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Access to truth

THE ROLE OF TEXTBOOKS AND PERIODICALS IN THE TRANSMISSION OF WESTERN SCIENCE INTO CHINA, 1840–1900

by

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Mme. President, ladies and gentlemen: I would like to begin by saying how surprised and delighted I was to be chosen as the winner of the 1996 Marc-Auguste Pictet Prize. I am particularly happy to receive it here in your beautiful city on the day when we honour the two-hundredth anniversary of the founding of the *Bibliothèque Britannique*, an extraordinary agent of the diffusion of scientific knowledge from my own country to continental Europe. The unique conditions of intellectual freedom in Geneva made it possible to facilitate the movement of new ideas at a time of political turmoil — not the first or last time Geneva has played such a role. I think it is therefore very fitting to be speaking here today about another great transcultural enterprise, the transmission of Western science into nineteenth century China.

In this talk I shall first consider some of the science textbooks translated or compiled between 1840 and 1900, and then discuss some of the journals which carried material on natural science. Before doing so, though, I would like briefly to reflect upon the purposes which any textbook might have. Firstly, to act as an *authority* to which the student or the teacher may go for guidance; secondly to establish *norms* such as technical vocabularies, systems of nomenclature and styles of explanation; thirdly, to *induct the student into the ways of knowledge and accepted practices* which define the given discipline, the Kuhnian paradigm within which 'normal science' is conducted; and, fourthly, to *popularise*, amaze and inform a wider public through the display of the wonders of nature and the applications of technology. To these I should add a fifth purpose, a "deep agenda", that of employing science to *support, refute or develop a certain set of philosophical, political or religious positions.*

The full range of issues relating to the translation of science into Chinese are too complex to mention more than very superficially here. In the nineteenth century some foreign commentators argued that the Chinese language was intrinsically unable to bear the precision of scientific expression, and that translation of textbooks into Chinese was therefore a futile exercise.[1] Despite these sceptical voices, translations were carried out and, to a large extent, they successfully refuted the doubters. In the first section of my talk my emphasis will be on the early science texts, particularly those relating to chemistry.

1. The missionary purposes of science

The attacks of the Western imperial powers on China were closely followed by the equally dangerous flow of foreign ideas, carried by the missionaries who flooded into China from the 1850s onwards. Although Christianity had been introduced to China centuries earlier by Nestorian and then Jesuit missionaries, the scale of their activities was far smaller numerically and geographically, and had much less effect on the majority of the population than the evangelism of China in the nineteenth century. The truths which the nineteenth-century religious and secular missionaries viewed themselves as imparting to the Chinese, are to us far more ambiguous, culture-centred and even open to question than they seemed in 1840. Science and religion are now usually regarded as at best uneasy allies if not in open conflict, whereas in the first few decades of the Protestant mission to China science was regarded as an essential auxiliary, 'winging the arrow'[2] of the Christian gospel to the Celestial Empire.

It was the alarming evidence of the power of the steamships and guns of the Westerners — and the threat that even the internal enemies of the dynasty might acquire them — that led a small group of Chinese statesmen to implement the first serious steps in learning from the Westerners first their military technologies and then the scientific principles which lay behind them. The two Opium Wars with the Western powers had made the weakness of the dynasty's own ships and guns painfully apparent. A small clique of modernisers who came to be called the Self-Strengtheners set up the earliest modern government schools, arsenals and translation bureaux in the early 1860s in order to train the shipbuilders, navigators, gunners and gunsmiths who could defend the dynasty from its internal and external enemies. At about the same time the first translation bureau was established at the Jiangnan Arsenal in Shanghai, an enterprise which would become the major source of translated materials on science in late imperial China.

Yet the earliest textbooks on science were not made by government translators, but by missionaries, who found that there were no suitable texts in Chinese on science, and who sought to remedy this through their own efforts. For many of them, science was an 'auxiliary of virtue'[3] which would promote their religion by opening the minds of the Chinese both to the wonders of creation and to the marvels of a technology founded upon Christian civilisation.

2. The earliest modern science textbooks in China

The use of science as a handmaid to religion has a distinguished history in China, dating back to the time of the great Jesuit missionary Matteo Ricci (1552–1610), who attempted to convince the literati of the superiority of the Christian religion by demonstrating the achievements of Western mathematics and astronomy. The Protestant missionaries of the nineteenth century also believed that science could convince the Chinese of the truth of the gospel in a way that preaching and religious tracts could not. Yet, by the 1870s most translators of science texts, with the major exception of

Alexander Williamson (1829–1890), preferred to keep their works free of religious sentiments. Those who were working directly for the Chinese government, such as John Fryer (1839–1928) and W.A.P. Martin (1827–1916), were of course unable to give any hint of a religious message in their texts, even though we know from their correspondence that both men saw themselves as "secular missionaries".

The earliest modern science textbook in China, *Bowu tongshu* 博物通书 [Philosophical Almanac], was published by the American medical missionary Daniel Jerome Macgowan (1814–1893) in 1851. Macgowan was then stationed in Ningbo 宁波, but he later worked as a private physician in Shanghai and at the Jiangnan Arsenal in the Translation Department under John Fryer. Macgowan's approach to his task was overtly evangelical, yet he was wary of giving the impression that religion and science were in some sense interdependent. Scientifically, the content of Bowu tongshu is very thin: it presents a series of electrical devices, and describes the phenomena they display, with little attempt to explain what is going on. Many elementary theoretical concepts such as electric current are not mentioned: it is therefore more an account of electrical phenomena and electromagnetic technology than an introduction to electrical science. It deals in a qualitative way with a number of electromagnetic phenomena, avoiding theoretical principles. There are few new coinages, the most notable being *dianqi* 电气 [lightning *qi*] for 'electricity' and *xitieqi* 吸铁气 [iron-attracting *qi*] for 'magnetism', both of which employed the traditional Chinese concept of *qi* 气 to create the new term. One of the most interesting passages is Macgowan's attempt to explain the virtues of telegraphy, using an ingenious system in which a needle pointed to the component strokes of the Chinese character you wished to transmit; he also suggested an alternative method, using the letters of the Manchu alphabet. [See Fig. 1] Neither proved practical in the nineteenth century, but have proved to be prophetic of current techniques for the computer input of Chinese characters.

Bowu xinbian 博物新编 [A new account of natural philosophy] was published in Shanghai in 1855, written by Benjamin Hobson (1816–1873), another medical missionary, as a compilation of information on modern science, for the Chinese medical students he was training in Guangzhou (Canton). *Bowu xinbian* was the first comprehensive attempt to explain post-1800 Western science to the Chinese. Although very elementary it nevertheless excited considerable interest amongst Chinese scholars such as Xu Shou who were already engaged in their own researches, and it undoubtedly encouraged them to carry out their own experiments with prisms and steam engines. [See Fig. 2][4]

According to John Fryer it was with the help of the diagrams in this book that they were able to build one of the earliest steamships in China.

3. Continuity with the Chinese tradition

The first text to give a relatively full account of the ideas (rather than the practice) of chemistry was *Gewu rumen* 格物入门, a seven-chapter compendium written by W.A.P. Martin, a missionary who later became the first President of the first modern

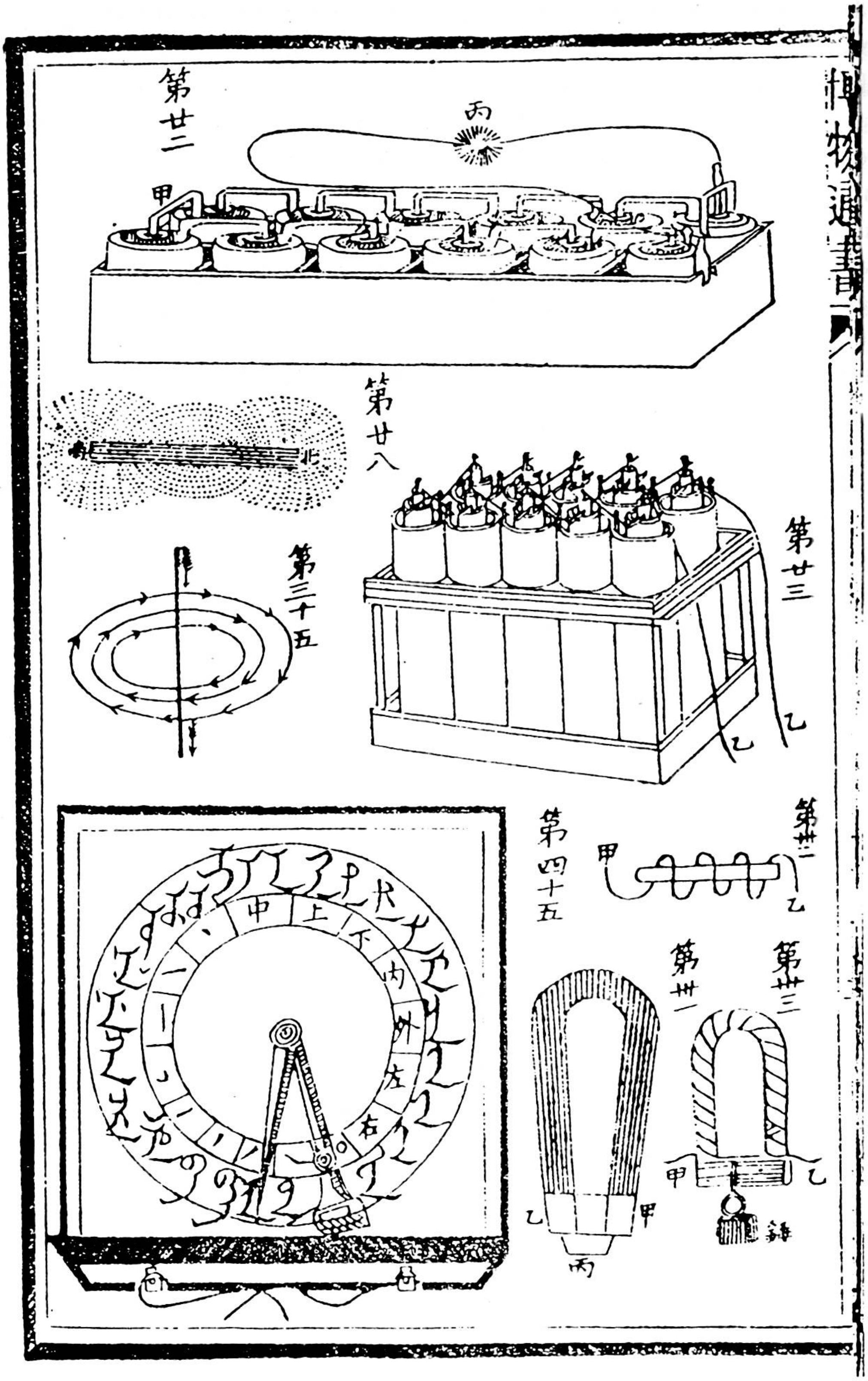

FIG. 1.

A page from *Bowu tongshu*, showing in the bottom lefthand corner the disc engraved with Manchu characters. (Reproduced by kind permission of the Wellcome Institute for the History of Medicine, London.

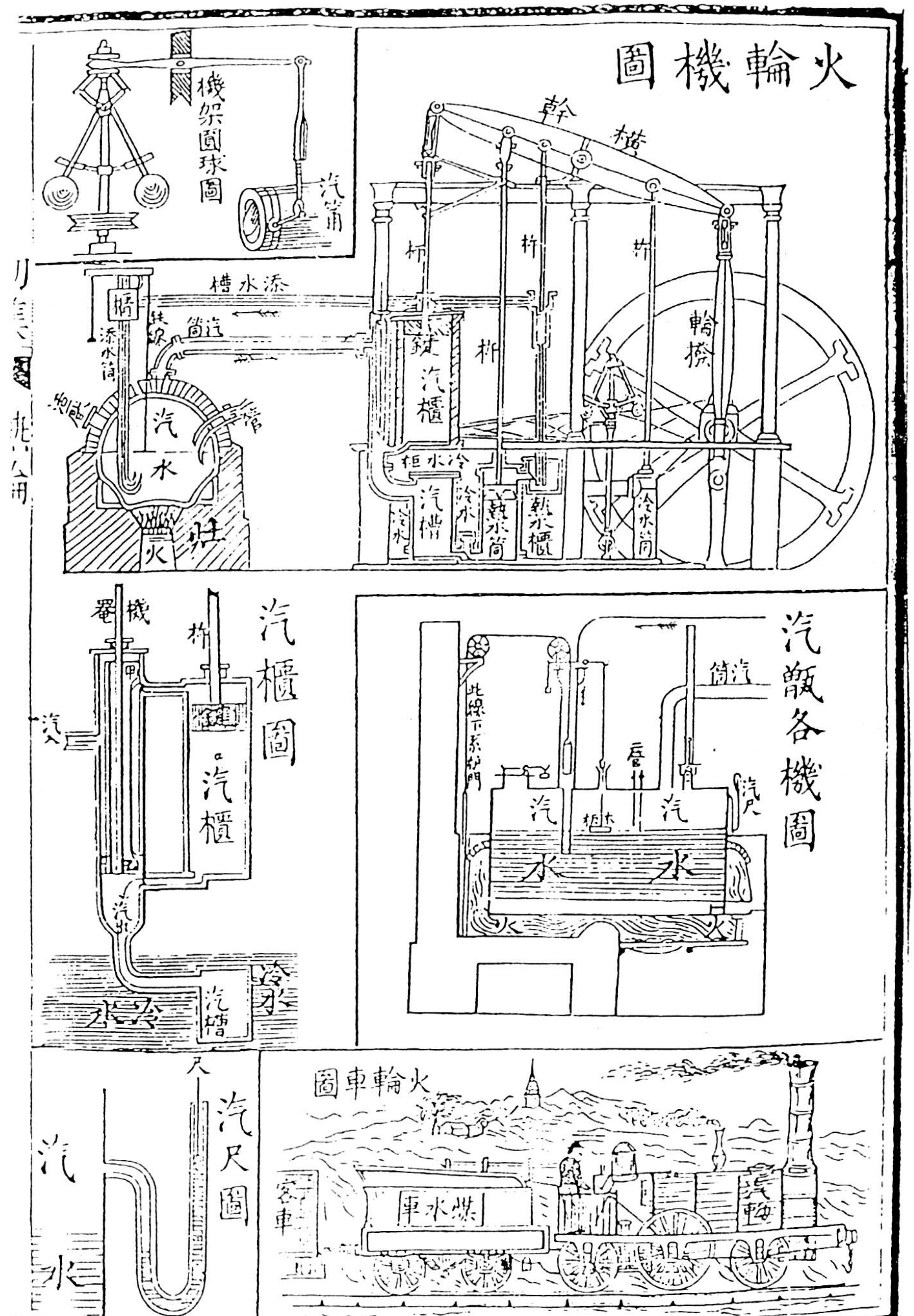

FIG. 2.
Steam engines illustrated in *Bowu xinbian*. (Reproduced by kind permission of the Wellcome institute for the History of Medicine, London).

government college, the Beijing Tongwenguan. Probably the most successful of the general science primers, *Gewu rumen* was reprinted many times in China and Japan, and was still in use in the early twentieth century. It was considerably more detailed than *Bowu xinbian* and although like its predecessors, it avoided theoretical principles, it was a sustained and serious attempt to explain the broad range of Western science to the lay Chinese reader, well-illustrated, probably by a Chinese artist. [See Fig. 3] Martin went to some trouble to make the ideas of chemistry seem as Chinese as possible, and the style of the drawings was used to suggest a traditional illustration technique. It was also a strong influence on all later science translations, especially those carried out at the Beijing Tongwenguan. The chemical section begins with an account of the chemical elements, and of what constitutes a chemical reaction, moving on to an explanation of the attraction between particles. Martin explains chemical combination as resembling the way in which strokes combine to make Chinese characters. This rather misleading analogy was an extension of an ancient parallel drawn by the ancient Greek originators of the atomic theory between atoms and the letters of the alphabet. Atoms were said to combine just as letters combine to form words. Since from a couple of dozen letters all known and unknown words could be generated, it was possible to explain the immense diversity of compounds formed from a relatively small number of elementary substances. Unfortunately the strokes in Chinese characters have, mostly, no independent existence, and so do not correspond to the free elements, and in any case the building of Chinese characters is *not* really describable in terms of a small number of discrete 'elementary' strokes. Nevertheless, Martin was the first person in modern times to attempt to make the idea of atoms comprehensible to Chinese readers, and as a first approximation his analogy was probably successful.

Unlike later authors, who tended to ignore the Chinese paradigms altogether, Martin went to some trouble to acknowledge the existence of the *wuxing* 五行 [Five Phases] theory, and then to explain — as tactfully as he could — why it was no longer accepted. Martin developed a relatively detailed chemical terminology, going well beyond *Bowu xinbian* in this respect, and was the pioneer in naming the majority of the chemical elements, adopting a pragmatic approach to nomenclature, using as far as possible existing Chinese terms from the alchemical tradition, and his eclectic methods were followed and extended by his colleague Anatole Billequin at the Tongwenguan in the texts *Huaxue zhinan* 化学指南 [Guide to chemistry] and *Huaxue shanyuan* 化学阐原 [An explanation of the origins of chemistry].

4. Synthesising a new terminology

The two most influential chemistry texts of the late nineteenth century, *Huaxue jianyuan* 化学鉴原 [The mirror of chemistry: a source-book] and *Huaxue chujie* 化学初阶 [First steps in chemistry], both translations of the same original text, probably the 1862 edition of David Wells' *Principles and applications of chemistry*.[5] *Huaxue chujie* was published in 1870 in Guangzhou, the result of collaboration between the

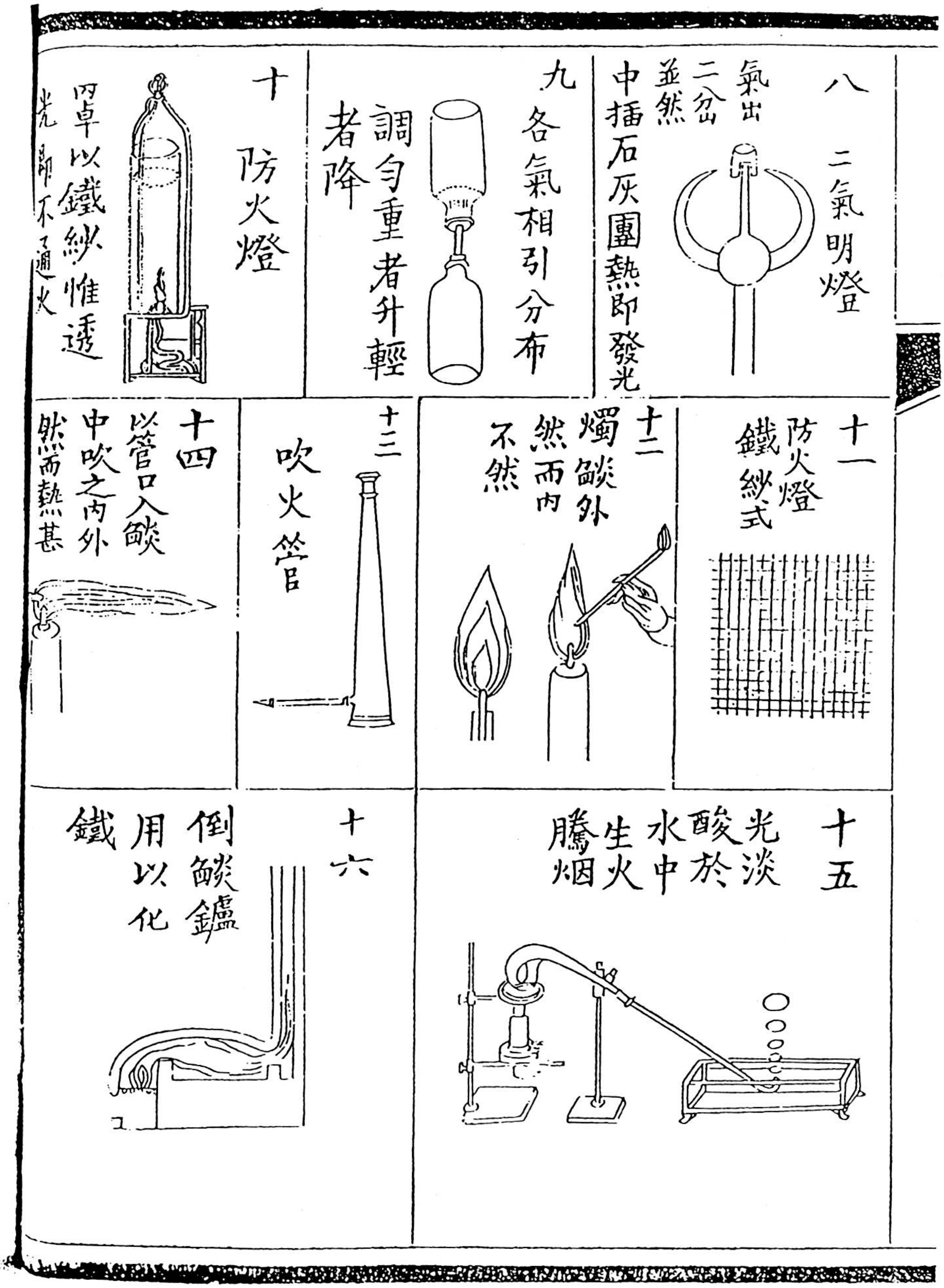

FIG. 3.

Chemical experiments illustrated in Gewu rumen (Reproduced by kind permission of the Wellcome Institute for the History of Medicine, London).

American Presbyterian medical missionary John Glasgow Kerr (1824–1901) and He Liaoran 何了然, who had been one of Benjamin Hobson's students. It was published in 1870 by the Boji Yiyuan 博济医院 in Guangzhou, a missionary hospital which had been founded by the missionary Peter Parker (1804–1888) and was later to be the alma mater of Dr. Sun Yat-sen (1866–1925). The shorter of the two translations, *Huaxue chujie* gives less detail about the more unusual elements, but provides the reader with a much stronger theoretical foundation in the early sections.

Xu Shou 徐寿 (1818–1884) and John Fryer translated *Huaxue jianyuan* at about the same time as Kerr and He Liaoran were working independently in Canton, and the result of their work was published slightly later, probably in 1871. There were serious discrepancies between the two texts in the terms used. This was not only due to the choices made by the translators: the Western science being transmitted was itself in considerable flux and confusion over fundamental matters such as atomic weights, the correct way to write chemical formulae, and the importance (or even the existence) of atoms. A major difference in the two translations is in the system used for denoting chemical formulae: Xu Shou/Fryer followed David Wells in using the dualistic or Berzelian system, in which compounds were regarded as compounds of positive [metallic] oxides and negative [non-metallic] oxides, such as for instance potassium chlorate: $KO.ClO_2$. The formulae of the oxides themselves were given as *equivalent formulae*, not the atomic formulae with which we are nowadays familiar. In an equivalent formula the symbols of the elements stand for one *equivalent* of that element, so for example the formula for water is HO and not H_2O. Many chemists still regarded equivalents both as inherently more reliable and heuristically more valuable than atomic weights, and continued to use equivalents rather than "atoms" in their textbooks.

The missionaries were of course unwilling to admit that the "truths" they were transmitting were in fact in flux, and a matter of heated debate: they tended in their early works to ignore the problem by translating the empirical, descriptive sections which, on the whole, could not be held in controversy. Whilst this might have been acceptable for the elementary texts, it proved impossible once any depth was attempted. Choices between systems had to be made, and John Fryer in the Jiangnan Arsenal translations kept to the system of equivalents which even he had to admit had become somewhat old-fashioned. Both translations proved to be influential: *Huaxue chujie* was used by Kerr as the basis of the chemical content of a series of medical texts, whilst the system in *Huaxue jianyuan* was extended to all the Jiangnan Arsenal translations on related subjects.[6]

5. Science journalism in China 1840–1900

We have some direct evidence of the students' view of *Huaxue jianyuan* in an account by Luan Xueqian, a student and teacher at the Shanghai Polytechnic in the 1890s, which shows that most students found it very difficult and indigestible — like "chewing wax" as he put it.[7] We can I think assume that most of the other textbooks would have been similarly forbidding to all but the most dedicated students.

Yet fortunately there were more accessible routes to learning science. One of the more surprising aspects of late nineteenth-century China is the richness and variety of its popular scientific journalism. In a country with few institutions teaching science seriously, there were yet a number of journals wholly or in part devoted to disseminating scientific knowledge to the Chinese. Addressed to a mass audience, they were certainly read by those who would have never attempted to struggle with works such as *Huaxue jianyuan*.

6. The early missionary periodicals

The Chinese journals even of the earliest Protestant missionaries attempted to impart some knowledge of Western science. William Milne (1785–1822) published a journal in Malacca *Chashisu Meiyue Tongjizhuan* 察世俗每月统计传 [A general monthly record, containing an investigation of the opinions and practices of society], which by 1819 was selling 1, 000 copies per month in Siam, Cochin-China and part of China itself. *Tianxia Xinwen* 天下新闻 [News of the World] edited by Samuel Kidd in Malacca 1828–1829 also included some scientific material. Karl Gutzlaff published his *Dong-Xi Yangkao* 东西洋考 [The Chinese Magazine] from 1833, first in Java and then Siam: it included some geographical and astronomical information. *Liuhe Congtan* 六合丛谈 ['Universal discussions', subtitled *The Shanghae Serial*] was edited by Alexander Wylie and published by the London Missionary Society Mohai shuguan 墨海书馆 [Inkstone Press] in Shanghai, and contained regular articles by the missionaries William Muirhead, Joseph Edkins and Alexander Williamson, typically four or five longer articles followed by a miscellany of news from around the world. The journal was reprinted in Japan, excluding the religious articles. The most interesting of these from a scientific point of view are those on geography by William Muirhead (1822–1900) and on natural theology by Alexander Williamson. Muirhead's article mentions the 62 chemical elements (*yuanzhi* 元质) and includes the earliest known use of the term *huaxue* 化学) for 'chemistry', but in a context which suggests that the term was invented some time before, probably at the Mohai shuguan in the early 1850s. Williamson's articles on natural theology were later published in *Jiaohui Xinbao* and *Wanguo Gongbao*, and finally in book form as *Gewu tanyuan* 格物探原 [Tracing the origin by the investigation of things] (1876).

7. From missionary journalism to popular science

Young J. Allen (1836–1907) arrived in Shanghai in 1860, an American missionary with the Southern Methodist Mission. He soon found that preaching to the Chinese was a very ineffective way of getting the Christian message across[8]. He accepted a half-time appointment at the Shanghai Tongwenguan teaching English in 1864, but he came to believe that science was a way of imparting the truths of the gospel. He began editing the *Jiaohui Xinbao* 教会新报 [Church News] in September 1868, and a number of science articles and translated books, such as *Gewu rumen*, *Huaxue jianyuan* and *Gewu* *tanyuan*, were serialised. In 1875, Allen changed the name of *Jiaohui Xinbao* to *Wanguo Gongbao* 万国公报 (*The Chinese Globe Magazine*), with an enlarged news section, and a more secular orientation. It was, according to its front cover

> devoted to the extension of knowledge relating to geography, history, civilization, politics, religion, science, art, industry, and general progress of Western countries.

It was suspended in 1883, because Allen was now involved in running the Anglo-Chinese college, but resumed in 1889, with a new English subtitle *The Review of the Times*, managed by the recently-formed Society for the Diffusion of Christian and General Knowledge among the Chinese, and ran until 1907. *Wanguo Gongbao* was to be one of the most influential journals, read by many reformers and the more progressive provincial leaders during the 1880s and 1890s, yet its scientific coverage was usually brief and superficial. At the time no Chinese-language journal compared in scope and depth of detail with *Gezhi Huibian* 格致汇编.

Gezhi Huibian was edited by the ex-missionary John Fryer and published under the auspices of the Shanghai Polytechnic, where for many years it was in truth the only public activity undertaken by the Polytechnic. It was the first Chinese-language journal to be entirely devoted to 'popular scientific information'. Fryer was careful to exclude political or religious topics, and even mathematics was given little space after the first few issues. The range of topics covered was enormous. At the end of each issue were advertisements for various types of machines and scientific instruments, some of which were also mentioned in the articles of the same issue.

The most interesting section allows readers to ask the editor questions on various matters of scientific interest.[9] We are not always even told the writers' surnames or where they come from, but it is clear that most are from the Treaty Ports, although there are also correspondents from Taiwan, Japan, and from the remoter provinces such as Yunnan. The same correspondent does occasionally appear to have written more than one question, although as no *ming* 名 [given names] are included one cannot be certain of this. The letters reveal little about their writers, although they do vary greatly in their knowledge of science, some asking questions with the directness of a novice, others with a subtlety which is likely only after long study.

We sometimes find the traditional Chinese explanations — sometimes in terms of folklore — being placed alongside the 'new' Western one. Fryer often uses queries of this type to point out the errors in the 'superstitious' beliefs of the Chinese, a role for science which he and many other missionaries sought to emphasise in showing the superiority of Western civilisation.

The most impressively technical of these are on astronomy, a science in which the Chinese had excelled long before Western contacts began. Chemical theory, by contrast, posed considerable problems, and was one of the areas in which most scepticism about Western ideas was expressed. It seems that the concept of chemical combination caused more than one reader difficulties, in particular the notion that something as obviously solid, opaque and black as carbon could be hidden inside something as white as sugar, or be contained in something as flimsy and transparent as air. A reader in Suzhou also found it unlikely that liquid water could really be made of two gases.

There were queries about the source of the sparks produced when a cat is stroked; why ice causes a water-container to crack, whereas frozen mercury does not damage a thermometer; what causes the sulphurous smell generated when the hands are rubbed together; why cats' eyes reflect light; the shape of a light-beam produced by a square hole; why black hair doesn't turn white when it falls; why sounds are clearer at night; and why faeces are a different colour from the food that is eaten. Their inquiries express a keen curiosity about the natural world which Fryer did his best to satisfy, but also tantalisingly suggest that some correspondents were not merely making casual observations but were actually carrying out their own experiments, and that the transmission of science was by no means only a question of passive or uncritical acceptance by the Chinese readers of the information Fryer and others chose to impart. The authentic voice of the experimenter, struggling with intractable equipment and obscure practical instructions, appears with Mr Zhou of Wuchang, who wrote

> I love science, and have bought several science books and many types of apparatus. I have tried out all the techniques contained therein, but they have not worked. I do not know whether there are mistakes in the books or whether the equipment is faulty, or whether it is because I am not following the instructions properly during my experimentation.[10]

8. Post-Shimonoseki journals

The defeats by Western powers after 1840 were bad enough for China's self-esteem, but the disastrous war with Japan in 1894–5 caused far deeper alarm. The despised "pirate dwarves", whose culture had borrowed so much from Chinese civilisation, were now able to destroy their giant neighbour's best ships and to dictate the terms of yet another humiliating surrender. The years which followed the Treaty of Shimonoseki (1895) saw an unprecedented interest in Western science, leading to the formation of many reformist "study societies" and journals which were (at least outwardly) concerned with the acquisition of scientific and technical knowledge from the West.

One such journal was *Gezhi Xinbao* 格致新报, which had French and English subtitles *Revue Scientifique* and *Scientific Review*, edited by reformist Chinese Jesuits in Shanghai, and the first scientific journal to be edited by the Chinese themselves. The front cover [Fig. 4] was decorated with the Latin alphabet and Arabic numerals. It was published from January to August 1898, and carried articles rather like those in *Gezhi Huibian* — although much shorter — with a section for readers' queries. The queries seem on the whole more naive than *Gezhi Huibian*: 'Why can you warm cold hands with your breath yet you can *cool* tea with the same method?'; 'Why is it that if iron and felt are at the same temperature, felt feels warm and iron feels cold?'; the shapes of water droplets on leaves; 'Is it true that drowned women face upwards, and

FIG. 4.

The front cover of the first issue of *Gezhi Xinbao*, decorated with the Roman alphabet, mathematical symbols, ships, railroads and pi. (Reproduced by kind permission of the Needham Research Institute, Cambridge).

men face downwards? Could it be that women are *yin* 阴 and therefore face the Sun?'; 'Why are there no tides in ponds?', and so on. The scientific quality of the editors' responses seems generally weaker than that of those in *Gezhi Huibian*.

Finally I should mention *Yaquan Zazhi* 亚泉杂志 [Yaquan Journal], the first journal in China to be devoted to modern chemistry, lasted from November/December 1900 to May/June 1901 which is notable for giving the earliest account in Chinese of the Periodic Law of the Elements, and for introducing the discoveries of several new elements such as helium, argon, radium and polonium. The majority of the articles were translated from Japanese, a reflection of the strong influence of Japan on the post-Shimonoseki Chinese intellectuals.

9. *Conclusion*

In considering the role of the science textbooks and journals, we must recognise that to a majority of Chinese scholars in late imperial China anything foreign was at least initially regarded with suspicion and disdain. "Learning from the barbarians" was seen as humiliating, and the activities of Western missionaries served only to reinforce the fear that Chinese culture was being subverted. The Christian agenda of the early textbooks thus only confirmed the Chinese scholars' prejudices about the uncouthness of the foreigners and of their foreign science. Moreover, the texts' subject matter seemed dull or arcane, and their literary style boorish: acceptable enough if one merely wanted to discover how to make a better ship or gun, but not to be taken seriously as the vehicle for a system of ideas.

The certainty which these textbooks imply also reflected the contemporary Western view of the steady march of progress and the cumulative nature of knowledge. An admission that previous ideas — or chemical formulae — were now proved inadequate or wrong would have been humiliating and dangerous, and was, as we have seen, resisted until the end of the century, when returned students from the West and Japan began updating the mid-century texts. The textbook paradigm of transmission proved a mixed blessing in slowing the passage of new ideas to China in the latter decades of the century.

By the 1890s there was a considerable demand for science textbooks, and there were Chinese students of science who had sufficient knowledge to write their own textbooks, for instance *Huaxue xinbian* 化学新编 [A new account of chemistry] on metallurgy and mineralogy by Y.T. Woo, who had studied abroad and on his return worked on chemical analysis at the Kaiping coal-mines. The role of the foreign missionaries in transmitting science was no longer dominant. After 1895 many Chinese students went to study in Japan, and it was the translations of Japanese science textbooks which were to be the major influence on the next generation of Chinese science students.

During the late nineteenth however the texts produced at the Jiangnan Arsenal were certainly the most numerous, and perhaps the most influential. Some writers have assumed that, because the texts existed, their diffusion must have contributed to the transmission of science into China, but it is far from clear to what extent and in what ways they played such a role in the transmission. The number of people in China with any serious interest in Western science was extremely small until the last decade of the nineteenth century. A few government schools taught science but, with the probable exception of the Beijing Tongwenguan, seem to have done the job rather badly. Beyond these official institutions were the missionary schools, which tended to ignore natural science in favour of English and religious instruction. Only in Dengzhou College does the Reverend Calvin Mateer (1836–1908) seem to have provided a sound science curriculum.

The existence of these textbooks *did* probably play a role, although the very slow progress made by science education in the 70s and 80s despite the rapid increase in the number of texts available, shows that in spite of all the optimistic statements by the few enthusiasts for science in China, the reality was official and public indifference to the efforts of the propagators, and often disappointment for the foreign agents of transmission who dedicated their lives to the advancement of science in the Celestial Empire.

The time-lag between the original publication and its Chinese translation meant that the Chinese were inevitably reading the science of at least a decade earlier. Although in part this delay was due to the time a translation took to prepare, it also probably reflected the science with which the foreign translator felt comfortable. With the exception of Anatole Billequin (1837–1894)[11], none of the foreigners engaged in translation were professional scientists, and they all were naturally happier in transmitting the science they had learned in their youth than the latest ideas in the West, some of which greatly modified or even contradicted those revealed in earlier works.

The journals which carried scientific matter to some extent made up for the deficiencies of the text books, as they quite often mentioned new discoveries which would not appear in book form for many years. These journals do not of course represent early Chinese versions of *Nature* or *Chemical News*. There simply was no significant constituency of Chinese scientists in the nineteenth century, and thus no demand for journals in which they could share their discoveries and voice their opinions. The remarkable richness and interest of the popular science journalism of this period in China should not conceal the fact that no more than a tiny minority of the Chinese people — even of the educated classes — had any interest in natural science. Until 1895 even in Shanghai there were no classes which the lay public could attend to extend their knowledge, and there is no evidence of a clamour for such classes to be put on.

a. These figures are all taken from R. Britton, *The Chinese periodical press 1800–1912* (Shanghai: Kelly & Walsh, 1933)— b. *ibid.*, 61 — c. *ibid.*, 53 — d. *ibid.*, 54 — e. *ibid.*, 55 (It became a monthly in 1889.)— f. *ibid.*, 93 — g. *ibid.*, 68 — h. *ibid.*, 51.

TABLE 1.

The circulations of some late Qing periodicals[a]

Name of journal	Daily	Weekly	Monthly
Gezhi Huibian	—	—	4, 000[b] [1876–1882]
Jiaohui Xinbao	—	700[c] [700]	—
Wanguo Gongbao	—	1, 800[d] [1876]	1, 800[e] [1898]
Shiwu Bao 时务报	—	10, 000[f] [1898]	—
Shen Bao 申报	15, 000[g] [1895]	—	—
Hu Bao 沪报	10, 000[h] [1895]		

Although the comparisons are inexact, we can see that, although small on an absolute scale, the circulation of the specialist *Gezhi Huibian* compared well with the newspapers of its day such as *Shen Bao* and *Hu Bao*, and no worse than *Wanguo Gongbao* which, though it contained some brief scientific articles, was mainly concerned with foreign news. Circulation in any case tells us little about readership: we do know that the most progressive officials and intellectuals read these periodicals and drew many of their ideas from them.

The efforts of the science journalists were thus not in vain. Their works were read, if only by an eccentric minority, and some of the readers were taking science seriously enough to attempt their own experiments, although with rather little encouragement from the editors: a noticeable feature of the articles is how little attempt there is to suggest simple experiments that readers could so for themselves. The tone is didactic, solemn, and probably rather forbidding, although we have no direct evidence of Chinese reactions to them, except that the emphasis on industry and technological novelties or gadgets was evidently frustrating to some of the more serious-minded scholars, who complained that there was too much emphasis on manufactures and not enough on the principles of science.

Books are dead things without the ideas which they contain being transplanted and given life by a soil where their ideas can take root and flourish. After the terrible defeat of 1895 there began to arise in Chinese intellectuals a sense of a great deficiency in their conventional culture, and a hunger for change which fed upon "foreign learning", the source of the "wealth and power" of the West. The translations by Yan Fu 严复 (1853–1921) of Thomas Huxley's *Evolution and Ethics*, John Stuart Mill's *Logic* and Herbert Spencer's *Sociology*, all published between 1898 and 1910, excited a popular interest which would have been inconceivable even a decade earlier. Chinese intellectuals discovered the political and philosophical background in which Western science had arisen, and science began to be connected to a wider discourse: it was no longer just a means to a military end, but suggested an outlook which could have political consequences. By May 4th, 1919 "Mr Science" and "Mr Democracy" were both invoked by the students of Beijing University in their search for ways of creating a modern China and a new world.[12]

1. 'Methods of imparting Western knowledge to the Chinese' in *Journal of the China Branch of the Royal Asiatic Society* **21**(1886), 1–21.
2. W.A.P. Martin, 'Western science as auxiliary to the spread of the gospel' in *Chinese Recorder* **29**(1897), 111–116 p. 116.
3. William Milne, writing in 1820 of his monthly missionary magazine *Chashisu meiyue tongjizhuan*:

   To promote Christianity was to be its *primary* object; other things, though they were to be treated in subordination to this, were not to be overlooked. Knowledge and science are the hand-maids of religion, and may become the auxiliaries of virtue. (R.S. Britton, *The Chinese periodical press 1800–1912* (Shanghai: Kelly & Walsh, 1933), 18).
4. James Reardon-Anderson, *The study of change* (Cambridge: Cambridge University Press, 1991), 19–21 and David Wright, 'Careers in Western science in nineteenth-century China: Xu Shou and Xu Jianyin' in Journal of the Royal Asiatic Society 5, 1(April 1995), 49–90.
5. David A. Wells, *Principles and applications of chemistry* 5th edition (New York: Ivison, Phinney & Co., 1862).
6. James B. Neal, 'Treatises on chemistry', *Chinese Recorder* **26**(1895), 187–190 p. 189.
7. James Reardon-Anderson, *The study of change*, 49 and David Wright, 'John Fryer and the Shanghai Polytechnic: making space for science in nineteenth-century China', *The British Journal for the History of Science* **29**(1996), 1–16 p. 14. Luan Xueqian was a graduate of Calvin Mateer's Dengzhou College in Shandong. (I am indebted to Wang Yangzong for the latter information.)
8. Adrian A. Bennett and Kwang-ching Liu, 'Christianity in the Chinese idiom: Young J. Allen and the early Chiao-hui hsin-pao, 1868–1870' in J.K. Fairbank (ed.) *The missionary enterprise in China and America*, (Cambridge, Mass.: Harvard University Press, 1974), 159–196 pp. 162–164.
9. The classic study of these is Li San-po, 'Letters to the Editor in John Fryer's *Chinese Scientific Magazine* 1876–1892: an analysis' in *Bulletin of the Institute of Modern History, Taibei* **4**(1974), 729–777.
10. Query #132 *Gezhi Huibian* **2**, 4(June 1877), 12a.
11. The translator of *Huaxue zhinan* and *Huaxue shanyuan*, who worked with Martin at the Beijing Tongwenguan, Billequin was a university graduate in chemistry.
12. See Danny Kwok, *Scientism in Chinese thought* (New Haven: Yale University Press, 1965). Science also played a role in the more recent student uprising of 1989, see Fang Lizhi, *Bringing down the Great Wall: writings on science, culture and democracy in China* (New York: W.W. Morton, 1990).