

Concepts of Nature

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CHAPTER ELEVEN

THE INVESTIGATION OF THINGS (*GEWU* 格物); NATURAL STUDIES
(*GEZHIXUE* 格致學), AND EVIDENTIAL STUDIES (*KAOZHENGXUE*
考證學) IN LATE IMPERIAL CHINA, 1600-1800

Benjamin A. Elman

When Europeans reached China during the 'age of exploration,' the *scientia* of their men of learning did not mean or connote 'natural science' per se among humanists, Jesuits, or more secular scholars 關格 in early modern Europe. A medieval French term, *science*, which was synonymous with 'accurate and systematized knowledge,' became, when Latinized, *scientia* and represented among scholastics and early modern elite the specialized branches of Aristotelian moral and natural philosophy. Included were the seven sciences of medieval learning: grammar, logic, rhetoric, arithmetic, music, geometry, and astronomy. These seven liberal arts in Roman times had served educationally as preparation for more specialized training in philosophy, medicine, or law.

In medieval times, Boethius' (c. 475-524) pioneering translations of Aristotle into Latin, for example, named the four mathematical disciplines (arithmetic, geometry, music, and astronomy) for elementary education as the *quadrivium* (four roads to wisdom), which balanced the three disciplines of logic (grammar, dialectics, rhetoric) known later as the *trivium* (three roads). After the Muslim harvest of classical learning was rediscovered in Europe by the time of Thomas Aquinas in Paris, the preferred order of Aristotelian learning had been set for the Renaissance scholars and bookmen: 1) logic; 2) mathematics; 3) natural science; 4) moral philosophy; and 5) metaphysics.¹

Similarly in Ming China, when terms such as *scientia* were translated by the Jesuits and their Chinese colleagues from Latin into classical Chinese, the elite written language of Chinese literati, the translations reflected the views and frames for the natural studies of the sixteenth century in China and Europe—not the 'science' of more modern times. *Xuewen* 學問 was the classical Chinese equivalent to correlate native categories of specialized learning with the *scientia* of the Jesuits.² Moreover, during the Jesuit-Chinese interaction in the seventeenth century, the 'investigation of things' (*gewu* 格物), 'exhaustively

¹ See Weisheipl, "Classification of the Sciences in Medieval Thought," pp. 54-55, 58-68, 81-90, and Lindberg, "The Transmission of Greek and Arabic Learning to the West," pp. 52-90. Cf. Ross, "Scientist: The Story of a Word," pp. 65-71, who notes that the term 'scientist' was not commonly used in English until the nineteenth century.

² On the issue of *scientia* = *xuewen* in Chinese glosses of Latin terms, I have benefited from discussion concerning Latin-Chinese glossaries with Han Qi. Latin-Chinese word glossaries compiled by the Jesuits and their Chinese collaborators were forerunners of modern dictionaries of the Chinese language. See Masini, "Using the Works of the Jesuit Missionaries in China to Study the Chinese Language."

mastering principles' (*qiongli* 窮理), and 'knowing heaven' (*zhitian* 知天) were at the core of the intellectual encounter between Chinese literati and the early modern West that the Catholic Church still represented. These classical Chinese terms were used by Chinese literati and Jesuits to accommodate both Western and Chinese views of practical studies, which included natural studies. In this cultural endeavor, we see an overlap between religious and scientific work on the part of the Jesuits and their Chinese converts and sympathizers.³

Between 1600 and 1773, Jesuit authors worldwide wrote more than 4000 works, 600 journal articles (almost all after 1700), and 1000 manuscripts dealing with the sciences. The vast majority were by Jesuit educators. Some 437 works were translated or compiled by the Jesuits and their converts in China between 1584 and 1790. Thirty per cent of that total (131) was in the sciences, while fifty-seven per cent (251) were on Christianity. Usually the Latin texts were orally translated by a Jesuit and dictated to a Chinese in a style known as *kouyi* 口譯 (oral translation) or *bishou* 筆受 (received writing). The Chinese collaborator then prepared a polished written version for review.

For example, Matteo Ricci (1552-1610) translated Christoph Clavius' 1607 *Elementorum* in this manner, as did Sabbathin de Ursis (1575-1620) for his 1612 *Taixi shuifa* 泰西水法 (Western Techniques of Hydraulics). Jean-Nicholas Smogolenski (1610-1656) and his collaborators introduced the European method for calculating eclipses in an astronomical work of circa 1656, which was also the first to introduce spherical trigonometry and logarithms. Later, Ferdinand Verbiest's (1623-1688) 1672 *Kunyu tushuo* 坤輿圖說 (Maps and Explanations of the Earth) furnished further information on world geography beyond Ricci's earlier *mappa mundi*. By way of contrast, most eighteenth-century translations in China were theological works, and Jesuits turned instead to translating Chinese works into European languages.⁴

1. Interest in Natural Studies during the Ming Dynasty

The Jesuits in late Ming China saw the 'investigation of things' (*gewu* 格物) and 'exhaustively mastering principles' (*qiongli* 窮理) as a necessary way station to the doctrinal transmission of the experience of God to the Chinese they hoped to convert. For late Ming Chinese such as Fang Yizhi 方以智 (1611-1671), their recovery of the 'concrete studies' (*shixue* 實學) of antiquity predisposed some literati to accept the Western learning brought by the Jesuits because it was an alternate form of the 'investigation of things' and was presented by the Jesuits as a confirmation of Chinese ancient learning.⁵ Because of the physico-theology lurking in the Jesuits teleology of nature, however, the

³ Standaert, "The Investigation of Things," pp. 395-420.

⁴ See Tsien Tsuen-hsuei, "Western Impact on China Through Translation," pp. 307-310, and Harris, "Transposing the Merton Thesis," pp. 29-65. See also *Siku quanshu zongmu* 107.23b-24a. Cf. Elman, "Geographical Research in the Ming-Ch'ing Period," pp. 1-18.

⁵ Peterson, "Fang I-chih," pp. 369-411.

investigation of things was ultimately 'to find God' for the Jesuits and 'to fathom principles' of the *dao* 道 for the Chinese. Despite this theological twist to the Jesuit interpretation, the Jesuit conception and practice of *scientia* was ingeniously presented by some of the Chinese who collaborated with the Jesuits, such as Xiong Mingyu 熊明遇 (b. 1579), as roughly corresponding to the natural studies of the Chinese.⁶

Xiong noted in his late Ming "Personal Preface" to his *Gezhi cao* 格致草 (Draft for Investigating Things and Extending Knowledge) that "Literati took to heart the *Great Learning* and of course spoke of the necessity of first investigating things and extending knowledge" (*Ruzhe zhi daxue, ze yan bi shou gewu zhizhi yi* 儒者志大學，則言必首格物致知矣。). Unfortunately, they had failed to capture the unity of knowledge (lit., "we can encompass the way of heaven and earth through a unified expression: *tiandi zhi dao ke yi yan er jin ye* 天地之道可一言而盡也") that the *Doctrine of the Mean* (*Zhongyong* 中庸) and *Mencius* (*Mengzi* 孟子) had extolled. What was required, Xiong explained, was a detailed examination of the heavens, earth, stars, constellations, the transformations of *qi* 氣, plants and animals, and "one by one on the basis of what each phenomenon actually was, one could seek out the reason for why things are as they are and thereby illuminate the principle for why they could not be any other way" (*yi yi yin dangran zhi xiang, qiu qi suoyi ran zhi gu, yi ming qi budebu ran zhi li* 一一因當然之象，求其所以然之故，以明其不得不然之理。).⁷

Both sides saw an order and purpose in the cosmos and on earth, which the Jesuits linked into a physico-theology that used theology and geography to delineate God and nature as one. Most Chinese literati also saw the earth and heavens as a harmonious whole, but their teleological view of nature framed arguments for the design of the cosmos around an eternal and always changing *dao* rather than around the chronology of a divine providence informing the cosmic order in Christianity. In place of a cosmos made up of 'four elements' (air-ether, fire, earth, water), the Chinese conceived of change in light of a 'Supreme Ultimate' (*taiji* 太極), which through the medium of *yang* and *yin* forces set in motion the five phases (*wuxing* 五行, earth, fire, metal, water, and wood) of cosmic evolution and yielded the concomitant production and destruction cycles of the 'myriad things' (*wanwu* 萬物) in the world.⁸

Indeed, Alphonso Vagnoni's 1633 *Kongji gezhi* 空際格致 (lit., 'Investigation of the Atmosphere'), was in part a refracted presentation of the theory of the four elements from the Conimbricenses edition of Aristotle's *Meteorologica* entitled *In Libros meteorum*, which was then used in the Jesuit

⁶ See Xu Guangtai, "Mingmo Qingchu xifang gezhi xue de chongji yu fanying," pp. 236-258.

⁷ See Xiong Mingyu's "Zixu" to the *Gezhi cao*, pp. 1a-5a, and elsewhere for examples of efforts to inscribe Chinese views of nature with the teleologies of the Jesuits.

⁸ On the five phases, see Sivin, "The Myth of the Naturalists," pp. 1-29, who notes that "by the first century BC, a coherent theory of *yin-yang* and the Five Phases as aspects of *ch'i* [*qi*] emerged." For discussion, see Glacken, *Traces on the Rhodian Shore*, and Thomas, *Man and the Natural World*.

University of Coimbra in Portugal where many missionaries were trained before leaving for Asia. In his translation, for example, Vagnoni tried vainly to convince the Chinese of the error of their ways for including wood and metal and excluding air-ether as the building blocks of things in the world.⁹ Rather than building blocks of the universe, Chinese literati perceived in the five phases evidence for the successive evolutive changes in all things. Chinese also perceived in *qi* a more fundamental material (*zhi* 質) and spiritual (*shen* 神) unity, which pervaded all things in the cosmos and undergirded the space-time evolution of *yin* and *yang* (*qi ze yinyang liangduan xunhuan bu yi* 氣則陰陽兩端循環不已), rather than the lifeless air-ether element enunciated by Vagnoni, following Aristotle, as one of the substrates of matter.¹⁰

In light of the Jesuit use of the 'investigation of things' to present their *scientia* to the Chinese, it is important to note that 'natural studies' in China had at times since the Yuan dynasty also been classified under the phrase *gezhi* 格致 (lit., 'inquiring into and extending knowledge,' *gewu zhizhi* 格物致知). At other times, particularly in the medieval period, and often simultaneously with *gezhi* after the Yuan, such interests were expressed in terms of *bowu* 博物 (lit., 'broad learning concerning the nature of things'). For instance, *bowu*, not *gezhi*, was one of the six major classification categories (*huibian* 彙編) for the thirty-two section headings (*dian* 典) in the *Gujin tushu jicheng* 古今圖書集成 (Synthesis of Books and Illustrations Past and Present), the largest *leishu* 類書 encyclopedia in imperial Chinese history, under which over 6100 items were organized.

Under *bowu huibian*, four section headings in the encyclopedia were included: 1) *yishu* 藝術 (arts); 2) *shenyi* 神異 (spirits and anomalies); 3) *qinchong* 禽蟲 (birds and insects); and 4) *caomu* 草木 (herbs and trees). In addition, the section headings for the heavens (*qianxiang* 乾象), seasonal occasions (*suigong* 歲功), and meteorological phenomena (*shuzheng* 庶徵) were included under the major classification category of celestial matters (*lixiang huibian* 曆象彙編).¹¹ The full mapping out of the asymmetrical conceptual categories associated with these two potential candidates in Song and Ming times for 'natural studies' (*gezhi*) and 'natural history' (*bowu*) respectively remains incomplete. Moreover we are still unsure how the two terms usually were deployed over time vis-à-vis each other.

In addition, other technical terms in ancient and medieval bibliographic classifications, such as *shuji* 術技 (skills and techniques), were used to

⁹ See the critique of Vagnoni by eighteenth-century Chinese literati in *Siku quanshu zongmu* 125.34a-b. For the Jesuit critique of *qi*, see Zhang Qiong, "Demystifying *Qi*."

¹⁰ See Vagnoni's *Kongji gezhi* A.1a-13b. See also Peterson, "Western Natural Philosophy Published in Late Ming China," pp. 295-322. Compare the account of the five phases in *Xingli daquan* 27.18a-19a, which remained orthodox for the civil examinations during the Ming and Qing dynasties. On the *Xingli daquan* see my *A Cultural History of Civil Examinations in Late Imperial China*, pp. 113-119.

¹¹ Giles, *An Alphabetical Index to the Chinese Encyclopedia, Ch'in Ting Ku Chin T'u Shu Chi Ch'eng*. Giles translates *bowu* here as 'Arts and Sciences.'

demarcate what we today refer to as science or technology.¹² The bibliographic categories of the *Qilüe* 七略 (Seven Summaries) bibliographies compiled by Liu Xiang 劉向 (c. 79-8 BC) and Liu Xin 劉歆 (46 BC-23 AD), for instance, can be reconstructed from the bibliographic monograph in the *History of the Former Han Dynasty* (*Hanshu yiwenzhi* 漢書藝文志). ‘Calculating Skills’ (*shushu lüe* 術數略) represented the sixth category of the bibliographic summaries in the *Qilüe*.¹³ The six subcategories were: 1) *tianwen* 天文 (astrology); 2) *lipu* 曆譜 (chronomancy); 3) *wuxing* 五行 (five phases); 4) *shigui* 著龜 (milfoil divination & scapulamancy); 5) *zazhan* 雜占 (miscellaneous prognostication); and 6) *xingfa* 刑法 (geomancy). The seventh category was ‘Medical Practice’ (*fangji lüe* 方技略) with four subcategories: 1) *yijing* 醫經 (medical books); 2) *jingfang* 經方 (pharmacology); 3) *fangzhong* 房中 (sexology); 4) *shenxian* 神仙 (immortality).¹⁴

In Han times, the *Liuyi* 六藝 (Six Technai) of the *Qilüe* and *Hanshu* focused on the six classical teachings, i.e., the ‘Six Classics’ (*Change, History, Classic of Odes, Annals, Rituals, Music*), and not the more ecumenical ‘Six Arts’ (also *liuyi* 六藝) of rites, music, archery, charioteering, calligraphy, and mathematics. This interesting division of meanings for the same term *yi* 藝 was followed thereafter in the official dynastic bibliographies. Subsequently, the *Qizhi* 七志 (Seven Reviews), also called the *Jinshu qizhi* 晉書七志, compiled in 473 by Wang Jian 王儉 (452-489), Vice-Director of Palace Library of Song dynasty (AD 420-478) made ‘Skills and Arts’ (*shuyi* 術藝) its sixth ‘category’ and presented ‘Maps and Charts’ (*tupu* 圖譜) as number seven.

The *Qilu* 七錄 (Seven Records) begun in 523 by Ruan Xiaoxu 阮孝緒 (479-535) organized its fifth category under the theme of ‘Skills and Techniques’ (*shuji* 術伎) with ten subcategories: 1) *tianwen* 天文; 2) *weichen* 緯讖 (omens and prophecies); 3) *lisuan* 曆算 (calendrics); 4) *wuxing* 五行; 5) *bushi* 卜筮 (divination); 6) *zazhan* 雜占; 7) *xingfa* 刑法; 8) *yijing* 醫經; 9) *jingfang* 經方; and 10) *zayi* 雜藝 (miscellaneous arts). Unlike the *Qilüe*, the *Qilu* framework for natural studies included medical studies under the same category.¹⁵

Although already in use during the Eastern Jin 東晉 dynasty (317-420), the ‘four classifications’ (*sibu* 四部) system became under the Sui dynasty (581-618) the orthodox classification system for all knowledge in the Imperial Library. The bibliography section of the *History of the Sui Dynasty* (*Suishu jingjie zhi* 隋書經籍志, lit., ‘Sui History Classics and Books Monograph’),

¹² For discussion, see Cary Liu, “The Qing Dynasty Wen-yuan-ko Imperial Library,” pp. 83-124.

¹³ *Hanshu* 30.1701. *Hanshu* 30.1775, gives the category as 數術 with the characters reversed. Subsequently, the *Qilüe biele* 七略別錄 (Separate Lists of the Seven Summaries) was issued as an independent Han catalog from the *Qilüe*. See Ssu-yü Teng and Biggerstaff, *An Annotated Bibliography of Selected Chinese Reference Works*, pp. 7-8, and Tsien Tsuen-hsuin, “A History of Bibliographical Classification in China,” pp. 309-310.

¹⁴ *Hanshu* 30.1765-1775. Cf. Cary Liu, “The Qing Dynasty Wen-yuan-ko Imperial Library,” pp. 482-483.

¹⁵ Liu, “The Qing Dynasty Wen-yuan-ko Imperial Library,” pp. 97-101, 104-105, 484-486, 497-499.

was compiled by Wei Zheng 魏徵 (580-643), then Director of the Palace Library. Wei applied the *sibu* sequence as orthodox historiography, i.e., the divisions according to which all documents in the Palace Library would be classified, for the first time.

In this framework, works on natural studies did not have their own main category, as in the *Qilüe* and *Qilu*, and instead were included in a number of subcategories under the main four divisions. The *Liuyi* 六藝 (Six Technai) were further institutionalized as a classical canon equivalent to the *jingji* 經籍 (classics) or *jingdian* 經典 (classical canon) under the Tang dynasty (618-906), and the imperial classification scheme of 'four divisions' was further legitimated politically by linking it to correlations with the four seasons (*siji* 四季), four directions (*sifang* 四方), the four colors (*sise* 四色), and the four virtues (*side* 四德).¹⁶

Later the Southern Song historian Zheng Qiao 鄭樵 (1104-1162) in his *Tongzhi* 通志 (Comprehensive Treatises) encyclopedia included an *yiwén lüè* 藝文略 (Treatise on Bibliography), which expanded the four classifications scheme to twelve main categories. Of the twelve main categories (*lüè* 略), several were linked to natural studies:

1) Classics	2) Rituals	3) Music
4) Philology	5) History	6) Pre-Han & Later Masters
7) Astrology	8) Five Phases	9) Arts
10) Medicine	11) Encyclopedias	
12) Literature ¹⁷		

Although Zheng Qiao's categories did not become normative, the encyclopedia was widely read and emulated by private scholars such as Sun Xingyan 孫星衍 (1753-1818), who in 1800 presented a new scheme of twelve major divisions of knowledge, which resembled Zheng's categories:¹⁸

1) Classics	2) Philology	3) Philosophy
4) Astrology	5) Geography	6) Medicine & Law
7) History	8) Epigraphy	9) Encyclopedias
10) Poetry	11) Arts	12) Fiction

Hence, based on this brief summary of the classification terms and bibliographic locations for natural studies used in the Imperial Library since medieval times,

¹⁶ See Tsien, "A History of Bibliographical Classification in China," pp. 311-313, and Liu, "The Qing Dynasty Wen-yuan-ko Imperial Library," pp. 101-110.

¹⁷ Tsien, "A History of Bibliographical Classification in China," pp. 314-315, and Ssu-yü Teng and Biggerstaff, *An Annotated Bibliography of Selected Chinese Reference Works*, pp. 109-110.

¹⁸ See Elman, *From Philosophy To Philology*, pp. 163-168.

when the 'four classifications' were usually in effect, we cannot simply assume that there was a single and unified traditional field of natural studies in China known as *gezhi* before the Jesuits arrived in China.¹⁹ Nonetheless, it appears to me, tentatively, that among late-Ming and post-Ming literati elite *gezhi* 格致 was becoming a common epistemological frame for the accumulation of knowledge. *Bowu* 博物 on the other hand carried with it a more common and popular notion of 'curiosities.'²⁰ For example, the *Taiping yulan* 太平御覽 (Encyclopedia of the Taiping Era [976-983]), compiled under imperial auspices by Li Fang 李昉 (925-996) during the early years of the Northern Song dynasty (960-1126), included earlier texts dealing exclusively with unusual events, strange objects, things, birds, spirits, and anomalies to provide a contemporary lexicon of textual usages in antiquity and medieval times that denoted the scope of *bowu* within classical writings, which the eighteenth century *Gujin tushu jicheng* (see above) emulated.²¹

Table 1. Forty-four Subdivisions of the *Siku quanshu* 四庫全書 (Complete Library in Four Branches of Literature). Fields associated with natural studies have been highlighted.

Classics 經部	History 史部
Change(s) 易	Dynastic Histories 正史
Documents 書	Annals 編年
Poetry 詩	Topical Records 紀事本末
Rituals 禮	Unofficial Histories 別史
Spring & Autumn Annals 春秋	Miscellaneous Histories 雜史
Filial Piety 孝經	Official Documents 詔令奏議
General Works 五經總義	Biographies 傳記
Four Books 四書	Historical Records 史鈔
Music 樂	Contemporary Records 載記
Philology 小學	Chronography 時令
	Geography 地理
	Official Registers 職官
Masters 子部	Institutions 政書
Confucians 儒家	Bibliographies and Epigraphy 目錄
Military Strategists 兵家	Historical Criticism 史評
Legalists 法家	
Agriculturalists 農家	

¹⁹ Xu Guangtai, "Mingmo Qingchu xifang gezhi de chongji yu fanying," pp. 236-258. Xu assumes that *gezhi* was a widely used traditional designation for natural studies without showing its uses or scope before the Jesuits arrived. My thanks to Cary Liu for his advice on this matter.

²⁰ See Campany, *Strange Writing*, pp. 49-52. See also, Qiong Zhang, "Nature, Supernature, and Natural Studies in Sixteenth- and Seventeenth-Century China."

²¹ *Taiping yulan* 612.4a-10a.

Medicine 醫家	Literature 集部
Astrology & Mathematics 天文算法	Elegies of Chu 楚辭
Calculating Arts 術數	Individual Collections 別集
Arts 藝術	General Anthologies 總集
Repertories of Science 譜錄	Literary Criticism 詩文評
Miscellaneous Writers 雜家	Songs & Drama 詞曲
Encyclopedias 類書	
Novels 小說家	
Buddhism 釋家	
Taoism 道家	

In the late eighteenth century the *Siku quanshu* 四庫全書 (Complete Library in Four Branches of Literature), which represented the climax of the classical scheme of disciplines, incorporated medicine and calendrical studies as subcategories under the 'Masters' (*zibu* 子部) category (see Table 1). Similarly the mathematical aspects of music were subsumed under the Classics, while chronography and geography were listed under History. We thus find no single unified category for natural studies in the imperially authorized bibliographies after the ancient *Qilüe* and *Qilu* organized such studies under the general category of 'calculating skills' (*shushu lüe* 術數略) or 'skills and techniques' (*shuji* 術伎). What we do find, however, is that the compilers of the Imperial Library catalog had linked mathematics and astrology under the same framework, which represented a Chinese response to the Jesuit impact on the 'new methods' (*xinfa* 新法) for successfully reforming the calculations associated with the Qing calendar.²²

2. Investigating Things and Extending Knowledge

When the Jesuits first arrived in Ming China, there was already considerable discussion among literati about an appropriate theory of knowledge. The debate often took the form of claims that morality (*zundexing* 尊德性) took precedence over formal knowledge (*daowenxue* 道問學). Earlier, the Southern Song (1127-1280) philosopher Zhu Xi 朱熹 (1130-1200), who became the core interpreter of the late imperial classical canon, argued that 'inquiring into and extending knowledge' presupposed that all things had their principle (*wanwu zhi li* 萬物之理). Zhu therefore concluded: "one should in three or four cases out of ten seek principles in the outside realm" (*sansifen qu waimian lihui fangke* 三四分去外面理會方可). In most cases, six to seven out of ten, however, moral principles should be sought within. Thereafter, the investigation of things

²² See the editorial introduction to the "Tianwen suanfa lei" 106.1a-2a.

became the key to opening the door of knowledge for literati versed in the Classics and Histories.²³

Due to Zhu Xi's scholarly eminence after the Southern Song dynasty, *gezhi* 格致 became a popular *Daoxue* 道學 (lit., 'Dao Learning,' also called 'Neo-Confucianism') term borrowed from the Great Learning (*Daxue* 大學; one of the Four Books) in the *Record of Rites* (*Liji* 禮記; one of the Five Classics) by literati to discuss the form and content of knowledge. In fact, however, there was much classical debate surrounding Zhu Xi's single-minded prioritizing of the *gewu* 格物 passage in the Great Learning to establish the epistemological boundaries for literati learning.²⁴ Yü Ying-shih's 余英時 longstanding claim that the seventeenth century turn among literati elites toward precise philology in classical studies can be traced back to sixteenth century debates surrounding the Old Text version of the *Great Learning* (*Daxue guben* 大學古本) deserves mention here.²⁵

Wang Yangming 王陽明 (1472-1528), for instance, preferred the Old Text version of the *Great Learning* (*Guben daxue* 古本大學) to gainsay Zhu Xi's 'externalist' views of the 'investigation of things' (*gewu* 格物) in the Four Books. One of the youthful stories associated with Wang Yangming related that in 1492, when he was in Beijing at the age of twenty-one *sui* 歲 to take the spring 1493 metropolitan examination, Wang had 'investigated' (*ge* 格, i.e., observed intently as in meditation) the bamboo in his official residence to search for its principles until he became seriously ill; thereafter he questioned Zhu Xi's views on the investigation of things as a naive enterprise and also pointed to the vagueness in the application of *gewu* to natural studies.²⁶ The official account in Wang's *Chuanxilu* 傳習錄 (Instructions for Practical Living), recorded between 1521 and 1527 while Yangming was in retirement, described the episode:

From morning till night I was unable to find the principles of the bamboo. On the seventh day I also became sick because I thought too hard. In consequence [my friend and I] sighed to each other and said it was impossible to be a sage or a worthy, for we do not have the tremendous energy to investigate things that they have. After I had lived among barbarians for three years, I understood what all this meant and realized that there is really nothing in the things in the world to investigate, that the effort to investigate things is only to be carried

²³ See *Zhuzi yulei* 18.14b-15a. See also Yamada Keiji, *Shushi no shizengaku*, pp. 413-472, and Yü Ying-shih, "Some Preliminary Observations on the Rise of Ch'ing Confucian Intellectualism," pp. 105-146.

²⁴ Gardner, *Zhu Xi and the Daxue*, pp. 27-59.

²⁵ See Yü Ying-shih, "Some Preliminary Observations on the Rise of Qing Confucian Intellectualism," p. 125, for discussion of Wang Yangming's critique of Zhu Xi's elucidation of the *Great Learning*, which created a textual crisis in the sixteenth century that Yü links to the emergence of evidential research in the late Ming. On the debate over the authenticity of new versions of the *Great Learning* in the late Ming, see Lin Qingzhang, *Qingchu de chungjing bianweixue*, pp. 369-386.

²⁶ See "Wang Yangming nianpu," p. 3. Xu Guangtai, "In the Name of 'Gewu Qiongli,'" stresses the vague relation between natural studies and Zhu Xi's agenda for learning.

out in and with reference to one's body and mind, and that if one firmly believes that everyone can become a sage, one will naturally be able to take up the task.²⁷

Wang failed the 1493 examination, not taking his *jinshi* 進士 (palace graduate) degree until 1499. Wang's alternate agenda for *gewu*, which he clarified in later years while serving as military plenipotentiary in Jiangxi 江西 province, dismissed tedious facts about things such as bamboo in favor of a unifying introspective knowledge of the self (*liangzhi* 良知), which could be harnessed for moral cultivation. Wang in effect had demonstrated that principles were not so easily grasped by following Zhu Xi's methods.²⁸

Subsequently, the delicate issue of the late Ming appearance of an even more ancient 'stone inscribed version of the Great Learning' (*Daxue shiben* 大學石本), which was later determined a forgery, reopened for many late Ming and Qing literati Wang Yangming's infamous claim that Zhu Xi had in Song times manipulated the original text of this key passage on *gewu* to validate and make canonical his personal interpretation of the 'investigation of things.' In particular, Wang Yangming gainsaid Zhu Xi's emphasis on *gezhi* ahead of morality (*chengyi* 誠意, lit., 'making one's intentions sincere'). For Wang and his late Ming followers the investigation of things and the extension of knowledge took a backseat to first making one's will sincere. It is interesting that in their attacks on Zhu Xi the Jesuits such as Matteo Ricci never raised the issue of Zhu's changes to the *Liji* version of the *Daxue*.²⁹

Such concerns continued, however, among Qing literati, when evidential scholars also challenged Zhu Xi's emendation of the *Daxue*. For example, at the age of ten *sui* (Chinese added a year at the first lunar new year after a child was born) Dai Zhen 戴震 (1724-1777) was studying Zhu Xi's standard version of the *Great Learning* (known as the *Daxue zhangju* 大學章句, lit., 'Parsing of phrases and words in the *Great Learning*'), when he asked his teacher about one of Zhu Xi's comments, which read:

The preceding chapter of classical text is in the words of Confucius, handed down by Master Zeng [Zengzi 曾子]. The ten chapters of explanation that follow contain Zeng's views and were recorded by his disciples. In the old copies of the work [in the *Liji*], there appeared considerable confusion from the disarray of the [original] tablets. But now, availing myself of the decisions of

²⁷ See *Chuanxilu*, in *Wang Yangming quanji*, p. 93, for the official account, translated in Wing-tsit Chan, *Instructions for Practical Living and Other Neo-Confucian Writings by Wang Yang-ming*, p. 249. The 'bamboo' story may be apocryphal. See Schorr, "The Trap of Words."

²⁸ Peterson, "'Chinese Scientific Philosophy' and Some Chinese Attitudes Towards Knowledge about the Realm of Heaven-and-Earth," p. 29.

²⁹ See Wang Yangming, *Chuanxi lu*, pp. 32-35, and Zhu Yizun, *Jingyi kao* 159.1a-7b, 160.1a-8a, 161.1a-12a. See also Wang Fan-shen, "The 'Daring Fool' Feng Fang (1500-1570) and his Ink Rubbing of the Stone-inscribed *Great Learning*," pp. 74-91.

Master Cheng [Cheng Yi 程頤, 1033-1107], and having arranged anew the classical text, I have rearranged it in order as follows.³⁰

Dai asked about Zhu Xi's rearrangement of the *Daxue* into: 1) a classical text by Confucius; and 2) ten commentarial chapters by Zengzi:

How does one know in this case that these are the words of Confucius recorded by Zengzi? Moreover, how does one know that Zengzi's intentions were recorded by his followers?

The teacher replied: "That is what the earlier literatus Zhu Xi said in his annotation."

Dai Zhen asked another question: "When did Zhu Xi live?"

The teacher answered: "Southern Song" [1127-1279].

Dai asked again: "When did Confucius and Zengzi live?"

The teacher replied: "Eastern Zhou" [770-221 BC].

Dai asked again: "How much time separates the Zhou [dynasty] from the Song?"

Reply: "About two thousand years."

Dai queried again: "Then how could Zhu Xi know it was so."

The teacher could not reply.³¹

In effect, Dai Zhen like Wang Yangming defied Zhu Xi's classical authority. As a *Daoxue* master, Zhu had elevated his own commentary on the *gewu* passage in the 'Great Learning' chapter of the *Record of Rites*, one of the Five Classics, by putting it into the mouth of one of Confucius' direct disciples. Zhu thereby had made his own commentary one of Zengzi's ten commentarial chapters. Dai Zhen exposed Zhu Xi's claim that Zengzi had written this important chapter, which Zhu included as one of the Four Books, as historically undocumented, as was Zhu's claim that the *Daxue* version in the *Liji* was corrupt because it gave no gloss prioritizing the *gewu* passage as the starting point for classical learning.

During the late Yuan, after Cheng Yi's and Zhu Xi's views on all the Classics were declared orthodox for the civil examinations that were restarted in 1313,³² *gezhi* as a *Daoxue* term was already used by the medical writer Zhu Zhenheng 朱震亨 (1282-1358) to denote technical learning. In Zhu's most famous work entitled *Gezhi yulun* 格致餘論 (Views on Extending Medical Knowledge), which was included in the *Siku quanshu* in the late eighteenth century,³³ Zhu opposed Song medical prescriptions, but he made a strong appeal to Yuan literati that they should include medical learning in their 'Learning of the Way.' In his view, medical learning was one of the key fields of study that not only complemented the moral and theoretical teachings of *Daoxue*, but it was also a key to the practical uses of the latter. The *Siku quanshu* editors cited

³⁰ See the translation of Zhu Xi's commentary in Legge, *The Four Books*, p. 360, which I have modified. For discussion, see Gardner, *Zhu Xi and the Daxue*, pp. 27-59.

³¹ Wang Chang (1725-1806), *Chunrongtang ji* 55.6b. This account was later included in "Dai xiansheng xingzhuang," in Dai Zhen, *Dai Zhen wenji*, pp. 251-260.

³² Elman, *A Cultural History of Civil Examinations*, pp. 29-38, 56-61.

³³ Zhu Zhenheng, *Gezhi yulun*, vol. 746-638.

Zhu's preface as arguing that medicine was one of the concrete fields that informed the 'inquiry into and extension of knowledge' (格物致知之一事).³⁴

In addition to its central epistemological place in literati classical learning since 1200, the notion of *gewu* was also applied to the collection, study, and classification of antiquities, as in Cao Zhao's 曹昭 (fl. 1387-1399) *Gegu yaolun* 格古要論 ("Essential Criteria of Antiquities," lit., "Key issues in the investigation of antiquities"), which was published in the early Ming and enlarged several times thereafter. The work originally appeared in 1387/1388 with important accounts of ceramics and lacquer, as well as traditional subjects such as calligraphy, painting, zithers, stones, bronzes, and ink-slabs.

The 1462 edition prepared by Wang Zuo 王佐 (*jinsi* 進士 of 1427) was considerably enlarged and included findings from the official Ming dynasty naval expeditions led by Zheng He 鄭和 (1371-1433) to Southeast Asia and the Indian Ocean from 1405 to 1433. Wang also added the subjects of imperial seals, iron tallies, official costumes, and palace architecture. In his "Preface," Wang added: "Whenever you see an object, you must look it all over, trace its appearance, and examine its history and origins. You should investigate its strengths and weaknesses, and distinguish its accuracy" (*fan jian yi wu, bi bian yue tupu, jiu qi lai li, ge qi you lie, bie qi shifou er hou yi* 凡見一物，必遍閱圖譜，究其來歷，格其優劣，別其是否而後已). He was particularly interested in ancient bronzes, calligraphic specimens, and curiosities (*gu tongqi shufa yiwu* 古銅器書法異物).³⁵

Similarly Li Shizhen's 李時珍 (1518-1593) *Bencao gangmu* 本草綱目 (Materia Medica, Arranged according to Drug Descriptions and Technical Aspects), published in 1596, reclassified the entire *materia medica* according to a new logic, which revealed Li's concern with the 'investigation of things.' Li Shizhen's 'Outline' (*fanli* 凡例) for his work, for instance, stressed the problem of nomenclature, or *zhengming* 正名 (lit., 'rectification of names'), as the main entry (*gang* 綱). All other sub-entries explained the names of things (*shiming* 釋名) themselves. Accordingly, Li Shizhen's enterprise was also a scholarly project:

I have actually practiced what we literati scholars call the 'study of the investigation of things' (*gewu zhi xue* 格物之學). This can fill the hiatus in the commentaries on the *Erya* 爾雅 (Coming Close to Correctness) [dictionary] and the *Shijing* 詩經 (Classic of Odes).

³⁴ See the 'Tiyao' 提要 (Abstract) of Zhu Zhenheng's study prepared by the editors of the *Siku quanshu*, compiled by Chi Yun, vol. 746-637.

³⁵ See the abridged version of the *Gegu yaolun*, in Hu Wenhuan, *Gezhi congshu*, vol. 25. See also Wang Zuo's "Xu," pp. 1a-b, and Percival, *Chinese Connoisseurship, the Ko Ku Yao Lun*. The new information from other parts of Asia, however, did not challenge the existing frameworks of knowledge in Ming China, which differs from the wider impact of sixteenth century oceanic discoveries in early modern Europe. See Lach, *Asia in the Making of Europe*, vol. 2, pp. 446-489.

Li Shizhen's explicit work of medicine thus also belonged to the long tradition of *gewu*.³⁶

Other late Ming *leishu* 類書 (encyclopedias) also encompassed a wide variety of books, including household manuals, quotation dictionaries, and collections of anecdotes. Their common feature was their topical arrangement. Those known as *riyong leishu* 日用類書 (household encyclopedias, lit., "daily use compendia") represented manuals for everyday living that were widely printed in South China, particularly by printers in Jianyang, Fujian, whose lower printing costs made cheaper editions accessible beyond the usual classically literate elite.

Seven types of "daily use compendia" emerged: 1) those oriented toward general topics; 2) oriented to civil office; 3) reference works (phrase dictionaries, etc.); 4) literary digests; 5) names and people; 6) stories/anecdotes; and 7) childhood primers. Among the common classification divisions included in such collections were: *tianwen men* 天文門 (astrology section), *diyu* 地輿 (geography/topography), *renji* 人紀 (human chronicles), *guanpin* 官品 (official goods), *liling* 律令 (penal laws and regulations), *guanhun* 冠婚 (marriage protocols), *zangji* 葬祭 (burial rites), *yixue* 醫學 (medical studies), *yangsheng* 養生 (nourishing life), etc. The audience for such quotidian works tended to be urbanites (*shimin* 士民) and commoners (*simin* 四民).³⁷

On the other hand, the Ming scholar-merchant and Hangzhou bookseller Hu Wenhuan 胡文煥 (fl. c. 1596) prefigured the Sino-Jesuit dialogue concerning *scientia* in the 1630s when he compiled and published his widely circulated *Gezhi congshu* 格致叢書 (Collectanea of Works Inquiring into and Extending Knowledge) in the 1590s as a late-Ming repository of classical, historical, institutional, and technical works from antiquity to the present in China. The *Gezhi congshu* presented a cumulative account of all areas of textual knowledge important to a literati audience in the seventeenth century. Because Hu also had wide ranging interests in medicine, Buddhism and Daoism, the collectanea contained a broad range of classical texts and esoteric writings. Like many Ming printers, Hu mixed and matched his editions and changed several original works to conform with his own formats. Based on works from these earlier editions, the *Baijia mingshu* 百家名書 (Famous Works of the Hundred Schools) collectanea was later published in 1603 and included many overlapping works.³⁸

Hu Wenhuan spent a considerable amount of time in his printing shops in Hangzhou and Nanjing. The latter was another very important Ming publishing center in the Yangzi delta, along with Suzhou, and Hu seems to have relied on the Nanjing book market for his editions. The Hanlin senior compiler Zhu Zhifan 朱之蕃 (b. 1564), who was famous empire-wide for finishing as the

³⁶ See Métaillé, "The *Bencao gangmu* of Li Shizhen: An Innovation for Natural History?" pp. 221-261, and Sivin, "Li Shih-chen," pp. 390-398.

³⁷ See Sakade Yoshinobu, "Kaisetsu—Mindai nichiyō ruisho ni tsuite," vol. 1, pp. 7-30. See also Chia, "Printing for Profit," pp. 242-245.

³⁸ See Wang Baoping, "Mindai no kakushoka Ko Bunkan ni kan suru kosatsu," pp. 47-57, and Wang Baoping, "Zhongguo Hu Wenhuan congshu jingyan lu," pp. 6-25.

optimus on the 1595 civil palace examination, added prestige to Hu's reputation as a Hangzhou scholar-printer by preparing a long 1603 preface to the overlapping *Baijia mingshu* collectanea. Because Zhu Zhifan was from Nanjing, Hu probably met him there. Zhu's preface made clear that Hu's collectanea was intended as a comprehensive library of works stressing astrology, calendrics, flora and fauna, medicine and longevity, in addition to the more classical themes of poetry, literature, philology, and technical glosses of things, objects, and affairs. Zhu Zhifan used the term *gezhi* in his preface for the *Baijia mingshu* to suggest the overarching unity Hu Wenhuan applied to such works, which linked the collection to the *Gezhi congshu*.³⁹

Morohashi Tetsuji 諸橋 轍次 has outlined an idealized catalog of the supposedly 346 total works collected by Hu for his dual collectanea. Only 181 were apparently extant in the *Gezhi congshu* by the late eighteenth century, according to the compilers of the *Siku quanshu*, who did not think very highly of Hu's pastiche of works, many of which he himself had written.⁴⁰ The editors attacked Hu's role as compiler by accusing him of simply lifting chapters out of several collections and presenting them as separate books, not his own to be sure, when they were really part of another, larger work. In addition, numerous different collections of both the *Baijia mingshu* and the *Gezhi congshu* are extant in libraries in China, Japan, Taiwan, and the United States.⁴¹ According to Morohashi, the *Gezhi congshu* collectanea was divided into thirty-seven categories (*lei* 類), such as classical instruction, philology, phonology, historical studies, rituals and regulations, legal precedents, geography, mountains and streams, medicine, Daoism, Buddhism, preserving life, agriculture, stars, physiognomy, poetry and literature, painting, and epigraphy, among others, but these categories were not apparent in all versions printed.

The portions that can be unquestionably tied to the main themes of the *Gezhi congshu* reveal Hu Wenhuan's efforts to republish and cumulatively build on previous works that focused on natural phenomena and 'names and their referents' (*mingwu* 名物) and 'affairs and things' (*shiwu* 事物). Starting with works annotating the *Erya* 爾雅 (Coming Close to Correctness) dictionary and

³⁹ See Zhu Zhifan, "Xu" to the *Baijia mingshu*, pp. 5b-6a. This collectanea is mistaken for the *Gezhi congshu* in both the Library of Congress, Asian Division, and in the Oriental Library of the Institute for Humanistic Studies, Kyoto University. For discussion see Wang Baoping, "Ribei Hu Wenhuan congshu jingyan lu," pp. 322-347. When compared to the *Gezhi congshu* the *Baijia mingshu* has a greater focus on poetry and literature, although each collectanea contained many of the same works that Hu Wenhuan compiled or wrote himself. Cf. Goodrich, *Dictionary of Ming Biography*, pp. 304-305. Cf. Yu Weigang, "Hu Wenhuan yu Gezhi congshu," pp. 63-65.

⁴⁰ *Siku quanshu zongmu* 124.14a-b. See also Morohashi, *Dai kanwa jiten* 15113.61.

⁴¹ For the *Gezhi congshu*, I have relied primarily on the version housed in the Rare Books Collection of the National Library of Taiwan, which contains 46 works and is clearly marked as the *Gezhi congshu*. In addition, I have used the version of the *Gezhi congshu* in the Gest Library at Princeton University, which contains 19 works. Both the Taiwan and Princeton versions have been compared with the *Baijia mingshu* housed in the Library of Congress, Asian Division, and the one in the Oriental Library of the Institute for Humanistic Studies, Kyoto University. Both the LOC and the Kyoto Institute have cataloged their version of the *Baijia mingshu* as the *Gezhi congshu*. My thanks to Soren Edgren and Martin Heijdra for their help on this bibliographic puzzle.

the *Shiming* 釋名 (Explication of Names), the focus was on a comprehensive account of etymologies and word definitions that would shed a collective light on the golden ages of antiquity and their enlightened governance.⁴² Liu Xi 劉熙 in his "Preface" (*Xu* 敘) to the *Shiming*, compiled circa 200 AD, noted that the work contained over 1500 lexical entries arranged according to 27 major semantic categories beginning with heaven and earth. The *Shiming* linked names with their referents based on a correspondence theory of language:

In the correspondence of names with reality, names have meanings that correlate. The common people use names daily, but they do not know the reasons why names are as they are. Therefore, I have chosen to write about heaven and earth, *yin* and *yang*, the four seasons, states and cities, vehicles and clothing, and mourning commemorations, which includes implements that even the common people have used, to provide guidance to the roots of names.

夫名之於實，各有義類。百姓日稱而不知其所以之意。故選天地陰陽四時邦國都鄙車服喪紀，下及民庶應用之器，論敘指歸。⁴³

The 'rectification of names' (*zhengming* 正名) for all things became a passionate classificatory agenda in Hu Wenhuan's collectanea. Overall, the *Gezhi congshu* collectanea emphasized a broad learning of phenomena (*bowu* 博物), one of Morohashi's thirty-seven categories, that encompassed natural and textual studies within a humanist and institutional agenda. Within the collection, Zhang Hua's 張華 (232-300) *Bowu zhi* 博物志 (Treatise on the Investigations of Things), and Li Shi's 李石 Song dynasty continuation, titled *Xu bowu zhi* 續博物志 (Continuation to a Treatise on the Investigations of Things) were subsumed under the general category of *gezhi* here. Other works included in the *Gezhi congshu* were the *Shiwu jiyuan* 事物紀原 (Record of the Origins of Things and Affairs) compiled by Gao Cheng 高承 c. 1078-1085, the *Wuyuan* 物原 (Origins of Things) by Luo Qi 羅頌 of the Ming dynasty, and the *Gujin shiwu kao* 古今事物考 (Examination of Ancient and Contemporary Things and Affairs) prepared by Wang Sanpin 王三聘 in the Ming dynasty.

In general these works stressed associating each human event, object/implement, or natural phenomena in terms of a teleology of their usefulness to humans and presented a genealogy of discovery that traced each item back to the appropriate sage, ruler, or scholar. In his "Preface" 序 to the *Shiwu jiyuan*, dated 1448 (with an internal date of 1444), Yan Jing 閻敬 opened by linking all myriad things and affairs to their principles which can be investigated by studying their origins:

The myriad things, which pervade heaven and earth and extend from antiquity to the present, always have matters changing within them. Things have myriad

⁴² On the *Erya*, see Loewe, *Early Chinese Texts*, pp. 94-99.

⁴³ Liu Xi, "Preface" to the *Shiming*, in the *Gezhi congshu*, pp. 1a-b. See also Loewe, *Early Chinese Texts*, pp. 424-428. I have modified the translation of the passage by Roy Andrew Miller on p. 424.

variations, affairs have myriad transformations, and for every matter and every thing, none is without principle or an origin. If one does not fathom the principle [involved], then there is no way to complete the knowledge in our minds. If we do not research the origins [of a thing or matter], then how can we unravel and fathom its principle? Therefore, sagely studies, give priority to investigating things and extending knowledge. Literary scholars value broad inquiry and wide learning so that not even one thing will be unknown. [Such lack of knowledge] would be an embarrassment for literati.

盈天地之間，唯萬物互古今，有事變焉。物有萬殊，事有萬變，而一事一物，莫不有理，亦莫不有原，不窮其理，則無以盡吾心之知。不究其原，又焉從而窮其理哉。故聖門之學，以格物致知為先，文學之士，以博問洽識為貴而一物不知，又儒者之所恥也。⁴⁴

The *Gegu yaolun* account of early Ming antiquities, mentioned above, was also included in the collection, but it was abridged by Hu Wenhuan to include only the key parts and titled *Gegu lunyao* 格古論要 (On the Most Important Items in the Investigation of Antiquities). Hu noted:

Antiquity must be investigated. When antiquity is investigated it always penetrates to the present. When things are investigated it always penetrates to humanity. Timely investigations are very meaningful.

謂古之不可不格也，古格而未有不通於今。物格而未有不通於人。格之時義大矣哉。⁴⁵

The inventory of 'organized knowledge' in the works that were included in the *Gezhi congshu* ranged from heaven and earth to birds, animals, insects, fish, grasses, foodstuffs, architecture, and tools. Such knowledge presupposed a Chinese frame of reference for the systematic collection of data from a wide variety of native sources about China's natural resources, the arts, and manufactures. For example, in *Shijing* 詩經 (Classic of Odes) studies, Hu Wenhuan's own *Hushi shishi* 胡氏詩識 (Mr. Hu's Knowledge of the *Classic of Odes*), which was included in the *Gezhi congshu*, emphasized that knowledge of "the names of birds, animals, herbs, and trees" (鳥獸草木之名) was very important for understanding the *Classic of Odes*. Hu's expertise was applied to detailing such information in the *Classic of Odes* by building on other works he had included in the *Gezhi congshu*: the *Fangyan* 方言 (Local Sayings), compiled by Yang Xiong 揚雄 (53 BC-AD 18) in the Western Han and annotated by Guo Pu (276-322) in the Jin 晉 dynasty); the *Shiming*; the *Erya*; the *Gujin zhu* 古今注 (Commentary on Things Old and New), compiled by Cui Bao 崔豹 of Jin dynasty c. 300 AD; and the *Bowu zhi*.

In his "Preface," Hu Wenhuan replied to critiques that his work was redundant or too nitpicking: "If one says that Master Zhu [Xi] brought together

⁴⁴ See these works in Hu, *Gezhi congshu*. For Yan Jing's "Preface" to the *Shiwu jiyuan*, see pp. 1a-b. Cf. Campany, *Strange Writing*, pp. 51-52.

⁴⁵ See Hu Wenhuan's "Hsu" to the *Gezhi congshu* ed. of the *Gegu lunyao*, in vol. 25, pp. 1a-2a.

[all knowledge about the *Classic of Odes*] and that I have split it all up, then what good is erudition?" (若曰朱子集之，而余乃分之。又何多識之足云).⁴⁶

Moreover, Hu Wenhuan included the *Piya* 埤雅 (Low Range of Correctness), compiled by Lu Dian 陸佃 in the Northern Song dynasty, to drive home his point. The "Preface" (*Xu* 序) to the *Piya*, perhaps written by Lu Dian after 1077, noted that the civil examination essay (*jingyi* 經義) was not used until 1056 and that before that literati had relied on mastering poetry for the civil examinations to attain fame. The result was that before 1056 literati had "a great deal of knowledge of birds and animal, herbs and trees, insects, fish, and dragons" (其於鳥獸草木蟲魚龍所多識). But when the examination essay took precedence, the "Preface" continued, everyone mastered classical skills (*jingshu* 經術) and no longer bothered with lyric poetry or rhyme-prose (*cifu* 詞賦). Ironically, because of the focus on classical skills, literati knowledge of things in the natural world diminished, which pointed to the importance of the *Shijing* and *Erya* for natural knowledge in both the *Gezhi congshu* and *Baijia mingshu* versions of Hu Wenhuan's collectanea.⁴⁷

In addition to Hu Wenhuan's Ming "Gezhi studies," Dong Sizhang 董斯張 completed the *Guang bowu zhi* 廣博物志 (Expansion of a Treatise on the Investigations of Things), which paid more attention to 'natural history.' Such works on *bowu* 博物 suggest that as a term *bowu* needs to be conceptually mapped asymmetrically with *gezhi*. Sometimes the former was included under the latter, sometimes not. In both *gezhi* oriented and *bowu* framed late-Ming works, the transformation of objects into artifacts, antiquities, and art objects was attempted. Indeed, the editors of the *Siku quanshu* made clear in their 1780s critique of the *Gezhi congshu*, that they disapproved of Hu's inclusion of works on *bowu* because such accounts represented literary writings (see the next section) that previously had been classified under 'Xiaoshuo' 小說 (lit., 'idle chatter and gossip,' i.e., fictional accounts). The editors nevertheless included Hu's collectanea under the *sibu* classification of 'Masters' (子) in the subcategory of *zajia* 雜家 (miscellaneous writers), rather than placing it under literature.⁴⁸

For our purposes here, it is intriguing that the term 'gezhi' was also chosen by Ming literati in the seventeenth century as one of the native categories of specialized learning (*xuewen* 學問), with the latter equivalent for many Ming literati to early modern European scientia. Early Jesuit translations of Aristotle's

⁴⁶ See the "Xu" by Hu Wenhuan dated 1593 to the *Hushi shishi*, in the *Gezhi congshu*, pp. 1a-3b.

⁴⁷ See the "Preface" to the *Piya* 埤雅, compiled by Lu Dian, in *Gezhi congshu*, pp. 1a-2b. In the *Lunyu* 論語 17/9, Confucius tells students that through study of the *Poetry Classic* they can become acquainted with names of birds, beasts, and plants. See Legge, *The Four Books*, p. 261: "The Master said, "My children, why do you not study the *Poetry*? The *Poetry* stimulates the mind, enables one to view things, how to form groups, how to vent resentments. You learn the duty of serving one's father, and further the serving of one's lord. One becomes more knowledgeable with the names of birds, animals, herbs, and trees."

⁴⁸ *Siku quanshu zongmu* 134.15a.

theory of the four elements (*Kongji gezhi* 空際格致, lit., 'investigation of space,' 1633) and Agricola's *De Re Metallica* (*Kunyu gezhi* 坤與格致, lit., 'investigation of the earth,' 1640) into classical Chinese, for example, had used the term *gezhi* 格致 in light of the Latin *scientia* (= 'organized or specialized knowledge,' or *xuewen* 學問, as *scientia* was translated in Chinese in the sixteenth century) in their titles.⁴⁹ Such titles suggest our earlier image of literati intellectual life before the arrival of the Jesuits has been one-sided, and that Dao Learning doctrine and natural studies, particularly medical and calendrical learning, were not mutually exclusive.⁵⁰

Willard Peterson in his valuable study of Fang Yizhi 方以智 (1611-1671) has noted how late-Ming views of the *Daoxue* doctrine of the 'investigation of things' had changed from a type of moral endeavor, purely, to an additional stress on external things. Fang Yizhi's magnum opus entitled *Wuli xiaozhi* 物理小識 (Notes on the Principles of Things) stressed material investigations to comprehend the seminal forces underlying patterns of natural change. Fang generally accepted Western explanations of natural phenomena, such as a spherical earth, limited heliocentrism, and human physiology, brought to China in the seventeenth century by the Jesuits, but he was critical of them for leaving behind material investigations and ending in unverified religious positions. Fang Yizhi favored, instead, descriptive knowledge of the natural world, and he inscribed the Dao Learning interpretation of the 'investigation of things' with a new view of the accumulation of knowledge, which gainsaid both the introspective focus of Wang Yangming and the moralist focus of Zhu Xi.⁵¹

In the interaction with Western *scientia*, then, Chinese literati were drawn into a moderate transformation of their own traditions of natural studies.⁵² In the late Qing, between 1865 and 1900, reformist Chinese officials and scholars reworked *gezhixue* 格致學 to designate 'modern science.' Subsequently *gezhixue* was replaced in the early twentieth century by *kexue* 科學 as the Chinese equivalent for post-industrial revolution 'science.' This repeated use of *gezhi*—from the late Ming to late Qing—suggests that native terms for Western 'science' were contested at different times and in different ways.⁵³

3. Ming Civil Examinations and Gezhi

Ming dynasty examination records reveal that civil examinations also tested knowledge of astrology (*tianwen* 天文), calendrics (*lifa* 曆法), and other

⁴⁹ See Pan, Jixing, "The Spread of Georgius Agricola's *De Re Metallica* in Late Ming China," pp. 108-118, and Reardon-Anderson, *The Study of Change: Chemistry in China, 1840-1949*, pp. 30-36, 82-88.

⁵⁰ Hart, "Local Knowledges, Local Contexts."

⁵¹ Peterson, "Fang I-chih," pp. 369-411.

⁵² *Gezhi congshu*, *passim*. See also Ssu-yü Teng and Biggerstaff, *An Annotated Bibliography of Selected Chinese Reference Works*, p. 105.

⁵³ For discussion, see Lydia Liu, *Translingual Practice*, pp. 20-42. See also my article "From Pre-modern Chinese Natural Studies to Modern Science in China."

aspects of the natural world, which at times were referred to as 'natural studies' (*ziran zhi xue* 自然之學).⁵⁴ The preeminent position of the Four Books and Five Classics was left unchallenged in the orthodox curriculum, but Ming candidates for both the provincial and metropolitan examinations, unlike their Song counterparts, were expected to grasp many of the technicalities in calendrics, astrology, anomalies (*zaiyi* 災異) and the musical pitch series (*yuelü* 樂律). The latter was the basis for official weights and measures. Indeed, during the Tang, Song and Yuan dynasties, works on calendrics and astrology had been banned from publication for security reasons. Only dynastic specialists working on the calendar in the astronomy bureau were allowed such knowledge, even though in practice popularly printed calendars and almanacs were widely available. Such restrictive policies continued outside the precincts of the Ming civil service examinations.⁵⁵

In the early Ming, for example, the Yongle emperor (r. 1402-1424) put calendrical and practical studies near the top of what counted for official, literati scholarship. He ordered Xie Jin 解縉 (1369-1415), the chief examiner for the 1404 metropolitan examination (on which 472 graduates drawn from over a thousand candidates were selected and appointed to high offices) to include questions that tested a candidate's 'broad learning' (*boxue* 博學, i.e., *boqia zhi shi* 博恰之士). Xie selected policy questions (*ce* 策) dealing with astronomy, law, medicine, ritual, music, and institutions, and the emperor was especially pleased with the top policy answer that year. More importantly, the emperor had legitimated 'natural studies.' Thereafter such questions regularly appeared on Ming civil examinations.⁵⁶

Late Ming concerns about the accuracy of the official calendar forced Chinese literati to evaluate and apply specific Jesuit techniques to reform of the Ming calendar. Derived from the Vatican's adoption of the Gregorian calendar in 1582 to replace the Julian under Christopher Clavius' leadership, the technical prowess that some Jesuits such as Matteo Ricci had learned as a result of studying under Clavius at the *Collegio Romano* proved fortuitous in Ming China.⁵⁷ Given our present understanding of how the Jesuits used their astronomical experience to influence the Bureau of Astronomy, and the interest early Manchu emperors had in astronomy, we would expect that such influence, as in the Ming, would have carried over to the civil examinations. The Manchu throne, however, sought to monopolize this potentially volatile area of expertise within the confines of the court. The contemporary calendrical debates between Jesuits and literati-officials, which challenged the Yuan-Ming calendrical system during the Ming-Qing transition, gave the imperial court pause about

⁵⁴ See Elman, *A Cultural History of Civil Examinations in Late Imperial China*, pp. 461-485. Cf. Sivin, "Introduction," pp. xi-xv.

⁵⁵ Deane, "The Chinese Imperial Astronomical Bureau," pp. 259, 322-324, 399-400.

⁵⁶ See *Huang Ming sanyuan kao* 2.3b, and *Zhuangyuan ce*, p. 15a.

⁵⁷ Dear, "Jesuit Mathematical Science and the Reconstitution of Experience in the Early Seventeenth Century," pp. 135-141.

allowing possibly divisive questions on the calendar to appear in civil examinations.⁵⁸

The collapse of the Ming dynasty and its Qing successor under non-Han rule created opportunities until 1685 for Jesuit experts in astronomy-astrology and music to break out of their subordinate positions and to challenge a discredited Ming elite for political power under a new Manchu ruling elite. The increased cultural importance of astronomical expertise, when the new dynasty had to reformulate in expert terms its calendrical and musical *raison d'être* as quickly as possible, probably outweighed, or at least challenged for a time, the cultural distinction accumulated by literati via mastery of classical studies. Court scholars such as Li Guangdi 李光地 (1642-1718) actively patronized specialists in calendrical calculations and made the musical pitch series a high priority in their officially financed research.⁵⁹

Consequently, in the 1680s, when the Manchu dynasty had mastered its political and military enemies, the intellectual fluidity of the early decades of the Qing began to disappear, leaving Han literati and Manchu elites in a precarious balance at the top (and Jesuit, Muslim, and Chinese calendar specialists again in the middle) of the political and social hierarchies. For example, after 1711 the Kangxi emperor knew of the Paris Académie Royale des Sciences, which the French Jesuit Foucquet translated into Chinese as the *Gewu qiongli yuan* 格物窮理院 (lit., 'Academy for the Investigation of Things and Fathoming Principles'). The emperor also modeled the court's *Suanxue guan* 算學館 ('Academy of Mathematics') after it, but these remained temporary organizations created by the emperor to solve his immediate needs. The new academies had no great impact outside the Kangxi court, where the French Jesuits worked mainly on calendar reform and the empire-wide land survey. The emperor did not encourage a broader focus on natural studies as was the case in early modern France.⁶⁰

In the process, policy questions on the Qing provincial and metropolitan examinations virtually ceased to include natural studies. Perhaps the hard-fought court victory of a shrewd Manchu emperor precluded in civil examinations the successful literati accommodation with the natural studies that had marked Ming civil examinations. In addition, the role of the French Jesuits sent by Louis XIV to the Kangxi court as 'royal mathematicians' and as members of the Paris Academy of Sciences declined. Their combination of scientific and religious objectives had proved as problematical for the Jesuits and their Church critics, as for the Kangxi court.⁶¹

⁵⁸ See Spence, *Emperor of China*, pp. xvii-xix, 15-16, 74-75. On the Yang Guangxian 楊光先 (1597-1669) anti-Jesuit affair in Kangxi court life in the 1660s, see Chu Pingyi, "Scientific Dispute in the Imperial Court," pp. 7-34. See also Huang Yilong, "Qingchu tianzhujiao yu huijiao tianwenjia de zhengdou," pp. 47-69.

⁵⁹ Hummel, *Eminent Chinese of the Qing Period*, pp. 473-475.

⁶⁰ Han Qi, "Gewu qiongli yuan yu Mengyangzhai," pp. 302-324.

⁶¹ Florence Hsia, "Some Observations on the *Observations*," pp. 305-333.

What we do know is that by 1715, the Kangxi emperor successfully banned focus in the civil examinations on study of astronomical portents and the calendar because they pertained to Qing dynastic legitimacy. He could not restrict such interest among the literati community outside the civil examination bureaucracy, however. The emperor, for example, decreed in 1713 that thereafter all examiners assigned to serve in provincial and metropolitan civil examinations were forbidden to prepare policy questions on astronomical portents, musical harmonics, or calculation methods. The latest works in Qing natural studies, court projects on which the Kangxi emperor had employed Jesuit experts, were put off limits to examiners and examination candidates. The ban on natural studies occurred within a general effort by the court to keep the mantic arts and discussion of auspicious versus inauspicious portents out of public discussion.⁶²

This evolving Qing ban on examination candidates studying astronomy, astrology, and music openly was noted at the time in Shen Xinzhou's 沈新周 1712 preface to his study entitled *Dixue* 地學 (Studies of Geography). Shen indicated that all discussions of astronomical portents (*yan tianwen* 言天文) were forbidden late in the Kangxi reign. In this public acknowledgement of Qing imperial policy, we see by way of contrast how important the Yongle emperor's early Ming decree had been in encouraging natural studies when he demanded such policy questions on examinations in 1404.

Likewise, we can understand how the Kangxi emperor's ban affected Qing intellectual life within the government. In place of the banned natural studies, historical geography in particular prospered as an acceptable examination field of Qing scholarship, although map-making was kept secret by the throne. The Yongzheng emperor, however, changed the Kangxi emperor's policy a bit by admitting imperial students with specializations in astrology (*tianwensheng* 天文生) into the dynastic schools.⁶³

4. 'High Qing' Evidential Studies and the Scope of Gezhixue

Such bans, however effective in the civil examinations, did not carry over to literati learning, where a decisive sea change in classical learning was occurring. Clearly there were limits to imperial policies outside the government. In contrast to their Ming *Daoxue* predecessors, eighteenth century 'evidential research' (*kaozheng* 考證) scholars stressed exacting research, rigorous analysis, and the collection of impartial evidence drawn from ancient artifacts and historical documents and texts. Evidential scholars made verification a central concern for the emerging empirical theory of knowledge they advocated, namely "to search

⁶² See *Huangchao zhengdian leizuan* 191.7b-8a. For discussion of these court compilations, see Elman, *From Philosophy to Philology*, pp. 79-80.

⁶³ See Shen, "Xu," in *Dixue*. See also *Qingchao tongdian* 18.2131.

truth from facts" (*shishi qiushi* 實事求是), a Han dynasty expression used as a slogan for impartial scholarship in the eighteenth century.⁶⁴

For the most part, 'High Qing' evidential scholars preferred not to use the term *gezhi* to describe their research agenda, because in the mid-eighteenth century *gezhi* was a 'Song Learning' (*Songxue* 宋學) category long associated with Zhu Xi's 'studies of principle' (*lixue* 理學), which they opposed.⁶⁵ In the seventeenth century, however, *gezhi* and *kaoju* (考據, i.e., = 考證) had been used together.⁶⁶ Under the Kangxi emperor, when a reaffirmation of Cheng-Zhu learning occurred, Song Learning views of *gewu* and natural studies remained perennial issues.⁶⁷ The mid-Qing program, however, involved the placing of proof and verification at the center of the organization and analysis of the classical tradition in its complete, multidimensional proportions, which now included aspects of natural studies and mathematics.

In the nineteenth century, when scholars softened their positions on the distinction between *kaozheng* and Song Learning, evidential scholars such as Ruan Yuan 阮元 (1764-1849) and the Cantonese literatus Chen Li 陳澧 (1810-1882), whose teaching career at the Xuehaitang 學海堂 (Sea of Learning) Academy in Canton influenced many local students, including Liang Qichao 梁起超 (1873-1929) and Kang Youwei 康有為 (1858-1927), linked the empiricism associated with *shishi qiushi* 實事求是 to the 'investigation of things.' Ruan Yuan noted:

Many earlier literati discussed *gewu*, but they associated it [with so many] empty meanings that they apparently failed to grasp that this was not the basic intent of the sages. I don't dare to be different in my discussion of *gewu*, yet [I say] it is the search for truth from facts and that's all.

Later in the nineteenth century, Chen Li equated the 'investigation of things' with *shishi* 實事 (concrete affairs = 'facts') and identified the 'extension of knowledge' with *qiushi* 求是 (search for truth).⁶⁸

By the late eighteenth century, reflecting the scholarly trends of the Qianlong era (1736-1795), the policy questions for civil examinations, for instance, began to exhibit a common five-way division of topics, usually in the following order: 1) Classics; 2) Histories; 3) Literature; 4) Statecraft; and 5) Local geography. The primacy of classical learning in the policy questions was due to the impact of Han Learning and evidential research among literati scholars, first in the Yangzi delta, and then empire-wide via examiners from the

⁶⁴ See *Hanshu* 5.2410: "When [Liu] De 劉德 took the throne as King Xian of Hejian in 155 BC, he restored scholarship and honored antiquity. He sought the truth in actual facts."

⁶⁵ On eighteenth century evidential research, see Elman, *From Philosophy to Philology*, pp. 57-85.

⁶⁶ For a seventeenth century example of the linkage between *kaoju* and *gezhi*, see Lu Shiyi, "Sibianlu lunxue" 3.7-3.9.

⁶⁷ See *Kangxi jixia gewu bian*, which was translated by the French Jesuits in 1779. See *Memoires* 4 (1776-1814), pp. 452-483.

⁶⁸ See Ruan Yuan, *Yanjingshi ji* 2.23b-2.24a, and Chen Li, *Dongshu dushu ji* 9.14. See also Elman, *From Philosophy to Philology*, pp. 245-247.

delta provinces of Jiangsu, Zhejiang, and Anhui. What fueled the popularity of the 1756 revival of first a Tang dynasty style poetry question on session one and then philology in the policy questions in session three of the civil examinations was the close ties between the rules for rhyming in regulated verse and the field of phonology, which became the queen of philology during the Qianlong reign.⁶⁹

Qing dynasty evidential scholars such as Dai Zhen had in mind a systematic research agenda that built on paleography and phonology to reconstruct the meaning (*yi yin qiu yi* 以音求義) of Chinese words. Later Wang Niansun 王念孫 (1744-1832), and his son Wang Yinzhi 王引之 (1766-1834), extended Dai's approach and attempted to use the 'meanings' of Chinese words as a method to reconstruct the 'intentions' of the sages, the farsighted authors of those words. Moreover, technical phonology when applied to the study of the history of the classical language reached unprecedented precision and exactness. To achieve this end, evidential scholars chose philological means, principally the application of phonology, paleography, and etymology, to study the Classics.⁷⁰

Qing philologists, because they were trained as classicists, were faced with numerous passages in the official (those associated with Confucius) and unofficial classics (for example, the medical classics associated with the Yellow Emperor, and the mathematical classics) from antiquity, which required technical training in mathematics, astronomy, geography, and calendrical studies to decipher. A full-blown scientific revolution as in Europe did not ensue,⁷¹ but *kaozheng* scholars made astronomy, mathematics, and geography in their research programs, another by-product of the changes in classical studies then underway.⁷² Animated by a concern to restore native traditions in the precise sciences to their proper place of eminence, which early in the eighteenth century was legitimated by the Jesuit accommodation policy toward Chinese learning, later evidential scholars such as Dai Zhen, Qian Daxin 錢大昕 (1728-1804), and Ruan Yuan successfully incorporated technical aspects of Western astronomy and mathematics into the literati framework for classical learning. Qian Daxin, in particular, acknowledged this broadening of the literati tradition, which he saw as the reversal of centuries of focus on moral and philosophic problems:

In ancient times, no one could be a literatus (*Ru* 儒) who did not know mathematical calculation. Chinese methods [now] lag behind Europe's because *Ru* do not know mathematics.

自古未有不知數而為儒者。中法之不絀於歐邏巴也，由於儒者不知數也。⁷³

The impact of evidential research made itself felt in the attention *kaozheng* scholars gave to the Western fields of mathematics and astronomy first

⁶⁹ See Elman, *A Cultural History*, pp. 503-520, 546-562.

⁷⁰ Hamaguchi Fujiō *Shindai kōkyōgaku no shisōshi teki kenkyū*.

⁷¹ Sivin, "Why the Scientific Revolution did not take place in China—or didn't it?" pp. 45-66.

⁷² Han Qi, "Bai Jin de Yijing yanjiu he Kangxi shidai de xixue zhongyuan shuo," pp. 185-200.

⁷³ Qian Daxin, *Qianyantang wenji* 3.335 (*juan* 23).

introduced by the Jesuits in the seventeenth century. Such interest had built upon the early and mid-Qing findings of Mei Wending 梅文鼎 (1633-1721), who was sponsored by Li Guangti and the Manchu court once his expertise in mathematical calculation (*lisuan* 曆算) and calendrical studies was recognized. Mei had contended that study of physical nature gave scholars access to the 'principles' (*li* 理) undergirding reality. In essence, Mei saw Jesuit learning as a way to boost the numerical aspects of the notion of moral and metaphysical principle.⁷⁴ At the same time, however, the imperial court and Mei Wending prepared preliminary accounts stressing the native Chinese origins (*Zhongyuan* 中源) of Western natural studies. Such origins made it imperative for Mei (and his highly placed follower in the early Qing court Li Guangti) to restore and rehabilitate the native traditions in the mathematical sciences to their former glory. Under imperial patronage during the Kangxi reign mathematical studies were upgraded from an insignificant skill to an important domain of knowledge for literati that complemented classical studies.⁷⁵

The term *gezhi* subsequently reappeared in Chen Yuanlong's 陳元龍 (1652-1736) *Gezhi jingyuan* 格致鏡原 (Mirror Origins of Investigating Things and Extending Knowledge), which was published in 1735. Chen had received the Kangxi emperor's orders in 1704 to compile a comprehensive work on astrology/astronomy (*tianwen* 天文), geography (*dili* 地理), human affairs (*renshi* 人事), plants and trees (*caomu* 草木), and insects (*chong* 蟲), but he held on to the manuscript for 20 years before publishing it. A repository of detailed information divided into thirty categories culled from a wide variety of sources, the *Gezhi jingyuan* represented a post-Jesuit collection of practical knowledge by a well-placed scholar in the Kangxi and Yongzheng courts.

In his collection, Chen Yuanlong narrowed the focus of Hu Wenhuan's late Ming *Gezhi congshu*, some of which had already been lost, to cover almost exclusively the arts and natural studies. For instance, Chen left out all poetry, rhyme-prose, and 'stories,' which separated the *Gezhi jingyuan* in the eyes of the *Siku quanshu* compilers from *Gezhi congshu* because the former left out all fictional material. Special attention was given to the origins and evolution of printing and stone rubbings, in addition to topics dealing with geography, anatomy, flora and fauna, tools, vehicles, weapons and tools for writing, as well as clothing and architecture. The Imperial Library editors included Chen's work in the *Siku quanshu* in the 1780s because they contended that Chen's catalog of entries "all were [examples of] broad learning and thus the work was titled 'investigating things and extending knowledge.'" The editors, who were for the most part partisans of 'Han Learning' (*Hanxue* 漢學), were by now able to separate *gezhi* as a term from 'Song Learning' and associate it with their

⁷⁴ See Wang Ping, "Qingchu lisuanjia Mei Wending," pp. 313-324, and Henderson, "The Assimilation of the Exact Sciences into the Ch'ing Confucian Tradition," pp. 15-31.

⁷⁵ See Limin Bai, "Mathematical Study and Intellectual Transition in the Early and Mid-Qing," pp. 23-61, and Jami, "Learning Mathematical Sciences During the Early and Mid-Qing," pp. 223-256. On the 'Chinese origins' theory, see Quan Hansheng, "Qingmo de 'xixue yuan chu Zhongguo' shuo," pp. 57-102.

emphasis on ascertainable knowledge derived from empirically derived research.⁷⁶

The seventeenth century impact of Jesuit knowledge in China was not always so easily domesticated in the eighteenth, however. Literati scholars took a range of positions concerning natural studies. A private scholar, Jiang Yong 江永 (1681-1762), for instance, combined classical loyalty to Zhu Xi's *Daoxue* teachings with knowledge of Western Jesuit studies obtained through evidential studies. Conservative as a classical scholar, Jiang was radical in his critique of both Han Learning and Mei Wending in natural studies for exalting nativist ancient studies in all cases. Jiang Yong recognized the advantages Western astronomy had over native traditions, while at the same time he continued to uphold the cultural superiority of the *Daoxue* view of morality. Although Jiang preferred Western learning for understanding the 'principles' of nature because they were more precise and consistent than native traditions, he maintained a clear distinction between astronomical methods and cultural values.⁷⁷

Overall, Ruan Yuan's compilation of the *Chouren zhuan* 畴人傳 (Biographies of Astronomers and Mathematicians) while serving as governor of Zhejiang province in Hangzhou from 1797 to 1799, reprinted in 1849 and later enlarged, marked the climax of the celebration of natural studies within the Yangzi delta literati world of eighteenth century evidential research, which had been increasing since the late seventeenth century. Containing biographies and summaries of the works of 280 *chouren*, including thirty-seven Europeans, this work was followed by four supplements in the nineteenth century. Limin Bai has noted how the mathematical sciences had begun to grow in importance among literati beyond the reach of the imperial court in the late eighteenth century. They were now linked to classical studies via evidential research. Because Ruan Yuan was a well-placed literati patron of natural studies in the provincial and court bureaucracy, his influential *Chouren zhuan* integrated the mathematical sciences with evidential studies. Mathematical and natural studies remained dependent on classical studies.⁷⁸

Via evidential studies, philology became one of the key tools that later scholars cum mathematicians and scientists, such as Xu Shou 徐壽 (1818-1882) and Li Shanlan 李善蘭 (1810-1882), employed to build conceptual bridges between Western learning and the traditional Chinese sciences in the nineteenth century. In the process, modern Western science and mathematics were initially introduced in the nineteenth century as compatible with native classical and technical learning. The Song-Yuan 'heavenly element notation' (*tianyuanshu* 天元術) and 'four elements notation' (*siyuanshu* 四元術) forms for expressing and solving quadratic and higher algebraic equations of several unknowns, once

⁷⁶ See Chen, "Fan-li," vol. 1031, pp. 1-3. I have also used the 1735 ed. of this work available in the Library of Congress. See also *Siku quanshu zongmu* 136.25a-26a.

⁷⁷ Chu Pingyi, "Ch'eng-Chu Orthodoxy, Evidential Studies and Correlative Cosmology," pp. 71-108.

⁷⁸ Hummel, *Eminent Chinese of the Qing Period*, p. 402. See also Limin Bai, "Mathematical Study and Intellectual Transition in the Early and Mid-Qing," pp. 23-30.

recovered in the late eighteenth century by Mei Juecheng 梅珏成 (1681-1763)—Mei Wending's grandson—and others, were thought by Qing evidential scholars to be superior to the algebraic techniques introduced to China by the Jesuits. Not until the introduction of the differential and integral calculus in the mid-nineteenth century, for which the Chinese could not find a precedent in China, did Li Shanlan and other Chinese mathematicians finally admit that although the 'four elements notation' was perhaps superior to Jesuit algebra, the Chinese had never developed anything resembling the calculus.

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