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REVIEW ESSAY

Science for the People: Science in the Making of Modern China

Shellen Wu, University of Tennessee

Miriam Gross. *Farewell to the God of Plague: Chairman Mao's Campaign to Deworm China*. Berkeley: University of California Press, 2016. 376 pp. $70 (cloth/e-book).

Sigrid Schmalzer. *Red Revolution, Green Revolution: Scientific Farming in Socialist China*. Chicago, IL: University of Chicago Press, 2016. 320 pp. $40 (cloth/e-book).

On an extended research trip to China a few years ago, I spent a couple of days as a flâneur in Beijing. I visited the zoo and in a quiet corner of the park discovered the building that had originally housed part of the late Qing agricultural experimental farm established in 1906. I went to Tiananmen Square and wandered to the nearby Wangfujing shopping district. At the entrance to the pedestrian street lined with Uniqlo and Zara storefronts, a large scaffold sign promoted scientific development and economic growth (figure 1). The bright yellow of the sign's characters matched the sprinkling of autumnal chrysanthemum planters framing it. Taking the train to the university quarters in Wudaokou, I meandered around the sleek glass towers on the Tsinghua campus. I didn't think much about the experience at the time. Recently, however, I realized that my meandering route through Beijing quite accidentally revealed the centrality of science to the story of twentieth-century China, from its roots in the late Qing to the current flourishing of scientific research in the country's premier universities. Beyond the cities, from the countryside to the frontiers, science helped to shape modern China. Science, it seems, is both ubiquitous in today's China and woven into the fabric of its twentieth century.

Figure 1. A public display exhorting "Scientific Development" at the entrance to the Wangfujing pedestrian mall near Tiananmen Square in Beijing. Photo taken by the author in October 2013.

Yet it wasn't so long ago that the list of works on modern science in China could be counted on one hand. Early twentieth-century Chinese intellectuals attributed the country's backwardness to its lagging efforts to adopt science. As they saw it, everything from the Chinese philosophical tradition to the rigid examination culture in the late imperial period hindered the development of science. For some, the denigration of the Chinese philosophical and intellectual tradition served as a rhetorical strategy, an exaggerated faulting of everything traditional that went hand in hand with the promotion of science and technology as a means of saving the nation (*kexue jiuguo*, or "saving China through science") (Wang 2002).

One of the ongoing tensions in the history of science in the first half of the twentieth century was, on the one hand, the desire of the Chinese scientific community to participate in and receive recognition from international professional organizations, and, on the other hand, the nationalist sentiment of many intellectuals. Recognized as the most developed Chinese science

during the Republican period, geology embodied this tension between the universal claims of science and the nationalist rhetoric geologists espoused as they sought to lay claims to the territorial sovereignty of the nation (Shen 2014). For the most part, however, even as they decried the Chinese state's meager support of scientific research, Republican-era Chinese historians of science echoed their Western counterparts to emphasize the distinctly Western trajectory of modern science. Zhang Zigao's history of science, written in 1932 and based on his lectures at Nanjing Higher School, explicitly denies the origins of science in China and India and argues that modern science is a product of Western civilization—from ancient Egypt and Babylon through the Greeks (Zhang [1932] 1989, 4). Similarly, Xu Shouzhen's 1931 overview of modern science traces an intellectual lineage from ancient Greece to the present (Xu [1931] 1989, 1–2). The heroes of these accounts are people like Aristotle, Francis Bacon, Isaac Newton, and Alexander Humboldt. It was difficult to see how China could reshape an ontology in which neither the ancient Chinese nor Indian civilizations played any discernible role.

During World War II, British biologist Joseph Needham traveled to the wartime capital of the Chinese resistance in Chongqing and toured the nearby offices (and air-raid shelters carved in caves) of the relocated Academia Sinica. The decision of most of the major universities and scientific organizations to retreat with the Nationalist (GMD) government to Southwest China took science out of the major coastal cities and had serious consequences for the rest of the century. In subsequent decades, Needham pioneered the study of science and technology in China by eagerly gathering information about early Chinese technological developments while also encouraging contemporary educational and research institutions based on Western models, but leaving blank the period immediately preceding the twentieth century (Hart 1999, 2000). He was able to do so with the collaboration and help of Chinese scientists, many of whom had already plumbed the classical literature for historical information on Chinese flora and fauna. Yet Needham's focus on the ancient flourishing of proto-scientific studies in China amplified its apparent absence in the more recent past. His formulation of the problem of science or lack thereof in China deeply colored mid-twentieth-century scholarship, including Joseph Levenson's work from the 1960s, which portrayed the Confucian intellectual tradition as incapable of accommodating modern science (Levenson 1964, 61).

After 1949, Chinese scientists' isolation from international scientific organizations bolstered the sense of mystery surrounding Chinese science. In the absence of archival and

fieldwork-based research in mainland China, American Sinologists saw in the limited propaganda materials coming out of China an astonishing vision of mass science transforming the Chinese countryside. As Gail Hershatter (2012) pointed out in her presidential address at an annual meeting of the Association for Asian Studies, it seemed to many Western observers that communist China had succeeded in what had seemed impossible: fundamentally reordering gender and class relations to create a new, egalitarian society. In this new world, science had become a tool of the masses, used to cure disease and hunger and to conquer nature. Science played a key role in the Communist Party's own narrative about its contribution to China's rise. Much about the Chinese revolution, it turned out, was pure fantasy—a fantasy eagerly imbibed by much of the Chinese population as well as leftist activists abroad. The rise of People's Republic of China (PRC) history in recent years has had as its chief task separating the kernels of reality from the illusion sold by glossy propaganda posters.

What did the Chinese revolution in fact accomplish for peasants, for women, and for youths? As Sinologists have struggled to answer this question, attention has finally and inevitably turned to the various ways science shaped twentieth-century China. Within the last two decades, scholars of China have begun to challenge the previous narrow definition of science as primarily a Western phenomenon by examining uniquely Chinese epistemological categories in both the premodern and modern periods (Schäfer 2011). Among China scholars in the West, James Reardon-Anderson pioneered the field with the publication of his work on the development of chemistry in China from the late nineteenth century to the present (Reardon-Anderson 1986, 1991). Since then, Laurence Schneider (2003) has examined the development of biology and genetics in China, primarily from the 1920s to the turn of the twenty-first century. Other scholars have examined physics, logic, and the translation of science in general (see Amelung 2004, 2014; Wright 1995, 1998; and Kurtz 2011). These studies reveal the presence of rich and fruitful careers in science and technology in the late Qing period, before specific disciplines of science had become rigidly defined; growing interest and professionalization during the Republican period; and, finally, the unique challenges of conducting science during the Communist era. The Chinese Communist Party (CCP) promoted its own vision of science as a tool for the masses, taking from the Soviet example the privileging of practical applications over theory.

Despite its importance, science remains an understudied aspect of PRC history. The recent provenance of the field underscores its deeply politicized history. In China, historians of science, particularly those at the Institute for the History of Natural Science (IHNS) within the Chinese Academy of Sciences, only began to broach modern science in China as a topic of study in the 1980s. The rapidly shifting political winds of the previous era had kept the topic largely off-limits (Wang 2007). Yet many of the signal achievements of the Communist Party prominently featured science. At the same time, the state—from the late Qing imperial bureaucracy to the Communist Party regime—both shaped the development of science and technology and benefited from the authority conferred by breakthroughs in science.

Right on cue, two excellent new works reveal the multifaceted and complex nature of science in the PRC. In *Farewell to the God of the Plague,* Miriam Gross examines how the Communist Party deployed public health campaigns as a form of "scientific consolidation," by using science as a means to extend its control over the population. Sigrid Schmalzer's *Red Revolution, Green Revolution* looks at agricultural science and the unique and distinctive trajectory of the Chinese green revolution. The very term "green revolution" betrays its Cold War–era roots. Originally coined in 1968 by the director of the U.S. Agency for International Development (USAID), William Gaud, the green revolution was seen as a way to elevate living standards around the world and secure rural populations against the appeal of Communism. Chinese agricultural science during the Maoist period resembled in some important ways the American agricultural extension programs of the early twentieth century, while diverging significantly from the stated goals of the U.S.-led green revolution.

Both works demonstrate the manifold ways science filtered into the countryside and became the basis of the party's interactions with the rural populace. As Gross succinctly explains, this science offered by the state was not necessarily a normative science, as we would understand it, based on formulating hypotheses and gathering empirical evidence. Instead, large parts of the Chinese population came to understand science as part of the state's authority. Clearly, this development is of great significance to our understanding of the modern Chinese state. Just exactly what does modern science mean in China? Science played a dual role—both reinforcing the authority of the state and forming the essential core of the CCP's claims on authority.

On June 30, 1958, after reading in the *People's Daily* that Yujiang County, a national model site in Jiangxi Province, had wiped out snail fever, Chairman Mao felt inspired to write a poem for the occasion, titled "Farewell to the God of Plague." As it turned out, the celebration was premature; to this day, schistosomiasis, or snail fever, remains endemic in China, although its effects have been much reduced by improved treatment options. Close to one million people still suffer from the disease (247). Yet most people in China believe the disease to have been completely eradicated. Borrowing the title of the Mao poem for her book, Gross investigates this apparent contradiction: how the crusade against snail fever, widely lauded as one of the great success stories of the Maoist years, has hidden beneath the surface of its triumphal narrative a complicated and equivocal history.

In 1949, snail fever was endemic in eleven provinces in the mainland and in Taiwan, altogether covering an area spanning 14.5 billion square meters. The disease is caused by a waterborne parasite carried by infected snails found in moist soils and areas around lakes and rivers. The use of night soil as fertilizer helped to spread the disease in agricultural regions. The campaign against snail fever has long been hailed as one of the signal achievements of the Maoist era. In fact, Gross demonstrates, the snail fever campaign took place over multiple decades, with peaks in activity during the Great Leap Forward in 1957–1958, the Cultural Revolution in 1966–1971, and a final renewed push in 1992–2001.

After Mao celebrated Yujiang's victory over snail fever, the disease continued to infect people in that county and elsewhere. Gross convincingly shows that the strenuous and ultimately short-lived preventive campaigns, which often involved manual killing of snails and repressive efforts to control feces management in villages, provided only short-lived "victories" in the 1950s. What ultimately made the difference was the development of more successful treatment regimens during the Cultural Revolution, aided by hundreds of thousands of urban medical professionals who were dispatched to the countryside, sent-down youths who were more open to trying new treatments, and, finally, a growing receptiveness to modern medicine and science in the villages themselves as a result of improvements in rural education.

Health campaigns were unfunded mandates (61). The CCP, spurred by Mao's interest, set targets for numbers of patients treated and acres of land cleared of snails. From a rational perspective, however, local cadres, whose primary objective was to meet grain production goals, had little incentive to divert valuable agricultural labor to combat the disease. Labor-intensive

prevention campaigns required constant follow-up and often faced resistant local populations who refused to tolerate the intrusion of the state's "poop" policing. Ultimately, even highly motivated armies of women and old people failed to eliminate snails entirely from the regions in which the disease was endemic. With Mao himself waxing poetic on the topic, there was pressure from the top for quantifiable results, particularly from model national sites like Yujiang. Nevertheless, faced with challenges ranging from the loss of labor from able-bodied workers to extended hospitalizations for treatment regimens, in the 1950s, both local cadres and villagers themselves often worked to undermine central directives.

What made schistosomiasis difficult to combat was not only the large areas throughout the country in which the disease was endemic, but also the long course of the illness. The disease goes through multiple stages, including acute, chronic, and late. A few of those who contract the parasite suffer immediately from malaria-like high fevers, which sometimes result in death. Most patients, however, may feel few or no symptoms for years. The long chronic stage of the disease makes it particularly difficult to manage. Most infected individuals begin to experience significant physical decline and show distended stomachs only in the late stages, years after the initial infection. The rural and largely illiterate population who suffered the highest incidence of snail fever did not connect the disease to snails. Affected populations needed to be convinced of this causal relationship.

In order to make the connection, the CCP turned to science. Over the course of the 1950s, Gross shows, the state managed to spread the idea of science as a form of state authority throughout Chinese society. One of the most fascinating sections of the book, chapter 4, discusses the various ways the state deployed science as both entertainment and propaganda. Theater troupes performed across the countryside and films depicted the devastating consequences of the disease. The most famous of the films on the topic, *Kumu feng chun* (Spring comes to a withered tree), tells the soap-opera story of star-crossed lovers unable to marry because of snail fever (with some help from the nefarious Nationalists, of course) (89). Although highly entertaining, the films and plays failed to relay important information about the disease. Proper manure treatment apparently didn't figure into the doomed romance story line.

In contrast, science exhibitions both attracted large audiences and introduced them to various apparatuses of science. Microscopes, in particular, revealed the true horrors of the parasitic worms in spectacular fashion. The novelty of these scientific instruments in the

countryside added to their appeal. Key campaign sites like Yujiang and Qingpu, an area near Shanghai, established exhibition halls in 1964 and 1973, respectively, filled with photographs, X-rays, slides, and even three-dimensional models (95). Such exhibitions generated considerable excitement and drew attendees from the surrounding region. When Jiangxi's Shangrao Prefecture held an exhibit in 1954, 14,500 people poured in from near and far to take a look. An even more impressive 80,130 visitors saw Qingpu's spring 1956 exhibition.

In the process of the multipronged campaign, the CCP managed to inculcate significant portions of the rural population with the value and authority of science. As Gross points out:

> Party propositions were promoted via statistics and tropes of rational efficiency. They learned to couch their choices in numbers, to give them legitimacy, and to explain their fixes in experimental and scientific language to gain recognition. Over time, the attributes of science would become a primary mechanism for signaling both authority and authenticity. (107–108)

In essence, science and the state forged a symbiotic relationship. Unlike the military-industrial complex created in the postwar United States, the Chinese government bypassed industry to directly influence the rural population.

By the Cultural Revolution—the slow change in attitude begun in the 1950s—the traveling exhibitions, gradually rising educational levels in the countryside, and dispatch of both young people and trained medical professionals from urban centers had begun to show results. Working from both provincial and local archives, Gross explains:

> Starting in the mid-1960s, almost all graduates of Western and traditional Chinese medicine schools were automatically posted to country hospitals in rural areas.… [B]y 1972, [medical personnel] had grown to 330,000 urban medical workers placed permanently in the countryside and another 400,000 doctors and nurses who visited as part of roving medical teams, a two-year post. (171)

The invention of faster-acting medicine allowed the campaign to turn the corner on treatment. Rather than locking down patients for long stretches of time for potentially poisonous treatment regimens, the new medicine enabled patients to be treated at home.

Gross argues that a process of "scientific consolidation" took place over the course of the multiple snail fever campaigns. Instead of science writ large, in the sense that Republican-era writers described the history of science, "Maoist-era grassroots science focused on performing field investigations to resolve pragmatic problems, and the Party hoped that the analyst could come up with novel, rational, and realistic solutions that would move the society forward" (204).

Gross recognizes the unevenness of such a campaign, which, despite bearing the personal imprimatur of Chairman Mao, took place over the course of multiple decades. What succeeded, in the end, was a combination of improved treatment and personal touch—the hundreds of thousands of people who went to villages. In this sense, Gross's conclusion dovetails with Sigrid Schmalzer's examination of the green revolution in red China. For Schmalzer, the difference was not the barefoot doctors, but the state agents, cadres, sent-down youths, and agricultural technicians whose methods closely approximated the early twentieth-century U.S. focus on extension and local experimental stations. Local agents often had to adjust to realities on the ground that diverged significantly from top-down directives. The net result of these series of local negotiations and interventions made the Chinese green revolution distinctive and unique.

Schmalzer explicitly connects her argument on the importance of the state agents to the work of political scientist James Scott. Instead of depicting an anonymous state that extends its control into gridded spaces, Schmalzer gives face to these agents of state power—the cadres and technicians who spanned the countryside and promoted the latest advances in seed development, soil science, and insect control, methods that sometimes borrowed from traditional farming methods. At other times, local agents strived in vain to convince farmers who made rational choices to prioritize rest over labor-intensive farming and weeding techniques. In the same way that directives from above to eradicate snails and manage feces encountered spirited resistance from villagers who saw nothing wrong with how things were always done, Schmalzer shows how the green revolution took place in China as the result of a series of interactions and compromises at the village level. In this respect, Schmalzer's conclusions complement the recent work of anthropologist Michael Hathaway on the impact of transnational environmental groups in Southwest China. Hathaway shows how Han and ethnic minorities in Yunnan Province adopted some measures promoted by the World Wildlife Fund (WWF) while pushing back against others (Hathaway 2013). Schmalzer's work points to another way that local histories can enrich overarching themes and movements like the green revolution.

For Schmalzer, the progress of Chinese agricultural science broke down into the key binary of *tu* versus *yang,* the traditional and homegrown versus the cosmopolitan and imported. She argues that this binary came to define Maoist science for the masses:

> In the terms of Mao-era scientific discourse, radical political and scientific leaders emphasized *tu* over *yang*.… *Tu* and *yang* mapped well onto other, more famous

> binaries that structured Maoist approaches to science—for example, red versus expert and theory versus practice—and also onto the binary at the heart of this study, the green and red revolutions. (34)

Some of the key figures in the story embodied this binary. Chapter 2 focuses on the entomologist Pu Zhelong, who, along with his wife, received his PhD at the University of Minnesota. Despite, or perhaps because of, his notably *yang* educational background, in his tireless work in the field and in numerous references to mass participation in his scientific publications, Pu went to unusual lengths to emphasize his empathy and involvement with peasants and the radical politics of his era.

The main subject of chapter 3, famed agricultural expert Yuan Longping, who has achieved iconic status in China for cultivating hybrid rice, illustrates another facet of this dichotomy of *tu* and *yang*. Yuan, like Pu Zhelong, took his work in rice breeding out of the university laboratory and into the countryside, where he collaborated with peasant assistants. His love of classical music and pictures of him playing the violin in rice paddies display his *yang* side as a "peasant intellectual." Schmalzer reveals the two entirely different and incompatible accounts of hybrid rice that emerge from contemporary accounts in the 1950s and 1960s and in the post–Deng Xiaoping era of reform and opening. During the Maoist period, Yuan was never mentioned in the singular but always as part of a collective in Hunan, which included peasant helpers like his student Li Bihu. This team of peasants and experts worked together and combined revolutionary zeal and persistence to create hybrid rice. Only in a December 1976 article in the *People's Daily* was Yuan's name even mentioned (81). Since then, however, Yuan has been given most of the credit for the work he did during the Maoist era. His fame has grown in the post-socialist era, while his erstwhile peasant helpers have receded into anonymity.

Both Pu and Yuan survived the political turmoil of the Maoist era by aligning themselves with the *tu* aspects of Chinese science, rather than the *yang* aspects of their educational backgrounds. Schmalzer shows how agriculture and the distinctly Chinese aspects of the green revolution navigated between these binaries: the *tu* and the *yang*, red versus expert, theory versus practice. Yet, as Yuan Longping's post–socialist era fame shows, such binaries were neither stable nor permanent constructs. Instead, their meaning constantly shifted according to the political winds and local negotiations of specific agents in specific places.

Elsewhere, Schmalzer (2014) has argued that during the Cold War the binary of *tu* and *yang* mattered more in the Chinese context than the applied versus theoretical divide did in the categorization of sciences in the West. The opposing pulls of *tu* and *yang* exacerbated tensions on the ground, particularly for the educated youths who headed to the countryside, the subject of chapter 6. Should the educated youths see themselves as leading innovation and setting an example in the countryside? After all, they were an educated minority sent to help villagers embrace the latest scientific and technological developments. But isn't the point of the sent-down experience also to learn from the peasants? What could the "traditional" farmers teach these youths? In the various ways that young people navigated these difficult questions, Schmalzer's account shows how socialism with Chinese characteristics translated into agricultural science with Chinese characteristics.

For these young people, agriculture experiments in the villages had real consequences. In the 1960s and 1970s, the mass starvation of the Great Leap Forward years lay in the not-so-distant past. Failure was not an abstract concept but entailed real hardships for villagers who took a chance on experimental crops and new farming methods. For some, the significance of their experiences in the countryside became apparent only in retrospect, while others looked back on those years with a genuine sense of accomplishment. The green revolution in China, for Schmalzer, reveals layers of meaning across time, as one might see layers in soils. The legacy of the socialist period continues to influence agriculture in China today. Agricultural science in contemporary China no longer takes place on collectivized farms but has returned to university laboratories and Academy of Sciences–sponsored institutes. But traces of mass agricultural science and efforts to involve the countryside remain. Now, however, it has a new name: the participatory plant breeding program.

In the process of unearthing the complex realities of science in Maoist China, both Schmalzer and Gross uncover the unexpected role played by gender. Initially, far fewer women received treatment for snail fever. Younger women were the primary caretakers of their children as well as their in-laws and occupied the lowest social position in the household. In the 1950s, treatment for the disease involved extended stays in the hospital, so women being treated not only could not contribute to household earnings but also had to neglect their roles as mothers and daughter-in-laws. Few women felt comfortable being absent for long stretches of time for treatment. The party recognized and targeted this problem in order to raise the treatment numbers

for women. At the same time, women were often assigned less desirable and unremunerated tasks, such as picking up snails from the ground using chopsticks.

In agriculture, the CCP recognized the importance of the *laonong*—the senior male members in the village, who served both as patriarchs and models for the rest of the village to take up new agricultural techniques (119–120). Propaganda posters showed professors and students surrounding the *laonong* and learning from him peasant knowledge of farming. The not-so-subtle message of the post underlined the importance of *tu* knowledge to experts and their lofty laboratory work. Despite considerable resistance from local communities, the CCP also encourage women to take up previously exclusively male aspects of farming, including livestock castration.

In these accounts of both public health campaigns and agricultural science, the advances the party made in the 1950s and 1960s on the transformation of gender roles have left an ambiguous legacy. Engagement in public health and agricultural science became a way for young women to leave behind the constriction of the social hierarchy in their villages, participate in national campaigns, and expand the horizons of their lives. On the other hand, these advances did not lead to a fundamental reordering of gender roles in the countryside in the long term. Nor did the young women leave behind their lives in the villages. Most of the women who studied agricultural science remained at the technician level and did not advance further. By the time Schmalzer conducted interviews in 2013, all the agriculture technicians she talked to were men. Science helped to shape twentieth-century China; for Chinese women, however, the revolution has yet to be realized.

Shellen Wu is associate professor of History at the University of Tennessee, Knoxville.

References

Amelung, Iwo. 2004. "Naming Physics: The Strife to Delineate a Field of Modern Science in Late Imperial China." In *Mapping Meanings: The Field of New Learning in Late Qing China*, edited by Michael Lackner and Natasch Vittinhoff, 381–422. Leiden: Brill.

———. 2014. "Historiography of Science and Technology in China." In *Science and Technology in Modern China, 1880–1940*, edited by Benjamin A. Elman and Jing Tsu, 39–65. Leiden: Brill.

Hart, Roger. 1999. "Beyond Science and Civilization: A Post-Needham Critique." *East Asian Science, Technology, and Medicine* 16: 88–114.

———. 2000. "The Great Explanandum." *The American Historical Review* 105 (2): 486–493.
Hathaway, Michael. 2013. *Environmental Winds: Making the Global in Southwest China.* Berkeley: University of California Press.
Hershatter, Gail. 2012. "Disquiet in the House of Gender." *The Journal of Asian Studies* 71 (4): 873–894.
Kurtz, Joachim. 2011. *The Discovery of Chinese Logic.* Leiden: Brill.
Levenson, Joseph. 1964. *Confucian China and Its Modern Fate.* Berkeley: University of California Press.
Reardon-Anderson, James. 1986. "Chemical Industry in China, 1860–1949." *Osiris* 2:177–224.
———. 1991. *The Study of Change: Chemistry in China, 1840–1949.* Cambridge: Cambridge University Press.
Schäfer, Dagmar. 2011. *The Crafting of the 10,000 Things: Knowledge and Technology in Seventeenth-Century China*. Chicago, IL: University of Chicago Press.
Schmalzer, Sigrid. 2014. "Self-Reliant Science: The Impact of the Cold War on Science in Socialist China." In *Science and Technology in the Global Cold War*, edited by Naomi Oreskes and John Krige, 75–106. Cambridge, MA: The MIT Press.
Schneider, Laurence. 2003. *Biology and Revolution in Twentieth-Century China.* Lanham, MD: Rowman & Littlefield.
Shen, Grace. 2014. *Unearthing the Nation: Modern Geology and Nationalism in Republican China.* Chicago, IL: University of Chicago Press.
Wang, Zuoyue. 2002. "Saving China through Science: The Science Society of China, Scientific Nationalism, and Civil Society in Republican China." *Osiris* 17: 291–322.
———. 2007. "Science and the State in Modern China." *Isis* 98 (3): 558–570.
Wright, David. 1995. "Careers in Western Science in Nineteenth-Century China: Xu Shou and Xu Jianyin." *Journal of the Royal Asiatic Society* 5 (1): 49–90.
———. 1998. "The Translation of Modern Western Science in Nineteenth-Century China, 1840–1895." *ISIS* 89:653–673.
Xu Shouzhen. (1931) 1989. *Xiandai kexue jinhua shi* [The evolution of modern science]. In *Minguo congshu* [Collected works of the Republican period]. Shanghai: Shanghai shudian.
Zhang Zigao. (1932) 1989. *Kexue fada lueshi* (A brief history of science). In *Minguo congshu* [Collected works of the Republican period]. Shanghai: Shanghai shudian.