LETTERS TO THE EDITOR IN JOHN FRYER'S *CHINESE SCIENTIFIC MAGAZINE*, 1876–1892: AN ANALYSIS

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As early as 1835, Alexis de Tocqueville warned of the danger of unbalanced technological advancement, when the basic sciences themselves were not pursued with vigor. When there was excessive "adherence to mere applications," he wrote, "principles would be lost sight of, and when the principles were wholly forgotten, the methods derived from them would be ill pursued."(1) Tocqueville's remark is an appropriate comment on the history of science and technology in China. John Fryer (1839–1928), who did much to introduce Western science and technology into China, shared Tocqueville's belief. Through the large number or scientific treatises that were translated into Chinese—and especially in the periodical he edited, *Ko-chih hui-pien* (The Chinese scientific and industrial magazine, 1876–1892(2))—Fryer strove to stimulate in the minds of Chinese readers

(1) Alexis de Tocqueville, *Democracy in America*, originally translated by Henry Reeve, revised by Francis Bowen, and further revised and edited by Phillips Bradley (New York: Alfred A. Knopf, 1963), Vol. II, p. 47.

(2) There are seven complete volumes of *Ko-chih hui-pien*, bound handsomely in the John Fryer Collection, University of California, Berkeley. The complete title of the first volume was "The Chinese Scientific Magazine: a monthly journal of popular scientific information with which is incorporated The Peking Magazine." Beginning with the second volume, its title was slightly varied as: "The Chinese Scientific and Industrial Magazine: a monthly journal of popular information relating to the sciences, arts and manufactures of the West with which is incorporated The Peking Magazine." Starting with the sixth volume, another caption was added: "The Medical Missionary Association

something akin to "scientific curiosity." He was often disappointed, however, by the response of the readers who, while appreciating the practical value of technology, showed little interest in pure science. The Chinese, as viewed by Fryer, were extremely practical people who "never do anything without looking all round and foreseeing results."(3) To be sure, he sensed that "a strong demand has set in among the majority of the thinking part of the nation for all the useful knowledge."(4) But, in 1895, after spending thirty-five years in China, Fryer still lamented the unreceptiveness of the Chinese to basic science:

> ...Western learning was introduced into China a long time ago. Those who are familiar with current affairs are pleased with the fact that Western learning yields practical value. Those who are learned also agree that it broadens one's perspective. Series of imitating endeavors have been undertaken, the College of Foreign Languages has been established and military and naval academies have also been opened. These, however, are only one aspect of [China's] imitation and certainly not significant undertakings for advocating Western learning....From the year 1874, some Chinese and Westerners had planned to establish the Polytechnic Institute in Shanghai [which was actually established in 1875]....We all thought that science would by now be popularized...but many years have elapsed with virtually no achievement....(5)

*of China has appointed this magazine as its organ for communicating information to the natives." Dates of publication for the magazine are: February 1876—January 1878, monthly; February 1878—January 1880, suspended; February 1880—January 1882, monthly; February 1882—December 1889, suspended; and Spring 1890—Winter 1892, quarterly.

(3) John Fryer, "The Future of China" (1915?), p. 18 in Fryer Papers, preserved in the Bancroft Library, University of California, Berkeley.

(4) John Fryer, "The Commerce of China" (1898), p. 29 in Fryer Papers.

(5) John Fryer, comp., *Ko-chih shu-yüan hsi-hsüeh k'o-ch'eng, shu-hsüeh k'o-t'i* (Syllabus of modern science of the Chinese Polytechnic Institute, mathematical problems), 1895, p. 1. See also the "Letters to the Editor" (hereafter, LE) section in the *Ko-chih hui-pien* (hereafter, *KCHP*), 196 (December 1877).

The preoccupation of the Chinese with matters of immediate utility is perhaps not surprising. Humiliated by the Westerners in war, the Chinese could not but be impressed by Western military weapons—warships, rifles, and guns. They were also impressed by the West's economic and industrial power, and realized, moreover, that the superior military and economic strength of the West was the product of a complex technology. The Chinese thus were willing to learn Western techniques for the sake of "wealth and power." A movement to adopt Western technology for this purpose, often referred to as the self-strengthening movement, developed in the period from 1861 to 1895 — coinciding exactly with Fryer's stay in China. The movement was plainly more imitative than creative; the kind of knowledge the Chinese sought was "lucriferous" (profit-making) rather than "luciferous" (enlightening).[6] While a few Chinese scholars devoted themselves to the study of mathematics, both Chinese and Western (the backgrounds and accomplishments of such men as Hua Heng-fang, Li Shan-lan and Hsü Shou remain to be studied more fully[7]), the general attitude toward the theoretical aspects of Western science was one of indifference. Even among scholars, interest in the

(6) *KCHP*, LE 118 (April 1877), 138 (June 1877), 140 (July 1877), and 158 (September 1877), for instance. No one ever inveighed more firmly than Bacon against the evils of purely "lucriferous" knowledge. See Marie Boas, *The Scientific Renaissance: 1450-1630* (New York: Harper & Row, Publishers, 1962), pp. 249-250.

(7) For brief biographical information on Li Shan-lan (1810-1882), see Arthur W. Hummel, ed., *Eminent Chinese of the Ch'ing Period, 1644-1912* (Taipei: Ch'eng Wen Publishing Company, 1970), pp. 479-480. Biographical information on Hua Heng-fang (1833-1902) and Hsü Shou (T. Hsüeh-ts'un, 1818-1884) can be found in Yang Mo, *Hsi-Chin ssu-che shih-shih hui-ts'un* (Records of the four scholars from Wu-hsi and Chin-k'uei), 1910, passim. Articles by Ch'ien Chi-po, Hua Shih-fang, Ch'eng P'ei-fang, and Hua I-lun in the *Pei-chuan chi pu* (Supplement to the Collection of epitaphs, comp. Min Erh-ch'ang, 24 vols. Peiping: Harvard-Yenching Institute, 1931) also contain rich information on Hsü Shou and Hua Heng-fang.

direct application of Western industrial and manufacturing technology was predominant.

However, any "paradigm"[8] or conceptual framework within which people think and work can change under certain circumstances; the "Zeitgeist"[9] or the spell of a dominant complex of ideas in a given period of time is subject to change and history does not stand still. It is not surprising, therefore, if during the nineteenth-century, some Chinese, despite their strong intellectual inhibitions, became curious about nature and about Western science under the stimulation of the new knowledge that was made available to them. This was not the first time that the human intellect managed gradually to slip away from its own shackles.

A glance at the letters to the editer from readers of Fryer's ***Ko-chih hui-pien***, the first major scientific magazine in China, sheds considerable light on this process of change. Since the magazine's readership was limited largely to Chinese in the treaty ports and other big cities, the writers of at least some of the letters were from a sector of Chinese society that had already experienced some degree of contact with things foreign. Although traditional ways of thought were still very much a part of the mental make-up of such readers, their interest — even if not necessarily typical of Chinese society at large — is nonetheless significant.

(8) For the concept of "paradigm," see Thomas S. Kuhn, ***The Structure of Scientific Revolutions*** (Chicago: The University of Chicago Press, 1970) and Dudley Shapere, "The Paradigm Concept," ***Science***, Vol. 172 (May 14, 1971), pp. 706-709.

(9) For the concept of "Zeitgeist," see Edwin G. Boring, "Dual Role of the Zeitgeist in Scientific Creativity," ***The Scientific Monthly***, Vol. 80, No. 2 (February 1955), pp. 101-116. Today we seldom use the term "Zeitgeist," for it is not a rigorous concept. Its equivalents such as "the spirit of the age" and "the intellectual climate," are being used with relatively little hesitation.

Of the 322 "letters to the editor"[10] published by Fryer in the *Ko-chih hui-pien* between 1876 and 1892, at least 123 (38.2 percent) demonstrated either some knowledge of scientific theories or an interest in and enthusiasm about scientific problems. My main objective in this article is to examine the nature of these letters, as an indicator of modern China's nascent interest in basic science. As a necessary background, the first part of this article discusses the place of John Fryer in China's history of science, and the role of the *Ko-chih hui-pien* in disseminating scientific knowledge and concepts. In the second part, a content analysis of the readers' letters is offered. Although perhaps not very many of the readers were scholars of profound classical knowledge, all were at least literate, and many of them demonstrated considerable knowledge of Chinese literature in their letters. Most of the writers were residents either of treaty ports or of large provincial cities in the Yangtze Valley. Among the readers who wrote letters, some (although it is impossible to say how many) must have been from families of merchants. But since many sons and relatives of the Chinese merchants of this period presumably still shared the literati's values, they are included under the rubric "literati" for the sake of convenience.

JOHN FRYER AND THE *KO-CHIH HUI-PIEN*

After a passage of 149 days around the Cape of Good Hope, John Fryer (1839–1928), a missionary of the Church of England, arrived in Hong Kong in August 1861 to become headmaster at St. Paul's College.

(10) The four inquiries on well-digging, mathematical puzzle, anesthesia, and tide sent by Westerners are not included. For these four inquiries, see *KCHP*, LE 50 (August 1876), 238 (May 1880), 283 (November 1881), and 317 (Summer 1892).

He taught at the College for two years and then went to Peking to succeed John S. Burdon as English instructor at the T'ung-wen Kuan (The imperial college of foreign languages, established in 1862).[11] In 1865 he moved to Shanghai and the following year assumed the editorship of the *Shanghai hsin-pao* (*The Herald*, 1864–1872), a Chinese-language edition of the *North-China Daily News*. Then, for a period of 28 years (1868–1896), Fryer was employed by the Chinese government as translator of technological and scientific books in the Kiangnan Arsenal in Shanghai. He left China in 1896 to take up the Louis Agassiz Professorship in Oriental Languages and Literature at the University of California, Berkeley, from which he retired in 1913.[12]

During the three decades of his stay in China, from the 1860's to the 1890's, Fryer became convinced that the Chinese needed not only to acquire knowledge of Western technology, but also to develop the spirit of scientific inquiry. This view was shared with equal fervor by Hsü Shou, who wrote the preface for the *Ko-chih hui-pien*. "It is hoped" he wrote, "that the Chinese people would eventually be able to investigate the very foundations of things and to understand thoroughly their principles" (*yu shih wu hua-jen t'an-so ti-yün chin-chih li chih so-i-jan*).[13] Fryer also became convinced that the best, if not the only, way to achieve

(11) It was not until 1867 that courses in pure sciences began to be offered at the T'ung-wen kuan, one of the earliest government schools in China. See Knight Biggerstaff, *The Earliest Modern Government Schools in China* (Ithaca: Cornell University Press, 1961), pp. 94–153.

(12) A biographical account has been given by Adrian Arthur Bennett, *John Fryer: The Introduction of Western Science and Technology into Nineteenth-Century China* (Cambridge, Mass.: Harvard University Press, 1967). See also Jonathan Spence, *To Change China: Western Advisers in China, 1620–1960* (Boston: Little, Brown and Company, 1969), pp. 140–160.

(13) John Fryer, *KCHP*, 1: 1 (February 1876).

this purpose was to expose the literati to Western scientific knowledge and concepts. During this period, except for some merchants and compradors who spoke "pidgin English," few Chinese had any command of English.(14) Fryer believed, therefore, that his translations and his magazine served an essential need. By making scientific information available to literate Chinese he hoped to contribute to the qualitative improvement of Chinese life.

According to Tsuen-hsuin Tsien's statistical study, a total of 399 Western scientific works were rendered into Chinese during the period 1850-1899, whereas from 1810 to 1867 only 47 such translations were made.(15) Of these 399 works, some 115 were prepared by Fryer and his collaborators.(16) While numerical information of this sort is not in itself significant, it is nonetheless indicative of Fryer's devotion to his cause. The attitude he carried into his work was particularly remarkable when compared to that of missionaries both before him and contemporary to him. The Jesuits of the Ming and early Ch'ing, and most of the Protestant missionaries of the nineteenth century, were primarily concerned with souls rather than with scientific knowledge—although they frequently attempted to use science as a tool of their evangelizing strategy. Matteo Ricci (1552-1610) stated that the Chinese were "slow to take a salutary spiritual potion, unless it be seasoned with an intellectual flavoring."(17)

(14) Yen-p'ing Hao, ***The Comprador in Nineteenth Century China: Bridge between East and West*** (Cambridge, Mass.: Harvard University Press, 1970), pp. 181-182.

(15) Tsuen-hsuin Tsien, "Western Impact on China through Translation," ***The Far Eastern Quarterly***, Vol. 13, No. 3 (May 1954), p. 327.

(16) Among Fryer's collaborators in translation were: Hsü Chien-yin, Hsü Shou, Hua Heng-fang, Chao Yüan-i, and Chiang Heng.

(17) Louis J. Gallagher, S. J., ***China in the Sixteenth Century*** (New York: Random House, 1953), p. 325. This is the English translation of Nicholas Trigault's publication of Matteo Ricci's journal.

Many similar statements can be found among the writings of nineteenth-century Protestant missionaries. Only Fryer, and a few other missionaries of his time, felt that the dissemination of scientific information to the Chinese was in itself a worthy end, quite apart from whatever relationship existed between science and Christianity. This, despite Fryer's own missionary background.(18)

Among the contributions made by Fryer was a new nomenclature in Chinese. A new scientific vocabulary had to be established and standardized if China was to assimilate Western knowledge, and Fryer was perhaps the first person who undertook this arduous task systematically.(19) His *The Translator's Vade-Mecum* (1888) offered a rich collection of

(18) It may be noted here that the first real diffusion of science in England through the *Edinburgh Journal of Science* did not take place until 1824, only fifty-two years before the first issue of the *Ko-chih hui-pien*. During the first forty years of the nineteenth century interest in the natural sciences in England was declining and men like Charles Babbage and Baden Powell lamented the state of English science. (See D. S. L. Cardwell, *The Organisation of Science in England: A Retrospect*, London: William Heinemann Ltd., 1957, Chapter III, passim.) Nonetheless a mechanistic and experimental tradition of science had long been developing in Europe through the work of Gilbert, Boyle, Hooke, Newton and many others before the turn of that century. New scientific concepts and technological devices were multiplying rapidly. Numerous scientific activities in Europe were taking place, even extending beyond national boundaries. The number of scientific publications, as well as professional journals and societies in all branches of natural science, was also increasing. (For scientific journals see George Sarton, *A Guide to the History of Science*, New York: The Renald Press Company, 1952, pp. 101-246.) Beginning with the first International Congress of Ophthalmology, held in Brussels in 1857, at least 44 international congresses in science had already been held in Europe before 1876, when *Ko-chih hui-pien* began publication. Prior to the close of that decade another 18 congresses were held. (See George Sarton, *A Guide*, pp. 290-302). They attest not only to the establishment of various disciplines in the sciences but to their professionalization as well. In the case of China, a similar scientific philosophy was lacking and the scientific activities of the European sort were nonexistent. Fryer's efforts were, therefore, of tremendous significance.

(19) For the significance of a nomenclature of science, see Charles E. Whitmore, "The Language of Science," *The Scientific Monthly*, Vol. 80, No. 3 (March 1955), pp. 185-191.

terminology and proper names in the fields of chemistry, *materia medica*, and mineralogy. Fryer approached the problem of terminology in the same methodical manner in which he executed his duties as editor of the *Ko-chih hui-pien*.[20]

The *Ko-chih hui-pien* was the first journal published in the Chinese language, explicitly and exclusively concerned with modern science and technology. Before the *Ko-chih hui-pien* was founded in 1876, and during the period in which it was published, other Western-sponsored magazines in the Chinese language already gave considerable attention to science and technology. Two important examples were the *Chung-Hsi wen-chien lu* (The Peking Magazine, 1872–1875, monthly) edited by Joseph Edkins, W. A. P. Martin, and John S. Burdon, and the *I-chih hsin-lu* (The Monthlv Educator, 1876–1878) edited by Young J. Allen.[21] But while articles on such subjects as mathematics, astronomy, medical jurisprudence, and optics can be found in the *Chung-Hsi wen-chien lu*, the periodical was not primarily designed for the dissemination of science *per se*. Published and distributed by the Kuang-hsüeh Hui (Society for the Diffusion of Useful Knowledge) in Peking, the declared aim of the *Chung-Hsi wen-chien lu* was to introduce "liberal thought" as well as modern science into China. It was in fact a general magazine providing information on "novel technologies, new methods of preventing floods, the ancient and

(20) The assiduity and the methodical manner with which Fryer compiled *The Translator's Vade-Mecum* can be observed in the several huge volumes of original manuscripts preserved and shelved in the John Fryer Collection in the Richmond Annex, University of California, Berkeley.

(21) According to Rosewell S. Britton, *The Chinese Periodical Press: 1800-1912* (Taipei: Ch'eng Wen Publishing Company, 1966), the *I-chih hsin-lu* was the first scientific magazine in China; but Fryer asserted that it was predominantly concerned with religious matters. See *KCHP*, LE 147 (July 1877).

modern history of the West, as well as the similarities and dissimilarities between the politics and customs of China and those of the Western countries."[22] In 1876 the Kuang-hsüeh Hui ceased to exist and its magazine merged into Fryer's new magazine. The reasons for the Society's discontinuation and the incorporation of its own organ with the *Ko-chih hui-pien* cannot yet be documented, but it is possible that the members of the Kuang-hsüeh Hui believed that the *Ko-chih hui-pien* would offer a qualitatively superior scientific magazine.[23]

In the *I-chih hsin-lu*, one finds a series of articles by William Muirhead on Bacon's *Novum Organum*, as well as a number of articles on astronomy, heat and other scientific subjects by Muirhead and Joseph Edkins. Articles concerning religious matters, however, occupied an equal, if not larger, proportion of the publication. The *I-chih hsin-lu*'s aim was stated on its title page: "The present Magazine is issued in the hope of its being useful in the advancement of Learning and Religion in China...much has been, and is being done for the enlightenment of the Chinese in different branches of knowledge, and these efforts are largely appreciated in various quarters. It is simply intended by means of this Miscellany to supplement and aid such efforts in carrying out the end they have in view...."[24] Clearly, *I-chih hsin-lu* was not meant to be as specialized as the *Ko-chih hui-pien*. There were, of course, a number of other Western-sponsored newspapers and magazines on the Chinese coast at the time, including the *Shanghai hsin-pao*, the *Chiao-hui hsin-pao*

(22) *Chung-Hsi wen-chien lu*, No. 1 (August 1872), preface 1b.

(23) The Medical Missionary Association of China, for its part, selected the *Ko-chih hui-pien* as its organ in the Chinese language beginning with the Spring issue of 1891. The Association had inaugurated in 1886 its *China Medical Missionary Journal*, the first English-written professional scientific journal in China.

(24) *I-chih hsin-lu*, 1:1 title page.

(Church News, 1868–1874), the *Wan-kuo kung-pao* (The Globe Magazine, 1875–1883, or The Review of the Times, 1889–1907), the *Hsiao-hai yüeh-pao* (The Child's Paper, 1874–?), the *Hua-t'u hsin-pao* (The Illustrated News, 1880–1913), and the *Chung-Hsi chiao-hui pao* (Missionary News, 1891–?). But while these journals published some scientific information, their material in this respect was even more unsystematic and sporadic than that of the *I-chih hsin-lu.*(25) In its time, *Ko-chih hui-pien* alone occupied the position of a scientific periodical comparable to the popular science magazines in Europe and America.(26)

(25) The coverage of the *Chiao-hui hsin-pao* and the *Wan-kuo kung-pao* has been analysed in Adrian Arthur Bennett, "Missionary Journalism in Nineteen-Century China: Young J. Allen and the Early *Wan-kuo kung-pao*, 1868-1883" (unpublished dissertation, University of California, Davis; 1970), Chapters IV and V.

(26) In Europe, in the late 1870's, there were at least 141 periodicals which may be described as general scientific journals, abstract and review journals, or journals on the history or philosophy of science. The growth of European scientific periodicals can be seen in the following table. To make the materials more manageable, they are arranged by decades. The numbers indicate the appearance of their first issues.

Scientific Journals of Europe, 1660's—1890's

Decades	Number of new scientific journals appeared	Decades	Number of new scientific journals appeared
1660's	3	1780's	2
1670's	1	1790's	6
1680's	3	1800's	7
1690's	2	1810's	4
1700's	1	1820's	15
1710's	2	1830's	7
1720's	1	1840's	13
1730's	2	1850's	16
1740's	2	1860's	21
1750's	3	1870's	26
1760's	1	1880's	29
1770's	3	1890's	38

In compiling this table, I have supplemented the information from George Sarton, *A Guide to the History of Science* with my own research from library catalogues. I intend

The *Ko-chih hui-pien* was published intermittently for seven years (see note 2 above), during which time a total of sixty issues appeared. Each issue carried one or more lead articles—often published in installments and consecutively paginated in the hope that readers themselves would bind them into separate volumes. The first major series (Vol. I) dealt with the natural sciences, covering a range of subjects sufficiently wide to familiarize Chinese readers with the various branches of modern science. Astronomy, mechanics, geology, metallurgy, thermology, natural phenomena (i. e., thunder, lightening, dew, fog, etc.), optics, magnetism, chemistry, botany, zoology and physiology were all presented. Realizing that China lacked the kind of mechanistic and experimental tradition of science that had been developed in the West through the work of Gilbert, Galileo, Boyle, Hooke, Newton and many others, Fryer presented articles on the various types of apparatus used for the study of meterology, chemistry, mechanics, hydrostatics, pneumatics, astronomy, biology and surveying in a series of 33 installments (Vols. III–VI). The magazine also published a variety of special articles on such subjects as Baconian scientific methodology, Western *materia medica* and medical science, physics, entomology and therapeutics.

In order to meet the reader's interest during its first few years, the *Ko-chih hui-pien* had to devote increasing space to applied sciences of practical use. A great many articles were published on manufacturing and technology, providing a rich store of information on 20-odd subjects as diverse as railway construction, the dyeing industry, artillery, the

*to be exhaustive, but one must be aware that some obscure journals may be overlooked. For the origins and development of scientific and technical periodicals from the seventeenth to the end of the eighteenth century, see David A. Kronick, *A History of Scientific and Technical Periodicals: 1665-1790* (New York: The Scarecrow Press, Inc., 1962).

manufacture of "lucifer" matches, kinetography, textile machinery, rice-hulling machine, the glass and sugar industries, the production of carbonated-water, and icemaking machine, the telephone, electro-metallurgy, and photography (see appendix). But Fryer never wavered in his aim of introducing pure science into China. During the first four years of his magazine, he not only continued to publish original articles on abstract theories, but also he preferred materials on the theoretical aspects of science in his translations of other Western scientific works.

After 1880 the magazine conspicuously shifted its emphasis to basic sciences, a trend which emerged with even greater clarity after 1885. Up to 1880, Fryer's published works outside of the *Ko-chih hui-pien* totaled 34 volumes, of which only 12 (or 35 percent) were on natural sciences. From 1800 to 1885, however, the percentage of works on the natural sciences increased to 63 percent; and during the next four years it increased further to 83 percent.[27] It may also be noted that Fryer paid increasing attention to mathematics as a foundation of scientific knowledge. It has been generally accepted that mathematics and the mathematization of hypotheses constitute the backbone of modern science;[28] and mathe-

(27) Bennett, *John Fryer*, pp. 34-36.

(28) Regarding the role of mathematics in modern science, Professor Alexandre Koyré, wrote that "Experiment—in contradistinction to mere experience—is a question we put in Nature. In order to receive an answer we must formulate it in some definite language. The Galilean revolution can be boiled down to the discovery of that language, to the discovery of the fact that mathematics is the grammar of science. It is this discovery of the rational structure of Nature which gave the *a priori* foundations to the modern *experimental* science and made its constitution possible." See his *Metaphysics and Measurement: Essays in Scientific Revolution* (Cambridge, Mass.: Harvard University Press, 1968), p. 14n. See also: Salomon Bochner, *The Role of Mathematics in the Rise of Science* (New Jersey: Princeton University Press, 1966); Alfreed North Whitehead, "Mathematics as an Element in the History of Thought," in his *Science and the Modern World* (New York: The Free Press, 1969), pp. 19-37; and Herbert Butterfield, *The Origins of Modern Science, 1300-1800* (New York: The Free Press, 1968), pp. 99-101.

matics had played an extremely important role in the European "scientific revolution." Feeling that perhaps the Chinese should begin their scientific inquiries by acquiring an interest in mathematics, Fryer created a special department in the magazine on mathematical problems.(29) However, the problems presented in this department failed to bring the already sophisticated traditional Chinese calculating techniques to a fusion point with the other branches of natural science.(30)

Initially, 3,000 copies of the *Ko-chih hui-pien* were issued. Nine months after the publication of its first issue, the first nine issues were reprinted in a second edition to meet the unexpectedly large demand.(31) The enthusiastic reception accorded the magazine attests that as early as the 1870's there was a widespread interest among the Chinese literati at least in some aspects of Western technology, if not in science itself. During the first year of its publication, the *Ko-chih hui-pien* was available

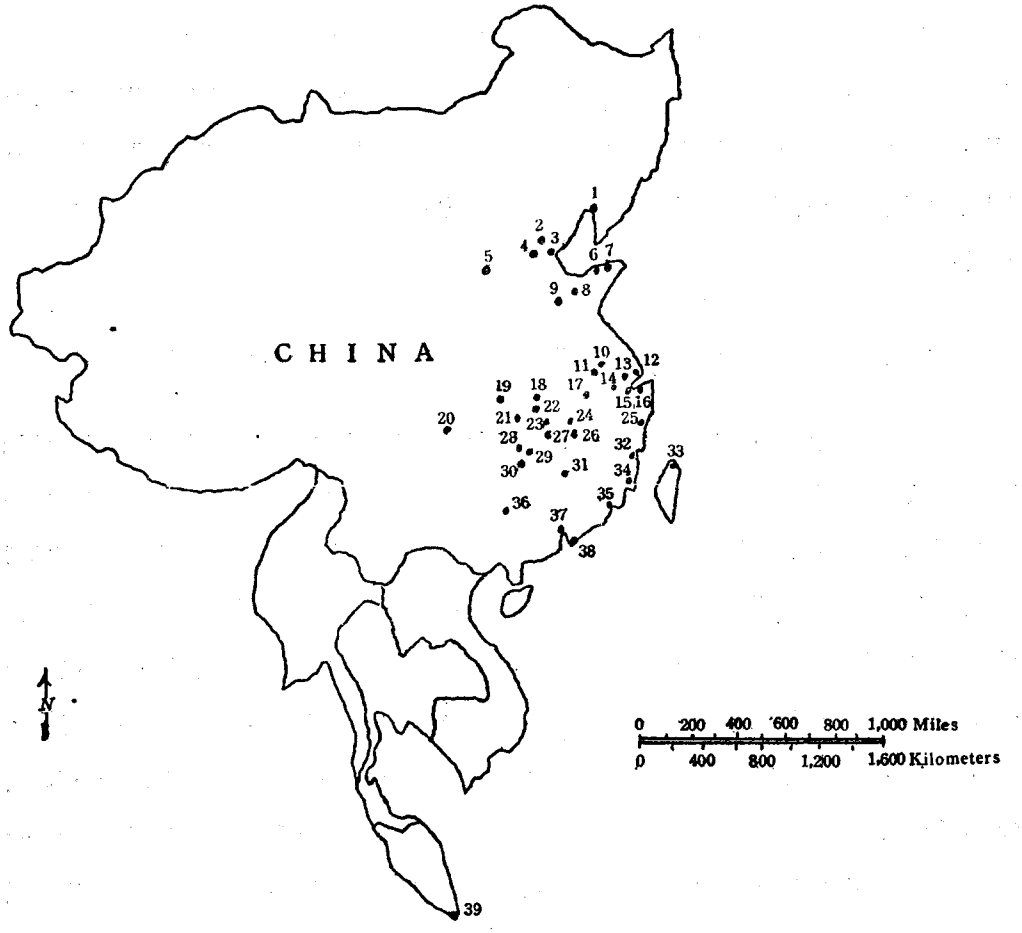
(29) The *Ko-chih hui-pien* consisted of 60 issues. This special department on mathematical problems can be found in 27 issues (February 1876—January 1877, May 1877—August 1877, and Spring 1890—Fall 1892). According to Fryer himself, more than half of the inquiries he received during the first seven months of *Ko-chih hui-pien*'s publication were concerned with mathematical problems (see *KCHP*, LE 63, September 1876). Yet, curiously, while the Chinese interest in mathematics was quite obvious, this department is not to be found in a total of 33 issues. The reasons for its disappearance remain to be explored.

(30) Mathematics, a formal science, though not a branch of natural science itself, is an indispensable intellectual force for the creation and emergence of rigorously workable concepts in natural science. It is the "abstractness" of mathematics, or its idealization of objects occuring in the physical world, however, makes it a dominant intellectual force. If the mathematics developed in Renaissance Europe had been confined to calculating techniques and separated from other disciplines of natural science, it would have been unable to contribute to the development of science in the way that it did. For traditional Chinese calculating techniques, see Joseph Needham, *Science and Civilisation in China* (Cambridge, England: The Syndics of the Cambridge University Press), Vol. 3, 1970, pp. 1-168 and Li Jen-yen (sic.) (Li Yen), *Chung-kuo suan-hsüeh shih* (History of Chinese mathematics; Taipei: Commercial Press, 1972), passim.

(31) See Fryer, *KCHP*, 1:22b (November 1876). Unfortunately, the number of the second edition is not known.

in 24 inland cities and coastal ports. In September 1877, agents in 27 towns distributed the magazine; in April 1880, 30. By the end of 1880, with the inclusion of Timothy Richard in Taiyuan as an agent, the number of the magazine's agents had increased to as many as 70, located

Locations of the distributing agents of the Ko-chih hui-pien



1. *Newchwang* 2. Peking 3. *Tientsin* 4. Paoting 5. Taiyuan 6. Tengchow 7. *Chefoo* 8. Tsingchow (Tsingchau) 9. Tsinan 10. *Chinkiang* 11. *Nanking* 12. *Shanghai* 13. *Soochow* 14. Yangchow, Kiangsu 15. *Hangchow* 16. *Ningpo* 17. Anking 18. *Hankow* 19. Ichang 20. *Chungking* 21. *Shashih* 22. Wuchang 23. Hingkwochow, Hupeh 24. *Kiukiang* 25. Wenchow 26. Nanchang 27. Wuhsueh, Hupeh 28. Yihyang, Hunan 29. Changsha 30. Hsiangtan 31. Shaopo, Kiangsu 32. *Foochow* 33. *Tamsui,* Taiwan 34. *Amoy* 35. *Swatow* 36. Kweilin 37. *Canton* 38. Hongkong 39. Singapore.

in 18 treaty ports and 21 coastal and inland cities (1. Anhwei: Anking; 2. Chekiang: Hangchow, Ningpo, Wenchow; 3. Fukien: Amoy, Foochow; 4. Hongkong; 5. Hopei: Paoting, Peking, Tientsin; 6. Hunan: Changsha, Hsiangtan, Yihyang; 7. Hupeh: Hankow, Hingkwochow, Ichang, Shashih, Wuchang, Wuhsueh; 8. Kiangsi: Kiukiang, Nanchang; 9. Kiangsu: Chinkiang, Nanking, Shanghai, Shaopo, Soochow, Yangchow; 10. Kwangsi: Kweilin; 11. Kwangtung: Canton, Swatow; 12. Liaoning: Newchwang; 13. Shansi: Taiyuan; 14. Shantung: Chefoo, Tengchow, Tsinan, Tsingchow; 15. Singapore; 16. Szechwan: Chungking; and 17. Taiwan: Tamsui. See map above; treaty ports are underlined).

THE READERS' RESPONSE TO THE *KO-CHIH HUI-PIEN*

John Fryer used the *Ko-chih hui-pien* not only to disseminate scientific knowledge and information but also to maintain two-way communication with his readers. For the latter purpose, he included a section entitled "Hu-hsiang wen-ta" (lit. "mutual questions and answers") or "Letters to the Editor." The reader was given an opportunity to have his questions answered, provided that they were related to science and technology. Even when some questions demonstrated no more than curiosity about trivial matters, Fryer would seize the opportunity and expand his answer to cover related scientific and technical facts. The letters published represented readership among almost all of the treaty ports, but there were also many letters (approximately 45 percent) from inland or outlying areas, including at least one from Taiwan and another from Yunnan.[32]

(32) *KCHP*, LE 257 (October 1880) and 189 (December 1877). Information concerning the localities from where the letters were sent is not always available. There were at least

Not all letters received by Fryer were published, but some of the printed ones were long enough to be considered as articles.

From January to June 1881, the "Letter to the Editor" department was suspended. According to Fryer it was because most inquiries received were not relevant to the magazine's purposes. While a large number of such letters were therefore never printed, those which appeared in the magazine do provide an idea of the readers' interests and attitudes. Excluding the four letters from foreign readers and the five miscellaneous inquiries regarding horse-racing, love, life insurance, and the price of the *Ko-chih hui-pien*, the 317 published inquiries can be roughly classified into two categories: (1) utility-motivated inquiries and (2) curiosity-motivated inquiries.(33) Those falling into the first category usually demonstrated little or no interest in scientific theories and were primarily motivated by the practical value of Western products or techniques. Those belonging to the second category were inquiries simply motivated by curiosity about things novel and strange, but there were a considerable number of letters which demonstrated interest in varying degrees of scientific knowledge. Statistics of these categories are provided below.

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*176 letters or 54.7 percent of the total were from treaty ports. The figure comprises: 52 from Shanghai, 19 from Canton, 16 from Hangchow, 13 from Tientsin, 13 from Amoy, 12 from Ningpo, 12 from Soochow, 11 from Foochow, 11 from Hankow, 5 from Swatow, 3 from Chefoo, 3 from Nanking, 3 from Newchwang, 1 from Kiukiang, 1 from Chinkiang, and 1 from Tamsui.

(33) A clear-cut distinction cannot be easily drawn here, for they are frequently overlapping. But for our purpose, which is to demonstrate the readers' response to Western science and technology, this categorization, though somewhat arbitrary, may be useful. For the five miscellaneous inquiries, see *KCHP*, LE 4 (March 1876), 26 (May 1876), 46 (July 1876), 113 (April 1877) and 147 (July 1877).

Categories of the "Letters to the Editor" Published in the *Ko-chih hui-pien*, 1876–1892

Category	Numbers of letters published	
Utility-motivated Inquiries		
Health and medicine	26	
Industrial and agricultural technology	79	
Public policy	24	
Sub-total	129	(40%)
Curiosity-motivated Inquiries		
Simple curiosity	65	
Scientific curiosity without previous knowledge of Western science	60	
Scientific curiosity based on some knowledge of Western science	63	
Sub-total	188	(58.3%)
Miscellaneous	5	(1.6%)
Total	322	

Source: *Ko-chih hui-pien*, 1876–1892.

Utility-motivated Inquiries

Under this category were inquiries about the utility of science and technology to the individual, to the Chinese state, or to both. Understandably, many readers were interested in Western medicine since its efficacy was often demonstrated by missionary doctors. No less than 26 inquiries (20 percent of the utility-motivated inquiries and 8 percent of the total number of letters) dealt exclusively with personal health problems and diagnoses.[34] For example, one reader wrote from Ningpo

(34) *KCHP*, LE 28 (May 1876); 30 (June 1876); 43 (July 1876); 60 (September 1876); 79, 83, 86 (November 1876); 87 (December 1876); 102 (March 1877); 122 (May 1877); 137 (June 1877); 145 (July 1877); 150 (August 1877); 163 (September 1877); 178, 184 (October 1877); 189 (December 1877); 219 (January 1878); 231 (March 1880); 236 (April 1880); 277 (August 1881); 280 (September 1881); 282 (October 1881); 290 (December 1881); 295 (January 1882); and 299 (Fall 1890).

seeking methods to alleviate pain caused by lime powder accidentally came in contact with the eyes.[35] Writing from Hankow, a Mr. Chang stated his belief that European beverages were better for health than tea:

> Some Westerners residing in China do not care for tea. Instead, they drink three other beverages: coffee, cocoa, and chocolate. I have access to all three of them and have tried them. They taste awful but I assume that the reason for drinking them must be their tonic value [since both their color and bitter taste are not dissimilar to Chinese herb drugs]. If the Chinese drink them, they might find them equally beneficial....[36]

Another reader wrote from Yen-t'ai (not Chefoo) in a similar tone:

> I find that the Westerners often drink *k'u-chiu* [lit. "bitter wine," i.e., beer]. They say that it is good for one's health. I have tried it several times and have discovered that it *is* beneficial. I do not know, however, from what material and by what method it is manufactured. I therefore do not dare drink much.[37]

There were at least two inquiries concerning first-aid techniques[38] and two with Western auristics.[39] Writing from Foochow, a reader was anxious to learn the methods of preventing sunburn.[40] A Mr. Tu, writing from Swatow, inquired about polyuria from which he had suffered for many years.[41] A reader in Shanghai was not too embarrassed to write Fryer seeking a cure for obesity.[42] There were also letters

(35) *KCHP*, LE 28 (May 1876).
(36) *KCHP*, LE 30 (June 1876).
(37) *KCHP*, LE 43 (July 1876).
(38) *KCHP*, LE 83 (November 1876) and 163 (September 1877).
(39) *KCHP*, LE 60 (September 1876) and 189 (December 1877).
(40) *KCHP*, LE 79 (November 1876).
(41) *KCHP*, LE 282 (October 1881).
(42) *KCHP*, LE 295 (January 1882).

inquiring about cures for asthma, the manufacturing of santonin, the properties of opium, the protection of eyesight, and Western anesthesia.[43]

Inquiries seeking techniques for industrial and agricultural production occupied a much larger proportion of the letters to the editor column. A total of 79 letters (24.5 percent of the total number of letters) were concerned with technological matters. Some of the readers seeking techniques of manufacturing presumably were aware of the fact that the increase of industrial and agricultural production in their private enterprises would benefit the country and the society in one way or the other. There were numerous inquiries concerning the techniques of manufacturing various Western products: sulphuric and nitric acids, sand filters, water-distilling machines, watch lubricants, candles, grape wine, iron supplement wine, apple wine, matches, vinegar, rope, menthol, dynamite, pencils, screws, electric incandescent lights, mercurochrome, ink, soap, cassia oil, candy, needles, saws, gold-leaf, rubber stamps, artificial ivory, files, etc. Usually, Fryer discussed the techniques of manufacturing such objects in detail in his replies.[44] Inquiries seeking techniques for extracting gold, copper, silver, lead, and tin from ores and other substances were also received.[45] Two articles of superior quality on the manufacturing of glass bottles and firebricks were contributed by

(43) *KCHP*, LE 87 (December 1876), 150 (August 1877), 219 (January 1878), 277 (August 1881) and 299 (Fall 1890).

(44) *KCHP*, LE 5 (March 1876); 47, 52 (August 1876); 70, 74 (October 1876); 55 (September 1876); 91 (December 1876); 101, 103 (March 1877); 127 (May 1877); 144 (July 1877); 152 (August 1877); 188, 203, 205 (December 1877); 233 (April 1880); 243 (June 1880); 266, 268, 270 (December 1880); 273 (July 1881); 289 (December 1881); 293 (January 1882); 300, 302 (Spring 1891); and 315 (Spring 1892).

(45) *KCHP*, LE 35 (June 1876), 85 (November 1876), 108 (April 1877), 109 (April 1877) and 244 (June 1880) for example.

Hsü Chien-yin (T. Chung-hu, 1845-1901), son of Hsü Shou (T. Hsüeh-ts'un) and a staff member of the Kiangnan arsenal.[46] Mr. Jen, writing from Anhwei, asked about techniques for wool-bleaching;[47] and Mr. Wang, apparently dissatisfied with the traditional Chinese methods of dyeing, inquired about alternative Western techniques.[48] Not a few letters were inquiries regarding the mysterious techiques of photography and of electro-plating. For example, writing from Hangchow, a reader demonstrated his keen interest in the technique used for copper plating. He asked:

> ... Sulphate of copper is essential in copper plating..., but not only is its price dear in China, it is also difficult to extract it in its pure form. If one desires to manufacture it by himself, would there be a simpler method?[49]

A Mr. Ch'iu, writing from Kiangsi, sought techniques for making emulsion of silver bromide (i.e., gelatin emulsion).[50] A Mr. Wu, obviously possessing the necessary skills for making emulsions, wrote from T'ai-chou, Chekiang:

> Sensitive paper is made by coating the printing paper with *yin-fen* [lit. silver powder, presumably, emulsion]. Photographers can prepare it by themselves. However, its quality deteriorates in a couple of days. It differs from the same paper imported from the West which does not change its color even after several months. Kindly inform me of its method of preparation so that the color can be preserved.[51]

(46) *KCHP*, LE 248 and 249 (August 1880).
(47) *KCHP*, LE 297 (Fall 1890).
(48) *KCHP*, LE 320 (Fall 1892).
(49) *KCHP*, LE 240 (May 1880).
(50) *KCHP*, LE 307 (Summer 1891).
(51) *KCHP*, LE 310 (Fall 1891).

Besides seeking techniques for industrial and commercial production, there were also letters soliciting more economical ways for agricultural production. Two readers jointly wrote to Fryer in April 1876 inquiring about machines employed for such purposes.(52) After collecting and translating the materials, Fryer published a special section in the *Ko-chih hui-pien* two months later dealing with agricultural machinery (tractors, mulchers, scarifiers, rice-hulling machines, etc.). It alone occupied 15 pages — fully illustrated and lucidly explained.(53)

While a great number of readers simply wanted to know how Western technology could be used to expand production and to improve techniques in their private enterprises, there was also a significant number of readers who concerned themselves with the problem of how technology could enhance China's "wealth and power." Reflecting a rising interest in the development of mining in nineteenth-century China were at least 9 letters dealing directly with the problem of adopting Western mining technology. Writing separately in 1876, 1877 and 1878, three readers sought specific information on coal-mining, gold-mining and the ventilation system employed for such purposes.(54) At least five letters in the magazine were inquiries regarding the identification of ores and the techniques of quantitative analysis to determine the profitability of a certain ore.(55) A reader, writing in 1881 from Ch'ang-chou, Kiangsu, was interested specifically in the employment of Western mining engineers to explore a vein of ore in Fukien.(56) Fryer, in reply, raised the issue of the large amount of

(52) *KCHP*, LE 9 (April 1876).

(53) *KCHP*, 2:1-8 (June 1877).

(54) *KCHP*, LE 62 (September 1876), 117 (April 1877), and 212 (January 1878).

(55) *KCHP*, LE 29 (June 1876), 84 (November 1876), 90 (December 1876), 97 (January 1877), and 276 (August 1881).

(56) *KCHP*, LE 286 (November 1881).

capital needed for initial investment in ore exploitation and therefore encouraged the interested readers to organize a joint-stock company.

Demonstrating their desire to enrich and strengthen China, 12 readers wrote (3.7 percent, not including letters on mining) to Fryer about their concern for national defense and various other public imperatives. For example, writing from Honan in 1876, A Mr. Wu was eager to learn the causes of the devastating periodic floods of the Yellow River and means of preventing them.(57) One reader inquired about the method of constructing underwater tunnels (1876), and another suggested that China adopt the running-water supply system of the West (1877).(58) Two readers, writing in 1877 from Sung-chiang and Hankow inquired about the profitability of planting boxwood and the method of purifying cottonseed oil in the hope of benefitting China economically.(59) There were at least two letters concerned with monetary problems. A Mr. Chou wrote from Hangchow in 1877:

> The paper of the money bills issued by Western banks is extremely durable [i.e., soft but tough]. If one holds it against the light, he observes the name of the bank, printed in Western letters, quite clearly. The color [i.e., the watermark] of the letters is either brighter or darker than that of the paper. This is the safest method of printing, for it prevents counterfeiting....(60)

Interested in the problem of minting, a reader wrote from Amoy in the

(57) *KCHP*, LE 11 (April 1876). Curiously enough, fourteen years had elapsed before Mr. Morrison, an English engineer, was invited to give special lectures dealing with the problem. A translated version of his speech can be found in Fryer, *KCHP*, 2:31-34b (Summer 1890).

(58) *KCHP*, LE 58 (September 1876) and 129 (May 1877).

(59) *KCHP*, LE 118 (April 1877) and 158 (September 1877).

(60) *KCHP*, LE 160 (September 1877).

same year:

> Previously, the gold, silver, and copper coins of the West were made by pressing the type matrix onto these substances. Later, minting machinery were devised and built. They are most convenient and are much better than coining manually. Coins minted in China are of a very poor quality and people can counterfeit them without difficulty. If the Chinese copper coins were made by using the Western method, not only would their sizes be standardized, but such a method would also facilitate business. Besides, the price of machinery and of type is not excessively high. Within a few years the capital invested will be balanced by the profits derived from minting....(61)

A certain Mr. Hsü in Shanghai earnestly discussed the pros and cons of building railroads to connect with the Russian lines near the border of Heilungkiang.(62)

While general concern for China's educational needs was curiously lacking, the readers of the *Ko-chih hui-pien* were not entirely apathetic toward at least some aspects of Western-style educational programs — especially the education of the physically handicapped. A Mr. Ku wrote from Tientsin in 1877:

> The blind exist in all countries. They are especially numerous in several localities in China. A great majority of them are fortunetellers, musicians, and singers. These professions, however, contribute little to society and their income is far from sufficient. If they could not engage even in these professions, they would become a burden to those who financially support them. Even if born into rich families, they would

(61) *KCHP*, LE 151 (August 1877). See also Frank H. H. King, "Monetary reform and the mint question," in his *Money and Monetary Policy in China: 1845-1895* (Cambridge, Mass.: Harvard University Press, 1965), pp. 211-228.

(62) *KCHP*, LE 303 (Spring 1891).

> become useless persons if they were simply fed and did nothing the year round....Please explain in detail the techniques used in the West which could also benefit China.(63)

Fryer suggested in his reply the romanization of Chinese language and the borrowing of Western tangible-letter system (i.e., William Moon's alphabet). Four years after the appearance of this letter, another reader wrote to solicit similar advice on the methods of educating the deaf and the dumb.(64) Fryer suggested the manual (sign-language) system in his reply to this inquiry.

Curiosity-motivated Inquiries

Despite the fact that a large number of the magazine's readers were primarily interested in technology or applied science, communications demonstrating the writers' curiosity about and interest in Western scientific knowledge were surprisingly numerous. Included in this category are inquiries motivated by general curiosity regarding non-scientific matters and those motivated by curiosity about scientific subjects with or without previous knowledge of Western science.(65)

A large percentage of the letters analyzed (approximately 21.1 percent of all the 322 letters) indicates a simple curiosity about things that were novel to Chinese custom and practice. For example, a reader in Ningpo

(63) *KCHP*, LE 136 (June 1877).

(64) *KCHP*, LE 230 (March 1880). For an interesting book on a Chinese alphabet for the blind, see Constance Gordon-Cumming, *The Inventor of the Numeral-type for China by the Use of which Illiterate Chinese both Blind and Sighted Can Very Quickly be Taught to Read and Write Fluently* (London: Downey & Co., Ltd., 1898).

(65) Although these sub-categories are not always easy to distinguish, there are two objective criteria used in determining into which group a given inquiry should fall, namely, (1) phraseology—i.e., how an inquiry is phrased or whether there is any scientific nomenclature used? (2) reference—i.e., is there any reference made to a well-known scientist and his ideas and/or any published scientific work?

praised the design of Western diving equipment as "very ingenious" and inquired about the way it functioned.(66) Writing from Shanghai, a reader requested information on the method used for determining the scale of magnification in a microscope.(67) A Mr. Huang wrote to ask the secret of a certain type of magical trick (which was actually based on optical illusions) popular in the West so that he could draw large audiences to make profit in ticket sales.(68) Impressed by the economy of Western alphabets, a reader wrote from Shanghai:

> Twenty four [sic] letters are used in Western languages. All the [European] languages can be expressed by those symbols. China alone has never used them. When and where was the alphabet first used?(69)

A reader in Shanghai asked if the Westerners, like the Chinese, kept genealogies.(70) A Mr. Chou in Canton wrote in 1877:

> In antiquity, Kung-yeh Ch'ang was able to understand the language of birds and Ko Lu of Chieh was able to understand that of the cows. Since these lengendary stories have been passed down orally, we may perhaps assume that such things were not totally inconceivable. Their methods, however, are no longer known. I wonder if there are ways [to interpret the animals' languages] in the West?(71)

A Mr. Yang wrote from Hankow asking why the price of mercury fluctuated.(72) Writing from Amoy, a Mr. Kuo wondered why the Western

(66) *KCHP*, LE 81 (November 1876).
(67) *KCHP*, LE 126 (May 1877).
(68) *KCHP*, LE 138 (June 1877).
(69) *KCHP*, LE 142 (July 1877).
(70) *KCHP*, LE 112 (April 1877).
(71) *KCHP*, LE 153 (August 1877).
(72) *KCHP*, LE 164 (September 1877).

countries annually purchased thousands of piculs of human hair from China,[73] and a reader in Canton expressed his amazement at the techniques of electrotherapy.[74] Writing from Tientsin, a Mr. Wu sought advice on how to eliminate the tattoo on his body.[75] Another inquiry sent by an obscure reader may also be included in the category of simple curiosity. He wished to know why flies and mosquitoes existed.[76]

There were also a great number of readers who, showing no previous knowledge of Western science, were generally curious about some phenomena of nature and were interested enough to address inquiries to the *Ko-chih hui-pien*. For example, one reader wrote in 1876:

> If one rubs against the fur of a cat in a dark place when the temperature is low, he sees sparks, hears a faint popping sound, and his fingers itch.... *What* causes all these phenomena?[77]

Having observed the cracking of several earthenware jars (of large dimensions, for holding water) in a chilly winter, a reader sought an explanation of the *cause* of their cracking.[78] Writing from Tientsin, a Mr. Hsü inquired:

> Hair turns gray and falls when one's age is advanced. A black hair [pulled out before it changes its color], however, does not turn gray, even after one thousand years. *Why*?[79]

One reader wondered *why* high altitude caused him discomfort, and another was puzzled by the change he had observed in the color of human

(73) *KCHP*, LE 209 (December 1877).
(74) *KCHP*, LE 221 (February 1880).
(75) *KCHP*, LE 293 (Summer 1890).
(76) *KCHP*, LE 312 (Fall 1891).
(77) *KCHP*, LE 1 (February 1876).
(78) *KCHP*, LE 2 (February 1876).
(79) *KCHP*, LE 106 (March 1877).

stools.(80) Many more inquiries sent from various localities, while demonstrating no previous knowledge of chemistry, medical science, physics, astronomy or other branches of modern science, showed interest in some scientific interpretation on various matters. Mr. Wang looked for evidence for the existence of carbon in sugar.(81) A reader in Soochow thought that the thermometer used by Western physicians could actually diagnose the patient's symptoms and was therefore curious about *how* the thermometer worked.(82) Mr. Shen wrote from Hangchow wondering if it was physically possible to measure the weight of something as light as a segment of human hair, while another reader asked if electric wire could really transmit human voices.(83) Writing from Canton, Mr. Huang was quite taken with one interesting aspect of sound — echo — and was led to inquire about the *theory* (*li*) behind it.(84) A writer, also in Canton, asked *why* corrosive acids turn wood into charcoal; yet another from Tientsin wondered *why* the world's supply of oxygen was never exhausted.(85) A skeptic among Fryer's readers questioned *whether* water really was a combination of oxygen and hydrogen.(86) Other inquiries of this nature included such questions as *why* it took at least three years for the light from the nearest star to reach the earth, *how* a photometer worked,(87) and *how* dew, frost, cyclones, mirages, and hail were formed.(88)

(80) *KCHP*, LE 168 (October 1877) and 235 (April 1880).
(81) *KCHP*, LE 88 (December 1876).
(82) *KCHP*, LE 116 (April 1877).
(83) *KCHP*, LE 131, 135 (June 1877).
(84) *KCHP*, LE 134 (June 1877).
(85) *KCHP*, LE 170 and 183 (October 1877).
(86) *KCHP*, LE 197 (December 1877).
(87) *KCHP*, LE 201 (December 1877) and 216 (January 1878).
(88) See *KCHP*, LE 195 (December 1877), 217 (January 1878), 220 (February 1880), and 241 (May 1880).

Some of the readers, while retaining their superstitious beliefs about nature, were nevertheless curious enough to seek further explanations. One reader in Ch'ing-chou, Shantung wrote:

> A rainbow is also called *ti-tung* [etymologically, animals belong to the species of serpent or scorpion]. It is the *yin-ch'i* [lit. lascivious air] in the universe created by the licentious coition of the sun and the rain. *How* would the scientist interpret this phenomenon?(89)

Fryer explained the refractive characteristics of light and color in Cartesian and Newtonian terms. A similar superstitious belief can be observed in the question of Mr. Tsou of Sung-chiang, Kiangsu:

> When it is cloudy and there is a rain storm, I can hear something like a ghosts' wail. It is known as the *ti-ch'ou* [lit. earth's mourn]. When I listen to it attentively, the sound then seems to be from somewhere else. I do not know what causes it. When I studied the classics, I discovered the phrase *yüeh-yün-erh-feng* [lit. When the moon turns nebulous, wind starts to blow]. I very often see a ring around the moon which is several times the size of the moon. It is called the *yüeh-chia* [lit. moon's cangue]. Is it wind or is it rain? What causes it? About a month ago I observed a black airy belt stretching from the east to the west across the sky in this area. It did not disperse for several hours. What kind of portent could this be?(90)

Fryer replied in part:

> This office has never seen ghosts, does not know how their wail sounds and therefore has no way to know to which category of melody it belongs....All the unfamiliar phenomena observed in the universe have their basis [in science]. If they are beyond

(89) *KCHP*, LE 223 (February 1880).

(90) *KCHP*, LE 252 (August 1880).

> the knowledge of the present, people will be able to discover them in the future.

Another group of readers was no less curious about nature, but remarkably enough, they seem to have sought scientific explanations on their own, and in the process they had become interested in science itself. What is particularly noteworthy is the fact that several highly technical articles or inquiries were written not by known Chinese scientists and mathematicians, but rather by obscure or anonymous Chinese readers. They demonstrated not merely a certain scientific curiosity but also a degree of genuine knowledge of Western science. For example, one reader wondered about the weight of heat and inquired:

> Heat causes a substance to expand and so does water. But water increases the weight of the substance; does heat also increase its weight?(91)

Fryer seized this opportunity to explain the erroneous conception contained in the "phlogiston" theory.(92) A Mr. Chao, in a critical analysis of Mr. Shih's article on phlegm (which had previously appeared in the *Ko-chih*

(91) *KCHP*, LE 194 (December 1877).

(92) "Phlogiston theory" was first found in J. J. Becher's *Physicae Subterranae* (1669). It was later expounded by the German chemist Georg Ernest Stahl (1660-1734) and was generally accepted by chemists from about 1730 until near the close of the century. Phlogiston, as known to Stahl and his followers, was the substance emitted during combustion and the calcination of metals. Many reactions became comprehensible when interpreted in terms of an exchange of phlogiston, so that often where a modern chemist sees a gain or loss of oxygen, Stahl and his followers saw an inverse loss or gain of phlogiston. Air was thought to be an unreactive medium that was usually present but acted only as a physical agent. Only after Henry Cavendish (1731-1810) engaged himself in serious studies of gases and after Lavoisier's (1743-1794) chemical revolution, when the common gases were discovered, did phlogiston become a big impediment to the interpretation of experimental work. For a fuller explanation, see A. Rupert Hall, *The Scientific Revolution, 1500-1800: The Formation of the Modern Scientific Attitude* (Boston: Beacon Press, 1970), pp. 328-338.

hui-pien), expounded on the human digestive system in an admirable manner.[93] Writing from Chia-shan, Chekiang, Mr. Sun challenged the belief that the theory of the sphericity of the earth was Western in origin. He cited the *Chou-pi suan-ching* (Calculating Methods, completed during the Han dynasty) as proof of its Chinese origin.[94] While an anonymous reader contributed an article on the sources of "force" (*li*), A Mr. Li of Soochow was curious about what exactly determines color.[95]

Several readers were curious about the causes of tides.[96] A fascinating observation sent by a Mr. Chang in Ningpo reads:

> According to the Westerners the cause of [lithospheric] tides is attributed to the moon's gravitational action upon the ocean on the surface of the earth. The earth rotates once diurnally and hence the water [on the surface of the earth] facing the moon rises....This is easy to understand. According to this, however, it should rise only once diurnally. Furthermore, not only the water facing the moon rises, but also the water on the other side of the earth. Therefore, tides rise twice diurnally. This is a fact that can be observed daily. Its theory, nevertheless, is difficult to comprehend....Based upon the gravitational action between the earth and the moon, the surface of the water opposite the moon not only should not rise but actually should fall....[97]

(93) *KCHP*, LE 232 (March 1880).

(94) *KCHP*, LE 263 (November 1880).

(95) *KCHP*, LE 313 (Spring 1892) and 316 (Summer 1892).

(96) *KCHP*, LE 18 (April 1876), 166 (September 1877) and 181 (October 1877). For the significance of the study of tides in the realm of natural sciences, see Harold L. Burstyn, "Galileo's Attempt to Prove that the Earth Moves," *Isis*, Vol. 53 (Part 2, No. 172), 1962, pp. 161-185 and Rear Admiral Leo Otis Colbert, "The Sun, the Moon, and the Tides," Webster P. True, ed., *Smithsonian Treasury of Science* (Washington, D. C.: The Smithsonian Institution, 1960), Vol. II, pp. 440-459.

(97) *KCHP*, LE 166 (September 1877).

Writing from Shanghai, Mr. Sun offered a highly intelligent interpretation of the causes of the tides. Included in his interpretation was a hypothetical gravitational center between the earth and the moon and the existence of a centrifugal force when the earth revolved around this center.(98)

Mathematics and astronomy seem to be two favorite subjects for a number of readers. Inquiries regarding mathematical problems and calculating instruments were many, and at least twelve of them were published in Fryer's magazine.(99) Among them, a certain Mr. Su offered 2024 possible ways of solving a mathematical puzzle which was very popular in the United States at that time.(100) There were at least fourteen letters concerning astronomical matters — all written in highly technical terms. A reader inquired about eclipses and another wrote about the correlation between sunspots and the differing amounts of heat they generate.(101) Questions concerning the movement of planets and those concerning the zodiac, the North and South Poles, and the like were numerous.(102)

In the field of physiology, one reader was curious to know the functions of the spleen, while another, observing the surprisingly large amount of saliva one needs daily, wondered what gland continuously produced it.(103) Inquiries in the field of chemistry and physics were also numerous. While two of the magazine's readers wondered about the nature of

(98) *KCHP*, LE 181 (October 1877).

(99) *KCHP*, LE 17 (April 1876), 40 (July 1876), 63 (September 1876), 76 (October 1876), 111 (April 1877), 119 (May 1877), 196 (December 1877), 245 (June 1880), 250 (August 1880), 255, 256 (September 1880), and 281 (October 1881).

(100) *KCHP*, LE 247 (July 1880). For the puzzle, see 238 (May 1880).

(101) *KCHP*, LE 15 (April 1876) and 279 (September 1881).

(102) *KCHP*, LE 3, 6 (March 1876), 13, 14, 16 (April 1876), 25 (May 1876), 37, 38 (June 1876), 54 (August 1876), 98 (March 1877), and 174 (October 1877).

(103) *KCHP*, LE 124 (May 1877) and 278 (September 1881).

mercury, another reader wanted to know why the magnetic power on a metal bar diminishes and fades away in the course of time[104] One reader, realizing that metal expands and shrinks depending on temperature, sought ways that would allow the pendulum to regulate the movement of a clock accurately, despite the variations of external conditions.[105] Another questioned why certain chemicals were used in photo-developing.[106]

Several readers offered their own observations and experiments. A reader in Shanghai reported on his observations of river tides.[107] A certain Mr. Hua observed the changing position of the rising sun.[108] A Mr. Yao in Ningpo described an experiment with light he performed in a dark room.[109] A Mr. Chou in Amoy, after conducting his own experiments, became skeptical of the age-old Chinese saying that *"chen-chin pu-p'a huo-lien"* or "real metal endures heat."[110] Writing from Soochow, a Mr. Sun pointed out that the Chinese *materia medica, Pen-ts'ao kang-mu*, was wrong when it said that one could extract mercury from *portulaca (ma-ch'ih hsien)*.[111]

Reflecting the interest of some readers in various types of scientific apparatus, Mr. Wang wrote in 1877 from Wuchang:

> I own a telescope. The diameter of the larger lens is a little over 2 inches. I am able to observe clearly the surface of the moon. There are mountains, craters, plains, lakes, and oceans. But according to the Westerners, the moon is devoid of air and

(104) See *KCHP*, LE 48 (August 1876), 64 (September 1876) and 99 (March 1877).
(105) *KCHP*, LE 45 (July 1876).
(106) *KCHP*, LE 306 (Summer 1891).
(107) *KCHP*, LE 18 (April 1876).
(108) *KCHP*, LE 54 (August 1876).
(109) *KCHP*, LE 68 (October 1876).
(110) *KCHP*, LE 141 (July 1877).
(111) *KCHP*, LE 146 (July 1877).

water, has neither plants nor animals, and its surface is freezing cold. Please provide me with concrete evidence supporting this hypothesis.(112)

One reader conjectured that equatorial heat caused the 78-mile difference between the horizontal and the vertical diameter of the earth, and another questioned the existence of carbon in the air, since it looked so transparently clear to him.(113) There were at least a few readers who had developed sufficient faith in Western science to instinctively question traditional Chinese beliefs. For example, one reader doubted the validity of Chinese physiognomy simply because it was Chinese; and another doubted the accuracy of the period of animal gestation recorded in China simply because it appeared only in Chinese literature.(114)

Despite the significant number of letters to John Fryer that indicate the intellectual stirrings among the Chinese literati and the broadening of their interest, it must be emphasized that most Chinese were attracted to Western science and technology by their practical utility. Fryer himself was in fact disappointed by the slow response of the Chinese to the gospel of pure science. As indicated above, among the 322 letters to the editor published in the *Ko-chih hui-pien*, only 123 letters (or 38.2 percent) showed any knowledge of, or interest in, scientific theories or abstract scientific problems. The rest either revealed superficial curiosity about novel Western inventions or demonstrated a desire to adopt Western technology solely to increase China's commercial production or to enhance her wealth and strength. The attitudes of most of the readers of the *Ko-chih hui-pien* in fact

(112) *KCHP*, LE 107 (March 1877).

(113) *KCHP*, LE 202 (December 1877) and 251 (August 1880).

(114) *KCHP*, LE 130 (May 1877) and 206 (December 1877).

paralleled those of the leaders of the self-strengthening movement, although the interests of many literati were in many ways much broader than those of the government leaders; they anticipated the more widespread awakening among the Chinese of the generation after 1895. Most nineteenth-century Americans were by no means less interested in the utility of science and technology than the Chinese readers of the *Ko-chih hui-pien*. Americans, too, were concerned chiefly with scientific and technological ideas which promised immediate material benefit.(115) The difference between China and the United States in this period, of course, is that America, deriving its scientific culture from Europe, always had a group of intellectuals fully in tune with discoveries in basic science, whereas no similar group of intellectuals existed in China. Furthermore, nineteenth-century Americans, though they might not all manifest an active interest in science *per se*, had at least a faith in it. They were living in an environment where rationalism was developed to a high degree. This was, perhaps, not the case in China. Since technological advancement was considered to be the keystone of material affluence in the nineteenth-century West, many Europeans, too, paid far less attention to basic science than to applied or practical science. The intellect of the philosophe, in either Europe or America, never disdained the application of scientific principles to everyday affairs. The case of nineteenth-century China confirms rather than disproves the validity of Perry Miller's proposition that "utility is pursued within universality."(116)

(115) Richard Harrison Shryock, "American Indifference to Basic Science during the Nineteenth Century," *Archives Internationale d'Histoire des Sciences*, No. 28 (1948-1949), pp. 3-18. See also George Daniels, *American Science in the Age of Jackson* (New York: Columbia University Press, 1968), pp. 6-33.

(116) Following Perry Miller's term, "Utility within Universality," in his *The Life of the Mind in America, from the Revolution to the Civil War* (New York: Harcourt, Brace & World, 1965), pp. 287-308.

There were letters in the *Ko-chih hui-pien* which indicate the fact that for some Chinese, at least, the interest in material technology for utilitarian purposes had already developed into a faith in it. In at least one case, the use of machinery in tea planting was suggested, without taking topographical factors as well as labor and other economic conditions into consideration.(117) On the other hand, there were those whose letters reveal a widespread belief that Western technology could be directly transplanted to China. One reader wondered whether apples grown in China could be used for producing apple cider; and another reader was amazed that the telephone at Hongkew, Shanghai, besides being able to handle foreign languages, could also transmit the Chinese language, which he considered very different.(118) Among the *Ko-chih hui-pien*'s readers, we see the emergence of the Chinese desire to introduce Western science and technology in a way that was appropriate to meeting Chinese needs.

It is evident that among the *Ko-chih hui-pien*'s readers who showed interest in Western science and technology, the majority of them were more interested in the practical utility of technology than in scientific truth. But the fact remains that a fair percentage of the readers had shown a genuine curiosity about natural phenomena and, moreover, had written to Fryer in scientific terms, seeking explanations. It is also clear that among Fryer's correspondents only a few revealed a remarkable degree of real understanding of Western science. Several of the readers who wrote letters to Fryer actually held on to traditional Chinese cosmological beliefs, as seen in the letters cited above on the rainbow and on bad weather as ominous portents. Nevertheless, it is not too

(117) *KCHP*, LE 148 (July 1877).

(118) *KCHP*, LE 101 (March 1877) and 207 (December 1877).

much to say that the *Ko-chih hui-pien*, by providing scientific as well as technological information, paved the way for the gradual acceptance of Western science by the Chinese.

If we conceive of science as a theoretical structure or a conceptual scheme regarding the functioning of the natural universe, it is evident that its intrinsic value was not fully realized by the Chinese until the 1910's and the 1920's when the sentiment of "scientism" began to dominate.(119) However, some beginning in this direction was already made in the nineteenth century, and without this gestation period, the later break-through could not have taken place so easily. In light of the deeply entrenched traditional Chinese cosmological views, it is clear that the more than one hundred Chinese readers who responded to John Fryer's message were truly opening a new epoch in Chinese history.

We may further conclude that the letters to the editor, written by Chinese from numerous cities (and by no means limited to the treaty ports), do indicate that there were stirrings in the Chinese consciousness that pointed to a new cosmology—at least to growing doubts about the traditional views of nature and life. While the majority of the writers of the letters Fryer published were probably commercially-minded individuals of urban China, we do know that the readers of the *Ko-chih hui-pien* included such profound thinkers as T'an Ssu-t'ung, later a leading reformer. There must have been other readers of the magazine who were affected by the scientific message yet had no occasion to write to Fryer or whose letters were not published. And if Thomas Kuhn is correct in his idea of a "paradigm" of human values affected by science,

(119) See D. W. Y. Kwok, *Scientism in Chinese Thought, 1900-1950* (New Haven: Yale University Press, 1965).

we can indeed expect the scientific awakening among the Chinese, which took place in these very decades, to generate new attitudes in the realm of ethics and even politics. Western scholars and missionaries such as John Fryer, who introduced science to China, actually prepared the way for the ethical-intellectual revolution that took place in such fertile minds as K'ang Yu-wei, T'an Ssu-t'ung, and even Sun Yat-sen. While few of the *Ko-chih hui-pien*'s readers were endowed with such perceptive minds as K'ang, T'an, or Sun, elements of a new cosmology were nevertheless entering into their consciousness.

APPENDIX

Content of the *Ko-chih hui-pien**

Vol.	Year	Subjects on modern science**	Subjects on manufacturing and technology	Others
I	Feb. 1876 | Jan. 1877	on natural sciences (12)@ astronomy, physics, geology, natural phenomena, chemistry, botany, zoology, physiology scientific theory (2) astronomy pump theory on particles medicine calculating machine chemical apparatus	steam engine, pottery, steam hammer, glass industry, textile industry, sugar industry, fire extinguisher, printing machine, artillery, mining techniques, ice-making machine, needle-making, agriculture	Japan's acceptance of Western science and technology
II	Mar. 1877 | Jan. 1878	new scientific methodology (Baconian) medical science astronomy on tides on insects on phosphorous physiology chemistry	apiculture, carbonated-water industry, typewriter, railway, gunship, gunnery agriculture, textile industry, diving equipment, iron ore, porcelain-making machine, ore refinery, glass-making, icemaking machine, bridge-construction, brick-manufacturing, button-making, earth-drilling, telephone, beer-producing, pump, agricultural machines	1876 International Exhibition in Philadelphia
III	Feb. 1880 | Jan. 1881	apparatus illustrating meterology and chemistry (12) chemistry of common life (12) medical science on electricity (3)	electro-metallurgy (9) photography	military defence (6) on translation (4) history of Russia (5)

Vol.	Year	Subjects on modern science**	Subjects on manufacturing and technology	Others
IV	Feb. 1881 | Jan. 1882	apparatus illustrating chemistry (12) chemistry of common life (12) on tides	gun-powder machinery (4) iron plant in England (6) artillery, scientific apparatus of physics, slide-projector, hemp industry, cement-manufacturing	geography (3) coastal defence (5)
V†	1890	apparatus illustrating mechanics, hydrostatics, and pneumatics (4) medical science—the sphygmograph (4) Western *materia medica* (4) entomology (3) calculating machine engineering	railway, typewriter, electric lights, steam engine and boilers (2), engineering, machinery and appliances, 'dynamo'-constructing, river engineering, mechanical contrivances (2)	Western drawing (4) sericulture horticulture linguistics (4) sanitary science (4) pearl fishries
VI#	1891	apparatus illustrating photography, microscope, telescope (4) Western *materia medica* (4) entomology therapeutics (4) lymph for tuberculosis physiology (3) on electricity (3) physical geography (2) table for equations of time	steam engine and boilers, sugar industry (2), dyeing industry, artillery, candle-making, ice-making, new machinery for manufacture of "lucifer" matches, 'Kinetograph,' warships	discoverers of land coinage geological notes
VII	1892	apparatus illustrating surveying instruments Western *materia medica* (3) on electricity (3) on light men and microbes medical science zoology (2) on the exact sciences (2)	textile machinery, manufacture of cotton-seed oil, notes on mineralogy, paper-manufacturing, copying machine, printing techniques, rice-hulling machine, steel industry, leather-making (2), artillery, map-constructing	on James Watt, World's Columbian Exposition at Chicago (2)

* An exhaustive list is impossible; one has to be selective. Due to the inconsistency of length of each article or essay, this table does not attempt to demonstrate a general trend of thought of the readship year by year. It attempts, rather, descriptively to provide a rough outline of the entire body of the *Ko-chih hui-pien.*

** The relation between science and technology is extremely complex. Science without the byplay of technology becomes sterile and technology without science becomes moribund. The arbitrary division of articles on science and technology under separate categories made here is based primarily upon their respective approaches and orientation. For instance, articles on calculating machines and apparatus are aimed essentially at introducing science to the magazine's readers and hence are found under the category of science.

@ The numerals in the parenthesis indicate numbers of installments for long essays.

† The journal in question changed from monthly to quarterly publication from this year forward.

The Medical Missionary-Association of China adopted the *Ko-Chih hui-pien* as its organ in the Chinese language from the spring issue of 1891 on.

GLOSSARY

Chao Yüan-i	趙元益
Chen-chin pu-p'a huo-lien	眞金不怕火鍊
Ch'eng P'ei-fang	程培芳
Chiang Heng	江 衡
Chiao-hui hsin-pao	教會新報
Ch'ien Chi-po	錢基博
Chou-pi suan-ching	周髀算經
Chung-Hsi chiao-hui pao	中西教會報
Chung-Hsi wen-chien lu	中西聞見錄
Chung-kuo suan-hsüeh shih	中國算學史
Hsi-Chin ssu-che shih shih hui-ts'un	錫金四哲事實彙存
Hsiao-hai yüeh-pao	小孩月報
Hsü Chien-yin (T. Chung-hu)	徐建寅(仲虎)
Hsü Shou (T. Hsüeh-ts'un)	徐壽(雪村/邨)
Hsü Yang-hu	徐仰虎
Hu-hsiang wen-ta	互相問答
Hua Heng-fang	華衡芳
Hua I-lun	華翼綸
Hua Shih-fang	華世芳
Hua-t'u hsin-pao	畫(花)圖新報
I-chih hsin-lu	益智新錄
K'ang Yu-wei	康有爲
Ko-chih hui-pien	格致彙編
Ko-chih shu-yüan hsi-hsüeh k'o-ch'eng shu-hsüeh k'o-t'i	格致書院西學課程 數學課題

Ko Lu of Chieh	介葛盧
k'u-chiu	苦酒
Kuang-hsüeh Hui	廣學會
Kung-yeh Ch'ang	公冶長
li (theory)	理
li (force)	力
Li Jen-yen (sic.) (Li Yen)	李人言(李儼)
Li Shan-lan	李善蘭
ma-ch'ih hsien	馬齒莧
Min Erh-ch'ang	閔爾昌
Pei-chuan chi pu	碑傳集補
Pen-ts'ao kang-mu	本草綱目
Shanghai hsin-pao	上海新報
Sun Yat-sen	孫中山(逸仙)
T'an Ssu-t'ung	譚嗣同
ti-ch'ou	地愁
ti-tung	螮蝀
T'ung-wen Kuan	同文館
Wan-kuo kung-pao	萬國公報
Yang Mo	楊模
yin-ch'i	淫氣
yin-fen	銀粉
yü shih wu hua-jen t'an-so ti-yun chin-chih li chih so-i-jan	欲使吾華人探索底蘊盡知理之所以然
yüeh-chia	月枷
yüeh-yün-erh-feng	月暈而風

格致彙編 (1876至1892) 讀者來函之分析

李 三 寶

中 文 摘 要

十九世紀以中文譯著介紹西方之自然科學知識與製造技術者，以英士傅蘭雅 (John Fryer, 1839–1928) 爲最勤，前後譯述西書竟達百餘種。傅氏主編之「格致彙編」雜誌，出版於1876至1892年間，爲研究中國近代科學史之重要資料。

科學與技術之相互關係，本甚複雜難論。傅氏力持前者爲本，後者爲末，勸我國士大夫勿急功近利，捨本逐末。但中國屢遭外侮，非富國强兵不能圖存。一般士大夫自以學習西國技術爲當務之急，於基本自然科學知識則頗淡漠。十九世紀中葉雖有華衡芳，李善蘭等數人專研數學，一般士商之興趣則多止於製造技術而已。新舊價值之替換轉移有時雖因種種文化及制度因素之障碍而遲滯緩慢，然在西潮激盪之下，推陳出新乃不可避免之事。「格致彙編」刋印之讀者來函及編者覆函，即「互相問答」一欄，固可反映當時士商急於功利之傾向，然亦可爲西方近代科學知識在中國逐漸萌芽生長之明證。本文分析1876至1892年間「格致彙編」讀者與傅氏來往信函計三百二十二件，其中至少有一百二十三件 (38.2%) 顯示讀者對科學理論確有若干程度之認識及相當之興趣。茲先略述傅蘭雅與「格致彙編」在中國科學史之地位，再介紹「互相問答」欄之內容。

(一)

傅蘭雅乃英國一牧師之子，自幼即對中國發生濃厚興趣。1861年，傅氏二十二歲，自英抵香港，於聖保羅學院執教兩年。1863年至北京同文館任英文教席，同時研讀中國書籍。越二年，易地上海，暫任「上海新報」編輯。1868年應上海江南製造局之聘任翻譯，自是羈留是職二十八年，其間一以介紹西方科學技術爲志。至1896年始辭職赴美，執教於加州大學 (1896–1913)，傅氏仍繼續西書中譯之工作，其忠於譯事者如此。據錢存訓先生之統計，1810至1867年間我國新成科學譯著僅有

四十七種。然1850至1899年間出版者，則有三百九十九種。其中出自傅氏及其助手徐建寅，徐壽（雪邨），華衡芳，趙元益及江衡等之手者計約一百一十五種，將近三分之一。傅氏譯著之嚴謹與精勤實超越晚明清初之傳教士。明清耶穌會教士多以介紹科學爲達到傳教目的之手段。傅氏則以傳播西方科學知識本身爲目的。於晚清民智之開啓與士人價值觀念之轉變影響頗大。

古語云：「工欲善其事，必先利其器。」十九世紀、西洋科學書籍中譯本每因名詞術語不統一而混淆不明，讀者苦之。傅氏於1888年出版「譯者手冊」爲科學名詞之統一開先河。此手冊且成爲十九世紀末提倡科學者不可少之工具書。傅氏所譯化學、醫學、礦學等術語皆經縝密思考而成，至今仍多沿用。

「格致彙編」創刊於1876年二月，爲中國最早之科學技術專刊。當時艾約瑟(Joseph Edkins)及丁韙良(W. A. P. Martin)等編輯之「中西聞見錄」(1872-1875)以及林樂知(Young J. Allen)編輯之「益智新錄」(1876-1878)雖亦介紹西方科學技術，但「中西聞見錄」除介紹數學、天文、法醫(medical jurisprudence)、光學以及防洪工程外，着重敍述中西政治、歷史、風俗之異同。整體而言，乃屬通俗刊物性質。「益智新錄」中雖偶刊有培根科學方法論以及有關天文、熱力學之科學短文，然乃以聖經教義之譯述與介紹爲主旨。其他如「上海新報」、「教會新報」、「萬國公報」、「小孩月報」、「畫(花)圖新報」、「中西教會報」等刊物雖各有其貢獻，亦皆非專門介紹科學知識之刊物，即或有此類文字，亦散漫而無系統，遠不如以科學技術爲唯一內容之「格致彙編」。

傅氏認爲自然科學之基本知識雖不如製造技術之眼前即可見諸實用，却爲一切技藝之根本，萬萬不可忽視。「格致彙編」第一年，自創刊起至1877年一月止，每月一期，共十二期，已將西方自然科學知識之菁華作有系統之介紹。舉凡天文、重力、地質、礦物、熱力、植物、動物、生理、光學、磁學、化學及自然現象諸門無不兼羅並包。其目的在使讀者對各門科學先有一概括之認識。傅氏又鑒於中國缺乏西方自吉柏特(William Gilbert)、伽俐略(Galileo Galilei)、波義耳(Robert Boyle)、虎克(Robert Hooke)、牛頓(Isaac Newton)以來逐漸發展之物理實驗傳統，故於1880年二月至1892年春季間共三十三期中介紹各種科學儀器之功能與

用法，並附圖不下千數百種。所刊圖版都於英國製鑄寄華。傅氏介紹之儀器包括氣象學、化學、重力學、流體靜力學、天文學、生物學、測繪學等所用之器具。至於純理論方面，傅氏則提倡培根之科學方法論。惜當時一般讀者之興趣多在實用技術方面。傅氏亦不得不遷就此種傾向，譯載有關實用之文字。例如鐵路之舖設、河渠之修濬、蒸汽引擎之性能、蠟燭火柴之製造、軍器、印刷、漂染、輾米、電話、電鍍、攝影等技術皆一一介紹（見英文稿附錄）。「格致彙編」此三十三期中，一般基本理論科學所佔之比重漸有不及實用科學與技術之勢。惟就傅氏本人而言，其勸人勿捨本逐末之原意並未改變。「格致彙編」前後出版六十期（1876年二月至1877年一月、1877年五月至1877年八月、及1890年春至1892年秋季停刊），其中二十七期皆有特闢之「算學奇題」欄，可見傅氏對於數學的確重視（惜所謂「奇題」乃限於算術與平面幾何，而未及於解析幾何與微積分，殊美中不足）。其目的在於刺激讀者對科學之興趣。同時「格致彙編」每期皆刊印有關基本科學之材料，從未間斷。

「格致彙編」之銷售量頗爲可觀。創刊時僅印三千份，未料銷路甚佳，爲應讀者需求，傅氏於九個月後即將已出九期再版出刊。新出各期之銷售量亦逐年增加。代銷處於1876年僅二十四處，至1880年四月增至三十八處。該年底，竟突增至七十處之多，分佈於通商口岸十八個城市及其他非通商口岸之大小城鎮二十一處（(一)遼寧省：牛莊。(二)江西省：南昌、九江。(三)山西省：太原。(四)江蘇省：揚州、蘇州、上海、南京、鎮江、邵伯。(五)浙江省：杭州、寧波、溫州。(六)福建省：福州、厦門。(七)廣東省：廣州、汕頭。(八)安徽省：安慶。(九)直隸：北京、天津、保定。(十)山東省：煙台、濟南、青州、登州。(十一)湖北省：漢口、武昌、宜昌、沙市、武穴、興國州。(十二)湖南省：長沙、湘潭、益陽。(十三)四川省：重慶。(十四)廣西：桂林。(十五)臺灣省：淡水。(十六)香港。(十七)新嘉坡。）該誌通行之廣足證在甲午戰爭以前之十餘年間，當時中國士商對科學技術、知識之興趣，已不斷增長。

（二）

「格致彙編」除介紹西洋科學技術知識外，特闢「互相問答」一欄以引起讀者

之興趣，並爲讀者解釋疑難問題。讀者來函甚多，傅氏不能一一爲之發表，惟傅氏對渠選印之函件，則不厭其煩，皆予以詳覆。本文所分析之三百餘「問答」概可分爲兩大類別：其一爲求實際效用者，其二爲純粹出於好奇心或進一步探求事物之理者。前一類讀者對科學理論之探求無甚興趣。後一類則除表示對一般事物現象之好奇外，並顯示對現代科學知識確有興趣，且非全無所知。本文分析乃注重中國士商對於科學技術之態度與認識，對傅氏覆文之內容則從略。茲將讀者來函之兩大類分述如次：

(一)求實際效用者。此類問答計一百二十九件，約佔所有發表之讀者來函總數40%。來函者興趣多在尋求立可奏效之實用技術，計有：(甲)關於醫藥者二十六件。提出之問題有石灰入目如何治療、苦酒(啤酒)是否可充補品、多尿病、氣喘、眼疾等如何醫治、鴉片癮如何戒絕、減肥及麻醉止痛有效辦法等。(乙)關於改良農業技術，增加日用輕工業品產量者，凡七十九件。如硫酸、硝酸、沙漏、蠟燭、繩索、火柴、薄荷、火藥、鉛筆、螺絲、電燈、墨水、肥皂等物之製造，又如冶金、鍊鋼、提鉛、提錫、漂染、攝影、電鍍之法等。(丙)關於使中國富强之一般政策者凡二十四件。有詢農耕機器者、有詢西國鑄錢廠之設備者、有詢礦場之設計與礦石之開採方法者、有詢黃河水患如何根治者、有詢西國盲聾教育者、亦有詢防俄之策者，不一而足。大體言之，「格致彙編」讀者興趣之範圍較當時自强運動領導人物之政策爲廣。

(二)出於好奇心或進而探求事物之理者。科學思想之發萌滋長有賴於人類對自然現象之好奇與進一步有系統之不斷鑽研。純倫理道德及心性運命之思考以及對自然界風花雪月之審美，雖各有其價值，俱無助於科學之發微。中國哲學思想體系中雖不乏老莊對自然之喜愛或宋儒對所謂格致之闡釋，惜殊少對自然作更進一步有系統之探索。宋明之學術傳統若非落於空洞之玄想則止於修齊治平之個人道德或社會政治問題而已。然自與西洋接觸漸繁後，國人探究自然與技藝之興趣逐漸增加。此種趨勢反映在「格致彙編」問答欄中可分三類。

(甲)因新奇事物之刺激發生好奇心，但無進一步探究其理者計六十五件。如寧波一讀者聞西國有潛水衣之發明，想「其法必甚靈巧」。傅氏於次年七月竟以十二

頁之篇幅詳答。湖北項姓讀者函曰：「天地化生無一無益之物，若蠅蚋蚊蜢之類，究有何益？…不知泰西博物君子有詳究之者否？」電話乃美人貝爾（Alexander Graham Bell）於1876年發明，而1877年六月卽有一上海讀者投函云：「美國有人設法用電線傳聲者，離數千里之遠，能聞聲而知何人之言語，此事甚奇…」表示急於一睹其物之意。此外有問西國何故向中國購買人髮者，有問望遠鏡與顯微鏡放大倍數測知之法者，有問水銀漲價原因者，茲不一一列舉。

（乙）由自然現象之觀察而發生合理且有趣之疑問，並探究其原因者。例如：某讀者問何故天冷時於暗處用手逆摩貓背，時見有細火發出，並有極微之響聲且手指感覺微癢。此等現象「胡爲乎來？請刋於『格致彙編』，以廣見聞。」天津許君問：「人髮年老則白，而脫落之黑髮則千年而不白，不知何故？」山東一讀者函云：「人登高常覺頭悶膚漲，何故？」陽湖呂姓讀者問：「人飲食，飲入者是黃色，何以便出者反成白色？食入者是白色，何以便出者反成黃色？」廣州黃君問：「本省有數處山中能聞回聲，最爲奇異。又有回聲至四、五次者，請問其理若何？」另一位廣東讀者問：「强水滴于木上必以水洒之，不然其木卽變黑色而壞，請問其故。」天津有筆名虛心子者函問：「閱格致之書，見有人物呼吸或燒火或腐爛各物或造釀必需養〔氧〕氣之說，但歷古以來世上之生齒甚繁，林林總總者難以數計。由何而得此養氣以敷日用乎？且世上之養氣亦能用盡否？」此外，科學求證之精神亦見於某些詢問函件之中。如漢口一讀者問：「現代化學書言糖內含炭質，有何便法能得其憑據？」蘇州某讀者來函：「嘗聞水係輕〔氫〕養二氣化合而成者，但不知由何考知？若以輕養二氣試之，果能化合成水否？」諸如此類對自然現象表示好奇之函件登出者計有六十件，傅氏皆於「問答」欄內根據科學理論一一詳答。

（丙）讀者中對於科學理論已有若干程度之知識，能以簡單科學觀念分析解釋自然現象者亦非少數。此類信函計六十三件。如上海有人問：熱與水俱能使物體膨漲，後者可增加物體之重量，前者亦可否？傅氏除予以解答外並藉機駁斥所謂「燃素」理論之謬誤。對潮汐現象有興趣之讀者亦有數人。如1877年九月份載寧波張君函曰：

「西人云潮水之故，因地球面之海洋爲月所引攝。地球每日一周，則對月之水面必凸出，而在凸處略爲漲足，此爲易明之理。而照此理，一日一夜，應漲滿一次。又云不但對月之水有此事，卽背月之水亦然，故一日一夜有潮水漲落兩次，此爲每日目見之事，但其理難明。因背月之水能凸出之故尙未考明。以地心之攝力並月之攝力而論之，則背月之水面不但不應漲反應落。予久思此事，愈思愈窒。卽查中國所有論潮水之書，亦不言明。故請問西書中如何論此事？」

上海一孫姓讀者更將其本人對潮汐現象之解釋函寄傅氏求教。此函甚能表示其對物理與天文方面之知識，茲全錄於下：

「西書謂地球繞日而行，實非日爲心，乃是日與地之公重心爲心。故地與日皆繞公重心行。然日體大而地體小，其公重心必在日邊。故日居中央不動，地球繞之以行，其實日球亦繞公重心也。月繞地球者亦然。如畫兩圈爲地月兩球，則兩圈心之間必有一處爲地與月之公重心，設命爲甲，則地球每月必繞一週。夫地球旣繞甲旋行必有離心力生焉，則地面之水必背甲而行。所以如命地面背甲之處爲丙（卽背月之處）則海水必凸起，又向月之處，海水被月之吸力吸聚，亦必凸起。故月在天心之時，月在地底之時均有潮來，卽所謂潮汐是也。此係鄙意杜撰，於理未知然否？」

傅氏除答覆問題之外並對孫君之好奇心與知識表示讚佩。其他讀者對天文現象如日月蝕，黃白道及天體之運行等表示有相當瞭解者，亦有數人。本文分析之信函中，至少有十四件提出有關天文學相當專門性之問題。

當時讀者實驗求證精神之端倪可從數件信函中看出。如寧波姚姓讀者曾仔細觀察日光透過室壁小孔之現象。初發現其孔雖方，而日影爲圓形。彼乃將此方孔改爲三角形，發現日影仍圓。然將該三角形放大至某一限度後再觀察之，則發現日影變爲三角形。厦門周君對中國古諺「眞金不怕火鍊」表示懷疑，竟以眞金試驗數次並以準確之天平稱之，發現其量實有減少。此類實驗雖極簡單，然所代表之實驗精神就十九世紀中國而論，殊難能可貴。讀者來函中有論述甚詳者，有善用專門名詞者；其中若干篇或可以論文視之，其作者且非當時少數知名之科學家或算學家，足證十九世紀晚期中國士商對西方科學有興趣而潛心研習者，已不乏其人。若干讀者由於對西方科學技術之興趣而逐漸對西學有信心，對中國傳統書籍中之若干觀念或

記載表示懷疑。如漢口某讀者以爲「西國最講格致之理」，因而懷疑中國命相之法，並詢求「西國相法」，因其「必有實據」也。上海某讀者函傅氏云：「獸族孕字之月數各有不同，中國書中所誌之數恐有差誤，因不詳察之故。」彼詳詢西方關於禽獸懷孕之月數，以爲必較中國古書所云爲有據。

綜觀上述對「格致彙編」讀者來函之分析，十九世紀晚期約在光緒初年之際，中國士商已不乏眞正對科學本身發生興趣或已有心得者（約佔讀者來函百分之 38.2 %）。但讀者中爲功利之目的而對科學技術發生興趣者仍佔多數(61.2%)。傅氏雖提倡純科學，但亦不得不遷就讀者興趣而登載有關實用之文章。其實即在十九世紀之美國，一般人對科學技術之態度亦多著重實際生產技術而忽視基本理論科學。然而美國之有異於中國者在其承襲歐洲自十六、七世紀「科學革命」以來逐漸發生滋大之科學傳統，且大學教育發達，於科學方法與理論之認識以及科學精神之培養皆遠勝於當時之中國，吾人治史者，可不必諱言。然若就中國歷史而言，則自十九世紀中葉以降實爲現代科學萌發之時代。清初及清中葉國人對曆算學雖有興趣，而士人眞正對科學技術之重視，實始於咸豐朝之後。依本文提供之材料，士人對於科學知識追求之興趣，隨新式教育之發展，至光緒中葉已有日增月盛之勢。嗣後至二十世紀二十年代，中國知識份子對於西方科學之認識與興趣已衍成普遍之風氣，影響文化與學術，至爲深巨。然吾人研究中國近百年現代科學發展之背景，實不能不上溯於同治、光緒兩朝先知先覺之士之努力。而西人如傅蘭雅之貢獻亦不可抹殺。抑有進者，光緒中葉國人在科學方面之覺醒，在一般文化、倫理、政治上皆有極大之影響。人俯仰於大自然中，凡對天文與物理現象之了解不免影響其對宇宙整體之認識。一切價值觀念亦無不隨人對自然之認識而演變。著名科學史學者湯馬士、孔(Thomas S. Kuhn) 在其名著「哥白尼革命」(The Copernican Revolution: Planetary Astronomy in the Development of Western Thought) 中特別强調科學革命之多元性 (plurality)，蓋科學爲文化之一面，而其影響又遍及文化之各方面也。哥氏之太陽中心說取代亞里斯多德以來爲一般人堅信之地球中心說無疑爲近代科學革命之核心因素。但天文理論之創新實僅爲當時整個歐洲思想革命之一方面而已，然「哥白尼革命」影響所及，則遍於歐洲文化之各方面。吾人欲了解「

哥白尼革命」之背景固不可不於天文理論之外尋求解答；而同時欲探研歐洲自十六世紀以來之社會政治學說與制度之演變，以及法國大革命以來對人權之逐漸重視及十八世紀啓蒙運動思想家 (les philosophes) 如盧梭(Rousseau)，孟德斯鳩(Montesquieu)，伏爾泰 (Voltaire)，達朗貝爾 (D'Alembert)，狄德羅 (Diderot) 等思想之形成亦不能不探究自哥氏以降新天文理論對一般思想之影響。光緒中葉乃中國現代科學萌發之時代，亦適爲變法革命運動初起之時代。中國新舊宇宙觀之逐漸交替實爲戊戌變法及辛亥革命重要之思想背景。此點牽涉問題頗多，容另文闡論之。

一九七四年三月成稿於加州大學戴維斯校區