

Cold Chains, Uneven Trust: Chinese Eggs and the Politics of Refrigeration

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Abstract: This article uses the global trade in Chinese egg products to rethink the history of refrigeration beyond narratives of technological diffusion and thermal colonialism. Tracing the rise of China's egg-processing industry in the treaty ports, it argues that refrigeration functioned not simply as a colonial technology but as an infrastructure through which states, firms, and consumers negotiated questions of hygiene, trust, and market power. British and American companies introduced refrigerated production systems that Chinese enterprises selectively adapted, while the rapid expansion of low-cost exports provoked protectionist campaigns and sanitary disputes in Europe and the United States. "Chinese eggs" became a political and cultural problem through which anxieties about industrial food, racial difference, and international competition were expressed. As export markets contracted during the interwar crisis, refrigeration expanded into China's domestic economy through cold storage, logistics, and mass consumer culture. The article shows how refrigeration reshaped both global food politics and everyday urban life in modern China.

Key Words: egg processing; food regulation; global commodity; mechanical refrigeration; modern hygiene; treaty port China

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Introduction

Mechanical refrigeration systems, which maintained precisely controlled low-temperature environments, enabled food preservation by addressing perishability and seasonality.¹ By the late nineteenth century, refrigeration technology was closely tied to imperial ambitions and resource extraction.² The rise of the global meat industry met growing urban demand and allowed European consumers to access high-protein animal products from the Americas, Australia, and New Zealand. Likewise, cold storage in tropical regions ensured that Western expatriates consumed imported foods that met familiar standards of taste and quality. Refrigeration facilities were installed in abattoirs and market buildings that colonial authorities constructed, functioning as biopolitical instruments that deployed health and hygiene regulations to guarantee a disease-free supply, while reserving their benefits for those who could afford them.³ Celebrated as a hallmark of modernity, artificial cooling catered to Western ideals of comfort and pleasure, while its unequal access reinforced racial and class hierarchies, dismissing local methods of food preservation and heat mitigation as primitive and contributing to the dispossession of Indigenous cultures and sensory traditions.

Yet accounts that frame the introduction of mechanical refrigeration to non-western societies primarily as “thermal colonialism” risk flattening the complex dynamics of technology transfer by reducing it as a simple process of domination.⁴ Tracing how the egg-processing industry in treaty-port China integrated cooling technologies into its global commodity chain, this article reframes mechanical refrigeration not merely as an instrument of empire, but as an infrastructural mediator that reorganized relations among states, firms, and consumers while unsettling the narratives of colonial hegemony. It foregrounds the agency of diverse stakeholders and the ongoing processes of negotiation, conflict, and adaptation that both shaped, and were

shaped by, the adoption and use of mechanical refrigeration.

China's military defeats from the mid-nineteenth century onward forced the opening of treaty ports, where foreign powers exercised extraterritorial jurisdiction within designated concession areas, advancing their commercial interests across the country. China's vast agricultural resources soon attracted business attention, with export companies based in the treaty port cities operating under multiple imperial influences, rival powers competing as readily as they cooperated.⁵ The abundant supply of eggs from inland regions proved particularly appealing to industrialized countries, where a rapidly growing sector removed eggs from their fragile shells and processed and repackaged their components into compact, durable, ready-to-use forms. Factories candled, broke, and processed eggs into standardized forms, preserving them with borax, drying them, or freezing them in tin cans. Wholesale bakeries, confectioners, and other food manufacturers preferred these products for their uniformity and convenience over shell eggs. With relatively cheap raw materials and low labor and transportation costs, China became a prime location for egg-processing factories supplying global markets, particularly Britain, France, Germany, and the United States. By 1929, eggs and egg products ranked as China's third-largest export—with frozen eggs comprising more than 80 percent—and met more than 90 percent of European demand.⁶ The egg-processing industry thus provides a critical lens through which to examine how refrigeration restructured the flows of capital and goods across global markets.

Refrigeration technologies did not simply diffuse; actors reworked them within local industrial contexts, producing new forms of expertise and authority. As the emerging egg-processing industry transplanted British and American practices to China, international trade standardized food production processes, with mechanical refrigeration as a crucial component.

Cold storage extended production beyond hens' natural laying cycles, increasing processing capacity, while egg freezing largely preserved the original quality. Imported machinery and expertise served as reference points, but Chinese companies leveraged their established relationship with local suppliers and adapted sanitation guidelines to compete.⁷ Although nationalists often viewed foreign factories as symbols of imperialism, and labor conflicts frequently disrupted their operations, egg-processing plants demonstrated how hygienic, efficient production could generate economic gains, inspiring Chinese efforts toward industrialization and modernization.⁸ Centering these sites of productivity and profitability complements scholarship on "hygienic modernity" that has mainly focused on medicine, nutritional science, and public health in twentieth-century China.⁹ By shifting attention to industrial infrastructures, this article argues that technological systems—not only scientific and regulatory discourses—shaped the material conditions under which economic development and social governance were negotiated.

Despite the promise of improved sanitation and economic benefits, the acceptance of refrigerated food relied on trust, especially as cold storage remained controversial even in the industrialized countries where the technology first took hold.¹⁰ Critics worried that it enabled the deceptive sale of out-of-season products as fresh, and suspicions lingered that it served speculative stockpiling more than genuine preservation. While meat packers were aware of consumer's sensitivity to the taste and appearance of their products, eggs, particularly when used as food ingredients, presented no such visible cues, and their origins went largely unnoticed.¹¹ When the influx of cheap processed egg exports from China posed a direct challenge to domestic poultry industries in the West, producers moved to defend their business interests by igniting protectionist campaigns in the media. These campaigns mobilized orientalist and racialized stereotypes to stir anxiety, while casting doubts on sanitation authorities that had permitted such

imports. The contestations demonstrate that refrigeration functioned not only as a material infrastructure but also as a system of trust, whose legitimacy had to be disputed and rebuilt across imperial and national boundaries.

Rather than merely balancing agricultural surpluses with urban demand, refrigeration reshaped supply chains within an increasingly industrializing and interconnected global food system. In the shadow of the Great Depression (1929–32) and the decline of free trade ideology, multinational companies grappled with overproduction and weak demand. While the egg business in China was primarily export oriented, the diversification of the processing industry—from cold-storage warehouse operations to ice cream manufacturing—broadened refrigeration’s reach into the Chinese domestic market, fostering demand and integrating the technology into everyday urban life. Across interdisciplinary scholarship, concepts such as the coldscape, cryopolis, and artificial cryosphere have emerged to examine how various forms of refrigerated spaces came to play infrastructural roles in food production, storage, distribution, and consumption.¹² These systems enhanced nutrition, comfort, and health while operating within the logics of exploitation and capital accumulation. Building on this scholarship, this study traces the historically specific formation of refrigeration infrastructure in treaty port China, reconstructing the conflicts and negotiations at local and international levels through which the egg-processing industry built extensive logistical networks and exerted control over commodity flows.

This article draws on a wide range of archival materials, including business records from leading egg export firms; governmental documents on agriculture, hygiene, and public health; and foreign office files and consular commercial reports. Alongside these, media sources, including local newspapers, trade journals, and industrial periodicals, illuminate professional and public discourse surrounding refrigeration and the egg trade. Rather than treating technology

transfer as a form of colonial imposition, this article highlights the fluid dynamics that shaped the industrial landscape in China and its integration into the global economy in the early twentieth century. By examining the mediations through which refrigeration operated along the commodity chains embedded within fragmented colonial structures, it intervenes in the historiography of technology and empire and argues that China's encounter with imperialism and industrial capitalism was consistently shaped by tensions between infrastructural promise and market forces.

The article proceeds in three stages. First, it examines the emergence of egg-processing factories in treaty port China and the role of refrigeration in reshaping industrial production. Second, it traces how eggs and egg products became sites of regulatory friction and technological distrust in Western markets. Third, it analyzes how firms reconfigured logistics and domestic markets in response to global pressures, embedding refrigeration into everyday urban life in China.

Building Modern Food Factories

The egg-processing industry in China originated in the late nineteenth century through chemical preservation and dehydration, but the introduction of mechanical refrigeration transformed its scale and character.¹³ Firms commanding large capital invested in the technology, building factories in major treaty port cities, tightening their grip on the market, and positioning themselves as guarantors of the latest food standards. William and Edmund Vestey's Union Cold Storage Company, a British multinational that competed with Chicago packinghouses in the global meat trade at a time when Britain relied heavily on imports, established its Chinese subsidiary, the International Export Company (IEC) in Hankou in 1907.¹⁴ In the United States,

the Underwood Tariff Act (1913), which lowered import duties, and the opening of the Panama Canal in 1914, which reduced shipping costs, shifted the egg-drying industry to China, a move reinforced by the pressures of rising food prices after postwar inflation.¹⁵ American firms soon established footholds in Shanghai, including Amos Bird (1915) and the Henningsen Produce Company (1918). Refrigeration served multiple functions within these operations: chilling incoming fresh eggs, cooling dried products, and freezing egg mixtures, a technique that had grown rapidly in the United States around 1900. Amid growing concerns over food purity and increasingly stringent regulations in Western markets, frozen eggs' superior retention of flavor and texture after thawing made them highly sought after.¹⁶ Demand drew new entrants, who hired technical experts and adopted established practices. Among them were Ewo Cold Storage (1921), affiliated with the British trading conglomerate Jardine Matheson, and the China Egg Produce Company (CEPC; 1923), financed by Chinese investors.

With the global expansion of the Union Cold Storage Company, the IEC set the precedent for the export of chilled and frozen foodstuffs from China. The IEC's first factory in Hankou, a trade hub connected to the provinces along the Yangtze River by waterways, sourced supplies from within a 400-mile radius. In 1910 alone, the IEC exported 180 tons of pork, 400 tons of game, 350 tons of chicken, 225 tons of duck, and 600 tons of eggs from China to Britain, along with 900 tons of eggs to the United States and Canada.¹⁷ Its growing impact on rising food prices sparked unrest and hostility toward its agents. Local gentry and Qing officials accused the company of violating treaties by operating beyond the open ports.¹⁸ Nevertheless, over the next decade, the IEC rapidly expanded its network from central China to include Harbin, Nanjing, Shanghai, and Tianjin, backed by its parent company, which made substantial profits from supplying the Allied armies.

The IEC's entry into egg processing challenged the primacy German firms had held in dried and preserved liquid products before World War I. To strengthen its position in European markets, the IEC argued that frozen eggs, preserved in their unaltered state, qualified for duty privileges, through which the Chinese government encouraged the repackaging of raw agricultural produce that would otherwise be economically unfeasible for export. In 1913, the commissioner of customs in Hankou initially rejected the company's application, citing earlier unsuccessful petitions from German firms. The IEC countered that freezing whole eggs would cause their expanded contents to break the shell and that their processing was analogous to removing peas from a pod. The British consul general in Hankou recognized the "ingenious" argument that frozen eggs merely "substituted a tin for nature's wrapping" and reported to Beijing.¹⁹ After negotiations with the Chinese Ministry of Foreign Affairs (Wai Chiao Pu [Wai Jiao Bu]), the company eventually secured a reduced duty rate.²⁰ From 1914 onward, frozen eggs were listed as a separate category in customs statistics.²¹ Annual exports of egg products to Britain consistently accounted for more than half of China's total export volume and, by 1931, had quadrupled to approximately 41,713 tons (689,704 piculs).²²

Egg processing required specialized expertise that trading companies like Jardine Matheson lacked, despite their extensive export experience through their China Produce Department. In 1919, the company hired American engineer Arthur Robinson, whose drying device had been installed in IEC factories, to oversee the design, construction, and equipment for the Ewo Cold Storage Company, a plant in Shanghai combining drying and shell egg storage facilities, including a fifty-ton refrigerating machine, with a "ton of refrigeration" defined as an engineering unit measuring the heat extraction rate, equivalent to melting 2,000 pounds of ice in twenty-four hours.²³ The factory underperformed, however, particularly after the introduction of

the Fordney-McCumber Act (1922), which increased U.S. tariffs. In response, the company began freezing eggs in 1925 and expanded its refrigeration capacity to serve the European market. Unlike drying, which required a specialized egg-dehydrating apparatus and manual labor, freezing required only cold storage for liquid eggs in tins. Jardine Matheson's Engineering Corporation, in collaboration with Robinson, introduced enhancements in building layouts and insulation, incorporating cooling facilities to enhance efficiency (see figure 1).²⁴ The choice of refrigeration systems and power sources was informed by insights from U.S. manufacturers Frick and York Shipley, and storage temperatures were set to maintain quality at minimal cost and ensure competitive pricing.

Meanwhile, the relocation of the American egg-drying industry to China introduced advanced processing technology and food standards. The H. J. Keith Company—founded by Herbert Judson Keith in Boston and one of the first packers to experiment with egg freezing in the United States—established its Chinese subsidiary, Amos Bird, in Shanghai in 1915. Simeon Curtis Keith Jr., a graduate of the Massachusetts Institute of Technology and later a lecturer, bacteriologist, and chemist there, oversaw the establishment of Amos Bird while serving as vice president of H. J. Keith.²⁵ Designed by refrigeration engineer L. Nordmeyer and equipped with machinery imported entirely from the United States, the factory was air-conditioned, with temperatures precisely tailored to the needs of each space. The breaking room, described in the *Far Eastern Review* as comparable to a hospital operating room, was constructed from concrete. The company enforced strict hygiene protocols. Spitting and chatting were forbidden, and workers had to be vaccinated, wear clean white uniforms (including caps and aprons), shower daily, and maintain well-manicured nails.²⁶

The emphasis on maintaining a sanitary manufacturing environment aligned with U.S.

guidelines, which H. J. Keith diligently followed. The promulgation of the Pure Food and Drugs Act (1906) empowered the United States Department of Agriculture (USDA) to conduct inspections, which extended to regulating the cold-storage industry. In 1911, the USDA seized H. J. Keith's frozen eggs packed by a local firm in Kansas, deeming them "deteriorated and decomposed," but the absence of established purity standards led to a prolonged legal battle.²⁷ The USDA's loss in the Supreme Court, in *Four Hundred and Forty-Three Cans of Frozen Egg Product v. United States*, 226 U.S. 172 (1912), prompted investigations into the burgeoning egg-processing industry. Laboratory results traced the bacterial contamination primarily to workers' fingers, utensils, and factory equipment used in breaking plants.²⁸ USDA investigators collaborated with the industry to plan factory construction and remodel facilities to enhance product quality, emphasizing environmental factors such as room temperature, natural light, ventilation, and the use of impervious building materials.²⁹ These findings revolutionized apparatus use and operational routines, with the USDA publishing step-by-step instructions for industry reference and increasing oversight by local authorities.³⁰

While strengthened USDA guidelines were intended to ensure food quality, their implementation also served producers by offering verifiable proof of compliance. Using the Shanghai factory of the Oregon-based Henningsen Produce Company as an example, L. G. Conner, a food product investigator in Washington, D.C., asserted in a 1930 article that sanitary working conditions were achievable in China, given that the frozen-egg production methods were essentially the same as those in the United States.³¹ Accompanying photographs show Chinese workers operating all the equipment (see figure 2). Women broke chilled eggs by striking them on a knife-edge fixed horizontally above a tray on which several cups were positioned. A small disc attached alongside the knife caught the yolk while the white fell into a

cup. After breaking two eggs, workers smelled the cup for mustiness; if detected, the contents were discarded, and the container was washed and sterilized. The approved yolks and whites were emptied into a larger container, churned into a homogeneous mixture, poured into cans for freezing, and weighed if needed. Once sealed, the cans were kept in cold storage, where they were placed in insulated containers before being loaded onto small cargo boats for transfer to refrigerated steamships for overseas shipment.

The China Egg Produce Company—established by Chinese dealers who felt undercut because foreign companies bypassed intermediaries to source eggs directly from farmers—vied for a prominent position on the international market by constructing competitive, state-of-the-art facilities in Shanghai and Qingdao. Its breaking room featured the mushroom slab structure popular for industrial buildings at the time, helping maximize clear height and allow for flat, smooth ceilings (see figure 3). Standardized equipment—such as glass cups, metal pails, rust-resistant breaking trays, and steam sterilizers made from galvanized materials—closely mirrored the specifications in USDA bulletins. Expansive steel sash windows wrapped around the corners, allowing abundant natural light to flood in, while sliding windows between the breaking and sterilizing rooms enabled seamless equipment transfer. The compact layout of workshop rooms optimized workflow and enhanced sanitation. Selected eggs intended for processing were cleaned and sterilized before being broken and, after treatment, tested physically and chemically for quality. Those exported in shells were graded, weighed, and packed in boxes bearing the company's trademark. Temperature in each storage room was recorded automatically. CEPC's facilities marked a significant advancement compared to earlier establishments, where dimly lit breaking rooms relied on lamps and eggs were stored in wicker baskets, and to local firms, where workers reportedly separated eggs with their bare hands (see figure 4).³²

CEPC acquired its machinery from Pacific Ice and Cold Storage, a failing American company, and enlisted its manager and engineer, William L. Carleton, who had previously worked for the Henningsen Produce Company and specialized in manufacturing egg products.³³ Foreign professionals often cited subpar construction materials, the lack of mechanical standards, and worker resistance as obstacles to industrial practices in China, but CEPC outfitted its facilities with locally built refrigeration compressors based on Carleton's designs and imported automated machinery as the business expanded. In 1925, the *Boston Daily Globe* published an article on Carleton, the only foreigner in a plant that employed nearly a thousand workers and processed 1.5 million eggs a day.³⁴ Carleton maintained his American lifestyle despite having lived for fifteen years in Shanghai, living in a "big, comfortable foreign-style home clinging to the New England atmosphere" and having access to imported food via refrigerated ships. He was not, however, a detached expatriate. A photograph showing the Carleton couple standing behind Zheng Yuanxing, the CEPC manager, seated in the middle alongside his wife and son and flanked by two company members, suggested a partnership built on trust.

From the 1900s onward, Chinese nationalist discourse increasingly framed industrial and manufacturing development at home as a way to reclaim economic sovereignty and advance nation building in light of the surge of mass-produced imported commodities under imperialist expansion abroad and the country's declining position in the global export market for tea, porcelain, and silk.³⁵ British and U.S. egg factories faced persistent challenges from social unrest and rising anti-Western sentiment.³⁶ In a 1924 speech on the "Principle of the People's Livelihood," Sun Yat-sen, leader of the ruling Chinese Nationalist Party, denounced "economic oppression" imposed by foreign forces, citing the IEC's imposing headquarters at the river port of Nanjing as an example.³⁷ He observed that Chinese farmers would "rather starve themselves

than stop exporting food abroad,” a condition he identified as central to why “China’s food problem remains unsolved.”³⁸ Drawing on insights from trips abroad, reform-minded Chinese entrepreneurs, including Zheng, nonetheless became leading advocates for modernizing the poultry industry.³⁹ With minimal state support, they pursued systematic improvements to domestic practices, ranging from experimenting with centralized farming facilities to promoting rural reconstruction at a time when chicken raising largely remained a sideline activity. They disseminated methods and proposals in professional journals to increase egg production as a means of strengthening the national economy and nurturing a healthier population, thereby distinguishing their initiatives from the more extractive approaches of foreign egg-processing firms.

Food from Afar

Preservation technology enabled goods to travel vast distances, making local specialties accessible worldwide, but it also shaped cultural attitudes, reinforcing geographically fixed perceptions of food’s origin.⁴⁰ For centuries, Chinese producers cured eggs with a paste of soda, straw ash, salt, and slaked lime, turning the whites into a translucent dark amber jelly and the yolks into a creamy grayish-black with a hint of ammonia. Shipped abroad, these pickled eggs (*pidan*) provided Chinese expatriates with a taste of home. Among those unfamiliar with the egg’s distinct taste and appearance, however, a widespread belief arose that the Chinese preferred “ancient” eggs, supposedly aged for hundreds or even thousands of years.⁴¹ Local media sensationalized such claims, perpetuating an image of China as an antiquated empire resistant to modern technology and paid little attention to scientific studies showing how the preservation method altered the egg’s composition beyond mere spoilage prevention.⁴² At the

same time, the Western fascination with Chinese goods, once bound up with cultural admiration, gradually eroded as China came to be seen as a declining power. Accusations of adulteration, already rampant in the increasingly industrialized food industry, were exploited by competitors to tarnish China's reputation, reinforcing racial stereotypes that depicted its people as dirty, dishonest, and lazy.⁴³

Public anxiety in the West over mechanical refrigeration heightened skepticism toward Chinese imports. In 1909, the arrival of the first shipment of frozen pork by the IEC to England triggered debate, with some portraying Chinese hogs as raised in filth and feeding on waste.⁴⁴ In the United States, the influx of cheap Chinese shell eggs on the Pacific Coast after 1914 coincided with growing distrust of cold-stored eggs, which were already notorious for concealed decomposition due to technological limitations in maintaining stable temperature and humidity levels and to insufficient regulatory oversight.⁴⁵ Local newspapers denounced the imports as nutritionally inferior, produced under unhygienic conditions, and sold at prices that threatened fair competition. While Chinese fowl had been imported to Britain and the United States for crossbreeding in the mid-nineteenth century, Chinese eggs were now characterized as smaller in size and darker in color, and recast as a new form of the "yellow peril."⁴⁶ In 1915, Oregon, Washington, and California passed laws mandating the labeling of imported eggs and related signage in all establishments where they were sold or used.⁴⁷ This was followed in British Columbia, Canada, by the Egg Marks Act (1916), which required the marking of "Chinese eggs" to differentiate them from those classified according to standard grading and preservation methods.⁴⁸

In response to negative portrayals of Chinese eggs in Anglo-American markets, promoters emphasized factory sanitation, often in exoticizing terms. Amos Bird was frequently

highlighted in industry publications and trade reports as an American pioneer.⁴⁹ At its processing plant, as on tea plantations and in textile mills, women's supposedly nimble fingers and keen sense of smell were framed as precision tools of production.⁵⁰ According to a 1916 article in *Far Eastern Review*, by offering higher wages and shorter working hours—the opposite of the conditions that local accounts cited as sparking strikes—the company could selectively hire women who “represented the Chinese idea of feminine beauty,” illustrated through full-body photographs in local attire. The imagery of young women working in hygienic environments, delicately and meticulously handling eggs, linked food purity and cleanliness to aestheticized labor, reinforcing orientalist, sexualized representations. While workers initially refused to wear white uniforms, associating the color with Chinese mourning rituals, they eventually complied with the uniform requirement and sanitation inspections as part of their daily routine.⁵¹

Meanwhile, food laws created barriers for small Chinese egg producers in inland regions seeking access to overseas markets. Unlike the modern factories in treaty port cities equipped with patented machines, most local firms relied on the more economical pan-drying method, in which shallow metal trays filled with egg mixture were placed in furnace-heated rooms. The evaporation process caused zinc oxide to leach into the product from the trays, where added ammonia used to prevent coagulation reacted with the metal. In 1917, the United States Department of Agriculture's Food and Drug Administration considered Chinese dried eggs containing more than 100 parts per million of zinc to be adulterated and banned their import accordingly.⁵² Confronted with embargo and severe losses, local guilds in China submitted protests to Washington through the U.S. consul general, citing reports from Louis W. Dupre, who had founded the Shanghai Chemical Laboratory in 1910 in the International Settlement, formed by the merger of the American and British Settlements, to provide testing, analysis, and

consulting services. Ultimately, producers were compelled to improve techniques or adopt imported machinery, while those unable to adapt were excluded from the market.⁵³

In contrast to smaller producers, larger firms in China wielded sufficient influence to persuade Congress to adapt U.S. legislation to accommodate the production cycle of their exports. Following the hens' laying season, eggs were processed from March through July, shipped to the United States by October, and supplied to the American market until the following summer—a timeline that often exceeded the twelve-month limit aimed at preventing hoarding and speculation. To accommodate Chinese products, an exception extended the allowable storage period for frozen eggs to eighteen months, as proposed by a 1921 bill on cold storage.⁵⁴ During a congressional hearing on the legislation, representatives from major American producers testified in favor of Chinese eggs, affirming their compliance with U.S. food laws and inspection standards: Harold Ingham Horsfield, president of the John Layton Company, one of the largest frozen egg importers with plants in China; Herbert Judson Keith, founder of the H. J. Keith Company; Harry E. Benard, director of the American Institute of Baking; George S. Ward, president of the Ward Baking Company; and I. C. Franklin, a storage specialist at the USDA.⁵⁵ Benard and Horsfield noted that these egg products, made from fresh eggs packed within a week of being laid, had lower bacterial counts than those produced in the United States, where profits often came from freezing cracked eggs that would otherwise be discarded. While justified on public health grounds, cold-storage regulation was also shaped by large overseas producers seeking an advantage over domestic competitors.

After World War I, France replaced Germany as the main continental destination for Chinese egg products, with frozen eggs first imported in 1910 and shortly thereafter widely used in biscuit and pastry making. Unlike Britain and the United States, France had no established

egg-freezing industry, and public “frigophobia,” or distrust of artificial cooling in food preservation, prevailed.⁵⁶ In 1921, Henri Martel, head of the Paris and Seine Department’s veterinary inspection service, commissioned laboratory tests on Chinese imports after a local business owner reported the storage of “rejected eggs” (*œufs de rebut*) under the 1919 egg inspection ordinance.⁵⁷ While the ordinance defined rejected eggs as slightly spoiled and unfit for direct consumption, it provided no specification for processed products. Martel alerted the prefect of police that samples from the supplier, tins recovered from biscuit factories, and products stored at the Clichy cold-storage facility after thawing showed characteristics of highly perishable, bacteria-rich foods. He recommended referring the matter to the Public Health and Sanitation Council (Conseil d’Hygiène Publique et de Salubrité) so the veterinary inspection service could enforce stricter surveillance, guide industry practices, and restrict Chinese frozen eggs, prompting immediate media attention.⁵⁸

Studies in French professional journals on refrigeration and public health, however, generally held that Chinese products were manufactured using up-to-date methods.⁵⁹ Responding to Martel, Léon Lindet, a professor at the National Institute of Agronomy (Institut National Agronomique) and a member of the Public Health and Sanitation Council, cited USDA documents to stress the rigorous protocols followed by British and U.S. firms in China, concluding that veterinary inspection at French ports would suffice as long as products remained frozen during handling.⁶⁰ Hygiene expert Frédéric Bordas confirmed Lindet’s position in his report to the Superior Council of Public Health of France (Conseil Supérieur d’Hygiène Publique de France), while proposing the development of egg-freezing industries in French colonies.⁶¹ He situated Martel’s concerns within broader anxieties over frozen foods, noting that no hygienic objections had been raised against other processed egg products. To counter doubts about origin,

Bordas cited investigations in London, the United States, and Canada, emphasizing the industry's extensive precautionary measures.

French inspection protocols for frozen eggs nonetheless remained unsettled. While Paul Juillerat, a member of the Public Health and Sanitation Council, pressed for binding regulations, Lindet argued that instructions should remain recommendations rather than mandatory prescriptions. He stressed that industrial users now better understood the scientific bases for public health regulations and would therefore voluntarily adopt hygienic safeguards, such as monitoring worker cleanliness and sterilizing containers, practices increasingly common in factories and households. Efforts to extend binding regulations nationwide stalled. The minister of agriculture offered no response, the minister of hygiene referred the issue to the Superior Council, and its members failed to reach consensus.⁶² The Superior Council concluded in its final assessment that regulating frozen eggs was unjustified given the absence of effective controls on domestic eggs and warned that flawed information risked discrediting an industry whose products were produced under exceptionally rigorous hygienic standards.

Confronted with Bordas's report, which suggested possible errors in his department's examinations, and with the remarks of the Council and the Superior Council, Martel perceived them as undermining the veterinary service's role in egg inspection.⁶³ In Paris, quality control had long been performed by egg counter-candlers (*compteurs-mireurs*) in the market halls and formalized by a 1919 ordinance, approved by the Ministry of Agriculture, that empowered the veterinary service to oversee egg-related sanitation and quality. Martel emphasized his department's competence in preventing spoiled eggs from entering circulation and contaminating the wholesale food supply. He further challenged the reliability of the bacteriological evidence cited by his opponents, particularly the report of John Eyre, professor of bacteriology at the

University of London (communicated by the British Refrigeration Association), which he criticized as methodologically limited and based on a single test conducted to certify imports in London, without investigating Chinese production practices. To reinforce his claims, Martel referred to a report by the Danish engineer André Mullertz, who had succeeded in establishing egg-processing factories in Europe but failed in China due to unhygienic conditions. In his disparaging description, Mullertz attributed egg contamination to soil fertilization with human waste and to hens's foraging in that soil for food, leading to frequent and deadly epizootics. While such polemical accounts reflected vested interests, the dispute revealed the fragmented nature of French sanitary governance, where competing areas of expertise shaped regulatory outcomes.

Chinese imports further intensified political battles over trade ideology by being priced far below local products. In the United States, punitive protectionist tariffs imposed in 1922 highlighted the Republican-Democrat divide, with Chinese eggs, Argentine beef, Australian mutton, and New Zealand wool cast as threats to the domestic market.⁶⁴ In Britain, where by 1933 nearly 94 percent of shell-free eggs came from China, tariff reforms to strengthen colonial trade further pressured these imports. Even before formal imperial preference was granted, the Empire Marketing Board, established in 1926, promoted "home and empire" goods, aiming to source eggs from Australia, Northern Ireland, and South Africa while limiting Chinese imports.⁶⁵ Dominion states with agricultural economies had viewed Chinese eggs with suspicion since the early twentieth century, with protectionist newspapers framing them as tuberculosis carriers and part of the so-called Asian menace.⁶⁶ Australia was soon seen as the replacement exporter for China. Agreements with London's largest bakery firms fueled rapid expansion of Australia's egg-processing industry, with exports to Britain tripling between 1930 and 1933.⁶⁷

Meanwhile, Britain's domestic protectionism intensified alongside its expanding poultry industry, marked by the National Mark Scheme, which began certifying home-produced eggs to government grading standards in 1929 and further excluded Chinese products. Leading the way, the *Daily Mail* described the "appalling circumstances" in China, with hens drinking water that was "usually green and slimy, and always obtrusively in evidence by its noisome stench." The *Daily Express* and *The Observer* also went on the "warpath," asserting that "every newspaper must agree that this trade should cease."⁶⁸ As for the public, the National Federation of Women's Institutes urged housewives to press the government to safeguard Britain's domestic industry, warning that imported processed eggs had been "collected and broken into a bowl at the corner of the room" teeming with "all sorts of germs."⁶⁹ The Scientific Poultry Breeders' Association, with around 22,000 members in Britain, published test results challenging the sanitary department's credibility.⁷⁰ In Parliament, Health Minister Hilton Young, bombarded with questions about the quality of Chinese eggs, defended their safety, citing bacteriological and microscopic results.⁷¹ The Bristol Local Board commented, "Imagination probably plays a considerable part in the mental assessment of the conditions associated with the breaking of eggs and the canning of their contents in foreign climes."⁷²

Given the significance of the egg export trade to the national economy, Chinese authorities set up standards to fulfill importing countries' requirements and sought to dispel misconceptions, particularly regarding traditional preserved eggs. The Ministry of Industry required all egg factories to maintain sterilization and refrigeration equipment, provide ample lighting and ventilation, and ensure hygienic working conditions. Products underwent strict testing and were monitored for proper labeling and packing. The Shanghai branch of the Bureau of Inspection and Testing of Commercial Commodities, established in 1929 under the Nationalist

government's Provisional Regulations of the Commodity Inspection Bureau of the previous year, oversaw the examination of animals, animal products, and other imports and exports across the provinces of Jiangsu, Zhejiang, Anhui, and Jiangxi. In 1935, its official publication, *Inspection and Commerce*, printed in English and distributed internationally, devoted an issue to eggs and egg products to introduce the latest developments and reassure foreign markets. The U.S. Department of Agriculture recognized that inspections conducted under the Chinese system at factories and export points and reinforced upon arrival in the United States were often more rigorous than those applied to domestic products. Nevertheless, consistent interpretations of testing results remained an ongoing challenge, fueling debates—frequently influenced by protectionist concerns—about the sanitation of Chinese imports.⁷³

Controlling Logistics

Despite the stigmatization of products from China, stakeholders profiting from the trade warned that curtailing it would cause economic fallout in related sectors, including shipping, insurance, distribution, storage, and, not least, the food-manufacturing industry. From the outset, the business strategy of these corporations sought to establish monopolies by cutting costs and using the cold chain to control the flow of perishables. Jardine Matheson entered the refrigeration industry by acquiring the plant of the Hongkong Ice Company, established by Scottish engineers John Kyle and William Bain in 1894, and later expanded its operation into a citywide network of cold-storage facilities. In a similar move in 1913, the IEC acquired the Shanghai Ice Company, a joint-stock enterprise and key supplier for the foreign community, despite controversy over whether such infrastructure should pass into a single company's hands.⁷⁴ The purchase secured a crucial foothold for the IEC, enabling it to sustain its export business even after its Nanjing

headquarters, plagued by labor conflicts, shut down in 1933. Envisioning an egg-processing network along the Yangtze Valley, Jardine Matheson planned a central plant at tidewater supplemented by smaller, cost-effective facilities closer to supply sources in the interior. Excepting establishing its Shanghai factory, the company never realized the satellite plants, which it intended to run during the manufacturing season and function as buying stations throughout the year. The company's reach was further constrained by the lack of cold-storage transportation from North China, whereas the IEC benefited from its parent company's fleet of refrigerated steamers.⁷⁵ To streamline procurement, CEPC deployed a refrigerated cargo boat, designed by Carleton, to navigate up the Yangtze River and collect eggs from local transport networks, such as junks, sampans, and hand delivery in bamboo baskets carried by laborers.

Nevertheless, rising tariff barriers, declining demand during the Great Depression, the expansion of poultry industries in importing countries, and intensifying competition drove market prices for egg products to unsustainably low levels, allowing only narrow margins despite continued increases in export volumes.⁷⁶ In response, Amos Bird, Behr & Mathew, CEPC, the Henningsen Produce Company, the IEC, and Jardine Matheson formed the so-called Conference, a coordinating committee of leading producers, in October 1930 to enforce production quotas, although the negotiations were far from straightforward.⁷⁷ The Conference closely monitored outsiders, and when their major competitor, the Chinese-invested Central Cold Storage Company in Shanghai, faced a financial crisis, the IEC and Jardine Matheson jointly acquired it. Through Zheng Yuanxing, they hired the company's cofounder and manager, Yan Ziyu, as a consultant to the six companies, on the condition that he refrain from engaging in the egg export business for three years.⁷⁸ According to Yan, when he had applied for a building permit for his company in 1929, the Shanghai Municipal Council, the administrative body of the International Settlement,

had deliberately attempted to obstruct him, partly due to Jardine Matheson's influence.⁷⁹

Exclusive technical expertise and distribution channels had always been critical for market dominance. After returning to the United States in 1927, William Carleton received compensation that barred him from joining competitors and was later appointed plant and constructional superintendent. At the same time, CEPC poached the engineer Elliott from Amos Bird, which was acquired in 1928 by the American meat giant Armour, while reassuring Armour's rival, Swift, of their continued collaboration, originally established by Carleton.⁸⁰ Jardine Matheson initially secured the costly, exclusive services of the engineer Arthur Robinson but grew wary of his role, suspecting that he was gaining expertise at its expense. Dismissing him, however, stood to jeopardize ties with its American distributor, whose relationship Robinson had helped cultivate.⁸¹ At the end of Robinson's ten-year tenure, he published the full details and plan of the Shanghai factory in *Ice and Refrigeration* (1930), a leading American journal with an international readership.⁸² Jardine Matheson downplayed the issue to avoid complications but regarded Robinson's actions as not "playing the game," a view shared by the IEC's parent company, Union Cold Storage Company, which accused him of flaunting the privileged position of established firms and attracting unwanted attention.⁸³

Concerns over losing technical advantage were not unfounded, as more factories in major Chinese cities gained egg-freezing capacity, and drying plants in the interior increasingly adopted modern cooling systems.⁸⁴ Engineer Carl G. Blomberg, who arrived in China in 1915, after the American egg-drying industry relocated, built plants in Hankou and Zhengzhou.⁸⁵ His factory plan, with a daily production capacity of five tons, demonstrates precise temperature control: chilling fresh eggs at 40°F (around 4°C), candling at 60°F (16°C), fermenting at 70°F (21°C), and packing and storing finished products at 60°F. Blomberg noted that local mechanics

and laborers generally constructed the plants, while all the machinery was imported from the United States, with some companies even dismantling facilities for reinstallation in China. Egg freezing remained largely limited to well-capitalized treaty port firms, but air-conditioned drying factories across the egg-producing regions provided practical models that motivated Chinese producers to employ foreign experts as advisers for their own operations.

Manufacturers of refrigeration facilities, initially drawn to China to build large-scale warehouses for export-oriented multinationals, soon established local agents to tap the domestic market. York Shipley, a global leader, set up a Shanghai branch, the York Ice Machinery Corporation, in 1925 to provide immediate local services (see figure 5). Within a decade, it had installed more than 350 machines across China, including at the Shanghai municipal abattoir complex, a project led by the Public Works and Public Health Departments of the Shanghai Municipal Council to centralize and regulate the meat supply of the International Settlement. In an effort to bring the city's provisioning under national control, the Chinese Nationalist government's Ministry of Industry allocated one-third of its budget of 1.2 million Chinese dollars for the Shanghai Fish Market to refrigeration plants in 1935, despite financial restraints, rejecting local storage offers, among them CEPC, whose warehouse space had fallen idle in the depressed market, and purchasing equipment from York.⁸⁶ The U.S. company positioned itself as a key advocate for commercial refrigeration in China, promoting cold storage to extend the preservation time of perishables, stabilize prices, improve living standards, and enhance public health.⁸⁷ To gain public recognition, York showcased the interior of the Henningsen Produce Company, which had installed its plant, in a 1936 edition of the widely circulated *Scientific American*.⁸⁸ According to the company, more than 6,000 tons of total refrigeration in China were devoted to the egg-freezing industry, suggesting that those who could afford it were intervening

directly in the food supply chain.⁸⁹

From an economic perspective, continuous operation of refrigeration machinery was necessary to maximize energy efficiency, but cooling demand in the egg-processing industry was inherently seasonal, driven by the natural laying cycles of hens. In the United States, egg freezing typically took place in rented cold storage or as a way of absorbing spare spatial capacity for merchandising, poultry packing, and butter production. In China, egg processing advanced ahead of the domestic refrigeration industry, where cooling demand remained limited despite a long tradition of harvested ice. Around Shanghai, for example, farmers collected winter ice and stored it in icehouses before selling to fishermen in summer.⁹⁰ The availability of cheap natural ice rendered early ice-making factories barely profitable. From the mid-1920s, however, the expanding egg-processing industry stimulated local refrigeration services. Jardine Matheson produced machine-made ice as a by-product of the egg-processing factory's refrigeration plant, designed to require no extra coal in the off-season.⁹¹ The plant, not originally intended for egg freezing, proved costly to repurpose.⁹² By the mid-1930s, Behr & Mathew, calling China's frozen-egg industry "a dying industry," partially converted its Shanghai plant to ice and fish storage and planned to sell its Hankou and Qingdao facilities, relying increasingly on sideline profits for survival.

Although Behr & Mathew's proposal was never implemented, CEPC considered the acquisition of its Shanghai plant promising, especially if it could be converted into a cold-storage warehouse with auxiliary food-processing facilities. CEPC had been actively cultivating clients among local hotels, restaurants, and retailers, expanding to handle a wide range of goods, including pork, poultry, vegetables, fruits, medicinal herbs, leather, and other dry goods. Its eight-story reinforced-concrete warehouse at Shiliupu was the hub of Shanghai's wholesale trade

to inland regions (see figure 6). Completed in 1933, it boasted a 10,000-ton capacity, dwarfing comparable structures and capturing the attention of passersby. The bottom four floors were fully equipped following “the latest US scientific practice.” A rendering of the building appeared in *Jianzhu yuekan*, the journal of the Chinese Architectural Society, and in *Shenbao*, one of Shanghai’s most widely read Chinese newspapers.⁹³ CEPC’s services were well received due to its low charges, prime location, and flexible storage and retrieval policies. The spread of mechanical refrigeration advanced knowledge of cold storage, with Chinese publications explaining scientific preservation alongside practical household methods.⁹⁴

Government regulation lagged behind commercial operations. Sanitary inspectors of the Shanghai Municipal Council reported difficulties in obtaining comprehensive data on private cold-storage warehouses, as the absence of licensing and registration requirements limited their authority to access these premises. Indirect investigations revealed poor cleanliness and disorganization in both Chinese- and foreign-run facilities, including those serving high-end venues. Although industry-wide standards for temperature and humidity were set, especially for sensitive items like eggs and strong-smelling products like fish, everyday enforcement remained weak. Containers, trays, and other support equipment were found dirty, and oversight of product handling was inadequate. For example, CEPC was observed storing unstamped pork carcasses of unknown origin. The report concluded that the “anomalous” status of these establishments posed a serious public health risk.⁹⁵ Similarly, the mandate to replace harvested ice with machine-made ice to ensure purity and cleanliness proved ineffective, as sanitation authorities found the ice stored in dark, damp iceboxes that serve as breeding grounds for bacteria.⁹⁶

Notably, in the early 1920s, ice cream remained a major contributor to cholera cases among Shanghai’s foreign population, fueling demand for imports from the United States. One

pioneering importer, the Velvet Ice Cream Company, earned its owner Paul Crawley the title of “Ice Cream King” in Shanghai; the business expanded quickly to Beijing, Hankou, and Tianjin, while serving as a front for opium exports into the United States, an operation that landed Crawley in prison in 1932.⁹⁷ Ice cream remained a luxury nonetheless, prompting a Chinese writer to half-jokingly suggest re-creating the fashionable experience by reusing Velvet’s signature cups and spoons while filling them with low-cost substitute.⁹⁸ Capitalizing on this trend, the Henningsen Produce Company used surplus cold-storage capacity to handle imported ice cream and began manufacturing it locally in 1926. With the plant’s expansion in the following years, it became a leading mass producer. Its brand, Hazelwood, known in Chinese as *Meinü pai* (beauty brand), quickly became a household name in Shanghai, propelled by the company’s promotion across billboards, newspapers, and magazines, shaping the city’s emerging cosmopolitan lifestyle.

Although Henningsen’s egg-processing business primarily served overseas markets, its publicity efforts, which emphasized refrigeration’s role in hygiene and nutrition, helped popularize ice cream locally. The company depicted its factory, located in a garden away from the city center, as a picturesque retreat, with a well-maintained lawn, a lily pond filled with goldfish, and rows of trees, shrubs, and flowerbeds. Inside the facility, sunlight streamed through steel-framed windows, filling the white-tiled space with “cleansing sunshine” and creating a bright, airy atmosphere. The air-conditioning and brick-and-concrete structure created a cool and comfortable environment, with the air “washed” to ensure cleanliness.⁹⁹ Within the ice cream plant, cutting-edge stainless steel equipment operated automatically. By combining an idyllic landscape with a manufacturing facility, the factory signaled food purity and healthfulness through modernity. Organized tours of the factory proved especially popular among students and

other young people.¹⁰⁰

Artificial cooling reshaped the food industry and drove a dietary shift toward chilled beverages and frozen confections. While the middle class socialized in ice cream parlors in major cities, the laboring classes in places like Chengdu enjoyed tea cooled with street ice.¹⁰¹ The American trade journal *Ice Cream Review* predicted in 1924 that the ice cream business had “no future” in China due to locals’ “inherent dislike of cold foods and drinks” and the high cost and limited availability of ice and dairy products. Yet three years later, the journal reported that nearly every catering establishment in Shanghai produced ice cream and displayed a poster from the Public Health Department of the Municipal Council offering detailed instructions in English and Chinese on how to make pure ice cream.¹⁰² Local children’s publications, women’s magazines, and popular science periodicals offered instructions for constructing ice cream makers, printed home recipes, and promoted ice cream consumption.¹⁰³ Shanghai’s integration of modern sanitation into local culinary practices provided points of reference for Europe and the United States, where solutions to food contamination issues only began to prove effective in the 1910s.¹⁰⁴

Conclusion

In examining the nineteenth-century application of artificial refrigeration in meat supply and ice manufacture to alleviate tropical heat, Rebecca Woods highlights its promise to “seamlessly unite the hemispheres—to weave the northern and southern domains of the British Empire into one frictionless whole.”¹⁰⁵ Yet the technology transfer associated with the establishment of the egg-processing industry in China, which became an important source of food for Great Britain, Europe, and the United States, especially after World War I, revealed intricate power relations

among stakeholders and reconfigured market connections beyond an imperialist agenda. While international export trade promoted the standardization of food production processes, the industry also demanded substantial investment. Multinational firms, including Chinese enterprises, leveraged technical expertise and proprietary technologies in mechanical refrigeration, a key component that enabled the consolidation of control over product flows.

This contested landscape intersected with emerging regulatory frameworks, as authorities and industrial actors grappled with questions of food safety and sanitation in an increasingly globalized supply chain. The arrival of Chinese products in Western markets sparked intense debates, shaped as much by cultural perceptions and suspicion as by assessments of quality, which remained disputed. Scholars have shown that beyond the stated aim of protecting consumers from product adulteration and fraud, business interests, particularly larger producers who capitalized on technological innovations, played a formative role in shaping governance, deploying hygiene and food standards to reinforce their market positions.¹⁰⁶ Cheap imports from China, in turn, prompted farmers and local associations in Western countries to orchestrate media campaigns that challenged the dominance of Chinese egg products, framing their objections in terms of public health and economic fairness. Food laws and tariffs in Western societies became instruments for navigating the tension between free trade and protectionism, though governmental approaches varied and evolved over time. While artificial cooling facilitated the circulation of commodities, the regulation of imports and exports functioned as a critical gateway, not merely a technical procedure guided by neutral scientific criteria but a mechanism reflecting and structuring domestic priorities, international positioning, and the shifting configurations of global trade networks.

The prosperity of the egg trade and China's prominent role in the global egg market

proved short-lived, with its low-cost advantage undermined by recurring economic and political instability before being abruptly severed by the outbreak of the Second Sino-Japanese War in 1937. Nevertheless, the industry left a lasting legacy through its large-scale introduction of artificial cooling, which embodied a form of techno-power capable of transcending climatological, geographical, and seasonal barriers. Upon leaving China for the United States, Carleton, celebrated by the press as the “founder of the egg-freezing industry” in China, spoke with conviction about the transformative potential of cold storage. He envisioned the “unlimited” possibilities for transporting goods across the country, from remote outposts to major cities, and predicted that the poorer classes would benefit most from its development. While recognizing that winning over Chinese merchants would take time and that growth would be gradual, Carleton remained optimistic, insisting that “so far the surface of this industry has hardly been scratched.”¹⁰⁷

With CEPC operating the largest private cold-storage warehouse in Shanghai, Carleton’s drive to incorporate mechanical refrigeration into China’s logistical networks, what today falls under the rubric of foodway modernization, resonated strongly with Jeffrey M. Pilcher’s notion of culinary infrastructure: the interweaving of material components, such as physical facilities, and immaterial ones, such as knowledge and expertise, that sustain food systems.¹⁰⁸ Initially attracted by the egg trade, equipment manufacturers expanding into the Chinese market championed refrigeration as a social good, emphasizing its contributions to public health and nutrition alongside its technological progressiveness. Similarly, the Henningsen Produce Company’s marketing of mass-produced ice cream underscored modern methods of production, situating the product within emerging sanitary regulations and introducing new flavors and tastes. While early ice-making ventures by foreign investors met with limited success in the late

nineteenth century, by the late 1930s, evolving standards for food hygiene and the declining cost of manufactured ice pushed the traditional ice-harvesting industry to the brink of collapse.¹⁰⁹ The export-oriented egg-processing industry thus provides a unique lens for examining the introduction of artificial cooling in a non-Western society. It illustrates how the technology's ambient and malleable qualities contributed to shaping the broader food system in modern China during the country's integration into the global economy, a process infused with friction and mediation—one in which refrigerated spaces became normalized in everyday production and consumption.

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Bibliography

Archival Sources

Bibliothèque de l'Hôtel de Ville, Paris, France (BHdV)

British National Archives, London, U.K. (BNA)

Jardine Matheson Archive, Cambridge University Library, Cambridge, U.K. (JMA)

Shanghai Municipal Archives, Shanghai, China (SMA)

United Nations Library and Archives, Geneva, Switzerland (UNOG)

Published Sources

Allen, George Cyril. *Western Enterprise in Far Eastern Economic Development: China and Japan*. London: Allen and Unwin, 1954.

Ashutosh, Ishan. "Frozen Modernity: The US-India Ice Trade and the Cultures of Colonialism." *Cultural Geographies* 30, no. 3 (2023): 413–28.

<https://doi.org/10.1177/14744740231154256>.

Barkan, Ilyse D. "Industry Invites Regulation: The Passage of the Pure Food and Drug Act of 1906." *American Journal of Public Health* 75, no. 1 (1985): 18–26.

<https://doi.org/10.2105/AJPH.75.1.18>.

Blunt, Katharine, and Chi Che Wang. "Chinese Preserved Eggs—Pidan." *Journal of Biological Chemistry* 28, no. 1 (1916): 123–42. [https://doi.org/10.1016/S0021-9258\(18\)86849-1](https://doi.org/10.1016/S0021-9258(18)86849-1).

Carpenter, Frank G. *China*. New York: Doubleday, Doran, 1925.

Chang, Jennifer Ning. "New British Companies in China: The Case of the International Export Company in Hankou, 1907–18." *Studies in Chinese History*, no. 8 (1998): 29–63.

Chang, Jennifer Ning. "Vertical Integration, Business Diversification, and Firm Architecture: The Case of the China Egg Produce Company in Shanghai, 1923–1950." *Enterprise and Society* 6, no. 3 (2005): 419–51. <https://doi.org/10.1093/es/khi057>.

- Chatterjee, Piya. *A Time for Tea: Women, Labor, and Post/Colonial Politics on an Indian Plantation*. Durham: Duke University Press, 2001. <https://doi.org/10.2307/j.ctv11cw1bt>.
- Claflin, Kyri Watson. "Les Halles and the Moral Market: Frigophobia Strikes in the Belly of Paris." In *Food and Morality: Proceedings of the Oxford Symposium on Food and Cookery*, 82–92. Totnes: Prospect Books, 2008.
- Conner, L. G. "Out of the Egg Comes a Growing Industry: The Story of Frozen and Dried Egg Products." *Food Industries* 2, no. 2 (1930): 52–56.
- Dikötter, Frank. *Exotic Commodities: Modern Objects and Everyday Life in China*. New York: Columbia University Press, 2006.
- DuBois, Thomas David. "Many Roads from Pasture to Plate: A Commodity Chain Approach to China's Beef Trade, 1732–1931." *Journal of Global History* 14, no. 1 (2019): 22–43. <https://doi.org/10.1017/S1740022818000335>.
- Freidberg, Susanne. *Fresh: A Perishable History*. Cambridge, MA: Harvard University Press, 2010. <https://doi.org/10.4159/9780674053854>.
- Freidberg, Susanne. "Freshness from Afar: The Colonial Roots of Contemporary Fresh Foods." *Food and History* 8, no. 1 (2011): 257–78. <https://doi.org/10.1484/J.FOOD.1.100983>.
- Freidberg, Susanne. "The Triumph of the Egg." *Comparative Studies in Society and History* 50, no. 2 (2008): 400–423. <https://doi.org/10.1017/S0010417508000182>.
- Friedrich, Alexander, and Christoph Hubig. "Kryosphäre." In *Technik—Macht—Raum: Das Topologische Manifest im Kontext interdisziplinärer Studien*, edited by Andreas Brenneis, Oliver Honer, Sina Keesser, Annette Ripper, and Silke Vetter-Schultheiß, 159–84. Wiesbaden: Springer Fachmedien, 2018. https://doi.org/10.1007/978-3-658-15154-6_9.

- Fu, Jia-Chen. *The Other Milk: Reinventing Soy in Republican China*. Seattle: University of Washington Press, 2018. <https://doi.org/10.1515/9780295744056>.
- Geist, Edward. "When Ice Cream Was Poisonous: Adulteration, Ptomaines, and Bacteriology in the United States, 1850–1910." *Bulletin of the History of Medicine* 86, no. 3 (2012): 333–60. <https://doi.org/10.1353/bhm.2012.0053>.
- Gerth, Karl. *China Made: Consumer Culture and the Creation of the Nation*. Cambridge, MA: Harvard University Asia Center, 2003. <https://doi.org/10.1163/9781684173860>.
- Goh, Chor Boon. *Technology and Entrepot Colonialism in Singapore, 1819–1940*. Singapore: Institute of Southeast Asian Studies, 2013. <https://doi.org/10.1355/9789814414098>.
- Grasset, Edmond. *Les Œufs Congelés: Importance Économique—Étude Bactériologique—Contrôle Sanitaire*. Paris: Libraires de l'Académie de Médecine, 1928.
- Higgins, David M., and Dev Gangjee. "'Trick or Treat?' The Misrepresentation of American Beef Exports in Britain during the Late Nineteenth Century." *Enterprise and Society* 11, no. 2 (2010): 203–41. <https://doi.org/10.1017/S1467222700009046>.
- Hobart, Hi'ilei Julia Kawehipuaakahaopulani. *Cooling the Tropics: Ice, Indigeneity, and Hawaiian Refreshment*. Durham: Duke University Press, 2023. <https://doi.org/10.1515/9781478023821>.
- Höhne, Stefan. "Kryosphären des Kapitals: Zur Urbanen Topologie des Gekühlten Lebens." In *Technik—Macht—Raum: Das Topologische Manifest im Kontext interdisziplinärer Studien*, edited by Andreas Brenneis, Oliver Honer, Sina Keesser, Annette Ripper, and Silke Vetter-Schultheiß, 185–206. Wiesbaden: Springer Fachmedien, 2018. https://doi.org/10.1007/978-3-658-15154-6_10.
- Honig, Emily. *Sisters and Strangers: Women in the Shanghai Cotton Mills, 1919–1949*. Stanford:

Stanford University Press, 1992.

Judge, Joan. “Women as Vernacular Knowers in China’s Long Republic (1894–1954): What We Can Learn from Cheap Print.” *Nan Nü* 25 (2023): 189–97.

<https://doi.org/10.1163/15685268-02512025>.

Knightley, Phillip. *The Rise and Fall of the House of Vestey: The True Story of How Britain’s Richest Family Beat the Taxman and Came to Grief*. London: Warner Books, 1993.

Lee, Seung-Joon. “The Patriot’s Scientific Diet: Nutrition Science and Dietary Reform Campaigns in China, 1910s–1950s.” *Modern Asian Studies* 49, no. 6 (2015): 1808–39.

<https://doi.org/10.1017/S0026749X14000286>.

Ludovice, Nicolo Paolo. “The Ice Plant Cometh: The Insular Cold Storage and Ice Plant, Frozen Meat, and the Imperial Biodeterioration of American Manila, 1900–1935.” *Global Food History* 7, no. 2 (2021): 115–39. <https://doi.org/10.1080/20549547.2021.1921466>.

Naylor, Simon. “Spacing the Can: Empire, Modernity, and the Globalisation of Food.” *Environment and Planning A: Economy and Space* 32, no. 9 (2000): 1625–39.

<https://doi.org/10.1068/a32166>.

Peckham, Robert. “Bad Meat: Food and the Medicine of Modern Hygiene in Colonial Hong Kong.” In *Moral Foods: The Construction of Nutrition and Health in Modern Asia*, edited by Angela Ki Che Leung and Melissa L. Caldwell, 173–98. Honolulu: University of Hawai‘i Press, 2019.

Perren, Richard. *Taste, Trade and Technology: The Development of the International Meat Industry since 1840*. Aldershot: Ashgate, 2006.

Phillips, Jim, and Michael French. “Adulteration and Food Law, 1899–1939.” *Twentieth Century British History* 9, no. 3 (1998): 350–69. <https://doi.org/10.1093/tcbh/9.3.350>.

- Pilcher, Jeffrey M. "Culinary Infrastructure: How Facilities and Technologies Create Value and Meaning Around Food." *Global Food History* 2, no. 2 (2016): 105–31.
<https://doi.org/10.1080/20549547.2016.1214896>.
- Pilcher, Jeffrey M. "Empire of the 'Jungle': The Rise of an Atlantic Refrigerated Beef Industry, 1880–1920." *Food, Culture and Society* 7, no. 2 (2004): 63–78.
<https://doi.org/10.2752/155280104786577860>.
- Rappaport, Erika. *A Thirst for Empire: How Tea Shaped the Modern World*. Princeton: Princeton University Press, 2018. <https://doi.org/10.1515/9781400884858>.
- Rees, Jonathan. *Refrigeration Nation: A History of Ice, Appliances, and Enterprise in America*. Baltimore: Johns Hopkins University Press, 2013.
- Robinson, Lisa Mae. "Establishing the Cold Chain: The Work of the United States Food Research Laboratory, 1907–1919." *Journal of Agricultural and Food Information* 7, no. 1 (2006): 19–37. https://doi.org/10.1300/J108v07n01_04.
- Robinson, Lisa Mae. "Regulating What We Eat: Mary Engle Pennington and the Food Research Laboratory." *Agricultural History* 64, no. 2 (1990): 143–53.
- Rogaski, Ruth. *Hygienic Modernity: Meanings of Health and Disease in Treaty-Port China*. Berkeley: University of California Press, 2004.
<https://doi.org/10.1525/california/9780520240018.001.0001>.
- Schneider, Albert. *Bacteriological Methods in Food and Drugs Laboratories with an Introduction to Micro-analytical Methods*. Philadelphia: P. Blakiston's Son, 1915.
<https://doi.org/10.5962/bhl.title.57249>.
- Schönach, Paula. "Natural Ice and the Emerging Cryopolis: A Historical Perspective on Urban Cold Infrastructure." *Cultural Machine* 17 (2018): 1–25.

- Seaver, Montgomery. *The Keith Genealogy*. Philadelphia: American-Historical Genealogical Society, 1930.
- Stanziani, Alessandro. “Negotiating Innovation in a Market Economy: Foodstuffs and Beverages Adulteration in Nineteenth-Century France.” *Enterprise and Society* 8, no. 2 (2007): 375–412. <https://doi.org/10.1093/es/khm025>.
- Starosielski, Nicole. *Media Hot and Cold*. Durham: Duke University Press, 2021. <https://doi.org/10.1215/9781478021841>.
- Swislocki, Mark. “Nutritional Governmentality: Food and the Politics of Health in Late Imperial and Republican China.” *Radical History Review* 2011, no. 110 (2011): 9–35. <https://doi.org/10.1215/01636545-2010-024>.
- Termohlen, William Dewey, Edgar Warren, and Clifton Court Warren. *The Egg-Drying Industry in the United States*. Washington, DC: United States Government Printing Office, 1938.
- Thorne, James Frederic. *Chinese Eggs: Conditions of Egg Production in China and Competition in Pacific Coast Markets, Prices Imports, Exports*. Salem: State Printing Department, 1916.
- Torrie, Julia S. “Frozen Meat and Fish, Imperialism, and France in the Era of World War One.” *Food and Foodways* 32, no. 1 (2024): 79–99. <https://doi.org/10.1080/07409710.2023.2298180>.
- Wang, Zhengfeng. “Icehouses in Motion: Knowledge Flows Across the Cryosphere.” *Roadsides*, no. 15 (2026): 67–75. <https://doi.org/10.26034/roadsides-202601507>.
- Wang, Zhengfeng. “Modernizing Urban Food Provisioning: The 1936 Shanghai Fish Market.” *Journal of the Society of Architectural Historians* 83, no. 1 (2024): 83–103. <https://doi.org/10.1525/jsah.2024.83.1.83>.

- Woods, Rebecca J. H. “Breed, Culture, and Economy: The New Zealand Frozen Meat Trade, 1880–1914.” *Agricultural History Review* 60, no. 2 (2012): 288–308.
- Woods, Rebecca J. H. “Nature and the Refrigerating Machine: The Politics and Production of Cold in the Nineteenth Century.” In *Cryopolitics: Frozen Life in a Melting World*, edited by Emma Kowal and Joanna Radin, 89–116. Cambridge, MA: MIT Press, 2017.
<https://doi.org/10.7551/mitpress/10456.003.0010>.
- Yu, Sarah Xia. “From Sanitation to Soybeans: Kitchen Hygiene and Nutritional Nationalism in Republican China, 1911–1945.” *Asia Pacific Perspectives* 17, no. 1 (2021): 6–37.
- Zhang, Yue, and Zhou Jianbo. *Danke qianqun: Yijia Zhongguo qiye de quanqiu tuwei (1923–1949)* 蛋壳乾坤：一家中国企业的全球突围：1923–1949 [Hidden champion of China’s modern egg industry: The global breakthrough of CEPCO (1923–1949)]. Beijing: Social Sciences Academic Press, 2024.
- Zhu, Xiang. “Nanjing yingshang heji yanghang yanjiu” 南京英商和记洋行研究 [Studies on the British International Export Company]. PhD diss., Nanjing Normal University, 2013.

¹ Freidberg, *Fresh: A Perishable History*.

² Freidberg, “Freshness from Afar: The Colonial Roots of Contemporary Fresh Foods”; Woods, “Nature and the Refrigerating Machine: The Politics and Production of Cold in the Nineteenth Century”; Torrie, “Frozen Meat and Fish, Imperialism, and France in the Era of World War One.”

³ Ludovice, “The Ice Plant Cometh: The Insular Cold Storage and Ice Plant, Frozen Meat, and

the Imperial Biodeterioration of American Manila, 1900–1935”; Goh, *Technology and Entrepot Colonialism in Singapore, 1819–1940*, 168–95; Peckham, “Bad Meat: Food and the Medicine of Modern Hygiene in Colonial Hong Kong.”

⁴ Hobart, *Cooling the Tropics: Ice, Indigeneity, and Hawaiian Refreshment*; Ashutosh, “Frozen Modernity: The US-India Ice Trade and the Cultures of Colonialism.”

⁶ DuBois, “Many Roads from Pasture to Plate: A Commodity Chain Approach to China’s Beef Trade, 1732–1931.”

⁶ Shiren Fan, “Zhongguo zhi danye” 中国之蛋业 [China’s egg industry], *Shehui zazhi* 1, no. 5 (1931): 3–18; Jiyuan Chen, “Zhongguo danchanpin zhi guoji shichang” 中国蛋产品之国际市场 [The international market of egg products from China], *Guoji maoyi daobao* 2, no 5 (1931): 1–11.

⁷ For the economic and business history of Chinese entrepreneurship: Chang, “Vertical Integration, Business Diversification, and Firm Architecture: The Case of the China Egg Produce Company in Shanghai, 1923–1950”; Zhang and Zhou, *Danke Qiankun: Yijia Zhongguo Qiye de Quanqiu Tuwei*.

⁸ For nationalism and labor movements: Zhu, “Nanjing yingshang heji yanghang yanjiu.”

⁹ Rogaski, *Hygienic Modernity: Meanings of Health and Disease in Treaty-Port China*; Swislocki, “Nutritional Governmentality: Food and the Politics of Health in Late Imperial and Republican China”; Fu, *The Other Milk: Reinventing Soy in Republican China*; Yu, “From Sanitation to Soybeans: Kitchen Hygiene and Nutritional Nationalism in Republican China, 1911–1945”; Lee, “The Patriot’s Scientific Diet: Nutrition Science and Dietary Reform Campaigns in China, 1910s–1950s.”

¹⁰ Rees, *Refrigeration Nation: A History of Ice, Appliances, and Enterprise in America*, 99–112.

¹¹ Perren, *Taste, Trade and Technology: The Development of the International Meat Industry since 1840*; Woods, “Breed, Culture, and Economy: The New Zealand Frozen Meat Trade, 1880–1914”; Pilcher, “Empire of the ‘Jungle’: The Rise of an Atlantic Refrigerated Beef Industry, 1880–1920”; Higgins and Gangjee, “‘Trick or Treat?’ The Misrepresentation of American Beef Exports in Britain during the Late Nineteenth Century.”

¹² Nicola Twilley, “The Coldscape: From the Tank Farm to the Sushi Coffin,” *Cabinet Magazine*, no. 47 (Fall 2012), <https://cabinetmagazine.org/issues/47/twilley.php>; Schönach, “Natural Ice and the Emerging Cryopolis: A Historical Perspective on Urban Cold Infrastructure”; Höhne, “Kryosphären des Kapitals: Zur Urbanen Topologie des Gekühlten Lebens”; Friedrich and Hubig, “Kryosphäre.”

¹³ Allen, *Western Enterprise in Far Eastern Economic Development: China and Japan*, 76–80.

¹⁴ Knightley, *The Rise and Fall of the House of Vestey: The True Story of How Britain’s Richest Family Beat the Taxman and Came to Grief*, 9–17.

¹⁵ R. J. Cole, “Egg Albumen: An Interesting Survey of the Growth of the Dried Egg Industry,” *Food Manufacture*, December 1933, 401–3; Termohlen, Warren, and Warren, *The Egg-Drying Industry in the United States*.

¹⁶ On the use of boric acid: Guy E. Mitchell, “Notes from Washington, D.C.: Eggs and Boracic Acid,” *Massachusetts Ploughman and New England Journal of Agriculture*, November 18, 1905; A. W. J. Macfadden, “Report on the Work of Inspectors of Foods for the Year 1917–18,” *Analyst* 516 (1919): 118; “Liquid Eggs from China,” *North-China Herald*, May 11, 1918; “Blow to Chinese Eggs,” *China Press*, November 12, 1925.

¹⁷ “Enclosure in Mr. Goffe’s No 32,” March 22, 1911, FO 228/2138, BNA.

¹⁸ Chang, “New British Companies in China: The Case of International Export Company in

Hankou, 1907–18.”

¹⁹ H. B. M., Consulate-General, Hankow, to Sir John N. Jordan, His Majesty’s Minister, Peking, letter, March 28, 1913, FO 228/2138, BNA.

²⁰ Wai Chiao Pu to W. Alston, letter, August 28, 1913, FO 228/2138, BNA.

²¹ Chinese Maritime Customs, *Returns of Trade and Trade Reports, 1914*, pt. 1, *Reports on the Foreign Trade of China, and Abstract of Statistics* (Shanghai: Statistical Department of the Inspectorate General of Customs, 1915), 75.

²² For detailed records: Chinese Maritime Customs, *Returns of Trade and Trade Reports* (Shanghai: Statistical Department of the Inspectorate General of Customs, 1915–21); Chinese Maritime Customs, *Foreign Trade of China* (Shanghai: Statistical Department of the Inspectorate General of Customs, 1922–32).

²³ Contract of Jardine Matheson and Arthur Robinson, 1919, JM/F11/206, JMA.

²⁴ Arthur Robinson, “Ewo Cold Storage Co.,” July 13, 1928; Cecil L. Mathew to Mr. Goldrei, letter, June 30, 1928; H. K. Peters, “Memo. Re Mr. E. G. Wilkison’s Comments on Mr. A. D. Robinson’s Proposals for New Plant at Ewo Cold Storage Co.,” July 17, 1928; A. D. Robinson to Jardine, Matheson & Co., Ltd., China Produce Department, letter, July 25, 1928; all from JM/I21/3/2/12/1, JMA.

²⁵ Seaver, *The Keith Genealogy*, 39.

²⁶ “Sanitary Egg Products Plant in Shanghai,” *Far Eastern Review* 8, no. 5 (1916): 161–63.

²⁷ Robinson, “Regulating What We Eat: Mary Engle Pennington and the Food Research Laboratory”; Robinson, “Establishing the Cold Chain: The Work of the United States Food Research Laboratory, 1907–1919.”

²⁸ M. E. Pennington, *Practical Suggestions for the Preparation of Frozen and Dried Eggs: A*

Statement Based on the Investigations Made in the Producing Section during the Summer of 1911, circular no. 98 (Washington, DC: United States Department of Agriculture, Bureau of Chemistry, 1912); M. E. Pennington et al., *A Bacteriological and Chemical Study of Commercial Eggs in the Producing Districts of the Central West*, bulletin no. 51 (Washington, DC: U.S. Department of Agriculture, 1914).

²⁹ M. E. Pennington, M. K. Jenkins, and W. A. Stocking, *A Study of the Preparation of Frozen and Dried Eggs in the Production Section*, bulletin no. 224 (Washington, DC: United States Department of Agriculture, 1916); M. K. Jenkins, *The Installation and Equipment of An Egg-Breaking Plant*, bulletin no. 663 (Washington, DC: United States Department of Agriculture, 1918).

³⁰ United States Department of Agriculture, *Points for Egg Breakers: How to Break Eggs for Freezing*, circular no. 74 (Washington, DC: United States Department of Agriculture, 1920); “Illinois Rules for Egg Breaking Plants,” *Ice and Refrigeration*, no. 50 (1916): 133.

³¹ Conner, “Out of the Egg Comes a Growing Industry: The Story of Frozen and Dried Egg Products.”

³² Our Hsuchowfu [Xuzhou Prefecture] Correspondent, “Evaporation of Eggs: Peculiar Industry of North Kiangsu,” *North-China Herald and Supreme Court and Consular Gazette*, May 30, 1914.

³³ “Foreign Genius and Chinese Skill in the Egg Freezing Business,” *China Weekly Review*, November 5, 1927.

³⁴ “Frozen Eggs by the Million Sent by New Hampshire Man from China,” *Boston Daily Globe*, August 15, 1925.

³⁵ Gerth, *China Made: Consumer Culture and the Creation of the Nation*.

³⁶ For accounts of worker strikes in foreign egg factories: *North-China Daily News*, March 3, 1917; *China Press*, February 3, 1922; “Efforts Are Made to Extend Strike to American Firms: Amos Bird and Company Are First to Be,” *Shanghai Sunday Times*, September 5, 1925; “Peilin danchang shanggong zhi cuozhe” 培林蛋厂上工之挫折 [Setbacks of starting work at Behr & Mathew], *Shenbao*, August 14, 1925; “Peilin danchang qianding tiaoyue” 培林蛋厂签订条约 [Behr & Mathew signed the deal], *Shenbao*, September 16, 1925; “Patriotism Is Patriotism but Industry Must Proceed: Workmanless Employer Opines,” *China Press*, October 6, 1931.

³⁷ Sun Yat-sen, *Sanmin Zhuyi* (Chongqing: Sanmin zhuyi qingniantuan zhongyang tuanbu wenhua jianshe yundong weiyuanhui, 1945), 347–75.

³⁸ Sun, *Sanmin Zhuyi*, 347–75.

³⁹ Reports on Zheng’s study trip abroad and his own articles circulated widely in industrial periodicals, including in *Ji yu dan* [Chicken and eggs], a poultry industry publication established in 1936: Zheng Yuanxing, “Zhongguo danye shilue” 中国蛋类史略 [A brief history of China’s egg industry], *Guoji maoyi daobao* 5, no. 9 (1933): 43–54; Yuanxing Zheng, “Woguo nongcun de ji yu dan” 我国农村的鸡与蛋 [Chickens and eggs in rural China], *Ji yu dan* 1, no. 1 (1936): 17–19; Zheng Yuanxing, “Woguo danlei chukou de yange he jinkuang” 我国蛋类出口的沿革和近况 [The evolution and current status of China’s egg exports], *Ji yu dan* 2, no. 1 (1937): 24–26.

⁴⁰ Naylor, “Spacing the Can: Empire, Modernity, and the Globalisation of Food.”

⁴¹ “Eggs Preserved in Clays,” *Michigan Farmer*, December 18, 1897; “How Chinese Like Their Eggs,” *Washington Post*, June 13, 1904; “Like Their Eggs Flavored: Chinese Have Little Use for Product of the Humble Hen When It Is Fresh,” *Columbus Journal*, August 11, 1909; “Chinese Eggs,” *Nottingham Evening Post*, May 21, 1909.

⁴² Blunt and Wang, “Chinese Preserved Eggs—Pidan.”

⁴³ Rappaport, *A Thirst for Empire: How Tea Shaped the Modern World*, 120–43.

⁴⁴ “Hankow Trade Report: Chinese Pork for England,” *North-China Herald and Supreme Court and Consular Gazette*, August 28, 1909; British Parliament Hansard, “Chinese Pork (Shipment to England),” September 6, 1909; British Parliament Hansard, “Chinese Pork,” April 13, 1910; “Chinese Pork for England,” *Bath Chronicle and Weekly Gazette*, August 12, 1909; “Chinese Pork Is of the Best Quality,” *Evening Telegraph*, May 24, 1910.

⁴⁵ Freidberg, “The Triumph of the Egg.”

⁴⁶ George Pickering Burnham, *The China Fowl: Shanghae, Cochon, and “Brahma”* (Boston: Press of Rand, Avery, 1874); “Poultrymen Say Chinese Eggs Are Noxious,” *Tonopah Daily Bonanza*, January 30, 1914; “Chinese Eggs Reach Omaha: Price Is Such that American Hen Is Threatened,” *Omaha Daily Bee*, February 18, 1914; “Coast Poultrymen Will Protest the Eggs from China,” *St. Louis Post-Dispatch*, March 22, 1914; “Chinese Eggs Are Cause of Alarm,” *Provo Post*, June 2, 1914; “Chinese Egg Peril,” *Los Angeles Times*, June 26, 1914; “The Filthy Egg from China,” *Elmore County Republican*, May 9, 1914; “Chinese Eggs Will Ruin the Oregon Egg Market,” *Evening Herald*, December 14, 1915; “New Yellow Peril Found,” *Pioneer Express*, October 8, 1915.

⁴⁷ Thorne, *Chinese Eggs: Conditions of Egg Production in China and Competition in Pacific Coast Markets, Prices Imports, Exports*.

⁴⁸ An Act Respecting the Marking of Eggs, Statutes of British Columbia, May 31, 1916.

⁴⁹ Thomas Sammons, “American Build Shanghai Egg Plant,” *Commerce Reports: Daily Consular and Trade Reports*, no. 184 (1915): 659; Thomas Sammons, “American Egg-Preserving Plant Opening in China,” *Commerce Reports: Daily Consular and Trade Reports*, no. 202 (1915): 771.

⁵⁰ Chatterjee, *A Time for Tea: Women, Labor, and Post/Colonial Politics on an Indian Plantation*; Honig, *Sisters and Strangers: Women in the Shanghai Cotton Mills, 1919–1949*.

⁵¹ Carpenter, *China*, 121–27.

⁵² Termohlen, Warren, and Warren, *Egg-Drying Industry*, 29.

⁵³ L. W. Dupre, “Egg Yolk and Red Tape,” *North-China Herald and Supreme Court and Consular Gazette*, November 3, 1917; “Egg Yolks Export to America Suddenly Stopped by Washington,” *North-China Herald and Supreme Court and Consular Gazette*, November 3, 1917; Thos. Wm. Bower, “Correspondence: Egg Yolk and Albumen,” *North-China Herald and Supreme Court and Consular Gazette*, November 10, 1917; “Correspondence: China Egg Product Factories,” *Shanghai Times*, November 20, 1917; “Egg Yolk and America: The Protest by Chinese Merchants,” *North-China Herald and Supreme Court and Consular Gazette*, November 24, 1917.

⁵⁴ U.S. Senate, February 17, 1921, *Congressional Record* 60 (1921): 3289.

⁵⁵ *Frozen Eggs: Hearing Before the Committee on Agriculture and Forestry, United States Senate, Sixty-Sixth Congress, Second Session, on H.R. 9521, A Bill to Prevent Hoarding and Deterioration of and Deception with Respect to Cold-Storage Foods, to Regulate Shipments of Cold-Storage Foods in Interstate Commerce, and for Other Purposes* (Washington, DC: Government Printing Office, 1921).

⁵⁶ Claflin, “Les Halles and the Moral Market: Frigophobia Strikes in the Belly of Paris.”

⁵⁷ *Compte rendu des séances du Conseil d'hygiène publique et de salubrité du département de la Seine* 27, no. 13 (1921): 259–64, BHdV.

⁵⁸ “Le Danger des Œufs Congelés Importés de Chine,” *Le Matin*, July 20, 1921; the same article is also cited in *Le Petit Parisien*, *La Dépêche du Berry*, *Le Temps*, *La France*, and many other

local newspapers. For coverage on Martel's report overseas: "Chinese Egg Danger: 36,000 Micros Discovered," Reuters, July 24, 1921; Henri Bouquet, "Les Œufs Congelés et la Santé Publique," *Annales d'Électro-Homéopathie et d'Hygiène*, no. 9 (1921): 126–28. For the response in China: Bruce Hopper, "Yes, Any New Egg Will Go Bad if It Is Allowed to Stand Awhile in the Sun," *China Press*, July 31, 1921.

⁵⁹ A. Monvoisin, "Les Œufs Cassés Congelés," *Revue Générale du Froid et des Industries Frigorifiques* 1, no. 12 (1920): 398–99; "Organisation de la Fabrication des Produits d'Œufs à Sanghai," *Revue Générale du Froid et des Industries Frigorifiques* 1, no. 12 (1920): 399; M. Michaud, "Les Œufs Congelés," *Bulletin de la Société Scientifique d'Hygiène Alimentaire et d'Alimentation Rationnelle de l'Homme* (1921): 415–23; John Eyre, "L'Examen Bactériologique des Œufs du Commerce Frais et Congelés," trans. L'Institut International du Froid, *Revue Générale du Froid et des Industries Frigorifiques* 3, no. 4 (1922): 132–34.

⁶⁰ *Compte rendu des séances du Conseil d'hygiène publique et de salubrité du département de la Seine* 27, no. 13 (1921): 253–59, BHdV; *Compte rendu des séances du Conseil d'hygiène publique et de salubrité du département de la Seine* 28, no. 25 (1922): 437–43, BHdV.

⁶¹ F. Bordas, "Le Commerce des Œufs Congelés et la Santé Publique," *Revue d'Hygiène*, no. 44 (1922): 613–32.

⁶² *Compte rendu des séances du Conseil d'hygiène publique et de salubrité du département de la Seine* 28, no. 21 (1922): 377, BHdV; *Compte rendu des séances du Conseil d'hygiène publique et de salubrité du département de la Seine* 28, no. 25 (1922): 437–43, BHdV.

⁶³ *Compte rendu des séances du Conseil d'hygiène publique et de salubrité du département de la Seine* 28, no. 25 (1922): 445–55, BHdV.

⁶⁴ Charleston B. E. Adams, "Do American Poultrymen Need Tariff Protection? Millions of

Chinese Eggs Produced by ‘Scavenger’ Hens, Dumped on Markets of United States Annually,” *Dillon Herald*, April 28, 1921; “Petaluma Fights for Tariff on Eggs, Says Lynden Man,” *Lynden Tribune*, January 27, 1921; “Market Affected by Chinese Eggs,” *Arizona Republican*, April 16, 1922.

⁶⁵ “New Empire Egg Trade,” *Daily Mail*, March 25, 1929.

⁶⁶ “Chinese Eggs,” *Australian Town and Country Journal*, May 12, 1900; “Chinese Eggs Must Be Prohibited: How Was the Plague Introduced,” *Australia Star*, June 30, 1900; “Chinese Eggs: The Quality Criticized,” *Farmer and Settler*, May 19, 1916; “Chinese Eggs: Menace to Australia,” *Leader*, July 1, 1916. For New Zealand: “Asiatic Menace,” *Lyttelton Times*, September 18, 1916; “Chinese Eggs: New Zealand Importations,” *Dominion*, April 26, 1916; “The Chinese Eggs: An Inferior Product,” *Auckland Star*, October 27, 1916; “Asiatic Scare in New Zealand,” *Japanese Times*, November 26, 1916.

⁶⁷ “Frozen Liquid Eggs: New Industry for Australia,” *Farmer and Settler*, June 9, 1932; “Egg Supplies to Britain,” *Courier-Mail*, March 14, 1934.

⁶⁸ “Liquid Eggs,” *Daily Mail*, March 18, 1929; “Campaign against Chinese Eggs,” *North-China Daily News*, April 12, 1929; “Filthy Chinese Eggs,” *Daily Express*, November 4, 1937.

⁶⁹ “Bacterial Content of Dried and Liquid Eggs: Chinese and Other Imports,” 1934–45, MH 56/429, BNA.

⁷⁰ “The Chinese Egg Industry: Hostile Propaganda of British Poulterers,” *Oriental Affairs*, November 1935, 213–15.

⁷¹ British Parliament Hansard, “Chinese Eggs,” March 14, 1935.

⁷² “Extract from a Report on the Health of the City and County of Bristol during 1935 by the Medical Officer of Health,” MH 56/429, BNA.

⁷³ George Whitfield Stiles and Carleton Bates, *Bacteriological Study of Shell, Frozen, and Desiccated Eggs: Made under Laboratory Conditions at Washington, D.C.*, bulletin no. 158 (Washington, DC: United States Department of Agriculture, 1912); Schneider, *Bacteriological Methods in Food and Drugs Laboratories with an Introduction to Micro-analytical Methods*; M. K. Jenkins, *Accuracy in Commercial Grading of Opened Eggs*, bulletin no. 391 (Washington, DC: United States Department of Agriculture, 1918); Grasset, *Les Œufs Congelés: Importance Économique—Étude Bactériologique—Contrôle Sanitaire*; H. W. Redfield, *Examination of Frozen Egg Products and Interpretation of Results*, bulletin no. 158 (Washington, DC: United States Department of Agriculture, 1929).

⁷⁴ “Shanghai’s Ice Supply: Proposed Sale of the Ice and Cold Storage Co.,” *North-China Herald and Supreme Court and Consular Gazette*, January 18, 1913; Herbert Birkett, “Shanghai Ice Supply,” *North-China Herald and Supreme Court and Consular Gazette*, January 25, 1913.

⁷⁵ David Landale to John Johnstone, letter, December 3, 1919, JM/J1/2/9, JMA.

⁷⁶ “Excessive Tariff Restrictions on the Importation of Chinese Eggs and Egg Products in the United States, Japan, Great Britain, Germany, France and Italy,” League of Nations, Monetary and Economic Conference, Economic Commission, July 17, 1933, London, United Nations Treaty Collection, UNOG.

⁷⁷ For the agreement: JM/I21/3/2/12/1, JMA.

⁷⁸ Minutes of the China Egg Conference Committee Meeting, October 30, 1931, Q229-1-108, SMA.

⁷⁹ Institute of Economics, Shanghai Academy of Social Sciences, *Shanghai Duiwai Maoyi (1840–1949)* 上海对外贸易 (1840–1949) [Shanghai’s foreign trade (1840–1949)] (Shanghai: Shanghai Academy of Social Sciences Press, 1989), 303–4.

⁸⁰ Y. S. Cheng, China Egg Export Company, to C. B. Duffey, Swift & Company, letter, November 3, 1927, Q229-1-66, SMA; China Egg Export Company to W. L. Carleton, letter, December 30, 1933, Q229-1-4-42, SMA.

⁸¹ A. Brooke Smith to David Landale, letter, July 4, 1924, J1/26/4, JMA. For Arthur Robinson's invention during his tenure at Ewo: A. D. Robinson, Desiccating Apparatus, U.S. Patent 1,300,746, issued February 10, 1920; A. D. Robinson, Desiccating Apparatus, U.S. Patent 1,389,597, issued September 6, 1921.

⁸² Arthur D. Robinson, "Egg Freezing and Drying in China," *Ice and Refrigeration* 79 (1930): 515–20.

⁸³ S. Vestey, Union Cold Storage Company Ltd., to Bernard, letter, January 25, 1931, JM/I21/3/12/2, JMA; J. J. Paterson to R. Mein Austin, letter, March 6, 1931, JM/J1/24/46, JMA.

⁸⁴ "A Modern Chinese Egg Factory," *Inspection and Commerce*, no. 9/10 (1935): 18. By 1936, there were around ten Chinese egg-drying plants with over one thousand employees and seventy plants with more than three hundred workers across the country. For the distribution of plants: Zhengshou Wang, "Zhongguo danye gaikuang" 中国蛋业概况 [Overview of China's egg industry], *Ji yu dan* 1, no. 4 (1936): 14–22.

⁸⁵ Carl G. Blomberg, "How Eggs Are Dried," *Food Industries* 4, no. 3 (1932): 100–102.

⁸⁶ Wang, "Modernizing Urban Food Provisioning: The 1936 Shanghai Fish Market."

⁸⁷ "The Advance of Commercial Refrigeration in China," *Inspection and Commerce*, no. 9/10 (1935): 9–14.

⁸⁸ "Breaking and Smelling 5,000,000 Eggs a Day," *Scientific American* 155, no. 3 (1936): 160–61.

⁸⁹ "Advance of Commercial Refrigeration in China," 12.

⁹⁰ Wang, “Icehouses in Motion: Knowledge Flows Across the Cryosphere.”

⁹¹ John Johnstone to David Landale, letter, December 9, 1920, JM/J1/42/10, JMA.

⁹² D. G. M. Bernard to B. D. F. Beith, letter, May 16, 1935, JM/J1/1/18, JMA.

⁹³ “Mow Chong Cool Storage,” *Jianzhu yuekan* 1, no. 12 (1933): 2; “Maochang lengqizhan nanshibu jijiang yingye” 茂昌冷气栈南市部即将营业 [The opening of the southern branch of the China Egg Produce Company’s cold-storage warehouse], *Shenbao*, March 27, 1934.

⁹⁴ Shunyun Chen, “Yihe lengqi zhucang xiandan zhi yanjiu” 怡和冷气贮藏鲜蛋之研究 [Study on cold storage of fresh eggs], *Guoji maoyi daobao* 5, no. 9 (1933): 83–91; Judge, “Women as Vernacular Knowers in China’s Long Republic (1894–1954): What We Can Learn from Cheap Print.”

⁹⁵ C. N. Bogomoloff, “Survey of Cold Storage,” U 1-16-1674, SMA.

⁹⁶ Shanghai Ice Merchants Association to Public Health Department, Shanghai Municipal Council, letter, December 29, 1934, U1-16-1551, SMA; Commissioner of Public Health to Secretary, Shanghai Municipal Council, letter, August 29, 1936, U1-16-1666, SMA.

⁹⁷ “‘Velvet’ Ice Cream Extending Its Field in China,” *China Press*, December 11, 1925; “McHenry Tells Court How Opium Taken to America in Crawley Case Testimony,” *China Press*, April 13, 1932.

⁹⁸ Gufan, “Chi bingqiling jingji fa” 吃冰淇淋经济法 [An economic way to eat ice cream], *Bingqiling*, May 29, 1927.

⁹⁹ “Health Standards High at Henningsen Factory,” *China Press*, July 4, 1934.

¹⁰⁰ Renquan Ma, “Yihe lengqi duizhan” 怡和冷气堆栈 [Ewo cold storage], *Kexue congkan*, no. 3 (1930): 31–32; Chengda Wu, “Canguan danchang ji” 参观蛋厂记 [A visit to the egg factory], *Shanggong yuekan* 2, no. 4 (1931): 55–57; Tryphon Ku, “A Visit to Hazelwood Park—The

Home of Hazelwood Icecream,” *China Weekly Review*, July 29, 1933; “Canguan haining yanghang bingqilin chang” [A visit to the ice cream factory of the Henningsen Produce Company], *Shanghai qingnian* 35, no. 21 (1935): 5; Zeming Zhao and Xiuyun Wang, “Canguan maocang danchang ji” 参观茂昌蛋厂记 [A visit to the China Egg Produce Company], *Qingshi nvzhong xiaokan*, no. 9/10 (1937): 139–42.

¹⁰¹ Dikötter, *Exotic Commodities: Modern Objects and Everyday Life in China*, 220–22.

¹⁰² “The Ice Cream Industry in China,” *Ice Cream Review*, June 1924, 130; “China Likes Ice Cream,” *Ice Cream Review*, February 1927, 47; “Department of Commerce Sees Growing Tendency Towards Native Chinese Ice Cream Plants,” *Ice Cream Review*, November 1927, 43; Shanghai Municipal Council, “Instructions for Making Pure Ice Cream,” *Ice Cream Review*, November 1927, 86.

¹⁰³ Xiren Ye, “Yizhi bingqilin ningjie qi” 一只冰淇淋凝结器 [One ice cream freezer], *Kexue Huabao* 5, no. 9 (1938): 373; “Bingqilin zhenhaochi” [冰淇淋真好吃], *Furen huabao*, no. 11 (1933): 7; Mengzuang Xu, “Xuegao zhi zhifang” 雪糕之制法 [The way to make ice cream], *Nongshe niankan*, no. 1 (1924): 173; Bucai, “Tan bingqiling” 谈冰淇淋 [On ice cream], *Shanghai changshi*, no. 22 (1928): 43.

¹⁰⁴ Geist, “When Ice Cream Was Poisonous: Adulteration, Ptomaines, and Bacteriology in the United States, 1850–1910.”

¹⁰⁵ Woods, “Refrigerating Machine,” 91.

¹⁰⁶ Barkan, “Industry Invites Regulation: The Passage of the Pure Food and Drug Act of 1906”; Phillips and French, “Adulteration and Food Law, 1899–1939”; Stanziani, “Negotiating Innovation in a Market Economy: Foodstuffs and Beverages Adulteration in Nineteenth-Century France.”

¹⁰⁷ “Founder of Egg-Freezing Industry Quits China,” *Shanghai Sunday Times*, October 23, 1927.

¹⁰⁸ Pilcher, “Culinary Infrastructure: How Facilities and Technologies Create Value and Meaning around Food.”

¹⁰⁹ Qiushen, “Gaoqiao de tianran bingchang shiye” 高桥的天然冰厂事业 [Gaoqiao’s natural ice industry], *Social Daily News*, March 23, 1937; Qiuyu, “Gei jiqibing dadao de tianranbing” 给机器冰打倒的天然冰 [Natural ice defeated by machine-made ice], *Social Daily News*, July 10, 1936.