

## *Review Article*

### SCIENCE AND TECHNOLOGY IN NON-WESTERN CULTURES

*by Jensine Andresen*

*Encyclopaedia of the History of Science, Technology, and Medicine in Non-Western Cultures.* Edited by HELAINE SELINE. Dordrecht/Boston/London: Kluwer Academic Publishers, 1997. 1,117 pages. \$640.00.

*Abstract.* Seline's edited volume reevaluates non-Western interaction between religious and scientific domains of human intellectual history. Middle Eastern, South Asian, and Chinese thinkers have played central roles in pursuing intellectual inquiry into topics of broad human concern. Although copious and nuanced literary collections in Arabic, Sanskrit, Chinese, and Tibetan languages document non-Western contributions, these primary sources often are inaccessible to Western scholars, creating the false illusion that members of non-Western cultures have offered only marginal contributions to the rigorous investigation of the natural world. This illusion is dispelled thoroughly by a number of excellent articles contained in Seline's volume.

*Keywords:* *Āyurveda*; colonialism; divination; indigenous; knowledge system; Mongols; multiculturalism; Ottomans; rationality; *Vedas*; Zoroastrianism.

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Non-Western contributions to the history of the interface between religion and science are woefully underrepresented in current religion-and-science discussion. Fortunately, sporting six hundred separate entries on topics ranging from the "Abacus" to "Zu Chongzhi" (a native of Hebei

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Province known for two approximating ratios and for authoring a mathematical text entitled *Zhui Shu*), Seline's edited volume catalyzes a thorough reconsideration of the scope of the ideational nexus influencing the interaction between religion and science in the West. In so doing, it provides a timely reference for scholars engaged in an examination of the historical and multicultural roots of Western science before the seventeenth century and the manner in which non-Western scientific, technological, and medical knowledge functioned in the lives of Middle Eastern and Asian peoples. Representing perspectives from religiously plural cultures, Seline's overview helps contextualize broad theoretical attempts to model "religious" and "scientific" modes of understanding as they relate to human nature.

Near the beginning of the *Encyclopaedia*, the article entitled "Acoustics in Chinese Culture" (pp. 10–11) by Chen Cheng-Yih, a.k.a. Joseph Chen (Department of Physics, University of California, San Diego) canvasses Chinese speculation on the nature of sound beginning with minister Shàn Mū Gōng's reflections in 522 B.C.E. through Wáng Chōng's first century C.E. mention of the connection between waves in water and in air. Along the way, we learn that the Chinese *bā-yīn* (eight tones) system of classifying musical instruments was based on distinct musical tones. The *Dà Shī* (Grand Music Masters) ensured that all music was composed in pentatonic intonations, and the eight tones were correlated with nature: *yīn* (metal), *shí* (stone), *tú* (clay), *gē* (skin), *sī* (silk), *mù* (wood), *páo* (gourd), and *zhū* (bamboo). Additional entries on aspects of Chinese technological and scientific understanding, for example, "Algebra in China" (pp. 43–47), "Astronomy in China" (pp. 108–11), "Divination in China" (pp. 249–51), and "Geography in China" (pp. 351–52), are similarly informative. Scholars with more far-reaching interests in religion and science in China also are invited to consult Fang Li Zhi's article, "Note on the Interface between Science and Religion," in Robert J. Russell et al., eds., *John Paul II on Science and Religion: Reflections on the New View from Rome* (Vatican City State: Vatican Observatory Publications, 1990), pp. 31–36; Joseph Needham, *Chinese Science* (London: Pilot Press, 1945); and Hu Daojing, executive editor, *Explorations in the History of Science and Technology in China: A Special Number of the "Collections of Essays on Chinese Literature and History"* (Shanghai: Shanghai Chinese Classics Publishing House, 1982).

Again referring to Seline's *Encyclopaedia*, "Astronomy in India" (pp. 114–17), by the ubiquitous K. V. Sarma (Adyar Library and Research Centre, Adyar, Madras, India), is highly recommended. As in many other ancient civilizations, astronomy in India was interwoven with religion, and many religious practices conformed to astronomical timings following the seasons, equinoxes, solstices, and new and full moons. The *Vedas* mention professions such as *Ganaka* (calculator) and *nakṣatra-darśa* (star-gazer), together with a branch of science referred to as *nakṣatra-vidyā* (star science). The *Rgveda* provides much speculation about the genesis of the

universe from nonexistence, the configuration of the universe, the spherical self-supporting earth, and the year of 360 days divided into twelve equal parts. Computational components and work rules for the timing of Vedic rituals are found in the *Vedāṅga Jyotiṣa* (Vedic Astronomical Auxiliary), a text written by Lagadha and dated to the twelfth century B.C.E. Drawing in part on primary textual translations produced by Brown University's David Pingree, Sarma discusses the *Siddhānta* (established tenet) texts, together with their rationalistic methodology. In India, planar and spherical trigonometry were used to develop geometrical models for a realistic understanding of planetary motion, thereby making it possible to predict eclipses. Sarma's contributions to the *Encyclopaedia* are numerous, and I also recommend "Lunar Mansions in Indian Astronomy" (p. 520), "Precession of the Equinoxes" (p. 827), and "Rationale in Indian Mathematics" (p. 845). To supplement the discussion of Indian science found in the *Encyclopaedia*, readers may wish to consult the *Indian Journal of History of Science*, particularly T. S. Kuppannasastry, "The Main Characteristics of Hindu Astronomy in the Period Corresponding to Pre-Copernican European Astronomy," no. 1 (May 1974): 31–44.

Articles on more than forty Arab scientists are included in the *Encyclopaedia*, for example, Ibn Abbād, the fourth century vizier; Ibn al-A lam, the tenth century astronomer; and Ibn Al-Bannā, the thirteenth century mathematician. Roshdi Rashed (Centre d'Histoire des Sciences et des Philosophies Arabes et Médiévales, C.N.R.S.-E.P.H.E., Paris) has written a remarkable article on Ibn al-Haytham (Alhazen) (pp. 405–9), a renowned, classical Islamic mathematician who contributed particularly to the field of geometry. For additional reading on Islamic science, readers are referred to Seyyed Hossein Nasr, *Islamic Science—An Illustrated Study* [s.l.] (World of Islam Publishing Company, 1976), and *An Introduction to Islamic Cosmological Doctrines: Conceptions of Nature and Methods Used for Its Study by the Ikhan al-Safa, al-Biruni, and Ibn Sina*, rev. ed. (Albany: State Univ. of New York Press, 1993).

Ekmeleddin Ihsanoglu's (Research Centre for Islamic History, Art and Culture, Istanbul, Turkey) article on "Ottoman Science" (pp. 799–805) examines significant developments in Ottoman scientific literature in the sixteenth-century period of the reign of Sultan Süleyman the Magnificent. Because the Ottomans needed geographical knowledge to determine the borders of their expanding territory and to establish control over military and commercial activities in the Mediterranean, the Black Sea, the Red Sea, and the Indian Ocean, they utilized both the geographical works of classical Islam and also works of European origin. In 1511, Piṛi Reis drew his first map, using his own detailed drafts and European maps, among them Columbus's map of America.

For scholars interested in the dissemination of ideas, I recommend Michael Adas's article entitled "Colonialism and Science" (pp. 215–20).

Adas, who teaches in the Department of History at Rutgers University, is the author of *Machines as the Measure of Men: Science, Technology and Ideologies of Western Dominance* (Ithaca: Cornell University Press, 1989). His article is followed by a series of shorter entries by other authors: "Colonialism and Science in Africa" (pp. 220–21); "Colonialism and Science in the Americas" (pp. 221–23); "Colonialism and Science in India" (pp. 223–26); and an unexpected gem, "Colonialism and Science in the Malay World" (pp. 226–29). According to Adas's rendition of events, regarding more general connections between colonialism and science, an account that combines historical survey with philosophical reflection, scientific advances facilitated European expansion overseas. On the heels of advancing European armies and administrators, botanists and geologists collected specimens for the gardens and medicine cabinets of their rulers and national scientific societies, and scientific institutions such as the Sibpur botanical gardens in Calcutta served as focal points for taxonomic experiments in procreation and hybridization. The Baconian, or mechanistic, strain of Western scientific inquiry undergirded the scientific side of European expansion, and certain characteristics of this mindset rendered colonial Europeans generally unreceptive to non-Western ways of thinking about the natural world, a situation still common today among many scientists and development specialists.

Analyzing the timing and nature of European interaction with non-Western cultures, colonizers' perceptions concerning the level of sophistication of indigenous epistemologies and material cultures, and the actual scientific and technological attainments of colonized people, Adas details the process by which Western science impacted overseas societies. The linkages between science and colonization differed greatly between non-settler areas of Africa, Asia, and Oceania, where small numbers of Europeans dominated large and diverse colonized populations, as compared to places such as Australia and the United States. The most telling differences occurred between areas that the Europeans ruled directly (such as India, sub-Saharan Africa, and Southeast Asia) and those they dominated indirectly through military threats and periodic interventions, economic influence, and the manipulation of indigenous leaders (most of the Islamic Middle East, Persia/Iran, China, Siam/Thailand, and Japan).

Also highly recommended is the series of entries entitled "East and West" (pp. 253–74). With separate sections on Africa, China, India, and Islam, this section of the *Encyclopaedia* surveys shifting nexi of scientific and cultural advance, including the four major centers of civilization existing from 500 B.C.E. to 1500 C.E. (China, India, Near East, and West/Greek). The article emphasizes Greek and Roman knowledge of the Near Eastern world, especially the Persian empire, and these civilizations' less accurate knowledge of India and China. This lack of Western understanding about India and China lasted until the late thirteenth century when the rise of the

Mongol empire in Asia resulted in direct overland travel between Europe and China, reviving European rulers' hopes of finding a powerful ally to the east of the Muslims. Shortly thereafter, the decline of the Mongol empire and the establishment of the Ming Dynasty in China in 1368 severed the direct connection between Europe and China. Older connections between Europe and the Near East and India were disrupted by the fall of Constantinople in 1454 and the establishment of the Turkish empire. At this juncture, Europe's isolation from the outside world was complete, not to be restored until the opening of the sea route around the tip of Africa in the last years of the fifteenth century.

A brief survey article entitled "Medical Ethics" (pp. 663–66) by Robert M. Veatch (Kennedy Institute of Ethics, Georgetown University) concisely differentiates practices in China, India, the Near East, Africa, and the Pre-Columbian Western Hemisphere. This article, too, is followed by a series of shorter selections on medical ethics and medical texts in China and India, an intriguing article entitled "Medicinal Food Plants" (pp. 676–79), and a series of articles: "Medicine in Africa" (pp. 679–83); "Medicine in China" (pp. 683–89); "Medicine in Egypt" (pp. 689–93); "Medicine in India: *Āyurveda*" (pp. 693–95); "Medicine in Islam" (pp. 695–98); "Medicine in Japan" (pp. 698–702); "Medicine in Meso and South America" (pp. 702–6); "Medicine in Native North and South America" (pp. 706–9); "Medicine in the Pacific Islands" (pp. 709–14); "Medicine: Talmudic Medicine" (pp. 714–17); "Traditional Medicine in Thailand" (pp. 717–19); and "Medicine Wheels" (pp. 719–20).

According to Veatch's introductory essay, medical ethics in non-Western societies often are addressed in the core ethics literature of the group (that is, religious texts and philosophical writings). This contrasts markedly with Western reliance on the Hippocratic Oath and the tradition surrounding it. The first explicit medical ethical writing in China usually is attributed to Sun Simiao (ca. 581–682) and sports the optimistic title, "On the Absolute Sincerity of Great Physicians." So-called Great Physicians practice the virtues of compassion and humaneness and are committed to preserving life. As in China, medical ethical teachings in India also are included within philosophical and religious texts, a prime example being the *Āyurveda* texts developed initially during the first millennium B.C.E. In the Near East, perspectives on medical ethics are articulated as early as the second millennium B.C.E. In Zoroastrianism, the physician was seen as a force for good in the struggle between good and evil. In Islam, medical ethics is grounded in the *Qurʾān*, with a rigorous commitment to the preservation of life and opposition to all killing, including euthanasia and abortion. Further, a ninth-century work, the *Adab al-tabib* ("Practical Ethics of the Physician"), reflects the Islamic synthesis of Hippocratic, Greek, and Arabic medicine.

Remarkable is the erudition with which David Turnbull (School of Society Inquiry, Deakin University, Australia) delivers his contribution entitled “Rationality, Objectivity, and Method” (pp. 845–50). Capturing the essence of science and also describing its mythic structure, Turnbull notes that terms such as “rationality,” “objectivity,” and “method” provide “the rationale for the celebration of modernism and the current domination of the West.” Writing from a historically informed and postmodern perspective, Turnbull proceeds to dissect the concept of rationality, specifically its allegiance to late twentieth-century occidental assumptions about what constitutes a knowing, moral, and sane individual. “Rationality” is not merely epistemological; the term carries ideological connotations that privilege certain ways of knowing over others. For this reason, the concept serves as “a constitutive element in the moral economy.”

Like rationality, “objectivity” often is heralded as a product of a science founded on established methods that seek to eliminate individual, institutional, and cultural biases, according to Turnbull. On closer examination, however, one notes that objectivity actually emanates from the institutionalized practices that serve in a particular culture to create self-evident validity. Like democracy, objectivity is a “historic compound,” a worthy goal that remains elusive. While the so-called scientific method still succeeds in reaching conclusions about the natural world, valued characteristics of scientific theories, including coherence, consistency, simplicity, and plausibility, all have proven difficult to express in a manner that can be used to measure all theories in all circumstances. Turnbull argues that empiricism, too, has its pitfalls. Experiments are performed on a simplified and artificial portion of reality, hence the universal generalizations drawn from these experiments are not final. Further, the role of skill and tacit knowledge in scientific practice can undermine the effectiveness of experimental replication as the litmus test of truth. So none of these concepts—rationality, objectivity, and method—may be derived from self-evident epistemological principles; instead, “they are embedded in the historically contingent processes of scientific practice, whereby the resistances and limitations of reality are encountered and accommodated.”

Yet another interesting series of entries in the *Encyclopaedia* focuses on “knowledge systems.” Also written by David Turnbull, the first entry in this series, “Knowledge Systems: Local Knowledge” (pp. 485–90), expands upon Geertz’s well-known analysis of the local process of knowledge construction. Inherently local negotiations and judgments, not absolute standards, establish the authority of knowledge claims. Turnbull advocates cross-cultural comparisons of knowledge production, which he notes largely have been absent from historical and social science discourse. Critiquing “the master narrative of modernism,” Turnbull argues that all knowledge systems, including the contemporary technosciences, are based on local knowledge. One of the most “post” of all modernisms, the sociology of



scientific knowledge, brings the local into thematic *bas-relief*. Reevaluating the role of theory, some philosophers of science have argued that, instead of relying on universal laws, real-world scientists often make do with rules of thumb deriving from the way phenomena present themselves to scientific instrumentation.

According to Turnbull, recognition of the localness of scientific knowledge “permits a parity in the comparison of the production of contemporary technoscientific knowledge with knowledge production in other cultures.” Consequently, the role of theory may be reevaluated, especially claims regarding its universal relevance. Turnbull credits Bruno Latour (“Visualisation and Cognition: Thinking with Eyes and Hands,” *Knowledge and Society* 6 [1986]: 1–40) with advancing our understanding of the movement of local knowledge, specifically through the account of the effects of small differences in the technology of representation (“immutable mobiles are the kinds of texts and images that the printing press and distant point perspective have made possible”), which cause large and powerful effects in science. Latour’s account is further supplemented by Steven Shapin and Simon Shaffer in *Leviathan and the Air Pump: Hobbes, Boyle and the Experimental Life* (Princeton, N.J.: Princeton Univ. Press, 1985). Following Turnbull’s introductory entry, more “local” entries follow on “Knowledge Systems of the Australian Aboriginal People” (pp. 490–94); “Knowledge Systems in China” (pp. 494–95); “Knowledge Systems of the Incas” (pp. 495–500); “Knowledge Systems in India” (pp. 500–2); and a fascinating article entitled “Korean Science” (pp. 502–6).

The contributors to the *Encyclopaedia* are an iconoclastic bunch. The editor, Helaine Seline, is the science librarian at Hampshire College; the Advisory Board is composed of Ho Peng Yoke, Needham Research Institute, Cambridge University; David Turnbull, Deakin University, Geelong, Australia; Jan P. Hogendijk, Mathematics Institute, University of Utrecht, The Netherlands; Gloria T. Emeagwali, Central Connecticut State University; Seyyed Hossein Nasr, George Washington University; and Susantha Goonatilake, United Nations, New York.

The “List of Authors” (pp. 1063–78) makes for interesting reading, as it delineates a range of renowned international scholars and potential participants in various religion-and-science conferences and symposia. Certain authors contribute heavily to the volume, for example Tian Se Ang (Edith Cowan University, Australia); Richard Bertschinger (Montacute, Somerset, England); Emilia Calvo (Universidad de Barcelona, Spain); Gregg DeYoung (American University in Cairo); R. C. Gupta (Ganita Bharati Academy, Jhansi, India); Ho Peng Yoke (Needham Research Institute, Cambridge, England); David A. King (Johann Wolfgang Goethe University, Germany); Paul Kunitzche (Universität München, Germany); Nakayama Shigeru (Kanagawa University, Japan); Fabrizio Pregadio (Venice, Italy); Boris A. Rosenfeld (Pennsylvania State University); Julio Samsó

(Universidad de Barcelona, Spain); and K. V. Sarma (Adyar Library and Research Centre, Madras, India).

Still, the selection process for the volume's contributors appears to reflect a lineage of personal contacts more than an assembly of scholarly authorities in each of the areas. A glaring series of uneven examples serves to illustrate this point. "Astronomy in Tibet" (pp. 136–39) was written by Yukio Ohashi, a respected Japanese Tibetologist who carefully appraises many key primary Tibetan texts relating to this topic (such as Bu ston Rin chen grub's *Rtsis kyi bstan bcos mkhas pa dga' byed*) together with an impressive concatenation of Japanese and German secondary sources. In stark contrast, the politically offensive "Chinese Minorities" article (pp. 197–200), in which Guo Shirong and Feng Lisheng of the Institute for the History of Science, Inner Mongolia Normal University, attempt to comment upon indigenous literature with which they clearly are only tangentially familiar at best, includes a technically inaccurate subsection on "Medicine" that attempts unsuccessfully to discuss important Tibetan medical texts amidst a blithering array of Tibetan spelling and transliteration errors. John A. Tucker's (University of North Florida) article "Environment and Nature: Japan" (pp. 298–302) similarly contains the author's highly individualistic construal of Buddhist philosophy amidst a sea of Sanskrit diacritical omissions. Such unevenness makes the *Encyclopaedia* potentially problematic for scholars wishing to rely on it alone without obtaining the second opinion of specialists in particular disciplines.

Practically, Seline's volume provides provisional bibliographies for each entry, which serve as ideal springboards for further research. Instructors in religion-and-science courses may wish to include this volume under the "Recommended Reading" portion of their course syllabi; but beware—weighing in at almost ten pounds with over one thousand pages, and retailing for \$650.00, the *Encyclopaedia* is more appropriately placed on the library reference shelf than in your students' backpacks.