
Some Aspects of the Introduction of Modern Science into China

Author(s): Cyrus H. Peake

Source: *Isis*, Vol. 22, No. 1 (Dec., 1934), pp. 173-219

Published by: [University of Chicago Press](#) on behalf of [History of Science Society](#)

Stable URL: <http://www.jstor.org/stable/225331>

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Some aspects of the Introduction of Modern Science into China

1. One of the most significant aspects of modern history is the transformation which China is undergoing in reaction to the impact of Western civilization. Among the most vital and fundamental phases of this modernization is the introduction of Western science and the application of its methods to the study of the physical and social phenomena of the country and its civilization. This phase of what may be called the Chinese Revolution—to use the word in its largest sense—was, interestingly enough, the first to develop. It is the purpose of this paper to outline the history of modern science in China during the three and a half centuries that have elapsed since it was first introduced by the Jesuits in the seventeenth century. From the historical point of view the subject divides itself into four periods, each of which represents a distinct phase. The first period extends from about 1600 to 1800. The second period includes the greater part of the nineteenth century from 1800-1895. The third period covers the years from the close of the war with Japan to 1912. The final period covers the twenty odd years since the establishment of the Republic.

2. The first two periods, which cover a span of nearly three centuries, brought China in contact with Western science at two epochs of its development. Seventeenth and eighteenth century science was brought to China by Catholic missionaries; while nineteenth century science was introduced largely by Protestant missionaries. Neither of these groups would have accomplished as much as they did had it not been for the assistance of a number of Chinese scholars whose thirst for knowledge was left unsatisfied by their own science. They frequently sought out the “Ocean men” eager to learn more of their science and willingly assisted

them in the arduous tasks of translation. During the first period the Catholic missionaries and their Chinese co-workers translated and published no fewer than seventy-one works of a scientific character. Eleven of these dealt with science and machinery in general, twelve with arithmetic, geometry and trigonometry, forty-four with astronomy and four with geography (1).

3. The Jesuits made themselves welcome at the Ming and the Manchu Courts in Peking, largely because of their ability to make accurate astronomical observations and to correct the calendar which had fallen into error at the hands of the Moslem members of the Astronomical Bureau (Ch'in T'ien Chien — 2114, 11.208, 1640) (2).

4. Certain of the Jesuits including Fathers URSIS, SCHALL and VERBIEST were for many years in charge of the calendar as members of the Imperial Astronomical Bureau. Other evidence of the reception accorded the westerners and their science in this earlier period is found in the Ming history where it is

(1) CORDIER, HENRI, *L'Imprimerie Sino-Européenne en Chine*, Bibliographie des ouvrages publiés en Chine par les Européens au XVII^e et XVIII^e siècles, Paris, 1901. For a fuller account of the publications of the Jesuits in China see *Notices Biographiques et Bibliographiques sur les Jésuites de l'Ancienne Mission de Chine, 1557-1773*. Tome I, XVI^e et XVII^e siècles, 561 pp., Chang-nai, 1932. For a description of the foreign and Chinese works on astronomy and mathematics which appeared in this and the following periods see WYLIE, A., *Notes on Chinese Literature*, (Shanghai, 1867) pp. 86-104. On the translation of ARISTOTLE into Chinese see CHANG EN LONG, "Europeans in China between the Ming and Ch'ing Dynasties." (in Chinese) *Library Science Quarterly*, Vol. IV, No. 3, 4, (Sept.-Dec. 1930) p. 452, and CLOUGHERTY, FRANCIS, "The Publications of the Catholic University of Peking," *Bulletin of the Catholic University of Peking*, No. 6 (July, 1929) pp. 69-72. The latter article tells of the recent publication in three volumes of the *Ming Li T'an* (7940, 6879, 10.688) a treatise on logic based on a compendium of scholastic philosophy used as a textbook in the college at Coimbra, Portugal which was translated by Father Furtado and Li Chih-Tsao.

(2) The numbers following Chinese words are the character-numbers given in H. A. GILES' *Chinese-English dictionary* (Shanghai, 1912). See HUMMEL, ARTHUR W., "Chinese, Japanese, and other East Asiatic Books added to the Library of Congress, 1930-31" *Report of the Librarian of Congress*, 1931, pp. 269-271, for interesting evidence of the severe punishment meted out to officials responsible for miscalculations in drawing up the calendar and the bitter opposition in certain Chinese quarters to the appointment of Jesuits to the Astronomical Bureau. For a select bibliography and critical comments on the development of astronomy in China from ancient times see VACCA, G., "Some Points on the History of Science in China", *Journal North China Branch Royal Asiatic Society*, N. S. Vol. 61 (1930), pp. 10-19.

written that the "majority of the books which they (the Jesuit missionaries) have written are what the Chinese have not yet treated of." (3).

5. With respect to the nature and extent of the influence of Western science in the seventeenth and eighteenth centuries on Chinese thought in general and their indigenous science in particular it is impossible, at the present stage of incomplete research in the field, to make a satisfactory appraisal. Differences of opinion exist. For example, the influential writer LIANG CH'I-CH'AO (4) believed the missionaries profoundly stimulated the literati of those centuries "opening to (them) a hitherto unknown world of ideas and providing (them) with a better logical method than China had yet known." With this statement the equally eminent scholar HU SHIH disagrees (5).

(3) For foreign names see *Index A*. MOULE, A. C., "The first arrival of the Jesuits at the capital of China," *New China Review*, Vol. 4, p. 455. The Jesuits of course adhered to the Ptolemaic system; "... and although COPERNICUS, TYCHO BRAHE and even KEPLER are frequently mentioned by name in connection with their labors, there is only slight allusions to the systems which have received their designations from these astronomers." Quoted from WYLIE, *op. cit.*, p. 88.

(4) For Chinese Names see *Index B*.

(5) LATOURETTE, K. S., *A History of Christian Missions in China*, (New York, 1929) p. 196; BERNARD, HENRI, S. J., "Whence the Philosophic Movement at the Close of the Ming (1580-1640)?" *Bulletin of the Catholic University of Peking*, No. 8 (December, 1931) pp. 67-73. Father BERNARD attempts to build up a case in support of the thesis that MATTEO RICCI perhaps influenced KU YEN-WU, the reputed founder of the Neo-Han school, the precursor of the modern philosophical renaissance and opponent of Sung Confucianism. He points out that RICCI went directly to the Han texts long before KU did. "Not content with securing a hearing from the Confucianists by rejecting idolatry, RICCI acted as innovator, and with the texts of CONFUCIUS in his hand, overthrew the insinuating exegeses of the commentators of the Sung dynasty..." (p. 70). While BERNARD does not specifically say so it appears that RICCI wished to strip Confucianism bare of the Buddhistic and Taoistic influences which the Sung philosophers had introduced in order to prepare the way for a possible synthesis of Confucianism and Christianity. The critical methods which he employed to achieve this purpose were perhaps of influence on KU YEN-WU and those who followed him. BERNARD put forth as other arguments that "... nearly all the scholars of the neo-Han school... passed through the discipline of the mathematical sciences brought to China by the Jesuits." while, his faithful disciples exercised great influence on the Tung Lin (12.248-7157) school (p. 73). On the other hand it should be pointed out that the Chinese scholars had developed methods of research prior to the arrival of RICCI in China which were in advance of those prevailing in Europe at that time. Moreover, the political events of the time marked by the decline of the native Ming dynasty and the conquest of China

6. Nevertheless, works published during and after this period of Catholic missionary activity, particularly in the field of mathematics, disclose marked western influence. For example, in the *Shu Li Ching Yün* (10,075, 6879, 2133, 13.833) published in 1723 by Imperial order, there is a comprehensive summary of mathematics, incorporating such Western developments as had found their way to China. It contains the earliest description of European algebra and the earliest complete treatise on logarithms in Chinese (6).

Also there was published in 1875 a large collection of mathematical works, the *Pai Fu T'ang Suan Hsüeh Ts'ung Shu*, (8556, 3617, 10.760, 10.378, 4839, 12.039, 10.024) wherein marked western influence derived in part from this first period is readily discernible (7).

7. The scientific work of the Jesuits appears to have started a revival of learning with respect to the native sciences, particularly mathematics. During the greater part of the Ming dynasty (1368-1644) native science had fallen into a low state; mathematical and astronomical studies being in abeyance resulting in many errors in the calculations of the calendar. It was the demonstrated superiority of the Jesuit methods which won for them the recognition of the Court [as we have seen.] The translation of western mathematical and astronomical works stimulated in the native scholars an interest in their own science as shown by the number of works that commenced to appear during the seventeenth century and continued to be put forth from then on into the nineteenth century, when renewed contacts with the West caused a resurgence of interest which has continued with vigor to the present time (8).

by the alien Manchus were a sufficient cause influencing a large number of literati to question the validity of Sung Confucianism. In this connection see HU SHIH, "The Chinese Renaissance," in the *China Year Book*, 1924, pp. 633-651.

(6) PEAKE, C. H., *Nationalism and Education in Modern China*, (New York, 1932) pp. 215, 216. Also see VAN HÉE, LOUIS S. J., "Première mention des logarithmes en Chine," *T'oung Pao*, Vol. 15 (1914), pp. 454-457 and WYLIE, *op. cit.*, pp. 89, 90. The first mention of logarithms appeared in the book *T'ien Pu Chên Yüan* (11.208, 9485, 589, 13.700) about 1650 by HSIEH FÈNG-TSO, a student of the Polish Jesuit SMOGOLENSKI.

(7) VAN HÉE, Père L., "Bibliotheca Mathematica Sinensis Péfou," *T'oung Pao*, Vol. 15, (1914), pp. 111-164.

(8) One of the most valuable of the recent studies is the first volume of the *Chung Kuo Suan Hsüeh Shih*, (2875, 6609, 10.378, 9893) "A History of Chinese

8. ALEXANDER WYLIE writing in the middle of the last century stated that, due to the fact that mathematical studies having been long dormant in China, when the Jesuits arrived, "... few if any of the native scholars knew what the ancient works contained, and the missionaries were left to teach many things as new, which had been well understood in China for ages past. The consequence was, the introduction of a new nomenclature in place of the old established terminology, and the latter having since been restored by native mathematicians, there are now two systems of terms, both of which being partially or simultaneously adopted in many modern treatises, have introduced a looseness and inaccuracy of phraseology, little to the advantage of mathematical studies" (9).

9. Père VAN HÉE, an outstanding authority on Chinese mathematics has critically evaluated the nature of this influence in his comments on YÜAN YÜAN's collection of biographies of mathematicians (10).

Therein he observes that the "Chinese display no special taste for and no real aptitude in the study of pure mathematics. To them it is the calendar and the observations of celestial phenomena that prove the most interesting, and in these biographies there is twenty times as much attention paid to astronomy as to any other subject" (11).

It is his conclusion that, "Not one of the learned men of China succeeded in completely assimilating European methods" (12).

Mathematics" published by the Academia Sinica. This volume covers the development to the time of the introduction of European mathematics in the latter part of the Ming dynasty.

(9) *Notes on Chinese Literature*, p. 95.

(10) VAN HÉE, Père L., "The Ch'ou-jên ch'üan of YÜAN YÜAN." *Isis*, 1926, pp. 103-118. For further observations by the same author on Chinese mathematics see his article, "Le Classique de l'île maritime, ouvrage Chinois du III^e siècle." *Quellen und studien zur Geschichte der Mathematik Astronomie und Physik*, Band II, Heft 3, 1932, pp. 256-280. He includes a select bibliography of studies in western languages on the history of Chinese mathematics. Also in this connection see VACCA, G. *op. cit.*, and SMITH, D. E. "Unsettled questions concerning the mathematics of China," *Scientific Monthly*, Sept. 1931, pp. 244-50.

(11) *Ibid.*, p. 106.

(12) *Ibid.*, p. 117. VACCA (*op. cit.*, p. 15) writes that no Chinese scholars of this period were "... able to have an original conception of Western Science, or to reconstruct it." For suggestive attempts to explain why the various sciences failed to develop in China consult FUNG, YU-LAN, "Why China has no Science,"

10. With the retarding of missionary activity, due in part to the repeated persecutions of the eighteenth century, direct contact with western scientific developments was largely cut off only to be renewed again in the middle of the nineteenth century by the Protestant missionaries. During the interim, the traditional complacency and attitude of superiority of the Chinese literati with respect to all alien cultures tended to reassert itself. YÜAN YÜAN writing in his biographies of mathematicians, which was first published in 1799, asserted that, "It is evident to those who are well versed in Chinese mathematics that Europe has added nothing new." He believed that European mathematicians simply developed fundamental principles and formulae which they had originally acquired from the Chinese (13).

11. However meager the results of the Jesuits contacts may have been from a strictly scientific point of view, from the historical point of view they were markedly influential in hastening the introduction of western science during the nineteenth century. The more intimate relations with western nations which followed the signing of the treaties of 1842-44 and the opening of the ports of Canton, Amoy, Foochow, Ningpo and Shanghai to foreign residence and trade, led to a greatly increased desire on the part of the officials and literati to learn more of the science, the geography and the general customs and practices of western countries.

12. A number of compendious works appeared to meet this demand, among which the most influential was perhaps WEI YÜAN's *Hai Kuo T'u Chih* (3767, 6609, 12.128, 1918) or "Descriptive and Historical Geography of Foreign Countries." Much of the materials for the work were amassed by Commissioner LIN at Canton "... from the writings of foreigners in Chinese and translations made from English newspapers and other works..."

International Journal of Ethics, Vol. 32 (1922) pp. 237-263; DUBS, HOMER H., "The Failure of the Chinese to produce Philosophical Systems." *T'oung Pao*, Vol. 26, (1929) pp. 96 ff.; HU SHIH, *The Development of the Logical Method in Ancient China*. (Shanghai, 1922) passim; MASPERO, HENRI, *La Chine Antique*. (Paris, 1927) pp. 607-621; DUYVENDAK, J. J. L., "A Literary Renaissance in China," *Acta Orientalia*, 1923, passim; and LIANG CH'I-CH'AO, "K'ê Hsüeh Ching Shên Yü Tung Hsi Wen Hua," (6089, 4839, 2133, 9819, 13.522, 12.248, 4031, 12.633, 5001) ("The Scientific Spirit in Eastern and Western Civilizations") *K'ê Hsüeh (Science)*, Vol. 7, No. 9 (Sept. 1922) pp. 859-870.

(13) VAN HÉE, L., "Le Classique de l'île maritime....," p. 259.

WEI YÜAN added from the materials at his disposal including information derived from the works of the Catholic missionaries of the seventeenth and eighteenth centuries. The last chapter discusses the construction of ships of war, of steam vessels, fire-arms, astronomy, etc. It was first presented to the public in 50 books in 1844. It became quite popular, an enlarged edition in 60 books appearing in 1849, while a third edition of 100 books appeared a few years later (14).

13. Scholars such as LI SHAN-LAN, HSÜ SHOU, HSÜ CHIEN-YIN and HUA HÊNG-FANG, whose interest in science was aroused through reading such works as this as well as the original scientific works of the earlier missionaries, were to prove of invaluable assistance to Protestant missionaries, such as ALEXANDER WYLIE and W. A. P. MARTIN in the introduction through translation of the science of their century.

14. JOHN FRYER, who for many years was associated with these Chinese as director of the translation bureau of the Kiangnan arsenal in Shanghai after 1868, informs us that they (with the exception of LI SHAN-LAN) were members of a little coterie of scholars at Wusih near that port, who sought eagerly to learn the secrets of nature and read with avidity the works of the Jesuits as well as native Chinese works on mathematics and astronomy (15).

A member of the group while on a visit to Shanghai chanced upon a copy of Dr. HOBSON's translation of a work on natural philosophy, the *Po Wu Hsin Pien* (9372, 12.777, 4574, 9178) published in 1855. The book proved to be a revelation to the members of the group enabling them to leap across the two centuries from seventeenth to nineteenth century science. They extemporized apparatus with which to perform the elementary experiments described in its pages and wrote papers on their observations. These papers accumulated in the home of the Hsü's where, unfortunately, they were lost when the house was

(14) WYLIE, ALEXANDER, *Notes on Chinese Literature*, p. 53; Ko KUNG-CHÊN *Chung Kuo Pao Hsüeh Shih* (2875, 6609, 8731, 4839, 9893) ("History of Chinese, Journalism") (2nd Ed. Shanghai, 1928), pp. 97, 99.

(15) "Science in China," *Nature*, May 5, 1881, Vol. 24, pp. 9-11. LAN T'IAO-FU "How to accept Western Science," *Chinese Social and Political Science Review*, Vol. XI, No. 4 (Oct. 1927), pp. 567-576.

destroyed in the course of the T'ai-p'ing rebellion. In 1862 these men and a few others (such as LI SHAN-LAN and YUNG WING) who knew something of the West and its science, were attached to the *yamen* of the great Viceroy TSÊNG KUO-FAN who was then bringing to a successful close his campaign against the T'ai-p'ing rebels. They served as his advisors in his efforts to strengthen the Empire through the introduction of Western applied science.

15. LI SHAN-LAN, the foremost Chinese mathematician of the nineteenth century, who likewise had his interest aroused in Western science through reading the earlier Jesuit translations, made his way to Shanghai, shortly after the opening of that port to foreign residence and trade, in the hope of meeting there Westerners and learning directly from them more of their science. There he met ALEXANDER WYLIE and was soon at work collaborating with him in completing the translation of EUCLID's *Geometry*, the first six chapters of which had been translated by MATTEO RICCI and HSÛ KUANG-CH'I some 250 years earlier. He also assisted WYLIE in translating HERSCHEL's *Outlines of Astronomy*, DE MORGAN's *Algebra* and LOOMIS' *Analytical Geometry and Differential and Integral Calculus*. He met the Rev. Dr. EDKINS and assisted him in the translation of WHEWELL's *Mechanics*.

16. His acquaintance with the scientific terminology created by the Jesuits made him a valuable assistant. These nineteenth century scholars profited considerably by the pioneering efforts of the Jesuits in rendering western scientific terms into Chinese as JOHN FRYER readily admitted. LI's ability was quickly recognized by reforming officials, who appointed him Professor of Mathematics at the *T'ung Wên Kuan* (12.248, 12.633 6353) or Imperial College of Peking when instruction in the sciences was introduced into that institution in 1865 (16).

17. Further evidence of the influence, from the historical point

(16) MARTIN, W. A. P., *Cycle of Cathay*, pp. 369 ff. I find myself in disagreement with VACCA's statement (*op. cit.*, p. 15) that WYLIE and LI SHAN-LAN did not contribute to the diffusion of western science in China. While it may be true that their translation work had to be rejected by a later generation of Chinese who had come, through study abroad, into more direct contact with western science, and who had evolved a more accurate terminology, nevertheless these pioneers as the Jesuits before them played an historic role in this introductory period, the significance of which I have attempted here to disclose.

of view, of the first period of the introduction of western science by the Jesuits on the nineteenth century literati is seen in the publication in 1865 by the Viceroy TSÊNG KUO-FAN of a translation of the fifteen chapters of EUCLID's Geometry. The circumstances resulting in the translation into Chinese of this work are most interesting as a reflection of the spirit of the times. These are recounted in the five prefaces appearing in the edition which TSÊNG KUO-FAN ordered printed in 1865. The prefaces were written by TSÊNG (actually composed by his son HUI-MIN), MATTEO RICCI, HSÜ KUANG-CH'I, ALEXANDER WYLIE and LI SHAN-LAN.

18. TSÊNG informs us that :

"The first six chapters of the *Chi Ho Yüan Pên*, (786, 3941, 13700, 8846) (EUCLID's Geometry) were taught to HSÜ KUANG-CH'I [a prominent official at the close of the Ming dynasty and a member of a wealthy and influential family] by the foreigner MATTEO RICCI. During the Hsien Fêng period (1851-1862) L SHAN-LAN of Haining began, with the Western scholar ALEXANDER WYLIE, the translation of the last nine chapters and the correction of the first six chapters. Thus was the work (begun 250 years earlier) completed. HAN LU-CH'ING of Sunkiang published it, but shortly thereafter the woodblocks were burned in the course of the T'ai-p'ing rebellion. LI SHAN-LAN, who worked under me in the Anking army, showed me the work saying: "This work is indispensable to mathematicians. It will be lost if it is not printed at once." After I had moved my headquarters to Chinling (Nanking) I ordered LI to correct the last nine chapters and to have them printed... and to do the same for the first six chapters as well." TSÊNG concluded his preface by pointing out that the inherent defect in Chinese mathematics lay in its complete absorption in specific practical functions resulting in a failure to discover the underlying principles; while EUCLID's Geometry dealt not with method, but with such fundamental principles (17).

(17) PEAKE, C. H., *op. cit.*, pp. 5, 6, and 216 notes 7, 8. There is in the DAVID EUGENE SMITH collection of works on mathematics at Columbia University a manuscript called the *Chi Ho Yüan Pên*. As the prefaces explain, it is a translation of the first six chapters of EUCLID, orally explained by MATTEO RICCI and put in its written form by HSÜ KUANG-CH'I. The work was then printed in 1607. A postface by HSÜ relates that after RICCI's death, a printed copy with corrections in his own handwriting was found. Assisted by two friends HSÜ prepared a revised edition in 1611 of which the SMITH manuscript is a copy. There is also a manuscript copy of this work in the SEIKADO (2179, 1158, 10,760) Library in Tokyo.

19. Another and more indirect influence of the earlier contacts in paving the way for the introduction of nineteenth century science is seen in the arguments presented in the memorials of officials advocating reform. These arguments recalled the welcome accorded western science as introduced by the Jesuit missionaries. Thus Prince KUNG, President of the newly organized bureau for the control of foreign affairs (Tsunqli Yamen 12.010, 6879, 12.831, 7751) stated in a memorial that the Emperor during the K'ang Hsi period (1662-1723) "... was deeply versed in Western science." Another common method to win over opposition was to flatter the conservatives by asserting as did KUNG in a memorial that "... Western sciences borrowed their roots from ancient Chinese mathematics. Westerners still regard their mathematics as coming from the Orient. It is only because of the careful enquiring nature of the Westerners that they are good at developing something new out of the old... China invented the method, Westerners adopted it..." (18)

20. Prince KUNG continues :

" During the K'ang Hsi period mathematical studies were connected with the astronomical board... In former times the farmers and soldiers knew astronomy, but in later times its study was prohibited, only a few knowing it [those connected with the court]. During the K'ang Hsi period the prohibition against astronomical studies was removed with the result that a greater and more widespread interest in it developed. Scholars who studied the Classics knew something about mathematics as well, and there were many works published which dealt with it in detail " (19).

21. The immediate events leading to the introduction of nineteenth century science centered in the unsuccessful wars with the Westerners in 1839-42 and 1858-60. The close of the second clash, marked by the signing of the humiliating treaties of 1860, left a number of the more enlightened Chinese and Manchu officials deeply concerned about the future safety of the Empire. Their faith in the fundamental validity and superiority of Confucian civilization was scarcely shaken, but it was painfully apparent

(18) PEAKE, C. H., *op. cit.*, p. 4. These ideas Kung no doubt derived from a reading of YÜAN YÜAN's Biographies. (See above note 10.)

(19) *Ibid.*

that their methods of warfare were hopelessly antiquated. First efforts at modernization, therefore, consisted in the establishment of arsenals at such strategic points as Shanghai and Foochow, for the purpose of manufacturing modern armaments and the construction of modern vessels of war. The spirit which animated these reforming officials was later well epitomized by the progressive Viceroy CHANG CHIH-TUNG as follows: *Chung hsüeh wei t'i; hsi hsüeh wei yung* (2875, 4839, 12.521, 11.025, 4031, 4839, 12.521, 13.449), "Western learning should be adopted for practical purposes, but Chinese learning should remain the guide." This narrow pragmatic conception of the value of Western science persisted in the minds of reforming officials into the present century. They were unaware of the existence of pure science as an independent body of learning, nor did they possess any appreciation of its spirit and its method.

22. Nevertheless, foreigners in the employ of the government, such as MARTIN, BILLEQUIN, FRYER and GIQUEL, had little difficulty in convincing enlightened officials, for example, Prince KUNG and Viceroys LI HUNG-CHANG, TSÊNG KUO-FAN and Tso TSUNG-T'ANG, of the necessity for instruction in mathematics, physics and chemistry as prerequisites for the designing and construction of modern armaments as well as the study of astronomy for the purpose of navigating vessels of war. Thus it came about that courses in these subjects were introduced, after 1865, into the arsenals and the Imperial College of Peking. Within a quarter of a century the value of western science had become sufficiently apparent to bring about the most fundamental change in the centuries-old civil service examinations that had occurred since the Ming Dynasty. This change by which science, particularly mathematics became an optional subject in an examination which the candidate voluntarily chose, took place in 1887. While it had little immediate effect, the psychological importance of the event should not be overlooked. The old body of learning, crystallized in the Chinese Classics, and made enduring through some twenty centuries by means of the examination system, for the first time found a competitor in the new body of learning from the scientific West.

23. Of prime importance in introducing western science to the Chinese, other than the employment of Westerners as instruc-

tors in the various newly established schools and at the arsenals, where courses in science were given, was the translation into Chinese of western scientific books. It was in the first place instrumental in giving to the reforming officials of this period some concept of the depth and value of western science and in the second place it won over increasing numbers of literati outside official circles and paved the way for the more thorough-going reforms of a later generation. The Rev. J. Jackson writing in 1893 stated: "We sometimes have men call upon us who are very well versed in science and mathematics, who have obtained their knowledge through the medium of books alone" (20).

JOHN C. FERGUSON, writing in 1892, pointed out that great unrest existed in Chinese literary circles, and that there was an "... immense sale of all kinds of mathematical and scientific books" (21).

24. The foremost centre for the translation of western scientific works was the translation bureau of the Kiangnan arsenal. In the period from 1870 to 1904 this bureau published 177 works, a majority of which were translations: 88 English, 19 American, 3 French, 5 Japanese and 2 German. The range of subjects was wide including not only works on chemistry, physics, astronomy, mathematics, telegraphy, navigation, ship construction, etc. but also a few works on government and law. The volumes were well illustrated and beautifully printed (22).

25. The sale of these works was surprisingly large and indicates a widespread interest (23).

In February 1876 FRYER started a monthly publication known as the *Chinese Scientific and Industrial Magazine* (Ko Chih Hui Pien — 6029, 1832, 5215, 9178) for the purpose of disseminating

(20) JACKSON, J., "Objects, Methods and Results of Higher Education in our Mission Schools," *Chinese Recorder*, XXIV (1893), pp. 7 et seq.

(21) FERGUSON, JOHN C., "Higher Education in China," *Chinese Recorder* XXIII (1892), p. 154.

(22) *Kiangnan Chih Tsao Chü Chi* (1208, 8128, 1911, 11.624, 2955, 923) (History of the Kiangnan Arsenal), pp. 15-23, 31 A. The Chinese Library of Columbia University has 107 of these works.

(23) By 1879 the ninety-eight works then published had obtained a sale of 31,111 works in 83,454 volumes. See FRYER, J., "Science in China" *Nature*, vol. 24 (May 19, 1881), pp. 54-57. FRYER states that many of these works went to Japan where they were no doubt of assistance to the Japanese in determining their own scientific terminology.

in a popular manner scientific information among the literati. Aiming to appeal to the learned, it was written in the dignified classical, or *wen-li* style. It was the forerunner of later popular science journals written for the most part in the vernacular in order to reach a wider circle of readers (24).

26. While the Shanghai arsenal translation bureau produced the greater bulk of translations in this period we find also that the Imperial College produced a number of works on chemistry, physics, mathematics and astronomy (25).

Moreover the Protestant missionaries who as we have seen resumed the task of translation begun by the Jesuits continued through the period to produce works of a scientific nature. Among such works were: Dr. HOBSON's popular works on Western medicine published during the middle of the century including a work on Anatomy (*Ch'üan T'i Hsin Lun*, 3176, 11.025, 4574, 7475), a treatise on Western medicine (*Hsi I Lüeh Lun* 4031, 5380, 7564, 7475); on therapeutics (*Nei K'ê Hsin Shuo*, 8177, 6089, 4574, 10.164) and a work on the medical treatment of women and children (*Fu Ying Hsin Shuo*, 3749, 13.318, 4574, 10.164); W. A. P. MARTIN's *Physics* (*K'ê Wu Ts'ê Suan*, 6089, 12.777, 11, 698, 10.378) 8 Vols. 1884; Dr. HOLBROOK's *Biology* (*Tsêng T'u Huo Wu Hsüeh*, 11.726, 12.128, 5324, 12.777, 4839) 1890; A. WILLIAMSON and Rev. Dr. EDKIN's *Botany* (*Chih Wu T'u Shuo*, 1849, 12.777, 12.128, 10.164) 1859; Dr. H. T. WHITNEY's, *Grey's Anatomy* (*T'i Hsüeh Hsin Pien*, 11.025, 4839, 4574, 9178) c. 1857; and Dr. S. A. HUNTER's *Squire's Manual of Therapeutics and Pharmacopoeia*, (*Wan Kuo Yao Fang* 12.486, 6609, 12.958, 3435) 1890. Many of these works were designed as textbooks for use in the rapidly increasing number of missionary schools (26).

27. While the Protestant missionaries took the lead during the nineteenth century in introducing to the Chinese Western civilization and its science, the Catholic missionaries were by no means inactive from a strictly scholarly and scientific point of view. The Jesuits returned after 1844 and considered the desirability

(24) See KO KUNG-CHÊN, *op. cit.*, pp. 115 ff.

(25) See *T'ung Wen Kuan T'i Ming Lu* (12.269, 12633, 6353, 11.009, 7940, 7386) (The T'ung Wen Kuan Catalogue), No. 5, (1893), pp. 55-57.

(26) CLAYTON, G. A., *A Classified Index to the Chinese Literature of the Protestant Churches in China*, (Shanghai, 1918), pp. 173-193.

of reestablishing the scientific mission to Peking which in the seventeenth century had been largely influential in gaining for them the favor of the Court. However, due to divided counsels among them and the prevalence of anti-foreign sentiments at the Chinese Court coupled with the fact that they were no longer dependent on official favour as formerly because of the toleration clauses in the treaties they decided not to return to Peking.

28. They made their headquarters instead at Zikawei (Hsü Chia-hui, 4748, 1139, 5190) near Shanghai on the ground given to them by the renowned seventeenth century Jesuit Hsü KUANG-CH'1 (27). In 1869 they began to collect materials for a museum of Natural History which has since grown to be one of the leading institutions of its kind in China, with much published material to its credit. After 1872 when they decided to make Zikawei a research centre the Jesuits established there one of the best known and most useful meteorological observatories in the whole Far East which issues daily weather reports and forecasts. They have also there a seismological station. Their large printing establishment publishes not only literature of a religious character but also scientific books and periodical literature including *Annales*, *Bulletins*, and *Memoirs*.

29. The Jesuits have likewise resumed their scholarly studies of Chinese history and civilization. Among works of this type perhaps the best known is the series "Variétés Sinologiques" which began in 1892 and now numbers no less than fifty-nine monographs. Apart from this series they have published a score of other works of a scientific character (28).

30. At another important Jesuit center in Sienhsien, Chihli (now Hopei) province scholarly work has been carried on particularly by Fathers COUVREUR and WIEGER who have translated extensively Chinese classical and historical literature. Another outstanding work is the *Vocabulaire des sciences mathématiques*,

(27) LATOURETTE, *op. cit.*, p. 235.

(28) *Catalogus Librorum Lingua Sinica Scriptorum*, Zikawei, 1917; *Catalogue les ouvrages Européens*, Imprimerie de l'Orphelinat de T'ou-Sè-Wè, Zikawei, 1927. The 59th monograph is entitled *Notices Biographiques et Bibliographiques sur les Jésuites de l'Ancienne Mission de Chine, 1552-1773*. Tome I, XVI^e et XVII^e siècles, 561 pp., 1932. The work gives the biographies and bibliographies of 248 Jesuit missionaries.

physiques et naturelles by P. CHARLES TARANZANO, S. J. in three volumes (Sienhsien, 1921-23) (29).

31. Other achievements by the Catholic missionaries in this and subsequent periods are the excellent scholarly studies of Chinese mathematics made by P. LOUIS VAN HÉE; the studies made in natural history by the Lazarist ARMAND DAVID who established a museum at Peking which was later transferred to the Chinese government; the geological explorations carried on by the Jesuit E. LICENT in Mongolia, who likewise established a museum in Tientsin; and the important archeological work of Fathers LICENT and TEILHARD DE CHARDIN (30).

32. While the Catholics founded many schools scientific instruction was not emphasized. "Little or no attempt was made," writes K. S. LATOURETTE, "to introduce the Chinese to Occidental learning beyond that directly connected with the essentials of the Catholic faith" (31). Nevertheless science instruction was provided for in certain institutions as at the Université l'Aurore, established by the Jesuits at Shanghai in 1903; at the L'Institut des Hautes Études Industrielles et Commerciales founded also by the Jesuits at Tientsin in 1922; and at the Catholic University of Peking, established in that city by the American Benedictines in 1925. The members of the staff of the Catholic University have emphasized the study of the history of foreign religions and missions in China and a number of valuable monographs have appeared. The University publishes a *Bulletin* and a sinological serial, the *Fu Jen Hsüeh Chih* (3627, 5627, 4839, 1918).

33. The problem of terminology has of course been an ever present one with those translating western works and one which has only begun to approach a solution within the past twenty years. The difficulties of the task in this earlier period gave rise to much confusion in the terms employed with little visible progress toward the establishment of a standardized terminology in a single scientific field. Indeed the difficulties of the task seemed well nigh insurmountable to some who asserted that

(29) *Catalogus Librorum Typographiae Sienhsien*, 1927.

(30) For a further account, of the work of Fathers LICENT and CHARDIN, see below § 88, and note 79.

(31) *A History of Christian Missions in China*, p. 236.

the Chinese language was incapable of incorporating and accurately expressing the terms employed by western scientists. Their solution was to teach the students entirely through the medium of a western language, usually English. However, the translators most proficient in the use of the language such as WYLIE, MARTIN and FRYER found it a fit though difficult medium in which to express western scientific terms and proceeded to the task of transplanting western science in Chinese soil with zest, encouraged as FRYER acknowledged by the pioneering efforts of the Jesuits before them (32).

34. FRYER writing in 1881 from a background of abundant experience, lays down in order of importance the methods of establishing a term: 1. Try to find an equivalent term in a Chinese work; 2. If unable to do so, then try to discover if it is in current use; 3. Failing that, make a new character, or give a new meaning to an existing or uncommon character; or invent a descriptive term; 4. and finally, these methods all failing, phonetically transliterate the term into Kuan Hua, or Mandarin. However, his advice was by no means always followed, the easy method of transliteration being frequently employed (33).

Many of the earlier translators while possessing considerable knowledge of the language were not trained scientists, thus the terms which they selected came to appear in the eyes of later translators as quite unsuitable. For example as late as 1917 textbooks in use called KMnO_4 "extra strong manganese alum of potassium" as the first chemistry text published about 1870 gave the general name for salt as alum (34).

(32) FRYER, J. "Science in China," *Nature*, vol. 24, pp. 54-57. Also consult his essay «Scientific Terminology....» in *Records of the General Conference of the Protestant Missionaries of China* (Shanghai, 1890), pp. 531-549.

(33) See the Rev. G. A. STEWART's comments in the *Chinese Recorder* vol. 25, pp. 88-90. For a general criticism see an article by GUSTAVE SCHLEGEL, "Scientific Confectionary" (*T'oung Pao*, Vol. V, pp. 147-151), where he warns against translating the many unscientific terms used by western scientists that were inherited from the earlier pseudo-science of the west, and recommends that they find more accurate descriptive terms.

(34) See WILLIAM H. ADOLPH, "Synthesizing a Chemical Terminology in China," *Journal of Chemical Education*, vol. 4, no. 10 (Oct. 1927), pp. 1233-1240. VACCA (*op. cit.*, p. 51) writes that WYLIE's attempt "... to translate with symbols half European and half Chinese the elements of differential and integral calculus found no followers."

35. Before the close of the period the need of standardizing terms had become sufficiently obvious to result in the formation of committees for the purpose. In 1890 the China Medical Missionary Association held its first meeting and a committee on terminology was appointed which, however, did not hold regular meetings until a decade later. At the 1877 Missionary Conference a permanent committee on schools and textbooks was appointed with JOHN FRYER as chairman and general editor. Under his direction efforts at standardization of terms used in textbooks were made. However, the period came to a close with very little real progress made in this direction. Another generation was to pass before marked achievement both in standardization of terms and in the formation of an adequate terminology could be noted.

36. The third period, extending from the close of the unsuccessful war with Japan in 1895 to the establishment of the Republic in 1912, was characterized by a broadening grasp of the nature of modern science in both its applied and experimental aspects. In the second period, as we have seen, the primary aim of reforming officials in bringing about instruction in mathematics and certain of the physical sciences was to strengthen the defense forces of the Empire. The sudden and humiliating defeat at the hands of the Japanese, toward whom they had traditionally held an attitude of cultural superiority, but who had, however, been modernizing their empire in a more efficient and thorough-going manner, clearly revealed to them the narrowness and inadequacy of their own reform program. In the atmosphere of pained surprise and alarm which followed the war, reformers both within and without official circles came boldly forth advocating in memorials to the Throne more fundamental military, educational and administrative changes. In these memorials we find criticisms of the early reform efforts and suggestions involving the translation of more up to date scientific works; the establishment of more laboratories that students might do actual experimental work, which had been largely denied them in the past because of the lack of scientific apparatus; the sending of more students abroad for scientific training, and, finally, the application of scientific technique to the exploitation of China's natural resources as well as to the

improvement of its commerce, industry and agriculture (35).

37. The exploitation of the country's natural resources was held to be of prime importance by the reformers, for as SHÊNG HSÜAN-HUAI, Director-general of the China Merchants' Steam Navigation Company, pithily summarized in a memorial in 1896, "The way to build a strong nation is to train good soldiers, but to train good soldiers plenty of money is necessary and to have sufficient funds trade and industry must be developed" (36).

These memorials prepared the way for the reform edicts that were soon to follow, which provided for the establishment of mining, agricultural, industrial and technical schools in general.

38. Of prime significance in paving the way for reform was the publication in the early part of 1898 of a collection of essays edited by the prominent statesman Viceroy CHANG CHIH-TUNG under the title "An Exhortation to Learning." It was a consummate summary of the reform tendencies of the time. The work was given Imperial endorsement in the same year and over a million copies are estimated to have been sold or distributed throughout the Empire. These essays while advocating the retention of the Classics as the basis of education vigorously plead for the introduction of "western studies" particularly of a scientific nature as a means for enriching and strengthening the Empire. They asserted also that not only should the military forces be strengthened, but more schools should be established in which Western sciences were to be taught; the examination system should be altered to permit the acceptance of western sciences in general; more western works should be translated; agriculture, industry and commerce should be scientifically studied; and finally railroads should be built and mines opened. Thus, science to come be conceived of not merely as a means by which to reform the calendar or forecast eclipses, as during the seventeenth century, or to modernize the defense forces of the Empire, as in the generation following 1860, but also as means for increasing the wealth and well-being of the Empire.

39. During the Hundred Days of Reform, June to September, 1898, progressive officials and literati under the leadership

(35) PEAKE, C. H., *op. cit.*, pp. 25 et seq.

(36) *Kuang Hsü Tung Hua Hsü Lu*, (6389, 4772, 12.248, 5005, 4773, 7386) (Official documents for the period 1875-1908), *chüan* 136, pp. 10-14.

of K'ANG YU-WEI and LIANG CH'I-CH'AO gained the support of the Emperor and many of the plans put forth in the preceding three years in memorials were promulgated with Imperial sanction. However, a period of reaction set in with the return to power of the Empress Dowager Tz'ü-HSI which persisted through the Boxer uprising of 1900. The march of the Allied troops to Peking and the flight of the Court to Shensi once again humiliated the Manchus and lowered their prestige in the country. It became apparent even to the reactionaries that the preservation of the dynasty itself lay in reform. Thus it came about that beginning in 1901 a series of reform edicts were proclaimed which launched the old Empire on a program of administrative, economic, and educational reform, similar to that which Japan had entered upon thirty years before.

40. In August, 1901, a decree was issued providing for the abolition of the old military examinations. In the following month a decree was sent forth providing for the beginnings of a modern educational system in which scientific studies were to have their place along with Classical studies. About the same time a decree was issued authorizing students to go abroad for study and promising them upon their return the privilege of taking examinations for official degrees. Following this decree and the abolition of the old civil-service examination (1905) students went abroad by the thousands each year, eventually returning with a fuller grasp of the elements of western civilization including its science, and confident that their country's salvation was to be attained through modernization. To the returned student goes a large share of the credit for bringing to China under the Republic the conception of pure science as an independent body of knowledge possessing its unique methods of research and for causing to spring up in China research institutions from whose laboratories and field expeditions have issued in recent years results of value and interest to the scientific world.

41. The courses of study provided for in the first educational system outlined in 1903 are indications of the high regard for Western science then held by officials. In the lower and higher primary schools the study of the Classics and language was to occupy not quite half of the time while the balance was to be devoted to the study of ethics, Chinese history and geography,

nature study, mathematics and physical culture. In the middle schools somewhat less time was devoted to Chinese language and the Classics while among the other studies biology, physics and chemistry as well as mathematics were to be taught. In the newly established provincial and national universities departments of science were established for the study of mathematics, astronomy, physics, chemistry, zoology, botany and geology, while special colleges for the study of medicine, engineering and agricultural and industrial techniques were envisaged. This system was an almost exact replica of the one then in operation in Japan. The similarity of institutions in the two countries together with Japan's demonstrated success in the application of western sciences and techniques were fundamental factors in bringing this about.

42. Following the establishment of the first Ministry of Education in 1905, one of its initial acts was to secure the issuance of a decree fixing the educational aims. The purpose of the new system they said was to educate all and not a talented few, and the aims should be loyalty to the Throne, respect for CONFUCIUS, the awakening of the people to a sense of their national responsibility, the promotion of militarism and the development of reality and practicality in education. The memorialists pointed out that one of the most valuable results to be derived from education was to be able to put to practical use what had been learned. We note that in the West,—to paraphrase their comments,—three hundred years ago, the scholars lost themselves in vague theories and unrealities much the same as Chinese scholars do today. But since the time of BACON, an Englishman who developed the theory of experimentalism and demanded proof for all things, westerners have followed what he said. That is why western science and industry are so developed and so progressive at the present time. Thus in the new schools there should be more emphasis on facts and less on theory while scientific experimentation must be provided for in higher schools (37).

43. During this period an increasing number of western books on science was translated. In official circles special bureaus were established for the purpose. The demand for books on

(37) SHU, HSIN-CH'ENG, *Chin Tai Chung Kuo Chiao Yü Shih Liao* (2021, 10.547, 2875, 1352, 13659, 9893, 7070) ("A Collection of Documents on the History of Education in Modern Times,") (Shanghai, 1928), Vol. II, pp. 96-102.

western civilization had increased to such an extent that private publishing houses sprang up to meet it. Among such concerns were the Commercial Press and the Chung Hua Press now the two largest houses in China. They found a profitable business in translating and compiling books on western history, science and education and in the preparation of textbooks for students attending the new modern schools, the number of which had increased to over six million by 1911. Many of the works including those on science were translations from Japanese. Thus we find that one Japanese publishing firm in Shanghai listed 608 works in its catalogue for 1904-5 of which 97 were on education, 31 on physiology, 27 on political economy and 19 on arts and sciences (38).

44. The missionaries continued to publish scientific textbooks during this period. They had however lost the leadership of Chinese progressive thought, which they had held prior to the turn of the century, due to the fact that the Chinese now came into more direct contact with the West through the translation of western books, as well as through travel abroad (39).

Yet the sales of their works increased to meet the demands of their own growing school system. Thus during the years 1896 to 1899 the number of scientific works sold averaged from 200 to 600 a year, doubling the sale in years immediately preceding the war with Japan (40).

(38) HARADA, J., "Japanese Educational Influence in China," *Records of the Fifth Meeting of the Educational Association of China*, pp. 101-105.

(39) See LATOURETTE, *op. cit.*, p. 646.

(40) Among the textbooks on science published by Protestant Churches prior to 1911 were the following :

POTT, F. L. H. (Editor) *New Science Series (Ko Chih Chiu Chung*, 6029, 1832, 2263, 2886), 9 Vol. 1899.

MATEER, C. W., *Geometry (Hsing Hsüeh Pei Chih*, 4617, 4839, 8804, 1790) 1905.

ZIA, H. L. & PARKER, DR., Loomis' *Trigonometry, (Pa Hsien Pei Chih*, 8504, 4532, 8804, 1790), 1909.

OWEN, S. (Rev.) & LI, CHIN-SHUAN, *Elements of Geology (Ti Hsüeh Chih Lüeh*, 10,956, 4839, 1791, 7564), 1899, 1909.

ZIA, H. L. (trans.) HENDERSON & WOODHULL's *Elements of Physics (Chih Hsüeh Hsin Pien*, 1892, 4839, 4574, 9178) 1904.

FERGUSON, J. C. & LI, SING-YUAN, *Chemistry (Hua Hsüeh Hsin Pien*, 5001, 4839, 4574, 9178) 1896, 1899.

NEAL, J. B. & SHANG, PAU-CHEN, *Analytical Chemistry (Hua Hsüeh Pan Chih*, 5001, 4839, 8610, 1892) 1897, 1908.

There follows below a statistical summary of the books on science published by the Protestant missionaries in China prior to 1918.

45. In this period Western thought and science commenced to alter and broaden the conceptions of modern Chinese intellectuals. LIANG CH'I-CH'AO and YEN FU are to be numbered among the few outstanding intellectual leaders who by their writings and translations brought about this transformation. HU SHIH, one of the foremost leaders of China and the "Father of the Chinese Renaissance" informs us that "through the popular writings of the late Mr. LIANG CH'I-CH'AO, the most powerful writer of his age, I came to know (in this first decade of the present century) a little of such western thinkers as HOBBS, DESCARTES, ROUSSEAU, BENTHAM, KANT and DARWIN" (41).

In his essays LIANG pointed out the admirable features of Western civilization and shocked innumerable Chinese out of their complaisant assumption that Chinese civilization was "... self-sufficient and had nothing to learn from the militant and materialistic West except in the weapons of war and vehicles of commerce" (42).

<i>Science</i> , in general	13 works
Arithmetic, all but one after 1910	11 »
Algebra, 1907-1917	4 »
Geometry, 1902-1912	8 »
Trigonometry, 1904-1911	2 »
Calculus, 1912	1 »
Astronomy, 1882-1914	18 »
Physics, 1884 and following	7 »
Hydraulics	1 »
Light	2 »
Heat, 1890, and 1899	2 »
Electricity, 1887 and following	3 »
Chemistry, 1871-1917	7 »
Biology, 1890	1 »
Zoology, 1893 ff.	8 »
Natural History, 1859 ff.	15 »
Geology, 1899 ff.	3 »
Agriculture, 1902 ff.	4 »
Medicine, 1900 ff.	13 »
Anatomy, 1850's ff.	7 »
Physiology, 1885 ff.	11 »
Hygiene and Sanitation, 1900 ff.	24 »
Pharmacy, 1890 ff. especially after 1900	8 »

Above information drawn from CLAYTON, G. A., *op. cit.*, passim.

(41) HU SHIH, In *Living Philosophies*, (New York 1931), p. 247.

(42) *Ibid.*

46. HU SHIH relates that he read YEN FU's translations of J. S. MILLS' *On Liberty* and HUXLEY's *Evolution and Ethics* (43).

The latter work was published in 1898 and was acclaimed by Chinese intellectuals. "Rich men gave money to have new editions made for wider distribution, because it was thought that the Darwinian hypothesis, especially in its social and political application, was a welcome stimulus to a nation suffering from age-long inertia and stagnation." (44)

The phrase: "survival of the fittest" found widespread journalistic expression. Even the "Shih" in his own name was adopted by Professor HU as it was the character meaning "Fittest" in the Chinese translation of the phrase. In 1907 HU became editor of a vernacular publication, one of many score of the time, called "The Struggle" which had for its purpose the popularization of modern ideas.

47. In the rush to meet the unprecedented demand for books dealing with science in this period it is not surprising that great confusion of terms arose. There was a marked influx of Japanese scientific terms which increased still more the confusion that had previously arisen. Despite this fact there was little attempt on the part of the Chinese to standardize scientific terms at this time. The missionaries made some progress, particularly the Committee on Terminology of the China Medical Missionary Association, established in 1890. By 1901 it had commenced publishing lists and had established sound principles for the determination of medical terms (45).

48. The outstanding developments that have transpired, in the course of the twenty and more years since the founding of the Republic have been the establishment of research institutions, and the application of scientific methods to the study of China's social, economic and historical problems. Accompanying these developments were the establishment of increased facilities for general instruction in the sciences as well as for advanced scientific training; the more accurate translation of up-to-date

(43) For a list of YEN FU's principal translations see PEAKE, *op. cit.*, pp. 219, 220. For an interesting criticism of YEN's work see LAN, T'IAO-FU, *op. cit.*, p. 572.

(44) HU SHIH, *op. cit.*, p. 248.

(45) STUART, G. A., "Scientific Terminology" *Chinese Recorder*, (June, 1901), vol. 32, pp. 305-6.

scientific books; the compilation of more adequate textbooks and the standardization of suitable scientific terminology. Finally, we can note the effect in the writings of contemporary Chinese philosophers and litterateurs of the introduction of modern science upon their conceptions of the universe and its origin and evolution, as well as in their objective and critical attitude toward their own civilization—its history, its institutions, and its mores.

49. Since the founding of the Republic in 1912, the formal study of the Confucian canon has been eliminated (except for a brief revival) under YÜAN SHIH-K'AI-1913-1916) from the curricula of the national educational system. As in the West, the addition of scientific courses to the curricula has been made at the expense of the classics. The general curricula of the middle and higher schools of China require that all students devote one-fourth of their time to the study of science. Students electing to take special scientific courses provided in the senior middle schools, the normal schools and the colleges, must, however, devote a greater amount of time to science study. More technical and industrial schools have in addition been founded. According to the annual report of the Minister of Education in 1930, fifty different institutions of higher learning offered 750 courses of a scientific nature for 1,232 students, comprising 6.26 % of the enrollment. In addition, there were some 2,000 students in technical schools. Thus, in that year, one out of every six students pursuing courses beyond the middle schools planned for a career in either the pure or the applied sciences. The proportion of students going abroad that has enrolled, or is enrolling for scientific courses is higher than this, reaching the estimated figure of 50 % among the 1500 or more studying in the United States.

50. The quality of the scientific teaching and the adequacy of the textbooks and laboratory equipment still leave much to be desired. Professor GEORGE R. TWISS, following an extensive survey made in 1922, reports that : “ With the exception of three or four middle schools and a few of the universities and colleges, the scientific equipment was found to be very inadequate...” while only a small percentage of the middle and normal school science teachers were well trained (46).

(46) In *China Mission Year Book*, (1924), pp. 283-287. Also consult TWISS, G. R., *Science and Education in China*, (Shanghai, 1925), *passim*.

51. Since that time efforts to improve this condition have been made. Special summer schools have been conducted for the purpose of giving science teachers additional training, while better textbooks have been translated or compiled. To these tasks the Science Society of China and the China Foundation, organized to administer the returned American Boxer Indemnity Funds, have given invaluable support. Despite these efforts the League of Nations Mission of Educational Experts in their report on education in China, which they drew up following an investigation made in the fall of 1931, stated in substance that science instruction in most schools still relies too much on textbook knowledge, often written in a foreign language and making use of non-Chinese materials. There is they emphasized not enough direct contact between the school and life. The students are not given an opportunity to apply to the physical and social world about them the methods and knowledge gained in the classroom. There is a notable lack of observation and experimentation on the part of the students themselves (47).

52. Science instruction has either fallen under the baneful influence of the book-memorizing tradition of old China or aims too exclusively at achieving utilitarian ends. The Educational commissioners felt that the Chinese "... ought to learn that science is worth man's while not so much for the material power it gives him as for the attitude to which it accustoms the mind" (48).

They should derive from western science its true human value, its spirit and method if they would use it to fertilize their own culture and achieve "... the new synthesis of science, art and humanity..." that potentially they and perhaps they alone have it within their power to produce to the benefit of all mankind (49).

It will take time to fulfill these ideals and well it is that in this introductory period certain Chinese educational and intellectual leaders have caught this vision and are attempting to make it a reality through the educational system.

53. The creation of a standardized scientific terminology for the various sciences has begun to attain satisfactory solution only

(47) *The Reorganization of Education in China*, (Paris, 1932), p. 96.

(48) *Ibid.*, p. 39.

(49) *Ibid.*, p. 35.

within the past twenty years. In 1916, the Joint Committee on Scientific Terminology was organized under the auspices of the National Government, with members representing the Ministry of Education, the Chinese Medico-Pharmaceutical Association, the National Medical Association of China, the China Medical Missionary Association and the Science Society. The problems which confronted this committee were extraordinarily complicated by the use of Japanese scientific terminology, particularly by Chinese scientists trained in Japan, together with the use by missionaries and the Chinese scientists and educators of their respective terminologies. The Committee had not only to bring these three groups to accept a standard terminology, but also to create new terms either because they did not exist or because older terms were revealed to be inaccurate in the light of later knowledge (50).

54. As a result of the labors of the committee, most of the terms for the various sciences have now been standardized and formally confirmed by the Ministry of Education. Among the special scientific dictionaries or encyclopediae that already have been published are: the medical encyclopedia *Chung Kuo I Hsüeh Ta Tz'ü Tien*, (2875, 6609, 5380, 4839, 10.470, 12.402, 11.177) (1921) containing some 70.000 items; the dictionary of "Zoological Nomenclature," *Tung Wu Hsüeh Ta Tz'ü Tien*, (12.256, 12.777, 4839, 10.470, 12.402, 11.177) (1922), containing 12.000 terms; the dictionary of "Geological and Mineralogical terms," *Ti Chih K'uang Wu Hsüeh Ta Tz'ü Tien*, (10.956, 1892, 6588, 12.777, 4839, 10.470, 12.402, 11.177) (1930) containing 6.500 items; and the "Complete Dictionary of Botanical Terms," *Chih Wu Hsüeh Ta Tz'ü Tien*, (1849, 12.777, 4839, 10.470, 12.402, 11.177) (1918, 6th ed. 1926) containing some 6.000 items. Substantial progress, moreover, has been made toward fixing the terminology in the fields of mathematics, physics, chemistry, and biology. These compilations usually give the English or Latin equivalent immediately following the Chinese term, while their usefulness

(50) LAN, TIAO-FU, *op. cit.*, pp. 572-576. He gives good illustrations of the inadequacy of Japanese terms from the Chinese point of view, and reveals the necessity of a thorough knowledge of Chinese literature by those engaged in fixing scientific terminology. On the importance of a knowledge of the native literature also see above § 34 and note 33.

is further enhanced by the addition of indices in Japanese and Western languages. The frequent retention of Roman letters and Indo-Arabic numerals to express mathematical and scientific formulae has led to the frequent practise of printing Chinese scientific journals and books in Western style: that is, in horizontal lines running from left to right.

55. The number of scientific articles and books that have appeared is legion. For example, an index of articles on botany, biology, zoology, heredity, and eugenics, morphology and physiology published in 1925 contained over 900 articles which appeared in fifteen different scientific journals (51).

In the course of the last twenty years no fewer than thirty scientific and technical periodicals have appeared, published by nearly as many scientific societies and research institutions (52).

56. It will be possible here to recount briefly the organization and research work of only the three foremost scientific societies. The Science Society of China was founded in 1914, significantly enough at Cornell University in Ithaca, New York, by a group of Chinese students (53).

In 1918 its headquarters were moved to Shanghai. Its purpose as originally defined was... "to promote general scientific knowledge and increase people's interest in the technical industries in China..." Its monthly journal *Science*, the foremost of its kind in China, has appeared regularly since 1915. The Society now has over a thousand members, representing the physical, the biological, the engineering and the social sciences. It also publishes its annual *Transactions*; monographs written by the members of its biological laboratory and the departments of zoology and botany; popular treatises and a series of scientific textbooks. It is cooperating with the Fan Memorial Institute

(51) Compiled by LEI CH'I-JUNG in the *Tsing Hua Journal*, Vol. II, No. 2 (Jan.-Feb., 1925).

(52) From a list kindly prepared for the writer by the Reference Division of the National Library of Peiping. Among the foremost scientific societies mentioned in this paper are the Astronomical Society of China, the China Mining Association, the China Society of Chemical Industry, the Chinese Engineering Society, the Chinese Geographical Society, the Chinese Physiological Society and the Institute of Mining and Metallurgy. Each of these societies publishes its own bulletin or journal.

(53) Information derived from pamphlet issued by the Society entitled *The Science Society of China*, (Shanghai, 1931).

of Biology (1928) in a project which has for its goal the systematic survey of the fauna and flora of the whole country. There have already been published systematic studies of Chinese ferns, flowering plants, fish and crustacea.

57. The department of zoology has grown from two persons to seven full-time research workers and three assistants. It has fairly good technical equipment and its specimens number 18,000 representing 1,300 species. Following a study of the fauna of Nanking it plans to extend its studies along the Yangtze river and down the coast. It also aims to make intensive studies of animal physiology, morphology and habits of life.

58. The botanical department was opened under the direction of Dr. H. H. HU in 1922. It is now concentrating its work on "... the classification and ecological observation of the flora... in Central and Southern China..." particularly in the provinces of Chekiang and Szechuan. Its museum has 10,000 classified and labelled samples representing 200 families, 1,300 genera and 800 species. The personnel, comprising one professor, 4 research students and two assistants, had published by 1931 some thirteen papers.

59. Another outstanding scientific research institution is the Chinese Geological Survey organized in 1916. Modern geological studies in this vast and still not too well known terrain run back, however, to the latter half of the nineteenth century with the studies of PUMPELLE whose investigations were made in the sixties, to RICHTOFEN in the seventies, as well as to BAILEY WILLIS, ELIOT BLACKWELDER and R. H. SARGENT who conducted their field work in the early part of the present century (54).

60. Their studies were a stimulation to the Chinese and provided them with a measuring rod by which to check their own efforts. It was only under the Republic that they began to lay the foundations for studies in the geological field. At that time and since, as in other scientific fields they have had to rely upon the instruction and cooperation of western scientists. The first Professor of Geology in China was a German, Dr. SOLGER.

(54) See *Research in China* in 3 vols. and an Atlas published by the Carnegie Institution of Washington in 1907. For an extended bibliography of the studies, particularly in the descriptive sciences made by Westerners in China see CORDIER, H., *Bibliotheca Sinica*, 2nd Ed., 4 Vols. and Supplement (Paris 1923), *loc. cit.*

Dr. ANDERSSON and Dr. GRABAU, the latter formerly Professor of Paleontology at Columbia University, have long been associated with the Geological Survey, the foremost representative of this branch of science in China (55).

61. Two returned students H. T. CHANG and V. K. TING organized the first school of geology shortly after the establishment of the Republic. By 1916 there were twenty graduates from among whom was selected the nucleus for the staff of the Geological Survey organized in that year as a separate institution under the Ministry of the Interior (56).

62. Dr. V. K. TING became the first Director of the Geological Survey. The Survey has had a steady growth since despite financial difficulties and has at present a sizable working Library, a Museum, paleontological, fuel and soil laboratories and a seismological station. It has secured funds from the China Foundation, from mining companies as well as from wealthy Chinese. It has made extensive progress in preparing a complete set of geological maps of China. From its inception it has been interested in investigating the mineral resources of the country. It first made a thorough survey of some fifteen percent of the known iron ore reserves, results of which were published in the *Memoirs of the Survey* (57).

63. Its survey of coal reserves covers almost the entire country. Over thirty detailed reports with maps have been published in its *Bulletin*. From the latest estimates the total coal reserves of China are about 260 billion tons. The oil fields of Shensi, Kansu, Szechuan and Kueichou have been investigated; also the antimony, lead and tin of Yunnan and the tin of Kuangsi. It has published a series of statistical reports and general statements on Chinese mining industry.

(55) *Bulletin of Geological Society of China*, "A. W. Grabau Anniversary Number," vol. 10, (1931).

(56) H. T. CHANG, "On the History of Geological Science in China," *Bulletin of the Geological Society of China*, vol. I, No. 1, pp. 4 et seq.

(57) TEGENGREN, F. R., "Iron ores and Iron Industry of China," *Memoirs of Geological Survey of China*, Series A, No. 2, (April, 1921). The author states that "... our knowledge regarding the geology and mineral wealth of China... is still very imperfect." (p. 1). He has summarized all earlier surveys and reports, many of which were made by foreigners. The work of earlier western investigators has undergone much revision. The estimate of RICHTOFEN and others as to the amount of China's mineral deposits appear now to have been exaggerated.

64. From the outset the Survey has emphasized the study of invertebrate fossils in view of their paleontological interest as well as for their stratigraphical significance for more precise knowledge of the Paleozoic and early Mesozoic formations. This work has gone forward under the competent guidance of Prof. A. W. GRABAU. A laboratory has been established for the study of Cenozoic fossils. Prof. GRABAU believes that some surprising results will come to science through a study of Chinese fossils as types found in the West have been found earlier in China and have survived longer (58).

65. To W. C. PEI of the Geological Survey goes much of the credit for the discovery of the *Sinanthropus Pekinensis* at Choukoutien some 75 kilometers southwest of the city in 1928-29. Anatomical studies by Père TEILHARD DE CHARDIN and C. C. YOUNG resulted in placing the hominid and associated fauna in the lower quaternary period, approximately contemporaneous with the Pithecanthropus of Java that is between 500,000 and 1,000,000 years ago (59).

66. The Survey has recently established a seismological station with Wiechert seismographs in the Western Hills near Peiping. A systematic study of over three thousand earthquakes recorded in Chinese historical records has been made. The latest enterprise of the Survey is a soil survey of China financed by the China Foundation with Dr. R. L. PENDLETON, an American, supervising the work (60).

67. The Academia Sinica has, since its inception by the National Government in May, 1927, under the temporary name, National Central Academy, been under the direction of the eminent educator Dr. Ts'AI YÜAN-P'EI (61).

Its organization comprises nine research institutes including the Institutes of Physics, Chemistry, Engineering, Geology, Astronomy, Meteorology, Psychology, Social Sciences and History and Philology, each organized as an independent unit with head-

(58) GRABAU, A. W., "Paleontology" in *Symposium on Chinese Culture* (Shanghai 1931), pp. 176-191.

(59) WONG, W. H., "Geology" in *Symposium on Chinese Culture*, pp. 192-214.

(60) For a summary of the work of the Survey during its first fifteen years see *The National Geological Survey of China, 1916-1931* (Peiping, 1931). Its publications comprise 24 volumes, 43 fascicles, 17 bulletins and 13 pamphlets.

(61) *The Academia Sinica and its National Research Institutes*, (Nanking 1931).

quarters in Nanking, Shanghai or Peiping. The Institutes have made rapid progress in launching and carrying out their respective research projects. The Institute of Meteorology is making hourly and daily records of climatic conditions at Nanking. The Institutes of Physics and Chemistry are making studies of the manufacture of chinaware, paper, paint, glass, as well as conducting researches on Chinese medicines. The Institute of Engineering is carrying on research at its laboratory in Shanghai. The Institute of Geology has sent out no fewer than ten geological survey expeditions. Extensive collections of Chinese flora and fauna are being made by the Metropolitan Museum of Natural History. The publications to date comprise some 150 articles, memoirs and monographs.

68. The China Foundation for the Promotion of Education and Culture has been of considerable aid in the rapid development of scientific research that has taken place in China in recent years. Founded in 1924 to administer the remission of further payments of the annual installments of the Boxer Indemnity due the United States it has resolved that these funds be "... devoted to the development of scientific knowledge and to the application of such knowledge to the conditions in China through the promotion of technical training, of social research, experimentation and demonstration and training in science teaching, and to the advancement of cultural enterprises of a permanent character, such as libraries and the like."

69. For the purpose of promoting the teaching of science the Foundation decided to establish thirty-five professorships in chemistry, physics, zoology, botany, psychology, etc. in the leading educational institutions of the country. It has also supported special summer training courses for middle school teachers of science. It has granted sums of money to the Fan Memorial Biological Institute, the Science Society, Geological Survey, and to the Academia Sinica. During 1930-31 twenty-five institutions received grants from the Foundation : 11 Universities and Colleges; 7 research institutes and 7 educational and cultural organizations in general. In the same period it granted 43 Scientific Research Fellowships. It has appointed a Committee on Editing and Translation under the chairmanship of Dr. HU SHIH which has for its purpose in part the translation of recent scientific works

and the edition of scientific textbooks. A number of texts for middle schools have already been published (62).

70. Biological studies have been the very last to develop.

Nevertheless, there are now twenty-three universities and colleges possessing biological departments, a few of which have zoological museums and herbaria. The value of such studies to agriculture and medicine is now widely recognized. The National South-eastern University, now the National Central University has been a leader in this field. The Metropolitan Museum of Natural History has been active in sending expeditions to Kuangsi, Szechuan and Kueichou, the results of which have been published in "Sinensia." The Biological Laboratory of the Science Society has been cooperating with the recently organized Fan Memorial Institute of Biology (1928) in commencing a systematic survey of the fauna and flora of the whole country. There has already been published systematic studies on Chinese ferns, flowering plants, fishes and crustacea (63).

71. A Marine Biological Laboratory was established in 1930 at the University of Amoy. It has become the foremost center for the study of marine flora and fauna in China. Amoy University has one of the largest herbaria in the country. The Botanical Institute of the College of Agriculture of the National Chung Shan University at Canton aims at a complete survey of the flora of Kuangtung province. Among the serial publications of these institutes and bureaus are : *Sinensia*, *Bulletin of the Fan Memorial Institute of Biology*, *Contributions from the Biological Laboratory of the Science Society of China*, *Sunyatsenia* and *Journal of Science* of the Tsing Hua University.

72. The progress being made in zoological studies is gradual. The Biology Department of Yenching University is studying the aquatic insects of Eastern China. The Fan Memorial Institute has been devoting a portion of its energies to the publication of a book descriptive of the birds of China, and the crabs of North China. The country, embracing as it does three climatic zones exhibits great variation of topography and the richest flora and

(62) See the sixth annual report of the China Foundation for the Promotion of Education and Culture (1931).

(63) PING, C., and HU, H. H., " Biological Science " in *Symposium on Chinese Culture*, pp. 227-240.

possibly fauna of all temperate regions with endemism highly developed (64).

This accounts for the unparalleled richness of the Chinese pharmacopæia. Certain notable additions to the storehouse of Western drugs as corydalis, ephedrine, sinomerium as well as chaulmoogra oil, the only known remedy effective in aiding the cure of leprosy have been recognized as contributions (65).

73. The introduction of the modern medical sciences into China began with the Jesuits in the seventeenth century. Father TERRENTIUS compiled a book on human anatomy in Chinese, while Father PARRENIN translated "L'Anatomie de l'homme suivant la circulation du sang, et des nouvelles découvertes par DIONIS" (66).

The Jesuits gained favor at Court in part because of their healing powers. The Emperor K'ANG HSI was cured of a malignant fever by one of their number in 1692.

(64) WILSON, ERNEST H., *China Mother of Gardens*, (Boston, 1929). This authority writes that, "Competent authorities estimate the Chinese flora to contain fully 15,000 species, half of which are peculiar to the country... (and it is) the richest flora in the world." (p. 278). "Our Tea, Polyantha and Rambler Roses, Chrysanthemums, Indian Azaleas, Camellias, Greenhouse Primroses, Mountain Peonies, and large flowered Clematis have all been derived from plants still to be found in a wild state in central and western China. The same is true of a score of other favorite flowers. China is also the original home of the Orange, Lemon, Citron, Peach and Apricot." Indeed there are few gardens in the north temperate zone that do not contain at least a few Chinese plants. (p. 279).

(65) For information on the *Pên Tsao Kang Mu* (8846, 11,634, 5900, 8080), the Chinese Materia Medica, and its contributions to modern medicine, consult WONG, K. C. and WU, L. T., *History of Chinese Medicine* (Tientsin, 1932) which contains an extensive bibliography. The writings of Dr. B. E. READ on Chinese drugs are especially noteworthy contributions to the subject. In particular see his *Chinese Materia Medica*, (Peiping, 1931). Also see BRETSCHNEIDER, EMIL, "Botanicon Sinicum: Notes on Chinese Botany from native and Western sources." *Journal North China Branch Royal Asiatic Society*, vol. 16 (1881), pp. 18-230; vol. 25 (1890-91), pp. 1-468; vol. 29 (1894), 623 pp.

(66) WONG, K. C. and WU, L. T., *op. cit.*, pp. 133, 134. The most authoritative work in Western languages on native Chinese medicine is Fr. HÜBOTTER's *Die Chinesische Medizin zu Beginn des XX. Jahrhunderts und ihr Historischer Entwicklungsgang*, (Leipzig, 1929; see *Isis*, 14, 255-63). There has just been announced a series of four volumes on Chinese acupuncture by G. SOULIÉ DE MORANT. The first of these, which is now in press is a translation by him and Dr. SAKURAZAWA of Dr. NAKAYAMA's "L'Acupuncture et la médecine Chinoise vérifiée au Japon." The remaining three volumes will be devoted to Chinese acupuncture itself. The publisher is PAUL GEUTHNER, Paris.

74. However, with the decline of missionary activity in the eighteenth century western medical influence came to an end. It was reintroduced early in the nineteenth century. In 1803 Dr. PEARSON of the East India Company introduced Jenner's vaccine. The major credit for the promotion of western medical practise from that time until the beginning of the present century goes to the Christian missionaries, particularly the Protestants. Throughout the nineteenth century they continued to open in practically all parts of the country clinics, dispensaries and hospitals, to translate books, and to formulate medical terminology (67).

75. A great step forward in raising the standards of medical instruction was taken in 1916 when the China Medical Board of the Rockefeller Foundation took over the Union Medical College of Peking as a result of which that institution has taken the lead in medical education in China. As far as standards and equipment are concerned it is scarcely without its peer in the world. Moreover the Foundation has granted financial aid to more than a score of hospitals and medical schools in China, and has assisted in endowing departments of biology, chemistry and physics in missionary and Chinese colleges. In the year 1929 alone it expended \$272.801 for the promotion of education in the natural sciences.

76. China is still far from being adequately supplied with well trained modern physicians, or suitably equipped hospitals. According to a report made by Dr. FABER, who made a survey of medical education on behalf of the League of Nations in the fall of 1930, there are only 4-5,000 modern trained physicians, or one for 80-100,000 people. At present there are only a dozen medical schools giving satisfactory training and they graduate only 180 Doctors a year.

Despite the obstacles to be overcome progress in the development of medical science has been steadily going forward in the face of discouraging political and financial handicaps.

77. The application of modern science to China's agricultural problems is only beginning (68). There are now twelve agricul-

(67) For an account of this development see WONG, K. C. & WU, L. T., *op. cit.*, and LATOURETTE, K. S., *op. cit.*, *passim*.

(68) FENG, R., "Agriculture," in *Symposium on Chinese Culture*, pp. 261-277; TAWNEY, R. H., *Land and Labour in China* (London, 1932), *passim*.

tural colleges in China of which three are national, six are provincial, one is private, and two are American missionary institutions. National and provincial colleges have been hindered by lack of funds and political turmoil. The Ministry of Agriculture has eleven experimental stations under its direction. One is a general station, four are Cotton investigating stations; one Tea, three Farm Animal, and two Forestry, respectively. The results to date are meager as this branch of applied science is still in an introductory stage through which all the branches have passed when first taken over from the West before the problems of the China field had become realistically grasped and the necessary adjustments made.

78. The outstanding College where effective work is now being done is connected with Nanking University, a missionary institution. Research there is under the direction of J. LOSSING BUCK who has gathered about him capable Chinese co-workers. The work in seed selection is especially noteworthy as are the surveys of agricultural conditions, the most extensive one of which was published by Dr. BUCK under the title, "*Chinese Farm Economy*," in 1930.

79. The incorporation of the social sciences, particularly economics, statistics and sociology into the curricula of the schools, and the application of the methods employed in these fields to the study of China's social and political problems has lagged for more than a generation behind the introduction of the physical sciences. Indeed it was only to come about after the Republic had been established a number of years. By that time the efforts of reformers to solve China's pressing problems through political reform and militarization along modern lines had clearly demonstrated their inadequacy. Discouraged by it all, intellectual leaders came to the realization that fundamental reform lay in modernizing the economic and social structure of their society and to accomplish this they felt that they must bring to a greater number of their people, through the easier medium of the vernacular language, some concept of western science and the methods by which to apply it to the solution of their own peculiar problems.

80. The use of statistical methods for ascertaining more accurately China's prevailing economic and social status as a prelude to the formulation of programs designed to improve

rural and urban conditions, has only recently come into vogue. The National government, which established its capital at Nanking in 1928, has set up a statistical bureau which cooperates with the various departments in gathering statistics with respect to population growth, wage scales, family budgets of peasants, industrial workers, etc. Some of the more significant results have been published in the official *Statistical Monthly*, the first number of which appeared in March, 1929.

81. In addition to the research work of the National government are the surveys made by the social affairs bureaus of the larger municipalities. The foremost of these bureaus is the one at Shanghai which has been publishing in its monthly journal, the *Shé Hui Yüeh K'an* (9803, 5184, 13,768, 5862), the first number of which appeared in January 1929, statistical studies on labor strikes, wage scales, price fluctuations, etc. in that city. Moreover, the government-supported Academia Sinica through its Institute of Social Sciences has been conducting researches on agrarian problems. It has already published the results of investigations made into the agrarian systems at a number of places including Wusih and Paoting. It has also collected ethnological data on certain tribal folk in the Far East, such as the Tungus in Manchuria and the Lolos in Szechuan.

82. Among the foremost private institutes for social and economic research are the Nankai University Committee on Social and Economic Research, of which the American-trained economist Dr. FRANKLIN L. HO is Chairman; the Institute of Social Research of the China Foundation, supervised by Dr. L. K. TAO, which publishes a *Quarterly Review of Social Science*; the research department of the National Association of the Mass Education Movement, which has made a comprehensive social and economic survey of life in one of the villages of Ting Hsien; and the Agricultural Department of the Nanking University, headed by J. L. BUCK. Among the publications made by Dr. Ho's Committee at Tientsin are accounts of conditions among factory workers in North China and the extent and effect of industrialization in China. The results of the survey made by the Mass Education Movement will be published in English by SIDNEY D. GAMBLE, who has been closely associated with the work in Ting Hsien since its inception. The Institute of Social Research

has published: "An Introduction to the Methods of Social Survey"; "Livelihood in Peking"; "Factory Workers at Tangku"; and a "Chinese Labor Yearbook." An especially interesting project, on which the Institute is at work, is a study of social and economic conditions under the Ch'ing dynasty, abundant material for which is to be found in the recently opened archives of that dynasty in Peiping (69).

The amount of material is evidenced by the engagement of as many as fifty copyists at one time to transcribe the documents on this subject.

83. The formal teaching of sociology in the colleges and universities has lagged lamentably according to Professor LEONARD Hsü of the department of sociology and social work of the Yenching University (70).

In 1927 with but one exception none of the government institutions of higher learning had a separate department of sociology (71).

The Christian institutions are far in advance—particularly the Yenching (72), Nanking and Shantung Christian Universities. However, there was a serious dearth of literature in the Chinese language for the conduct of such courses in 1925. Hsü deplors the lack of textbooks in sociology especially prepared for Chinese students, and containing material illustrative of Chinese life (73).

84. As has already been observed the foundations for the production of original and effective research have been laid more firmly in the physical and natural sciences than in the social sciences. In historical studies, however, the Chinese have antedated Western historians in the use of the inductive method, and in the gathering of evidence in order to criticize ancient texts. In fact by the middle of the seventeenth century Confucian scholars of the school known as the *Han Hsüeh P'ai* (3836, 4839,

(69) PEAKE, C. H., "Documents Available for Research on the Modern History of China," *American Historical Review*, vol. XXXVIII, No. 1 (Oct. 1932), pp. 61-70.

(70) See "The Teaching of Sociology in China," *Chinese Social and Political Science Review* (July, 1927) vol. XI, no. 3, pp. 373 et seq.

(71) The sociology department of the National University of Peking is the exception. It commenced in October, 1922 the publication of a *Social Science Quarterly*.

(72) The sociology department of Yenching started publication of the *Yenching Social Science Quarterly* in April, 1930.

(73) "Chinese Sources in General Sociology," (C. S. P. S. R.) Vol. II, No. 1 (January 1927), pp. 14 et seq.

8583) in their efforts to emancipate Confucianism from the subjectivism and rationalism of CHU HSI and his school in the Sung dynasty, (who had been unduly influenced by Buddhist and Taoist metaphysics) "... had developed a genuinely scientific method of study and investigation. Every philological reconstruction of textual criticism had to be based on evidences. With the aid of this new methodology the scholarship of the last three hundred years became quite scientific and a number of historical sciences, notably philology, textual criticism and archeology reached a high stage of development" (74).

85. The movement to reconstruct China's past which began then was given renewed impetus by K'ANG YU-WEI, who at the close of the nineteenth century in his efforts to make reform popular in China went back of the Han dynasty (206 B.C.—221 A.D.) forgeries to what he called the "authentic" texts of CONFUCIUS himself and attempted in his book, "Confucius as a Reformer," *K'ung Tzu Kai Chih K'ao* (6605, 12.317, 5783, 1910, 5966) (1897) to picture the Master as playing the rôle of an innovator rather than being "... a mere historian and conservator and of ancient values" (75).

In his book "Forged Classics of the Wang Mang Period," *Hsin Hsüeh Wei Ching K'ao* (4574, 4839, 12.522, 2122, 5966) (1891) an attempt is made to prove that many of the Classics were forgeries of that period (9-23 A.D.). Later scholars more under the influence of Western critical methods of research than K'ANG, asserted he did not go far enough in his criticism of the Classical and historical literature, remaining, as he did, to the end of his life, an ardent Confucianist.

86. Out of the contact with Western civilization and the introduction of Western methods of historical research including archeology and comparative studies in folklore came the *Chêng Li Kuo Ku* (697, 6879, 6609, 6190) movement for the reorganization of China's cultural heritage (76).

(74) HU SHIH, "The Civilizations of the East and the West" in *Whither Mankind*, p. 32; HUMMEL, ARTHUR, W. *The Autobiography of a Chinese Historian* (Sinica Leidensia, Vol. I, Leyden, 1931), pp. v-XLII. For possible Jesuit influence on this movement see above Note 5.

(75) HUMMEL, *op. cit.*, pp. XI-XIII.

(76) For a statement of the aims and methods of this group and of those associated with this movement see HUMMEL, *op. cit.*, pp. XXX-XXXVI.

Speaking of Western influence on this movement KU CHIEH-KANG, one of its outstanding leaders has written that

... the introduction of new sciences from the West exerted a powerful influence upon Chinese scholars, awakening them to the necessity of a radical change in their methods of study, involving a re-systematization of all our ancient knowledge, in order to increase its intelligibility and ascertain its historical value. The first outcry for the 'reorganization of the national past' (*Chêng Li Kuo Ku*, 697, 6879, 6609, 6190) began with the writings of CHANG T'AI-YEN, but the problem was not systematically attacked until HU SHIH propounded his concrete program... When Dr. HU SHIH returned from the West, he brought with him western historical methods by which he was able to illustrate, by the use of novels and folklore, the evolutionary changes in our ancient social system" (77).

87. Contact with the West not only gave Chinese scholars new methods of research but also supplied them with a new and a broader point of view from which to study their own past. They were able to escape a thought-world bounded by Confucianism, and to view with less prejudiced eyes other schools of thought in China that once unsuccessfully, though not without leaving certain traces of their influence on the Confucian system, competed with the Confucianists for the allegiance of the people and the State. With respect to these, HU SHIH has written, that, "For my part, I believe that the revival of the non-Confucian schools is absolutely necessary because it is in these schools that we may hope to find congenial soil in which to transplant the best products of Occidental philosophy and science" (78).

88. The introduction of western archeological methods into China by foreigners and the use made thereof either by foreign or Chinese or joint Sino-foreign expeditions, has resulted in a more authentic and satisfactory portrayal of the origin and development of Chinese civilization than has been traditionally set forth in Chinese Classical and historical literature. In the course of certain surveys conducted by the Geological Survey under the supervision of the Swedish member of the staff, Dr. J. C. ANDERSSON, very interesting and illuminating neolithic sites were chanced upon

(77) HUMMEL, *op. cit.*, pp. 150, 152.

(78) HU SHIH, *The Development of the Logical Method in China*, (Shanghai, 1922), p. 8.

in Manchuria, Kansu and Honan. These discoveries together with the work of European archeologists, such as PELLIOU and STEIN and Fathers CHARDIN and LICENT, as well as the location of the site of the Honan divination bones of the 2nd millenium B.C. stimulated the Chinese to undertake extensive archeological studies. For centuries since the Sung dynasty Chinese scholars have conducted archeological studies of the limited antiquarian type. During the last one hundred and fifty years of the Manchu dynasty the interest in these studies was extensive, as many as four hundred valuable works having appeared (79).

89. However, the Chinese have failed until very recent years to study materials *in situ* and to derive therefrom their full significance as revealing the origins and development of Chinese civilization. The Institute of History and Philology of the Academia Sinica has now taken up this work. Its first important diggings have been at Anyang. The Freer Art Gallery of the Smithsonian Institution has cooperated in this work in its early stages through its field representative Carl Bishop (80).

Another scientific expedition of much promise is that led by the famous Swedish explorer SVEN HEDIN. It began its work in Inner Mongolia and Chinese Turkestan in 1927-28. To its staff was appointed ten Chinese students and scholars who have

(79) LIANG CH' I-CH'AO, "Archeology in China" *Peking Leader Reprint* No. 25 Peking, 1926; WANG KUO-WEI, "Archeology in the Sung Dynasty," *China Journal of Arts and Sciences*, Vol. VI, No. 5, pp. 222-231. The Jesuit Fathers LICENT and TEILHARD DE CHARDIN were the first to discover in 1923 evidences of the existence of paleolithic man in China. They have contributed greatly to the furtherance of the study of pre-historic man, particularly CHARDIN who has long been closely associated with the Geological Survey. See CHARDIN and LICENT, "The discovery of a paleolithic industry in North China," *Bulletin of the Geological Society of China*, Vol. 3, No. 1 (1924), pp. 45-50; LICENT, CHARDIN and BLACK; "On a presumably pleistocene human tooth from the Sjava-ossogol deposits," *Bulletin of the Geological Society of China*, Vol. 5, Nos 3-4 (1927), pp. 285-290; ANDERSSON, J. G., "Early Man" *Memoirs of the Geological Survey of China*, Series A, No. 3, pp. 131 et seq.; SMITH, ELLIOT G., "The Discovery of Primitive Man in China," *Antiquity*, March, 1931, pp. 21-26 and NELSON, N. C., "Archeological Research in North China," *American Anthropologist*, Vol. 29, No. 2 (April-June, 1927), pp. 177-200. Also see the reports of the Central Asiatic Expeditions of the American Museum of Natural History.

(80) LI CHI, "Archeology," In *Symposium on Chinese Culture*, pp. 215-226. The Anyang reports of the Academia Sinica have been recently awarded the Julean prize by the Academie des Inscriptions et Belles-lettres,

assisted in the meteorological, geological and archeological work of the expedition (81).

90. The Literary Revolution which arose in 1917 had for its purpose the freeing of Chinese thought from the restraining shackles which expression in the Classical or Wen Li language imposed. The necessity of finding a freer medium of expression in the vernacular, or the Pai-hua made itself more and more apparent as the Chinese moved further into the intellectual, political and social currents of the modern world. Students in the modern schools no longer had the time to memorize the Classics as of yore nor learn to write in a cryptic and archaic style long since divorced from the nation's living speech. Moreover, the urgent desire on the part of the leaders to reach an ever increasing number among the masses in order to win their support in the effort to solve social and political problems that pressed on every hand led to the widespread use of the vernacular. The times were ripe for this change and within a few years the greater number of new books and magazines which appeared were written in the vernacular while the government ordered that it be taught in primary schools. The intellectual ferment was deepened and intensified. An analysis made of the innumerable articles in the four hundred magazines that quickly sprang up reveals that ten per cent were of a scientific character; forty percent were purely literary, while fifty percent were devoted to general discussions of an ethical, philosophical and political character (82).

91. The Youth Movement which arose in 1919, likewise bears evidence of the influence of modern science particularly as it gave support to anti-religious movements. Science and religion were held to be irreconcilably antagonistic. CH'ÊN TU-HSIU, one of the leaders of the movement, writing in the *Youth Magazine* advised the students among other things to be "... scientific and not idealistic... Idealism is proper to the infant stage of peoples. All religions were produced by idealism. That which makes the people of Europe actually superior to all nations is

(81) SVEN HEDIN, *Across the Gobi Desert*, (New York, 1932), p. 41.

(82) DE VARGAS, P. H., "Some Elements in the Chinese Renaissance," *New China Review*, vol. IV, 1922, p. 243. In this connection also consult DUYVEN-DAK, J. J. L., "A Literary Renaissance in China," *Acta Orientalia*, Vol. I, 1923.

their positive science, their reason. Science and reason have made an end to ignorance and superstition." Science, he pointed out hasn't explored all phenomena as yet, but its practical applications are already numerous and these the young of China should embrace as a means whereby to preserve and strengthen the nation (83).

The anti-religious movement of 1922-24 was highly colored by the general conception of the antagonism between science and religion.

92. The philosophies born of the rise of modern science and the industrial revolution have secured widespread acceptance among the intelligentsia. Representative works of such outstanding philosophers and scientists as DESCARTES, HUME, ROUSSEAU, DARWIN, NIETZSCHE, SPENCER, HUXLEY, SCHOPENHAUER, EINSTEIN, RUSSELL, JAMES and DEWEY have been translated into Chinese.

93. The traditional skepticism of Confucianism with regard to the "spirits" and its emphasis on the "here and now" relationships of men in society made easy the ready acceptance of the pragmatic and naturalistic tendencies of contemporary western thought. The struggle of the Ch'ing scholars to emancipate Confucianism from the metaphysical interpretations of the Sung philosophers achieved an unforeseen success through contact with western thought that resulted in the rejection of Confucianism itself as an adequate philosophy with which to meet the problems of this age. The temper of modern thought in China is seen in the welcome accorded the lectures of Professors DEWEY and RUSSELL in China and the less enthusiastic reception given in some quarters the visit of RABINDRANATH TAGORE.

94. The pragmatic tendency in Chinese thought is best represented by HU SHIH, a former student of JOHN DEWEY. He once wrote, "We have studied and observed the need of our time; we cannot help but conclude that the greatest of all is the application of scientific methods to the problems of life" (84).

The naturalistic tendency is represented by TING TSAI-CHUN, an opponent of metaphysics, who calls his theory of knowledge "skeptical idealism" (85).

HSIAO TZŭ-SHĒNG finds the moral law and the natural law

(83) Père LÉON W EGER, *Le Flot Montant*, p. 9 et seq.

identical, and is thus in part a Confucianist. The realistic tendency in literature is represented by CH'ÊN TU-HSIU and LU HSÜN (Chou Shu-jên) (86).

Such Confucian influence as remains is seen in the humanistic tendencies of most Chinese thinkers.

95. The profound influence of scientific thinking on leading scholars is seen in the publication in 1923 of a series of discussions on the relations of science to life and conceptions thereof by such men as LIANG CH'I-CH'AO, V. K. TING and CHANG CHÜN-MAI (87).

The discussion was started by V. K. TING's article "Science and our Philosophy of Life." HU SHIH wrote an introduction to the work summing up the discussions, and closing with his credo (88).

This credo draws its inspiration from the verifiable results of scientific research in all fields. He holds that space is infinitely large (the concept of finite space and an expanding universe had not then wide acceptance) extends over infinite time, that there is no need of the concept of a Creator, nor benevolent Ruler; that man differs in degree and not in kind from the animal world; he believes in the evolution of organisms and of society; that all psychological phenomena are explainable by the law of causality; that morality and religion, are subject to change; that matter is full of motion and not static. He believes in the immortality of the "Larger Self" and "... that to live for the sake of the species and posterity..." is the religion of the highest order; all other religions being selfish. "This new credo is a hypothesis founded on the generally accepted scientific knowledge of the last two or three hundred years... I propose to call it... the Naturalistic Conception of Life and the Universe" (89).

This conception he asserts is "... not necessarily devoid of

(84) *Collected Essays*, vol. III, p. 270, quoted by Y. S. HAN, "Some Tendencies of Contemporary Chinese Philosophy," *Journal of Philosophy*, vol. 25, no. 19, (1928), p. 509.

(85) *Ibid.*, p. 509.

(86) *Ibid.*, pp. 509-513.

(87) "An Examination of Science and the Life of Man," (*K'ê Hsiieh Yü Jên Shêng Kuan*, 6089, 4839, 13.522, 5624, 9865, 6363), 2 vols., (3rd ed. 1925).

(88) HU SHIH in *Living Philosophies*, pp. 260, 261.

(89) *Ibid.*, p. 262.

beauty, of poetry, of moral responsibility, and of the fullest opportunity for the exercise of the creative intelligence of man " (90).

96. Finally, by way of conclusion, it may be observed that the introductory stage in the history of modern science in China is now drawing to a close. Modern educated Chinese have fostered the introduction of the applied sciences as the only effective means of securing for their nation that position of equality and influence in the world which its material resources and its people entitle it to assume. Moreover, a few of these intellectual leaders have caught a vision of the rewards and possibilities of research in the pure sciences and have established a number of research institutes. Within recent years Chinese scientists have taken their places at important international scientific congresses. One no longer hears, as frequently as in the past, the blunt assertion that the Chinese, because of certain racial and social characteristics are incapable of becoming accurate and objective scientists. Nor do doubts concerning the possibility of expressing in the Chinese language scientific terminology make themselves so conspicuous as formerly. Furthermore, many of the Chinese given to philosophical speculations have found in modern science a more satisfying interpretation of the Universe and of man's place therein than in the older world-conception of Confucianism, or in the metaphysics of Buddhism and Taoism.

97. To be sure modern science has not yet attained that independent status which it holds in certain Western countries, nor in Japan. The promotion of scientific training and research is still dependent to a degree, not only upon the guidance and stimulation of foreign scientists in China, but also upon foreign financial assistance extended indirectly through returned Boxer Indemnity funds, or through the China Medical Board Inc. and Mission Boards (91).

Moreover, the quality of science instruction, in the developing,

(90) *Ibid.*, p. 263.

(91) While the Catholic and Protestant missionaries have lost the leadership in scientific research and instruction to the Chinese themselves, nevertheless, they have continued to contribute to the development of science in China. The scientific instruction in their schools and Universities is on a par with that available in the best Chinese institutions. For a fuller treatment of their contribution in the earlier periods see above § 1-44.

though still far from adequate educational system, calls for marked improvement which will take much time, money and effort, to bring about. Nevertheless, sufficient independent researches have been conducted by the Chinese themselves in their own established institutes and departments of science with results of increasingly higher quality, to give foundation to the assuring belief that the modern sciences have taken root in Chinese soil.

Department of Chinese

CYRUS H. PEAKE.

Columbia University, New York City.

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