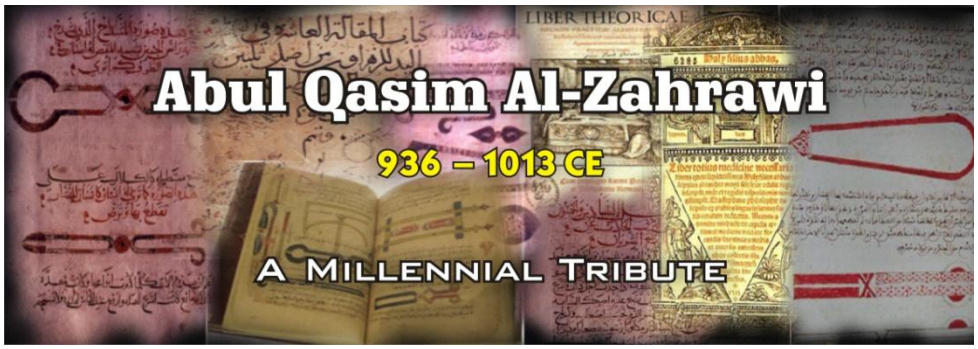


Sociology of Islamic Science: A Preliminary Exploration

Professor A. R. MOMIN

Broadly defined, the sociology of science focuses on the linkages and interactions between scientific knowledge and social and cultural structures and processes. The areas and themes covered under this rubric include the social organization of science, the structure of the scientific community, the social context of scientific norms, and the role of cultural factors, including religion, in the rise of modern science.

The celebrated German sociologist Max Weber (d. 1920), in his celebrated work *The Protestant Ethic and the Spirit of Capitalism,* argued that Protestantism, which laid great emphasis on rationality, utilitarianism, industriousness and hard work, played a key role in the emergence of capitalism and modernity in Europe in the medieval period. This idea was carried further by Robert K. Merton, one of the most influential American sociologists of the 20th century. Merton argued that Puritanism played a central role in the rise of modern science.

Much of the discussion in the sociology of science – as in much of Western historiography and social science theorizing -- is embedded in a Eurocentric framework. G. Blue and T.

Brook have pointed out that the generalizations of social science invariably rest on the belief that the West occupies the normative starting position for constructing general knowledge. Consequently, almost all empirical and conceptual categories in respect of society and state, politics and economy and feudalism and capitalism have been conceptualized primarily on the basis of Western historical experience.

American and European sociologists who have focused on the social context of scientific knowledge proceed from the assumption that the rise of science in Europe during the Renaissance was a unique phenomenon. They ignore the fact that the beginnings of science can be traced, centuries earlier, to China, India and the Islamic world, that Muslim scientists were forerunners of many scientific discoveries, innovations, procedures, instruments and devices, that European scientists in the Middle Ages owed much to the seminal and wide-ranging contributions of Muslim scientists.

The substantive areas and themes that are in the focus of analysis in the sociology of science are embedded in the specific historical, social and cultural context of Western societies in the Middle Ages. Had Western sociologists of science taken cognizance of the development and social context of scientific knowledge in China, India and the Islamic world, they would have realized that the scope of the sociology of science was indeed much wider and that the subject needed to be approached in a comparative framework. Thomas S. Kuhn, in his well-known work *The Structure of Scientific Revolutions* (1970) has made some original and highly significant observations about the social context of Western science. [1] Kuhn has perceptively observed that science does not progress in a linear accumulation of new knowledge but undergoes periodic paradigm shifts, which usher in scientific revolutions. Had Kuhn focused on the intercultural transmission of scientific knowledge in the medieval

period and on the dynamics of the interactions between Greek science, science in the Islamic world and the Renaissance, he would have modified or revised some of his propositions and conclusions.

Mercifully, Western historians of science have made a commendable attempt to make amends for the injustice done to the contributions of Muslim scientists by European historians of science during the Middle Ages. Unfortunately, the sociology of science is yet to shake off the burden of Eurocentrism and academic parochialism. This subject awaits the attention of Muslim scholars. What is offered in the following is in the nature of preliminary, tentative observations which, hopefully, may be of some help in formulating a nuanced and sophisticated sociology of Islamic science.

1. Social and Cultural Context of Scientific Knowledge

1.1. Motivational Matrix of Scientific Knowledge

Western historians of science generally maintain that the main stimulus for the pursuit of scientific knowledge in the Islamic world was provided by the translations of Greek works on mathematics, science, medicine and astronomy in the 8th and 9th centuries. This view betrays a Eurocentric perspective and is based on a misrepresentation of historical evidence. In reality, the primary motivation for the burst of intellectual and scientific activity that was witnessed in the early centuries of the Islamic era was provided by the Quran and Hadith. The Quran says that what distinguishes man from animals is the capacity for reason, self-awareness and moral choice. It repeatedly urges Muslims to reflect over and unravel the mysteries of the universe and human existence (Quran 13:3; 33:72). It is significant to note

that the world knowledge (*ilm*) in its various derivatives is mentioned at 778 places in the Quran.

The Prophet (SAAW) emphasized that the acquisition of knowledge was an obligation on every Muslim. He urged his followers to seek knowledge and disseminate it far and wide and warned against concealing or withholding it. The Islamic view of knowledge is remarkably open, cosmopolitan, egalitarian and inclusive. Thus the Prophet is reported to have said, "Wisdom is (like) the lost animal of a Muslim; he catches hold of it wherever he finds it." He advised his secretary Zayd ibn Thabit to learn foreign languages in order to communicate with the rulers of foreign lands. Franz Rosenthal has remarked that Islam's invaluable and enduring gift to mankind is that it made the hidden treasures of knowledge available to all sections of society, regardless of the distinctions of birth, class, rank or gender. [2]

Significantly, the discharge of some Islamic obligations required some knowledge and understanding of natural phenomenon. For example, the determination of the direction of the *qibla* for offering prayers requires at least some elementary knowledge of physical geography and astronomy. It is not a mere coincidence that almost all astronomical handbooks written by Muslim astronomers during the medieval period contain a chapter on the determination of the *qibla* and the construction of a *qibla* compass. Similarly, fasting during the month of Ramadan requires an elementary knowledge of astronomical phenomena. The elucidation of the rules of Islamic law relating to inheritance and succession prompted the study of mathematics among Muslims.

The view that the primary motivational and foundational matrix for the pursuit of scientific knowledge in the Islamic world is provided by the Quran and the Prophet's *sunnah* is shared and affirmed by quite a few Western historians of science. An eminent German historian of

science E. H. F. Meyer has stated that "the holy Quran has been the mother of all sciences among Muslims." Douglas Guthrie, in his book *A History of Medicine* (1958), has stated that progress in medical knowledge during the Islamic period was principally motivated ad inspired by Islamic beliefs and practices. Rosenthal explained the motivation for the urge to acquire foreign knowledge in the following words: "Probably neither the practical utilitarianism which made the acquaintance with medicine, alchemy and the exact sciences desirable for the Muslims, nor the theoretical utilitarianism that induced them to occupy themselves with philosophical theological questions, would have been adequate to motivate the extensive activity of translation, had not Muhammad's religion, from the very beginning, emphasized the role of knowledge (*'ilm*) as the main force in religious life and thus for human life in general… Without this pivotal position of knowledge, which is characteristic of Islam and which indeed almost borders on religious reverence, the translation activity would presumably have been less scientific, less comprehensive and have been limited rather to what was absolutely necessary than was actually the case." [3]

The transmission of the Greek legacy in science through the translation of Greek works undoubtedly played an important role in the development of science in the Islamic world. However, it needs to be pointed out that the translation movement was not the source of the burgeoning of scientific knowledge in the Islamic world but a consequence of a culture of knowledge and writing and rational inquiry that preceded it. [4]

1.2. The Culture of Writing and the Dissemination of Scientific Knowledge

Writing, or the commitment of the word to space, enlarges the potentiality of language beyond measure. More than any other single invention, writing has transformed human consciousness.[5] The culture of literacy entails an emphasis on the accuracy of transmission and a sense of history. Writing has played a crucial role in the preservation, transmission and dissemination of knowledge, including scientific knowledge.

Jack Goody points to the central role of the circulation and dissemination of ideas and knowledge and the modes of transmission – especially writing on parchment or paper – in the progress of civilization in general and of scientific knowledge in particular. [6]

Paper was invented in Southeast China between the first century BCE and the first century CE. It was made from bamboo, mulberry, hemp waste and old rags, and was initially used as a wrapping material. The Chinese kept the technique of paper making a closely guarded secret for well over six centuries. In 751, a war took place between the Chinese and the Arabs at Talas in Central Asia. The Chinese lost the war and a number of Chinese soldiers were captured as prisoners-of-war by the Arabs. The Arabs set a condition that the Chinese prisoners could secure their release by teaching them the technique of paper making, to which the latter agreed. Muslims contributed to the craft of paper making in three important and ingenious ways. First, Chinese paper was made from mulberry and young bamboo shoots, as a result of which it was quite fragile and expensive. Muslims experimented with linen, cordage and rags, which made the paper sturdy and much less expensive. Secondly, they introduced certain ingenious techniques such as maceration of rags

with a stamping mill. Thirdly, unlike the Chinese, Muslims did not keep the knowledge of paper making to themselves. Instead, they disseminated it far and wide. The first paper factory was set up in Baghdad in 793 and in a relatively short time, paper factories sprang up in Samarqand, Damascus, Egypt, Morocco and Andalusia. The first paper factory in Europe was established in the Spanish city of Jativa, whence the technology of papermaking passed into Italy and other parts of Europe. Before the 13th century, paper was brought to Europe from Andalucia, Sicily and Morocco. Interestingly, the earliest extant European document written on paper is a deed of King Roger of Sicily, inscribed in Greek and Arabic in 1102. [7]

1.3. A Culture of Interactive and Inclusive Openness

Muslim scholars, scientists and philosophers have always eschewed epistemological xenophobia and exclusion. They had no hesitation in drawing on the knowledge, wisdom and reflections of past cultures and civilizations. The process of assimilation of scientific knowledge from Greece, India, Persia, Egypt and Mesopotamia began in the early centuries of the Islamic era. In the early decades of the 8th century, the Umayyad caliph Umar ibn Abd al-Aziz (ruled 717-20), who was held in high esteem for his sincere and deep commitment to Islamic values and principles and for his piety and personal integrity, commissioned the translation from Syriac into Arabic of a 7th century medical work written by an Alexandrian priest Ahrum.

The intercultural transmission of scientific knowledge was greatly facilitated by extensive travels and explorations undertaken by Muslim explorers, seafarers and voyagers and large networks of trade and commerce. Jack Goody points out that the Islamic lands stretching from Spain to India and the east constituted an enormous, contiguous and relatively stable

commercial zone, in which there was much exchange not only of goods but of ideas and of people. [8] In the 9th century, there were said to be over 100,000 Muslim merchants in Canton. [9] The Silk Road linked a vast stretch of land from China to India and from Central Asia to Europe and played a highly important role in economic, technological, cultural and scientific transmission. A wide range of goods and commodities, including spices, wool, ivory, precious stones, gold, linen, ceramics, furs, weapons and horses, were exchanged and traded along the Silk Road. The caravans on the Silk Road passed through the famed cities of the Islamic world, including Samarqand, Bukhara, Merv, Herat, Baghdad and Kashghar. [10] Toledo became known as the "City of Three Cultures," where Christians, Muslims and Jews lived in an atmosphere of peaceful coexistence and shared its cultural and scientific legacy.

The intercultural exchange and transmission of scientific knowledge in a multiethnic environment during the medieval period produced a cross-fertilization of ideas in science, medicine, technology and philosophy and fostered a cosmopolitan outlook. Muslim scientists looked upon science as the shared heritage of mankind. In medicine, it resulted in the synthesis and integration of various medical traditions and systems from India, Persia, Greece and Byzantium.

This intercultural transmission and synthesis of scientific knowledge provides an effective refutation of the idea of cultural absolutism, popularized by Samuel Huntington.

2. A Multiethnic and Multi-Religious Milieu

The scientific community – scientists, translators, physicians, astronomers, mathematicians – in Baghdad, Egypt, Damascus, Cordoba, Sicily, Toledo, Venice and other centres of

scientific learning the Middle Ages, which played a highly important role in the development and dissemination of science in the Islamic world, was truly multiethnic and multi-religious in composition. It comprised Muslims, Nestorian and Jacobite Christians, Jews, Magians, Sabaeans and Hindus. Abu Bishr Matta (d. 940) and Qusta ibn Luqa (d. 912) were Christian. Jurji ibn Bakhtishu (d. 830), who was employed by the Abbasid caliph Al-Mansur as a court physician, was a Christian. Ibn Maymun or Maimonides (d. 1204) was an Andalusian rabbi. Ali ibn al-Abbas al-Majusi (d. 944) was a Magian. Thabit ibn Qurra (d. 901) was a Sabaean from Harran. There were at least two Hindu translators, Mankah and Dahan.

Abbasid caliphs employed Nestorian and Jacobite Christians for the translation of scientific works from Greece into Arabic. Yuhanna ibn Masawayh (d. 857), who was head of Bayt al-Hilmaah, established by the Abbasid caliph in was a Nestorian Christian. Hunayn ibn Ishaq al-Ibadi (d. 873), known as Johannitus in medieval Europe was a disciple of Ibn Masawayh and was a Nestorian Christian. He and his students translated a large number of Greek scientific and medical works into Arabic and Syriac. The Abbasid caliph Harun al-Rashid established a large hospital at Baghdad and entrusted its supervision to a Christian physician, Jibril ibn Bakhtishu. Jibril was later appointed as a court physician by the caliph Al-Mansur.

Al-Razi, Ibn Sina and Ibn Rushd had no direct access to Greek works on science and medicine. They relied on translations of Greek scientific treatises by Nestorian and Jacobite Christians.

During the Golden Age of Islamic science, Muslim scientists had diverse ethnic, linguistic and regional backgrounds, including Arabs, Persians, Moors, Egyptians, Assyrians and Indians. Albiruni, for example, was of Persian origin who spoke Khwarizmian, a dialect of

Persian. Similarly, Al-Khwarizmi, Ibn Sina, Al-Razi, Nasir al-Din al-Tusi and Ali ibn Rabban al-Tabari were of Persian origin. Al-Zahrawi, Al-Zarqali and Ibn Zuhr belonged to Andalucia. Ibn al-Haytham was an Arab fro Basra while Al-Idrisi came from Morocco. Ibn al-Nafis, who was of Arab descent, was born in Damascus, from where he moved to Egypt.

3. Institutionalisation of Scientific Knowledge

The institutionalization of science in the Islamic world was set in motion in the 8th century and was effected through a wide network of libraries, colleges, scientific academies, translation bureaus, hospitals and observatories. Most of these institutions were maintained through charitable endowments (*awqaf*). A scientific institution of great importance, known as *Bayt al-hikmah*, was founded in Baghdad by the Abbasid caliph Al-Mamun around 815. It comprised a scientific academy, a translation bureau, a library and an observatory. It was at *Bayt al-hikmah* that a large number of scientific and philosophical works from Greece, India, Persia and Egypt was translated into Arabic.

The famed libraries of Cordoba, Baghdad, Damascus, Cairo and Istanbul were treasure troves of Islamic and scientific learning. In the 10th century, the library of the ruler of Cordoba, Al-Hakim II, consisted of 400,000 books according to the historian Al-Maqqari, and 600,000 according to the Lebanese monk Casiri. This was at a time when the largest library in Christian Europe was that of the monastery of St. Gall in Switzerland, which had 800 volumes. [11]

Suleymaniye Library, Istanbul

The establishment of a wide network of hospitals and medical colleges in the Islamic world during the medieval period represents a glorious chapter in the annals of Islamic civilization. Between the 9th and the 10th centuries, five hospitals were established in Baghdad, Qayrawan, Makkah, Madinah and Rey. The most well-known of these hospitals was the Adudi Hospital, built in 982. A splendid hospital, known as Bimaristan, was established by the caliph Adud al-Dawla in Baghdad in 982. In the 12th century, Salah al-Din al-Ayyubi founded the Nasiri Hospital in Cairo, which surpassed all other hospitals in Islamic lands on account of the exemplary competence of its physicians, ready availability of medical aid and efficiency of service. Caliph Al-Mansur founded a splendid hospital in Cairo in 1284. The hospital complex included a pharmacy, a dispensary, a well-stocked library and store rooms. During the reign of the caliph Al-Mutadid (d. 902), mobile medical units were introduced. The ambulant hospital, which was carried on camelback, was equipped with doctors, nurses, attendants, medicines and food.

A hospital built by the Ottoman sultan Bayezid II in Edirne in 1488 had a wide reputation for the treatment of mental illnesses. The physicians at the hospital used a variety of ingenious healing methods, including music therapy, water sounds and scents. The hospital was in operation for nearly four centuries until 1878. In 1993 it was incorporated into Tarakya University and converted into a medical museum.

Medical colleges attached to hospitals enrolled students, who were required to complete the prescribed medical course and pass a series of examinations in clinical theory and practice. After passing the examination, they were given a license (*ijazah*), which authorized them to work as a physician or to teach medicine. This system of examination and licensing of physicians reached Europe via Sicily, where it was introduced by King Roger in 1140. One of the earliest medical colleges in Europe was founded in Paris in 1180. It was modeled after medical colleges in Islamic lands and was maintained trough endowments.

A hospital, attached to a mosque complex, built by the Ottoman sultan Bayezit II in 1488, had a wide reputation for the treatment of mental illnesses

4. Globalisation of Science and Medicine

Most commentators trace the beginnings of globalisation in the second half of the 20th century. However, globalisation is neither such a recent nor an absolutely unique phenomenon. The distinguished economist and Nobel Laureate Amartya Sen emphasises that "globalisation is neither new nor a folly, but a global movement of ideas, people, technology and goods from one region to others, benefiting the people at large". Sen argues that globalisation's history spans several centuries and that it has contributed to the progress of the world through travel, trade, migration, the spread of cultural influences and the dissemination of knowledge and understanding.

Historians A. G. Hopkins and Christopher Bayly have used the term proto-globalisation to describe the phase of increasing trade links and cultural exchanges that characterised the period from 1600 to 1800, which preceded modern globalisation. Three points in this connection are note-worthy. First, the current discourse on globalisation, which is manifestly Eurocentric or West-centric, needs to be critiqued and decentred. Amartya Sen has rightly argued that the active agents of globalisation have sometimes been located quite far from the West. He points out that around 1000 AD, some of the most important technological inventions and innovations such as the clock, magnetic compass, paper, printing, gunpowder and the wheelbarrow were invented by the Chinese and subsequently spread across the world, including Europe. Second, we need to look at globalisation not as an isolated phenomenon that emerged in the West in recent times, but as the outcome of historical, social and cultural processes that took place in many non-Western contexts and that preceded modern globalisation by many centuries. In other words, we should look at globalisation

from the perspective of social and cultural history and, as in the case of science and technology, as the product of cumulative progress and development. Third, a distinction needs to be drawn between modern globalisation and proto-globalisation or incipient globalisation. Furthermore, the scope and span of proto-globalisation or incipient globalisation needs to be extended beyond the 17th century. Proto-globalisation or incipient globalisation should not be looked upon as merely an earlier phase of globalisation, but as an important precursor or forerunner of globalization, which significantly impacted processes and linkages that have become a hallmark of modern globalization.

Proto-globalisation or incipient globalisation encompasses all those historical events and processes that covered a vast expanse of territory, entailed transcending geographical barriers and national borders, and involved diverse peoples and cultures. These include the Silk Road (a vast network of trade and cultural linkages and transmission routes that linked East and West for nearly two millennia), the worldwide sweep of global religions such as Christianity, Buddhism and Islam, the worldwide diffusion of Chinese technology, especially papermaking, printing, magnetic compass and gunpowder, and world empires such as the one created by Genghis Khan and his son and successor Ogodei and the Ottoman Empire. Islamic civilization made an enduring and highly important contribution to proto-globalisation.

It is widely recognised that one of the most important contributions of Muslims to Western civilization was the transmission of the scientific and philosophical legacy of the ancient world to medieval Europe. A movement for the globalisation of science, medicine and philosophy was set in motion in Baghdad during the reigns of the Abbasid caliph al-Mansur (754-775) and his great grandson al-Mamun (d. 833). This movement was marked by extensive translations of scientific, medical and philosophical works from ancient Rome,

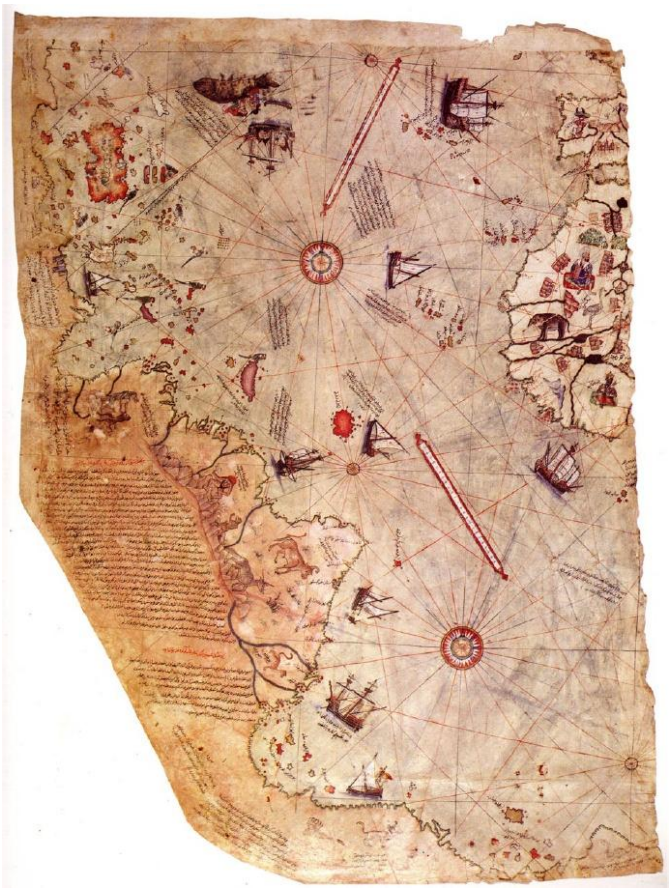
India, Persia and Egypt, a creative synthesis of the researches of Muslim scholars and scientists and those of the ancients, the establishment of scientific institutions, the employment of Arabic as the lingua franca of scientific communication, and the creation of a multiethnic, multi-religious community of scientists and scholars. The Nobel Laureate Amartya Sen has remarked that "as leaders of innovative thought in that period in history, Muslim intellectuals were among the most committed globalisers of science and mathematics." [12]

Although the individuals who were involved in scientific research, experiments, translations and other scientific activities in the Islamic world in the medieval period came from diverse ethnic, religious and linguistic backgrounds, they employed Arabic as the common language of scientific research and communication. From 622 to 1492 Arabic replaced Greek as the international language of science and medicine. Roger Bacon (d. 1293) acknowledged that almost all of Aristotle's works were available only in Arabic translations and that without Arabic, Greek knowledge would have never reached Europe. The great popularity of the printed Arabic texts of the works of Ibn Sina, Al-Razi and Al-Zahrawi in medieval Europe is truly amazing. Some 940 copies of the printed Arabic text of Ibn Sina's *Canon* were sold in Europe during the Middle Ages. It is interesting to note that some of the important works of Greek scientists, such as the seven volumes of Galen's *Anatomy,* Ptolemy's *Planisphere* and Galen's commentary on Hippocrates's *Airs, Water, Places* have survived only in their Arabic translations. The original texts have been lost. A number of European intellectuals, scientists and physicians, including Roger Bacon d. 1292), William Harvey (d. 1657), Vesalius (d. 1564), Arnold De Villanova (d. 1311), Mondinode Luzzi (d. 1326), Guy Du Chauliac (d. 1368), Andreas Alpagus (d. 1522) and Michael Servitus (d. 1553), had a good knowledge of

Arabic. Zacharias Rosenbach (d. 1614), a prominent German physician, suggested the introduction of an Arabic language course for medical students at Herborn Academy, the first German scientific academy founded in 1584. Rosenbach argued that such a course would enable students to read the original Arabic text of Ibn Sina's *Canon.*

A distinctive feature of globalization is the shrinking of time and space. Muslim astronomers, scientists, mathematicians, cartographers, navigators and seafarers in the medieval period made an outstanding contribution to the processes that led to the shrinking of distances and the reduction of time. In the 10th century, Al-Biruni calculated the dimensions of the spherical earth with remarkable accuracy and calculated, with amazing precision, the circumference of the earth. He also worked out with remarkable precision the difference in longitude and latitude between Ghazni in Afghanistan and Mecca. Maps prepared during the medieval period greatly contributed to the knowledge about the expanse and boundaries of the earth and the location of continents and oceans. The celebrated historian of Islamic science and technology, Fuat Sezgin, has shown that Muslim cartographers combined the navigators' knowledge with studies of astronomy and mathematics to compile maps of astonishing precision. In 820 the Abbasid caliph al-Mamun had commissioned the preparation of a global map, in which a number of distinguished astronomers and geographers were involved. The map, which was discovered by Sezgin at the Topkapi Museum in Istanbul and announced by him at the Frankfurt Book Fair in 2004, shows with remarkable clarity and precision the oceanic expanses surrounding the continents as well as large parts of the Eurasian and African continents with recognizable coastlines and major seas.

Muslim navigators and seafarers in the Golden Age of Islamic Science (from the 8th to the 16th centuries) undertook long sea voyages eastwards and explorations deep into Africa. By the 9th century, Arab maritime traders had reached as far as Canton in China. The sea voyages undertaken by Muslim navigators gave them a more complete view of geography than that of ancient Greeks and Romans.



The map of Piri Reis

Muslim navigators and explorers from West Africa and the Iberian Peninsula traveled across the Atlantic Ocean and the Americas between the 9th and 14th centuries, long before the arrival of Christopher Columbus. The famous map of the Turkish general and cartographer Piri Reis shows the presence of Muslims in America centuries before Columbus set foot

there. The map also provides a remarkably accurate measurement of the distance between America and Africa.

The insatiable thirst for scientific knowledge prompted some Muslim physicians to undertake extensive travels. Thus, Ibn al-Baytar of Malaga (d. 1248), the greatest botanist of medieval times, travelled from Andalucia through North Africa and Egypt to collect medicinal herbs and plants for his encyclopaedic work *Al-Jami al-Mufradat.* It is interesting to note that Ibn al-Baytar provided the names of medicinal plants in his encyclopaedic work in Arabic, Persian, Berber, Greek and Romance languages. [13]

Medicinal plants and herbs, mentioned in the works of Muslim physicians, were sourced from distant lands, including India, China, Southeast Asia and Africa. In most cases, they were procured through merchants who traded along the Silk Road. In the 13th century, during the Yuan era, medicines from Islamic lands as well as Greece found their way into the Mongol court in China. The Mongol rulers had officially designated medical institutions for dispensing "Muslim" medicines. Some of Ibn Sina's works and the Arabic translations of Galen and other Greek physicians reached China in the 13th century. In his *Canon*, Ibn Sina listed and recommended the use of at least 17 medicinal herbs which were sources from China. Rashid al-Din Fadl Allah (d. 1318), a prominent physician, was in regular contact with Chinese physicians. He sent one of his pupils to China to collect Chinese medical works. He then had them translated into Persian. Ali ibn Sahl Rabban al-Tabari (d. 858), in his well-known work *Firdaws al-hikmah*, included a section on Indian medicines and discussed their sources and uses.

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