioration ..." (London: HMSO, 1904), 40.

fifty years or more; but it was very likely the case that working-class Britons ate almost exclusively white bread. And, for the very poorest, there was little else besides white bread and tea, as the investigators found.[34]

The Staff of Life

"Bread" was more than simply a part of diet, even if it were the greater part. Frequently referred to as "The Staff of Life," for the working classes of Britain in the nineteenth century, "bread" was a synecdoche of all material life, and indeed a certain level of material sustenance. This is visible in the many, many references to "earning bread" in some form or other. Henry Mayhew began his 1849 discussion of the London poor by noting that they all pursued various strategies to "pick up a crust."[35] It is true that for most of the very poorest Londoners that he saw, bread—along with tea—was the essential article of food, his use of the term suggests more than simply feeding oneself. It was a matter of survival in a market-based world that offered little succor. About sixty years later, Maud Pember Reeves described the survival of the poorest segments of the East End in much the same terms:

Bread… is their chief food. It is cheap; they like it; it comes into the house already cooked; it is always at hand, and needs no plate and spoon. Spread with a scraping of butter, jam, or margarine, according to the length of the purse of the mother, they never tire of it as long as they are in their ordinary state of health. They receive it into their hands, and can please themselves as to where and how they eat it. It makes the sole article in the menu for two meals in the day.[36]

[34] Ibid., 83.
[35] Henry Mayhew, *London Labour and the London Poor* (London: Penguin, 1985), 5.
[36] Magdalen Reeves, *Round About a Pound a Week*, Repr. (London: Virago, 1994), 97.

This use of the term "earning one's bread" was not limited to the very poorest. The Chartist William Lovett, wrote that he chose to open a bookseller's shop on Tottenham Court Road, "conceiving that to be a business by which I might earn my bread."[37]

The same terms for describing bread permeated popular culture in the nineteenth century. Edwin Waugh's descriptions of Lancashire during the Cotton Famine of 1862 included a set of letters by John Whittaker, published in the *Times* under the pseudonym "A Lancashire Lad." His correspondence included several songs that he claimed were being sung throughout Lancashire. One, by Eliza Cook and titled, "Stanzas to my Starving Kin in the North," illustrated the connections between bread and clothing in Lancashire, "Where the good, the honest—unclothed, unfed,/Child, mother, and father, are craving for bread!"[38] The same volume contained "The Mill-Hand's Petition," originally published as a broadsheet but edited into a song. In this song, the American Civil War, the disruption in trade and slowdown in factory work, and the distress of the working classes there were woven together through bread.

> War's clamour and civil commotion
> Has stagnation brought in its train;
> And stoppage bring with it starvation,
> So help us some bread to obtain.
> For humanity is calling.[39]

Invocations of bread as a broader symbol of work and independence were not limited to Lancashire during the Cotton Famine, and indeed appear throughout the second half of the nineteenth century. In 1880, the Labour Emancipation League published a collection of songs, including "The Song of Freedom," by Herbert Burrows. One verse went

[37] Lovett, *The Life and Struggles of William Lovett*, 244.
[38] Edwin Waugh, *Home-Life of the Lancashire Factory Folk During the Cotton Famine* (Simpkin, Marshall, 1867), 255.
[39] Ibid., 262–3.

In rags and starving go your wives
While you are robbed, and he who strives
To earn his daily bread, derives
    But hunger for support[40]

Finally, the association between bread and work could cut both ways. Among his "Machine-Room Chants," Tom Maguire included a poem about "The Duchess at Number Three." He described a girl who was supported primarily by her father; her age is unclear from his words, but she was evidently not married and had no children. She, however, works in a factory in order to obtain a little extra money to purchase luxuries, and in so doing she was taking "bread and tea," that is, work and the ability to support oneself, from another woman.

It wouldn't find bread and tea
For me
They say I am cutting other girls out
Who work for their bread and tea, no doubt;
But, thank you!
England's free,
Te-he. [41]

In all of these cases, then, "bread" was both the material object and the broader symbol of self-sufficiency through work, and therefore of working-class independence.

With the importance of bread and its necessary connection to work and the material conditions of working-class life, it is not surprising that "bread" could play a prominent role in moments of sharp political conflict. "Bread riots" in Britain were quite rare after the 1830s, but they did occasionally happen; more commonly, "bread" featured in political actions usually associated with more explicitly political aims, such as Chartism. John Urie, an artist and photographer born in Glasgow in 1820, recalled a Chartist riot in that city in

[40] Herbert Burrows, *A Song of Freedom* (London: Labour Emancipation League, 1880).
[41] Tom Maguire, *Machine-Room Chants* (London: Labour Leader, 1895), 19.

1848. It was a period of high unemployment and high prices; the weavers of the West of Scotland were "falling apart before the power looms," he recalled, and publicly agitated for relief. Their actions illustrate the deep connection between sustenance, work, and "bread." Urie explained that the cry "Give us bread!" was common among the weavers and out-of-work artisans who gathered on a March afternoon. The city had set up soup kitchens and was distributing food, but, "Many of the recipients of these doles also regarded this as adding insult to injury—giving them charity in place of work and wages." The angry residents of Glasgow marched to City Hall, demanding that "bread or work," but when the Councilors announced that there would be another distribution of food, a riot broke out. "We want something better than that, and we mean to have it," replied the workers' deputy in his meeting with the Glasgow authorities. At this point, they marched through the streets, taking bread and other provisions where it could be found, and even at one point looting an ironmonger's shop for weapons. The riot ended only when soldiers, called from local barracks, marched through the streets.[42] The artisans' actions may seem contradictory: they demanded bread, and "bread or work," but then rioted when another distribution of food was announced. But, their actions are entirely consistent in a world in which "bread" and "work" are one and the same. Demanding bread was not simply a matter of demanding charity, for that would have signaled dependence and un-freedom, and, Urie said, some regarded that as an insult. When they called for "bread," they were insisting on the right to an independent existence sustained through their own labor.

The symbolic importance of bread is also visible when people fell below a threshold that allowed them a sufficient—if not exactly comfortable—existence; in cases such as

[42] John Urie, *Reminiscences of Eighty Years* (Paisley: Alexander Gardner, 1908), 62–8.

these, it was necessary to resort to some other kind of food, “below” bread in status and cultural value as well as price. Mayhew described in detail the life and travels of a 38-year-old cotton spinner in 1849. While serving in the army, he was flogged for insubordination and discharged without a pension. He had since survived by wandering about the industrial North of England, looking for work. At one point, he stole aboard a steamer between Dublin and Liverpool. When the captain found him, “he gave me a kick and some bread, and told me to work, so I worked for my passage twenty-four hours.” Frequently forced to sleep in workhouses, he lived on oatmeal porridge, or sometimes “ a pint of coffee and a half-pound of bread.” While walking to London in the winter, he was “half-hungered on the road… eating turnips out of this field, and carrots out of that, and sleeping under hedges and haystacks.” The man related his conversation with an old farmer who found him and exclaimed, “‘Poor fellow! Have you been out here all night?’ I answered, ‘Yes.’ He gave me some coffee and bread, and one shilling…”[43] Some working people did everything they could to maintain the appearance that they ate bread. A Mrs. Wilkins, in a letter about her life before and shortly after the repeal of the Corn Laws in 1846, wrote that her husband would “take out bread in the morning and bring it home at night,” skipping his midday meal so that his fellow working-men did not see that he could not afford to eat.[44] John Whittaker, writing as the “Lancashire Lad” in *The Times* in the 1860s, found a similar pattern among out-of-work cotton operatives. As he discussed the state of distress many of the working people of Manchester felt, the fundamental cultural importance of bread was obvious. Not only was the bottom line of subsistence described in terms of bread, but some families were “so reduced that the only food they have had has been a porridge made of Indian

[43] Mayhew, *London Labour and the London Poor*, 392–3.
[44] *Hungry Forties*, 122.

meal." Unable to afford "even oatmeal," these families were "so ashamed of their coarser food that they have done all that was possible to hide their desperate state from those about them."[45]

Bread, and particularly white bread, carried significance in the opposite direction as well. There was a particularly aspirational quality to the consumption of white bread which many writers in the nineteenth century described. In an account reproduced in 1904 and detailing the "good old times" before 1846, one old man recalled that "When he was a child *white bread* was considered a great luxury—so much so that when his father used to take his work in Nottingham, he would frequently promise to bring the children a penny white loaf on his return, and such was the eagerness of the little ones to possess this luxury, that they many times went three or four miles to meet their father that they might have it a little sooner."[46] George Mimms, who grew up near Walton, said that as a child, "We thought as much of getting a piece of white bread in those days as a poor man does now of getting a piece of cake."[47] Dodd found the same pattern obtained in London in 1856. He claimed that, "a Londoner deems it derogatory to his position, and a sign of poverty, if he do not eat 'best wheaten' bread"; "best wheaten" was a term originating in the old Assize of Bread, and indicated the highest quality of bread, which in practice meant the whitest.[48]

For the middle and upper classes, bread just was not nearly as important a signifier of wealth; for them, it is much finer dining that signified real prosperity and opulence. In particular, having a cook was a major element of status, for it signaled that the housewife

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[45] John Whittaker, "Letter from 'A Lancashire Lad,'" *The Times*, April 22, 1862.
[46] *Hungry Forties*, 94–5.
[47] Ibid., 119.
[48] George Dodd, *The Food of London: A Sketch of the Chief Varieties, Sources of Supply, Probable Quantities, Modes of Arrival, Processes of Manufacture, Suspected Adulteration, and Machinery of Distribution, of the Food for a Community of Two Millions and a Half* (London: Longmans, Brown, Green and Longmans, 1856), 204.

was a manager of her domestic staff, and not required to do any (or very much) physical work herself.[49] This view is evident, though not always explicitly, in cookery books and household management manuals. These were intended for either cooks and domestic servants working in bourgeois and aristocratic households, or for those housewives in the petty bourgeoisie or upper levels of the working class who sought to imitate those above them in the class hierarchy, or at least to improve their "household economy." In some ways, these publications were probably quite useful; even for an experienced cook, having a ready list of recipes for a dozen different varieties of cake or quick bread would be useful. In other cases, however, they were quite obviously not of much practical benefit.

The case of bread fits squarely into the latter category: virtually all cookery or domestic economy books included recipes for some kind of basic loaf bread, but the recipes were so vague that the chances of producing a loaf of quality from them without already being an experienced baker were slim. A recipe from 1852 asked for simply "flour," water, and "yeast," made into a "thin batter" (that is, a sponge), left overnight, and then kneaded into loaves and baked.[50] *Cassell's Dictionary of Cookery*, published in 1883, included several recipes for bread. It reproduced Cobbett's recipe from the 1820s, two different recipes for "Household Bread," and one for "Home-made Bread." In each case, the recipes remained very vague, warning the reader that with "very fine bread… the dough should be softer than with seconds or brown bread," and that it was necessary to use "good yeast." These were tips that anyone experienced with baking would have known.[51] The 1882 *Handbook of Domestic Cookery* provided a virtually identical recipe, but did take the time to point out the

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[49] Andrea Broomfield, *Food and Cooking in Victorian England: A History* (Westport, Conn.: Praeger, 2007).
[50] Frederick Bishop, *The Illustrated London Cookery Book* (London: J. Haddon, 1852), 370.
[51] *Cassell's Dictionary of Cookery. With Numerous Illustrations.* (London: Cassell, Petter, Galpin & Co., 1883), 76–7.

drawbacks of using a domestic servant to bake bread: "Making bread at home for those who live in towns is a questionable economy," for the baker was much more likely to succeed and could usually provide high-quality bread at a good price. The author did acknowledge that a well-done home-made loaf could have a "peculiar sweetness," but any cook or servant capable of producing the highest quality of home-made bread would have had no use for such vague and formulaic recipes in the first place.[52]

For middle- and upper-class Britons, bread may have been purchased from the baker or baked by a skilled cook, but in either case its cultural and caloric significance was minor. *Cassell's Dictionary of Cookery*, for example, spent far more ink discussing the role of bread in fine dining. The author suggested that it saved time to "put a good-sized piece of bread to each person at starting," for "Some persons' dinners are quite spoilt for want of bread, and bread is one of those things that even good waiters are very apt to forget to hand of their own accord." About the only thing worse that a waiter forgetting to distribute bread, the author wrote, was "to have a nice piece of partridge or woodcock getting cold on one's plate, and to see it and smell it while waiting for bread."[53] For the middle and upper classes, then, bread was—as with working class Britons—present at virtually every meal, but it carried little of the cultural significance that it did for those lower down the socio-economic and cultural scales.

[52] *Handbook of Domestic Cookery, Adapted to the Requirements of Every Household. With Many Recipes for Ordinary and Special Use.* (London and Glasgow: WIlliam Collins, Sons, & Company, 1882), 276.
[53] *Cassell's Dictionary of Cookery*, lxxiii.

The Bread of Idleness

For the liberal Victorian state, bread played crucial roles in both the systems of discipline that state deployed, and in the system of security. Liberalism is admittedly a vague term; it may refer to the ideology and practice of laissez-faire, anti-statist political economy, or, as Lauren Goodlad and others have argued, a set of moral virtues necessary to thrive in such a political economy.[54] In this case, however, it is best simplified as the notion that a state is best that governs the least. As Samuel Smiles, the immensely popular Victorian moralist, wrote in 1859, "the function of government is negative and restrictive, rather than positive and active"; it's only appropriate function, he believed, was protective, "of life, liberty, and property."[55] In the same year, the political philosopher John Stuart Mill bought this philosophical view to its core exaltation of the individual in his essay *On Liberty*, when he argued that "the sole end for which mankind are warranted, individually or collectively, in interfering with the liberty of action of any of their number, is self-protection"; or, put another way, "Over himself, over his own body and mind, the individual is sovereign."[56] This required, in other words, a state and society that did not intervene. Instead, the organization of society, its production and consumption of resources, was left to the market. In this view, human beings were essentially *homo economicus*, beings whose essential end was to obtain wealth. A state that accommodating this view of human beings was one that allowed humans to pursue their inherent self-interest, and that therefore removed itself from any kind of interventions that might impede or distort the pursuit of self-interest.

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[54] Lauren Goodlad, *Victorian Literature and the Victorian State: Character and Governance in a Liberal Society* (Baltimore: Johns Hopkins University Press, 2003).
[55] Samuel Smiles, *Self-Help: With Illustrations of Character and Conduct* (Boston: Ticknor and Fields, 1861), 16.
[56] John Stuart Mill, *On Liberty* (Boston: Ticknor and Fields, 1863), 23.

In reality, the creation of a liberal society required not merely the removal of older sets of restrictions, but the active construction of a liberal state. And, while this state professed to do as little as possible and thereby preserve the liberty of its citizens, in fact it required the institutionalization of coercive measures to enforce the operation of the market. At the heart of the liberal state were the workhouse and the prison, and the pivotal moment in its creation was the Poor Law Reform Act of 1834. Better known as the New Poor Law, this was a dramatic reordering of the state's relationship to the poor. The Elizabethan Poor Law had been modified in 1795 by what came to be known as the Speenhamland system. This was the codification of the right of subsistence which underpinned the old moral economy: it provided subsidies to the wages of working people who earned anything under set amounts, based on sliding scales set by the price of bread. Local rates funded theses subsidies, known as "allowances." However, in the first decades of the nineteenth century, the number of people collecting these allowances grew rapidly, and, therefore, so too did the parish rates. Pauperism seemed an intractable problem: wages plummeted as employers found that they could cut wages, since their workers would have the difference made up by the parish; but, what motivation did workers have then to be more productive, or to seek better employment? The number of paupers seemed to be ever growing, and fewer and fewer of them seemed willing to work for wages.

But, while the political economy of high parish rates, unproductive labor, and pauperism were no doubt real issues in the minds of liberals political economists such as Adam Smith, Thomas Malthus, and David Ricardo, and the great liberal reformer Edwin Chadwick, this was an issue that manifested as a problem of morality. The fundamental problem in the minds of many reformers was that the Speenhamland system, with all its paternalistic intentions, had de-coupled work from reward. They believed that the allowances and workhouses then in operation gave too much to the poor, allowing them to live in apparent luxury without having properly earned their bread. In this way, they saw it as "demoralizing" to the poor, removing the incentive to work hard, and making them lazy and insolent; in the minds of reformers, the Speenhamland system and many of its paternalistic administrators actively encouraged, or at the very least shamefully enabled, sloth and insolence. This perception permeated the 8000-page report on the old Poor Law that a Parliamentary commission produced in 1834. It was clear not only in the new policies adopted, but in the various witnesses that provided evidence. A Mr. Booker, Assistant Overseer at Bishopsgate, summed up the problem: "I am confident," he claimed, "that there are no people who have a pound a week in wages who live so well as the people in any well-dieted workhouse."[57] The problem was obvious: in his view, those actually working were less well off than those who lived on the largess of the parish, doing no work. The problem extended not only to the poor, but also to the middle- and upper-class people who ran the workhouses and set the allowances. J. W. Pringle, reporting on pauper relief in Southampton, wrote that he had attended meetings of the local poor law guardians, at which the issue of high parish rates was raised. As they considered various solutions, there was a suggestion "to give brown instead of fine white bread to the paupers," and thereby reduce the costs to the parish and thence to the rate-payers. For some of the guardians, however, this threatened their paternal status atop the local hierarchies of power. They responded to this suggestion by claiming that they "would never consent to reduce the

[57] "Report from His Majesty's Commissioners for Inquiring into the Administration and Practical Operation of the Poor Laws," Reports of Commissioners, 44 (London: House of Commons, 1834), Appendix A, p. 91.

comfort of the poor," a claim that Pringle said "they would repeat out of doors to court popularity."[58]

The antidote to this system of "de-moralized" society, as well as the means of implemented a liberal state, was the New Poor Law. This reform sharply reduced the allowances, or "outdoor relief," given in money under the Speenhamland system, and replaced them with relief "in kind," or with "indoor relief" in the form of life in the workhouse. In other words, the state withdrew its direct financial support of the British working population, and replaced that support with a system designed to compel each able person to work: the parishes became institutions that provided a bare minimum of material support to the poor in exchange for menial labor such as breaking rocks or picking oakum, with their clearest articulation in the workhouse. Built into this system, and necessary for its logical operation, was the principle of "less eligibility." This principle insisted that the conditions within the workhouse had to be worse than the conditions outside, for only in that case would the indigent avoid the workhouse if they possibly could. As Chadwick described it, it was vital that the parish, where individuals and families might go if they could not support themselves, was "by far the worst paymaster and the hardest taskmaster." For Chadwick, the meaning of this was clear: the parish would offer very hard labor, such as breaking rocks or picking oakum, in return for "low wages, not in money but in kind," and in particular "brown bread."[59] The white bread whose distribution had seemed so inappropriate, undeserved, and actively harmful to Pringle, would be no more.

Although those who entered the workhouse were not technically "prisoners," since they could leave if they so chose, these institutions were still disciplinary in nature: those

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[58] Ibid., Appendix A, p. 287.
[59] Ibid., Appendix A:58.

who entered them were referred to as "inmates," were separated by age and gender, were confined at various times, and were closely supervised as they carried out the work that would earn their meager rations. And, what was true of the workhouse was doubly true for its more coercive cousin, the prison. Those who offered some kind of resistance to the broader system of enforced labor market participation via the workhouse risked starvation, or imprisonment for vagrancy, theft, or other petty crimes. It was vital that life in the prison be as harsh as possible, because if conditions inside the prison were somehow "too good"—as difficult as that may be to imagine—then in the minds of Britain's liberal administrators, that would not only encourage the sloth and vice they were attempting to remedy, but would even incentivize the commission of crimes in order to be sentenced to long terms in apparent luxury. Without this mechanism, Chadwick asked rhetorically, what motivation for the poor was there to "eat the meat of industry, rather than the bread of idleness?"[60]

Those receiving outdoor relief, inmates in workhouses, and prisoners were all dependent on the state for some part of their daily bread—and the bread provided by the state was brown. From the beginning of the operation of the New Poor Law, the state kept track of what the expenditures were for the various Poor Law Unions—combinations of parishes for the purpose of administrative expediency—around the country. No central authority mandated any particular diet for workhouse or prison inmates, and thus each local institution was free to select the diet that it saw as most suited to the local working population. Indeed, as Chadwick himself later admitted, no one in Britain really knew what the bulk of the population ate. All that mattered was that the food in the workhouse or the

[60] Ibid., 156.

prison be below that available to the wage-earning population in quantity and quality. In practice, this meant brown bread: in 1835, the Poor Law Commissioners for England and Wales began their practice of recording the dietaries and outdoor relief given in each workhouse via a survey sent throughout the country. Along with the various items such as gruel, potatoes, and bacon, the only entry for bread was "Brown Bread."[61]

Giving payment in kind meant that they received bread baked on contract for the parish, and, while Poor Law administrators claimed that "the supplies of bread given in the new [workhouse] unions were always as good as those obtainable from the shopkeepers, and were frequently declared to be much better," it unlikely that the laboring population agreed.[62] The bread available via contract bakers was brown, while, if what bakers like John White in 1828 and the author of the *Guide to Trade* in 1841 described is true, then bakers' bread was almost universally white—or at least as white as was possible with the addition of alum.[63] In any case, whether the working population agreed as to the quality or not, "bread" as an object clearly held meanings dramatically different for them, as opposed to the liberal reformers and administrators who created and managed the workhouses and prisons of Victorian Britain.

The brown bread distributed by parishes, in workhouses, and in prisons was politically loaded, a fact visible in the initial reactions to the change, which in several locations included not only anger and dismay, but also "riotous proceedings." Sir Francis Bond, head of the Poor Law Commissioners in East Kent, described the responses of the local population in detail.

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[61] "First Annual Report of the Poor Law Commissioners for England and Wales," Reports of Commissioners, 500 (London: House of Commons, 1835), 79.
[62] Ibid., 29.
[63] See Chapters Three and Four. White, *A Treatise on the Art of Baking*; *The Guide to Trade: The Baker; Including Bread and Fancy Baking with Numerous Receipts* (London: Charles Knight and Co., 1841).

…they assembled in great numbers to attack, not only the relieving officers, but to insult and assault their own magistrates; when armed with clubs they dragged the independent labourers from their work, forcibly obliging them to join their gang; when they grossly insulted women who earnestly desired, for the sake of their children, to accept the bread; when they declared to one or two Kentish yeomen, that if they dared to interfere, 'they would hang them up the heels to their own trees;'[64]

At Heckingham, in Suffolk, the attempt to introduce "discipline in the disorderly workhouse" resulted in the inmates there "setting fire to the workhouse" and destroying a quarter of the structure. Similar incidents took place in Essex, Hertfordshire, and elsewhere in Devon.[65] Bond's description of these events was typical of liberal reformers' views of the paupers: that they were lazy, refusing to work, but also violent and unruly. In this way, the New Poor Law was an attempt to "discipline" the working population in multiple ways. As Bond put it, "such conduct explained most clearly the miserable progress of unrestrained pauperism," and clearly made the case for "the necessity as well as the beneficence of the Poor Law Amendment Act."[66]

In other cases, the destitute responded to the new, brown bread in a more passive but still revealing manner. The 1836 Report of the Poor Law Commissioners recorded, in addition to riots, an account of the poor refusing to eat or even touch the bread. At Okehampton, in Devon, those eligible for some relief feared that "acceptance of the smallest relief exposed them to the forfeiture of all their goods," and "that the bread distributed by

[64] "First Annual Report of the Poor Law Commissioners for England and Wales," Appendix B, p. 104.
[65] "Second Annual Report of the Poor Law Commissioners for England and Wales," Sessional Papers, 595 (London: House of Commons, 1836), 5.
[66] "First Annual Report of the Poor Law Commissioners for England and Wales," Appendix B, p. 104.

the relieving officers was mixed with poisonous ingredients." W. J. Gilbert, Esq., active in Poor Law administration in Devon, wrote to the Commissioners that

> …the peasantry fully believed that all the bread was poisoned, and that the cause for giving it instead of money was the facility it afforded of destroying paupers; that all the children beyond three in a family were to be killed; that all young children and women under 18 were to be spared; that if they touched the bread they would instantly drop down dead; and I saw one poor person at North Molton look at a loaf with a strong expression of hunger, and when it was offered to her, put her hands behind her and shrink back in fear lest it should touch her. She acknowledged she had heard of a man who had dropped down dead the moment he touched the bread.[67]

Brown bread, then, was impossible to separate from its political and economic context, and indeed, for the destitute in British workhouses, that political and economic context of bread could overcome their hunger.

In the minds of the Poor Law Commissioners, these incidents could only have been the work of "persons interested in the continuance of the old system," by which they meant local elites who wanted to preserve their positions atop the old paternalist hierarchy, the small tradespeople and merchants who supplied the working population and who therefore relied indirectly on workers' cash allowances, or members of the working population who wanted to continue receiving outdoor relief for little or no work. The Commissioners assumed that the problems arose from subversive members of these groups contriving "to infuse into the minds of the peasantry the most idle and groundless apprehensions." In the context of the New Poor Law's transformation of the relationships between the state and the working population, however, their reactions appear far more as a manifestation of the new political nature of bread. If the state that had once protected their right to subsistence had now become their "worst paymaster… and hardest

[67] "Second Annual Report of the Poor Law Commissioners for England and Wales," 328.

taskmaster," and brown bread was a symbol of this transformation, it is not at all surprising that the working people feared and rejected it. Indeed, the two particular rumors that apparently circulated illustrate the inherent connections between brown bread and dependence: those receiving indoor relief feared losing their possessions if they accepted any relief, a clear signal of their fear of dependence. And, the darker color of the bread provided suggested to them not merely a loaf that was lower in quality or less palatable, but one that was impure and personally dangerous to their bodies.[68]

Bread played a fundamental role in the operation of the disciplinary institutions of nineteenth-century Britain, and it reached it an extreme state in Birmingham Borough Prison in the early 1850s. Prisons had to operate under a slightly different regime than workhouses, although the principles were similar. In a workhouse, the key was to determine which inmates were deserving poor, and who therefore might be simply given relief, and which were not, and who therefore might be made to work. The former category included the very old and very young, and the ill or otherwise infirm. Among for the former category, relief in kind, the Poor Law administrators believed, acted as a kind of "self-acting test of the validity" of an application for relief. If an applicant judged medically fit were offered work for bread but refused it, then it was assumed that he or she did not *really* need it, or they would not have refused.[69] Prisons, on the other hand, held individuals who were sentenced to confinement (and often hard labor) but not death, and therefore were obligated to provide a bare minimum of subsistence. A right of subsistence thus existed in the prison, as a necessary element of the prisoner's incarceration and reform. This

68 Ibid., 5.
69 "First Annual Report of the Poor Law Commissioners for England and Wales," 6.

minimum, however, could be very small, as the inmates and governors of the Birmingham Borough Prison discovered.

Built in 1849, this prison was intended as an "airy and well-built " facility for up to 200 inmates, and the Birmingham magistrates appointed Captain Alexander Maconochie as governor in what must have seemed an auspicious personnel move. Maconochie had previously served in the Royal Navy, and there had overseen the management of the convict settlement at Norfolk Island, on the northeastern edge of the Tasman Sea in the South Pacific Ocean, the body of water separating Australia and New Zealand. There, at one of the very last convict settlements in the British empire (convict transportation had all but ceased at that point), he developed what he termed the "mark system." This system held that "no prisoner should be considered as *entitled* to any other food than bread and water, and should earn an improved dietary, together with other indulgences and rewards, in proportion to the number of 'marks' which he should obtain for diligent performance of his labour, and for general good conduct."[70] In other words, it reduced the right of subsistence due to one in the care of the state to its very minimum; in this case, that minimum could be reduced to water and a mere six ounces of bread. Anything more could be "earned" only through work, a mechanism that mimicked the operation of the market. The bread was, naturally, a very coarse brown bread; indeed, for many prisoners accustomed to white bread before they arrived in the prison, the brown bread served there was inedible.[71]

In order to earn more than this meager diet, Maconochie put the prisoners to work, and one possible task was to operate the "crank machine." This was a weighted crank with

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[70] "Report of the Commissioners Appointed to Inquire into the Condition and Treatment of the Prisoners Confined in Birmingham Borough Prison," Sessional Papers, 1809 (London: House of Commons, 1854), iii.
[71] Ibid., xiv.

a simple handle, in an otherwise empty cell. To perform labor on the machine, the prisoner simply turned the hand, with 10,000 revolutions per day as the standard. Initially, two crank machines were installed in the prison, and attached to the millstones that were used to grind the bread eaten by all there. After less than two years in charge, the Birmingham magistrates found Maconochie's methods too lax, having resulted in "an undue laxity of discipline, and a want of perfect cleanliness and order." They replaced him with Lieutenant William Austin, also a Royal Navy veteran, who had served as the assistant governor under Maconochie. Austin's discipline was considerably harsher than even Maconohcie, and he promptly ordered the installation of twelve more crank machines in a dedicated "crank ward," overseen by a special warden charged with weighting the machines and ensuring that prisoners completed their assigned number of turns. Shortly after assuming control of the prison in October of 1851, rumors began to circulate of "alleged cruelties" in the prison. Several inmates died in custody, including Thomas Hodgetts, a man being held before trial for felony at the Warrick Assizes, and one, a fifteen-year-old boy named Edward Andrews, committed suicide in his cell. This prompted a series of investigations that bring to light both the cruelty of the mid-Victorian prison and the role of bread therein.

The investigation into the deaths of prisoners, Austin's governorship of the prison, and conditions therein, revealed a particularly cruel version of prison discipline but one focused especially on work and bread. While Maconochie had used crank machines, under Austin's governance, they became integral elements of the disciplinary system in the prison. Prisoners were typically required to complete 10,000 revolutions of the crank in eight hours of labor; in order to accomplish this, a prisoner had to complete one revolution approximately every three seconds. As this involved the manipulation of five pounds for children, ten pounds for adult women, and fifteen pounds for adult men, this amounted to labor “most severe and exhausting”; in the course of their investigation, the commissioners calculated that a boy would have to exert a force equal to one-quarter horsepower, but an average boy was only about one-tenth the size of a typical workhorse.[72] Moreover, such labor must have been psychologically taxing as well, for the prisoners were required to perform their labor alone, in a dimly lit crank cell. The only sensory stimulus was the counter on the machine itself, slowly counting up to 10,000 as the hours ticked away.

Austin withheld food as a coercive measure to compel the prisoners to carry out this labor. The standard practice in the prison was to allow prisoners full rations only if they completed certain numbers of revolutions at particular mealtimes. Thus, if a prisoner did not complete enough revolutions to keep himself on pace for 10,000, he could go the whole day without food, being given only the small loaf and water to which he was “entitled” under the mark system. Prisoners who were behind schedule were kept in the cell to continue “working” until their required 10,000 revolutions were completed, even late into the night. Indeed, many prisoners were routinely kept at the crank until after the hour they were meant to return to their cells, and it was not uncommon for prisoners to record well over 10,000 revolutions in this case. This was because the cells were unlit, and as the day darkened, it was impossible for someone in the cell to see just how many revolutions were completed. Thus, they continued working until the crank warder came for them; in an additional example of cruelty, surplus revolutions did not roll over to the next day’s labor.[73]

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[72] Ibid., vii.
[73] Ibid., vii–xi.

Anyone unable to complete their assigned task was given only the barest minimum of subsistence, which could be as little as six ounces of coarse bread and water.[74] Such labor would have been difficult under any circumstances (indeed, it was likely every bit as strenuous as the exercise regimes undertaken by elite athletes today), but its unsustainability on a prison diet was obvious. As the commissioners noted, "no human being, whether adult or juvenile, could continue to perform such an amount of labour of this kind for several consecutive days, especially on prison diet, without wasting much and suffering greatly."[75] Austin disagreed, and evidently saw diet as a broad tool for discipline, for he routinely put prisoners on bread-and-water diets for "insubordination" beyond the crank machine. This was a very wide category of offenses that could include anything from striking the guards and warders to speaking to other prisoners.

It is tempting to view Austin's methods as cruel, and they no doubt were. The commissioners said as much when they condemned him for his practices, and found him responsible for the deaths of prisoners in his charge. His methods were not, however, aberrant from the broader logic of liberalism. Paupers and criminals, in the minds of many Victorian liberals, needed to be reformed, and work was the primary mechanism to do that. Austin's system was a sort of refined and perverted version of the market as a disciplinary mechanism: the "work" performed had no actual value, for the crank machines installed by Austin were not—as Maconochie's were—connected to the flour mill or any other productive purpose. The crank machine served only to compel the prisoners' bodies to act. And, the food they received was the most extreme example of "earning one's bread": here, "bread" was no longer a synecdoche of material life, but the actual lived reality of prisoners'

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[74] Ibid., vii–viii.
[75] Ibid., vii.

lives. It was not outside the logic of the market, then, so much as that logic taken to such an extreme that it directly resulted in the deaths of prisoners. In their deaths, the bio-politics of bread and discipline were laid bare.

Although they were not the only prisoners to suffer in the Birmingham Borough Prison, the cases of Edward Andrews and Thomas Hodgetts are particularly useful in illustrating the relationships between work and bread in Victorian Britain. Edward Andrews was fifteen, “of a thin spare habit of a body, about five feet high,” and had been committed to the prison several times: for stealing garden fruit, throwing stones in the street, and finally, for stealing four pounds of beef; prison officials described him as “a very ignorant poor boy, very desolate in his circumstances.” He was illiterate, and “utterly devoid of any religious notions,” and while some of the prison officials called him “mild, quiet, [and] docile,” Austen himself referred to him as “sullen” and “dogged.” He was, in this way, a “deviant” pauper, having either evaded the disciplinary influences of education and the market, and having actively resisted the Victorian state’s major concern with the protection of property. The antidote to such a “problem” child was, for Austen and indeed for the liberal state broadly, work. Accordingly, he was put to work on the crank machine almost as soon as he arrived at the prison. He was frequently unable to complete the 10,000 revolutions, and was disciplined several times for various offenses ranging from having a dirty cell to breaking the crank machine to which he was assigned. He was accordingly punished with bread-and-water diets for several days at a stretch, was also several times put into a “punishment jacket”—essentially a straightjacket that was then chained to a wall. Through this period, he was “crying and wailing most piteously, and speaking of his misery and wretchedness.” He complained bitterly of his deprivation of food and his inability to perform the labor required by the crank machine, and was ultimately heard telling another inmate “in coarse language” that he would not do it any more. After several such months in the prison, he took his own life, hanging himself from the bars of his window with the strap of his hammock.[76]

Thomas Hodgetts, whom the prison surgeon Mr. Blount uncharitably described as a “heavy, dull, stupid-looking man,” entered the prison while awaiting trial for felony at Warwick, but shortly after entering suffered a series of epileptic seizures, and on at least one occasion lay unattended all night upon the floor of his cell. He ate little while incarcerated, rejecting the “prison bread” provided to him. After his death, eighteen of the small brown loaves were found in his cell, suggesting that he had eaten little, if anything, for about a week prior to that. He was all but unable to perform work on the crank machine, and to several of the prison warders an the governor, Hodgetts appeared to be lazy, “pecking” or “shamming” about his illness, and using his debility to avoid this labor. Thomas Cotterill, a first-class warder, at one point “shook the prisoner roughly,” and accused him of faking his illness; Thomas’s son Edwin Cotterill, a crank warder, reportedly added that, “A good horsewhipping would do him good. If I had him three or four days at the crank, I would do him good.” Whether he was exaggerating his illness or not, he suffered a severe seizure early one morning, at which point the infirmary warder Edward Henry Perks found him. Hodgetts recovered somewhat, and Perks testified that

I thought the prisoner seemed a little better, and I asked him if he thought he could eat anything, and he said 'Yes,' as well as he possibly could; and I went down to the cookhouse and fetched a little broth. I gave him the broth, likewise a little white bread. During that

[76] Ibid., vii–xi, 142–3.

time [Thomas] Cotterill came in, and he asked me what business I had to give the prisoner white bread unless ordered by the surgeon. I said, 'The prisoner appears to me to be in a dying state;' and I said, 'I took upon myself to give him the white bread.' Then he said, 'I shall report you to the governor for it.' I said, 'You can do it, and welcome.'[77]

Hodgetts was, however, deemed to be indeed quite ill; he was removed to the infirmary that morning, and died there before the day was out. His last meal very likely included white bread.

In the cases of Andrews and Hodgetts, then, are the twin prongs of the Victorian state's disciplinary apparatus: Andrews, compelled to work but unable and unwilling, either mentally or physically, to perform the work, took his own life rather than perform the mindless and meaningless labor for his daily bread. Hodgetts found a tiny bit of relief from the regime of labor and coarse bread, in the form of white bread, but only in his dying hours. This, then, was the regime that the liberal state so il-liberally imposed: the hard labor of the market, or a simulation of the same, in return for the coarsest forms of brown bread. It is not surprising, then, that brown bread became a symbol of un-freedom and dependence. But, conversely, if brown bread signaled un-freedom, then white bread signaled the opposite: freedom from dependence on the state. If "bread" broadly was a synecdoche for "material life," the New Poor Law invested in the *color* of bread an assessment of one's status in the disciplinary and market-based social order of Victorian Britain.

[77] Ibid., xiv–xv, 105.

White Bread and Free Trade

By the 1860s, British society and the workhouses in them were undergoing an important shift. By that point, the workhouses were inhabited mainly by children, the elderly, and the infirm. "Able" paupers were growing rare, and punishing members of the "deserving poor" was less important than providing for them. As an 1867 report on the "Proper Dietaries in Workhouses" noted, the workhouse population was now largely "such as may fittingly receive [relief], viz., the aged and infirm, the destitute sick, and children." This meant a change in the very nature of the institution: "Workhouses are now asylums and infirmaries," the report noted, "and not places where work is necessarily exacted in return for food, clothing, and shelter."[78] The globalization of Britain's wheat ecology was also fully underway by the 1860s, and bread across the country was getting whiter.[79] In the context of these two shifts, Dr. Edward Smith, well known for his surveys of the diets of Lancashire textile workers during the Cotton Famine in 1862 carried out a set of further studies on the diets of the working people across the country and on its various disciplinary institutions. Smith was an important figure in the development of nutritional science, and he made a series of important recommendations.

Economy was always a vital matter for prisons and workhouses, and feeding inmates a sufficient diet as cheaply as possible was an obvious priority. Smith, in part building on the research of Justus von Liebig but also on his own contributions, argued that whiter flour was a better food overall. He examined wheat chemically, explaining that, as current physiological knowledge held, it was vital to supply both carbon and nitrogen, and

[78] *Accounts and Papers of the House of Commons: Thirty-Eight Volumes; Poor (England and Wales); Poor (Metropolis); Poor (Ireland); Poor Rates and Pauperism. Session 5 February to 21 August 1867.*, vol. LX, 22 (London: HMSO, 1867), 12.
[79] See Chapters One and Two.

to ensure that as much as possible of the food was fully absorbed. Wheat provided more nitrogen and less indigestible bran than barley, rye, or oats. Pound for pound—or loaf for loaf—it was therefore more nutritious and more amenable to absorption in the digestive tract than other grains. Previously its cost had been so much greater that it still made sense to buy or consume non-wheat grain, flour, and bread, particularly for rural populations with some kind of special access to grain via gleaning or another customary arrangement. After the repeal of the Corn Laws, and with the expansion of Britain's wheat ecology overseas underway, the economics of grain choice changed.[80] "Great changes have occurred in the present century by the reduction of the price of wheat in relation to that of other grains," Smith explained; "formerly, the difference in cost was far greater than the difference in nutritive value." By 1866, however, "the difference of cost is so little, whilst that in nutriment remains as before," and therefore wheat was the more economical grain.[81]

Moreover, he argued that whiter flour was more economical than the coarse brown flour so often used in the preceding decades. The flavor is superior, he explained, being "softer and more agreeable… [and] liked by children, women, and men alike." Because of its better flavor, the inmates were more likely to eat it. Inmates refusing food because of its unpalatabiliy was a clear waste of food and harmful to everyone, and a common occurrence when the diet was brown bread, or worse, gruel or a loathsome "stir-about" of whatever grains came to hand, including maize, widely reviled in Britain. And, again drawing upon contemporary physiological research, he noted that white flour contained less indigestible

[80] See Chapter One.
[81] Edward Smith, "Dietaries for the Inmates of Workhouses," Command Papers, No. 3660 (London: House of Commons, 1866), 36.

bran than coarse flour. This meant not only that white flour was itself more fully digested, but that brown flour could be actively harmful in this regard, because it could cause purging, and "carry food from the bowels, which, if allowed to remain, would have been digested and used in the nourishment of the system." Smith's own research on the diets of the working population supported the notion that white bread was nutritionally more economical than brown flour, as one of his central findings in his previous surveys was that working people ate almost exclusively white flour. He found that previously, there had been a certain economy in brown flour, but the increased availability of supplies from overseas, and consequently the wider availability of finer flours meant that the price of brown flour was nearly as high as whiter flours, and sometimes even higher.[82]

With all of these factors in mind, Smith recommended that the state follow the changing practices of the working population (though perhaps not changing preferences, since the working classes of Britain had long purchased whiter flour and bread when they could), whose "universal experience" was that brown flour was "not so desirable as white flour for their use." He suggested "seconds" flour. This was still a shade or two darker than what most people bought from the baker, as many bakers, particularly in big cities, used flours finer than seconds. Institutional bread probably also remained somewhat darker than bakers' bread because their contract bakers did not use alum. All told, however, it was relatively white compared to that used previously. In 1867, union workhouses across the country accepted Smith's recommendations. Their report referenced Smith's recommendations, reproducing almost verbatim whole sections from his report the previous year. Economy was the key: in altering the workhouse dietary to white bread, the

[82] Ibid., 36–7.

Poor Law Board sought specifically to select a diet "by which the least possible portion passes out of the body undigested and wasted."[83]

If workhouses adopted whiter bread as a result of their changing population and nature, prisons remained more punitive institutions. In such a situation, although the same questions of economy of cost and digestion obtained, the moral implications of white and brown bread remained. As a result, prison dietaries continued to use brown bread through the rest of the century. There were reforms in 1865 and 1877 that helped standardize diets, but prisons continued to mandate darker bread. An overview of prison diets in 1878 made clear their recommendation for "whole meal" in bread. It cited much of the same research that Smith had a decade earlier, but sought a way to continue giving prisoners brown bread. Chemical analyses of the components of wheat berries and flour provided this; the report noted that if whole meal flour were used directly in the making of dough, certain chemical compounds in the bran and outer layers of the endosperm (the starchy kernel of the wheat berry) inhibited fermentation and gluten formation, resulting in a "somewhat heavy loaf." The solution, then, was to use finer flour in making the dough, and, once the dough was fully formed in such a way as to produce a well-risen and therefore digestible, loaf, to then add elements to make it brown: "sharps, &c." Brown bread was a bread of dependence, discipline, and punishment, and thus brown bread was the bread of prison.[84]

While dependent population had to endure brown bread, those who remained independent of the workhouse and free from the prison could and did purchase white

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[83] *Accounts and Papers of the House of Commons: Thirty-Eight Volumes; Poor (England and Wales); Poor (Metropolis); Poor (Ireland); Poor Rates and Pauperism. Session 5 February to 21 August 1867.*, LX:12–20.
[84] Henry Selwin-Ibbetson, "Dietaries in Prisons (England and Wales) (acts 1865 and 1877)," Reports of Commissioners, XLII.53 (London: House of Commons, 1878), 22–4.

bread. To the extent that bread was a synecdoche of material life, white bread in particular was the sign of independence and freedom. And, in terms of the emerging global wheat ecology, white bread was the bread of Free Trade. Smith's recommendations for the move to white bread in the 1860s were based to a considerable extent on medical research, but were also rooted in the reality of working Britons' diets, of which no one in the country knew more than Edward Smith. British bread was indeed growing whiter, and it was in substantial part due to the repeal of the Corn Laws in 1846, and the expanding wheat ecology that Free Trade made possible. Indeed, the twin processes of whitening bread and a globalizing wheat ecology accelerated in the 1870s and 1880s: foreign wheat accounted for more than half of all bread after 1873[85]; in the late 1870s and through the 1880s, British millers exchanged their millstones for steel rollers, which allowed them to produce more and whiter fine flour from a given quantity of wheat[86]; millers and bakers also developed techniques for combining different kinds of wheat to produce whiter, more lightly-textured, more highly-risen loaves of bread.[87]

The relationships between white bread and a global wheat ecology that Free Trade made possible were not obvious, and not explicitly state; British consumers did not list "white bread" as one of the benefits of Free Trade, so much as "cheap bread." But, Free Trade discourse did have an underlying notion of nature more broadly. Early Free Trade agitation focused mainly on the Corn Laws, the duties on imported grain levied in 1815 as a means to keep the price of domestic wheat and therefore land rents high. Arguments against these duties deployed a two-pronged strategy of Christian moralizing and

[85] See Chapter One.
[86] See Chapter Two.
[87] See Chapter Four.

condemnations of various middlemen. Underlying both was the old moral economy that privileged as direct as possible a relationship between the production and consumption of food. This is manifest in the wide range of potential villains charged with making bread "artificially" expensive, by both supporters and opponents of protective duties on grain. One author put the prices of grain and bread into biblical terms, claiming that "In the Bible we find cheapness and plenty always represented as signs of God's favour, dearness and scarcity as marks of his displeasure." Those responsible for high prices were, this author claimed, "Forestallers, Monopolists, and all manner of men who made a profit by raising the price of corn artificially." In former times, these "abhorrent" individuals had been seen as a public enemy, and treated as such, but in recent decades, "barbarous and inhumane…laws to make bread dear" had been introduced.[88] Another author made similar charges against the "speculator, the free-trade liberal, the true locust, the true canker-worm, [and the] nest of Quaker corn-factors" who allegedly drove up grain prices, as well as against millers and bakers, arguing that in an 11d. quartern loaf, less than ½d. went to the landlord (still perhaps a hefty price considering that at least 80 loaves came from each 280 lb. sack of flour!).[89]

However, Free Trade policies do not, by their very nature, do away with these middlemen, or necessarily return people to more direct relationships between production and consumption. Rather, they double down on middlemen, since by definition international commerce relies on a wider array merchants, sailors, and commercial intermediaries—middlemen—to organize it. Instead, it offers a different kind of

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[88] *Is Cheap or Dear Bread Best for the Poor Man?* (London: James Ridgway, 1841), 3–4, LSE Pamphlets 0383.
[89] Arthur Ashpitel, *The Factor, the Miller, and the Baker Get More than the Farmer ... out of the Loaf : A Few Facts on the Corn Laws Defending the Agricultural Interest.* (Richardson, 1839), 6–9, 16–7, LSE Pamphlets 0300.

relationship between production and consumption, one that exists on a global, or at least international scale. One 1841 pamphlet noted that God had created the world in such manner that His "blessings are not equally but promiscuously distributed among the various nations." To make the most of this reality of the world, "Free Trade is only wanting to enable every nation to exchange its superabundance for its wants, and thus diffuse general and equal blessings on all the inhabitants of the known world."[90]

It is unclear to what extent these arguments actually appealed to working-class Britons, for whom brown bread awaited in the workhouse or prison should they fail to provide for themselves and their families. Certainly arguments opposing the Corn Laws on the grounds that it would bring lower agricultural prices and therefore lower wages were widespread. Paul Pickering and Alex Tyrrell argued that the Anti-Corn Law League, the pressure group that ultimately organized resistance to the Corn Laws and played a prominent role in their repeal, was largely a middle-class group. Their attempts to appeal to working class supporters met with mixed success at best, particularly outside the industrial regions of England.[91] There were, however, at least some clear associations between Free Trade, material plenty, and political freedom in 1846. At a dinner celebrating the repeal of the Corn Laws, one Anti-Corn Law League member predicted wheaten bread for all; he recalled the days of his childhood, when for months at a time he and his family "never had a piece of wheat bread in the house"; he celebrated repeal as an invitation to the world to "supply plenty of bread for us all," in exchange for Britain's iron and coal, cloth and cutlery. The broader result of this, he assured his audience, was sure to be "other kinds

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[90] *Cheap Bread! Free Trade! And Good Wages!!! Observations and Remarks on Free Trade* (London: E. Palmer and Son, 1841), 5.
[91] Pickering, *The People's Bread*.

of freedom," up to and including "free voting and… full and fair representation of the people."[92]

Frank Trentmann argues that, in the late nineteenth and early twentieth centuries, "Free Trade grew into a genuine national and democratic culture, reaching across all classes and regions, mobilizing men, women, and children, and cutting across party political divides."[93] His narrative of Free Trade as a cultural movement, as well as a political one, pivots on the 1906 General Election. At that point, Free Trade as a set of policies, inaugurated by the repeal of the Corn Laws in 1846, was genuinely threatened when the Conservative Party under Joseph Chamberlain ran on a platform of reintroducing tariffs, including one on grain. It was at this point that Free Trade became a salient issue, marked by political protest, new forms of political communication, and a resounding victory for the Liberal Party and the maintenance of Free Trade policies. And, as Trentmann argues, Liberals deliberately deployed bread as a political symbol in this campaign, blanketing the electoral landscape with images of "big and little loaves": rather old-fashioned cottage loaves (most urban bakers preferred the rectangular loaves as they could be baked more efficiently), a small one labeled "protection" and a large one labeled "free trade."[94]

"Attractive symbols for embodying complex economic relations," the big and little loaves were a continuation of the discourse of cheap bread that animated repeal of the Corn Laws; this began at least as early as 1841, when the Anti-Corn Law League adopted the loaf as its symbol, along with the demand for "our bread untaxed." The ACLL compared small English loaves to much larger Polish loaves, and medium-sized French loaves, using

[92] Joseph Barker, *Blessings of Free Trade, and How They May Be Increased and Made Lasting: A Speech, Delivered at the Wortley Free Trade Rejoicing Dinner, on Monday July 27, 1846*, 1846, 3–4, 7, 15.
[93] Trentmann, *Free Trade Nation*, 2.
[94] Trentmann has several excellent examples included in his work. Ibid., Plates VIII and IX.

bread as a prop to argue for free trade. Sixty years later, Liberal politicians repeated this tactic, comparing a large and white English loaf to the "black" bread of protectionist Germany. Trentmann notes the apparent paradox of this choice as a political symbol, for as the price of bread declined with the expansion of Britain's wheat ecology, it took us less of Britons' budgets. By that logic, it should have been diminishing in cultural relevance, as it declined in economic relevance. But, as a synecdoche of material life, it retained the potency it displayed earlier in the century.[95] The only reason that it was not more widely deployed from the 1850s to the 1890s is that for those decades, Free Trade was part of the broad consensus of Victorian Britain. And, that consensus carried with a liberal state, a global wheat ecology, and ultimately white bread for (nearly) all.

Conclusion

In the end, then, the liberal state provided two fundamental kinds of bread: in its disciplinary apparatus, it served brown bread, a holdover of lower-class status from the older moral economy. On the other hand, the liberal state embraced a system of security, using a market economy to situate Britons within an increasingly global wheat ecology. This expanding wheat ecology made white bread possible for all who could afford it.

[95] Ibid., 88–94.

CONCLUSION

Ultimately, both bread itself and the meanings associated with it changed significantly in the second half of the nineteenth century. In 1846, Britons' bread was, in a word, local. It was made from largely local ingredients; the archipelago itself supplied more than three-quarters of all the wheat consumed. Plus, many rural Britons at that point were actively engaged in producing their own bread: many of the tenant farmers grew grain, and in many cases must have simply reserved their own household's consumption from that which they put up for sale; rural proletarians worked in arable agriculture for tenant farmers, and in some cases even retained gleaning rights and thus collected it themselves. Even in the rapidly growing cities, the bulk of food consumed came from fairly close by. Only London and perhaps some of the industrial North were dense enough concentrations of people and purchasing power to attract wheat from afar consistently.[678]

This strictly geographical consideration of "local" is insufficient. It does not capture the deeply local and particular nature of the steps involved in transforming wheat into bread, both physically and culturally. Physically, the milling trade was indispensible: the number of Britons who regularly ground their own grain was vanishingly small, and for much of the working population, particularly in cities, such activity would have been a waste of time. Millers thus stood between the production of wheat and the consumption of bread, but the British milling trade in 1846 was still largely a matter of country mills. Certainly there were some mills located in the big cities, especially London and Liverpool, but the great bulk of Britain's wheat was milled into flour in country mills. The millers

[678] See Chapter One.

doing this work knew very well the farmers who grew the wheat they bought, and thereby knew what to expect from any given shipment of grain. They knew the particular characteristics of their local soil, agricultural methods, and climate. This represents a variety of "local" knowledge, for milling expertise was not systematized or institutionally disseminated. It was, rather, based on apprenticeships, learning by experience, knowing the particulars of milling certain kinds of grain using certain tools and passing that knowledge along to others through discussion and demonstration.[679] That same local knowledge is also visible in their business connections, for millers tended to deal with a constant set of merchants and bakers. Thus, there were fairly stable links from farmers to millers to bakers.

The baking trade was also quite "local." Like millers, bakers in 1846 sought out supplies of wheat and flour that were consistent and known to them. Some, again in the larger cities like London and the industrial North, certainly bought imported flour, but such activities were full of risk and uncertainty. It appears that most bakers preferred to use the supplies that they knew best, and the institutional knowledge necessary to make the fullest use of foreign supplies simply did not exist in 1846. Baking was also a direct reflection of local environments. Many bakers grew their own yeast within their bakery, and those that did not obtained it from brewers and distillers in their neighborhood. In both cases, the yeast was quite local, with somewhat different mixtures of species in different locales and depending on the particular methods used to produce yeast. And, through Britain and Ireland, different methods of baking were employed. Whether they used long processes with multiple stages of sponges and fermentation, or knocked up straight doughs was a

[679] See Chapter Two.

matter of their customers' particular preferences, the nature of their raw materials, and their own skill. Given the wide variability in raw materials and the bespoke nature of baking knowledge—like milling, it too was based on long apprenticeships and learning by doing, with little institutionalized systems for the dissemination of knowledge and the production of expertise—the bread itself must have varied widely across the Archipelago. Broader divisions of city-white and country-brown, or sweet southern and sour northern bread certainly obtained, but even within those broad divisions there must have been immense variety.[680]

The expert knowledge of physicians was also essentially local in 1846, although was somewhat less so than the trade knowledge of millers and bakers. Chemical physiology was developing rapidly, and Liebig's *Animal Chemistry* in 1840 went a long way toward creating a consensus about the universal laws that governed bodies, environments, and the particular relationships between the two as they manifested in food. Certainly, however, physicians in the first half of the nineteenth century saw local environments as extremely important. The chief problems of bread identified by physicians in the 1860s were, after all, those connected to the physical contact between bakers and bread, and the filthy environments in which they worked—not the nutritive value of wheaten bread, which was virtually always wholly endorsed.[681]

Finally, the meanings of bread to consumers were essentially local as well. While there were broad patterns of aspiring for whiter bread, for a large portion of the population, "bread" was their life. It stood in for their own personal struggles in the world of liberal Britain: a world of low wages, long hours, dangerous working conditions, dirty

[680] See Chapters Three and Four.
[681] See Chapters Three and Five.

and crowded cities, and the ups and downs of barely-regulated capitalism. The system of workhouses and prisons that acted to enforce labor market participation after the passage of the 1834 New Poor Law did exist nationally, but it was implemented locally, with considerable variation.

All of this had changed by the start of the First World War, less than seventy years later. By 1914, more than four-fifths of Britain's wheat came from abroad, along with much of the rest of the nation's food. The environments that sustained British bodies were global in scope: wheat fields on every inhabited continent supplied Britons at one point or another.[682] Millers and bakers had both developed extensive systems of much more "universal" knowledge: they drew on scientific discourses to know the world's wheat and flour supplies, and to use them to their maximum profitability, producing far more white flour and white bread than in 1846.[683] Physicians had wholly accepted and continued to develop the universal categories of chemical physiology as their basic understanding of human relationships to environments through food. Indeed, the development of thermodynamic models of nutrition meant that at a very fundamental level and to a greater extent than even Liebig's early variety of chemical physiology, the environments that produced food were simply not seen as important.[684] And, for the bread-consuming population of Britain, whiter, more highly risen bread had become the standard across the country. Even workhouses had adopted whiter bread.[685]

The creation of a uniform white loaf across Britain is difficult to imagine without liberalism. Only with the removal of duties on imports could a global supply of wheat begin

[682] See Chapter One.
[683] See Chapters Two and Four.
[684] See Chapter Five.
[685] See Chapter Six.

to enter Britain. At the same time, the uniform white loaf is equally difficult to imagine without the extensive set of biopolitical interventions. Milling, baking, and chemical physiology were all forms of biopolitical expertise: the liberal state played little direct role in their articulation, but these forms of knowledge were ultimately necessary for the success of market-based system of security constructed by the liberal state in the first half of the nineteenth century. And, despite the often grim tales of adulteration, filth, and exploitation that fill the pages of this work, we should not lose sight of the fact that the creation of a global wheat ecology was beneficial in important ways for Britain. The prices of wheat and bread did drop; real wages did rise, in substantial part of because of the changing prices of food; Britons frequently made perfectly clear that they much preferred the uniform white loaf to the old "local" loaves. And, with their increased purchasing power, British people expanded their diet. The creation of a global wheat ecology thus led, paradoxically, to diets that were broader than simply bread. None of these elements were without their critics, of course, and they certainly had a range of consequences well beyond falling bread prices. Never the less, it is hard to argue against the proposition that a global wheat ecology had not raised the standard of living for many Britons by the early twentieth century.

The meanings of bread, and ultimately of Britons' relationships to environments both near and far, had also changed considerably. At the most basic level, if most Britons knew where most of their food came from in 1846, the opposite is true for 1914. The population had become heavily urban, and the proportion working in agriculture was smaller than ever and still shrinking. The environments that produced Britons' daily bread were distant and, beyond that, were not accessible to the bulk of the population. Only a tiny portion of the population—those small groups who deployed biopolitical expertise—actually knew with any concrete certainty where the country's food came from. For a small handful of Britons, the global wheat ecology that fed the country was visible; and, for them, their tasks often specifically involved obscuring the existence of the same. To be a miller or baker in Victorian Britain meant erasing knowledge of food's origins while moving wheat, flour, and bread through the human world. Absent the direct or relatively proximate knowledge of the environments that produced bread, many Britons by the early twentieth century saw in bread something else: freedom and prosperity. Liberalism, in the form of Free Trade, had brought down the prices of food, increased real wages, and given Britons white bread. It provided so much white bread, and the medical establishment largely endorsed it, so that even the workhouses no longer emphasized brown bread as they had at their inception in the 1830s.

This, then, was the Cartesian binary made real, the central contradiction of Britain's environmental history: as Britons were more and more tied to the appropriation of unpaid work/energy from a global ecology, the material and cultural distance between themselves and that same ecology grew. Britain's environmental history became global in the nineteenth century, even as it reached into British homes, and into British bodies.

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