

Science and Scholarship in Al-Andalus

For Europe and Western civilization the contributions of Islamic Spain were of inestimable value. When the Muslims entered southern Spain - which they called al-Andalus - barbarians from the north had overrun much of Europe and the classical civilization of Greece and Rome had gone into eclipse. Islamic Spain then became a bridge by which the scientific, technological, and philosophical legacy of the 'Abbasid period, along with the achievements of al-Andalus itself, passed into Europe.

In the first century of Islamic rule in Spain the culture was largely derived from that of the flourishing civilization being developed by the 'Abbasids in Baghdad. But then, during the reign of 'Abd al-Rahman III (912-961), Islamic Spain began to make its own contributions.

'Abd al-Rahman III was passionately interested in both the religious and the secular sciences. He was also determined to show the world that his court at Cordoba equaled in greatness that of the caliphs at Baghdad. Sparing neither time nor expense, he imported books from Baghdad and actively recruited scholars by offering hand some inducements. Soon, as a result, scholars, poets, philosophers, historians, and musicians began to migrate to al-Andalus. Soon, too, an infrastructure of libraries, hospitals, research institutions, and centers of Islamic studies grew up, establishing the intellectual tradition and educational system which made Spain outstanding for the next four hundred years.

One of the earliest of the scholars drawn to al-Andalus was 'Abbas ibn Firnas, who came to Cordoba to teach music (then a branch of mathematical theory) and to acquaint the court of 'Abd al-Rahman with the recent developments in this field in Baghdad. Not a man to limit himself to a single field of study, however, Ibn Firnas soon began to investigate the mechanics of flight. He constructed a pair of wings out of feathers on a wooden frame and made the first attempt at flight, anticipating Leonardo da Vinci by some six hundred years. Later, having survived the experiment with a back injury, he also constructed a famous planetarium. Not only was it mechanized - the planets actually revolved - but it simulated such celestial phenomena as thunder and lightning.

As in the 'Abbasid centers of learning, Islamic Spain's interest in mathematics, astronomy, and medicine was always lively - partly because of their obvious utility. In the tenth century Cordoban mathematicians began to make their own original contributions. The first original mathematician and astronomer of al-Andalus was Maslamah al-Majriti, who died in 1008. He had been preceded by competent scientists - men like Ibn Abi 'Ubaydah of Valencia, a leading astronomer in the ninth century. But al-Majriti was in a class by himself. He wrote a number of works on mathematics and astronomy, studied and elaborated the Arabic translation of Ptolemy's *Almagest*, and enlarged and corrected the astronomical tables of the famous al-Khwarazmi. He also compiled conversion tables in which the dates of the Persian calendar were related to Hijrah dates, so that for the first time the events of Persia's past could be dated with precision.

Al-Zarqali, known to the West as Arzachel, was another leading mathematician and astronomer who flourished in Cordoba in the eleventh century. Combining theoretical knowledge with technical skill, he excelled at the construction of precision

instruments for astronomical use and built a water clock capable of determining the hours of the day and night and indicating the days of the lunar months. He also contributed to the famous Toledan Tables, a highly accurate compilation of astronomical data. Arzachel was famous as well for his Book of Tables. Many "books of tables" had been compiled before then, but his is an almanac containing tables which allow one to find the days on which Coptic, Roman, lunar, and Persian months begin, other tables which give the position of planets at any given time, and still others facilitating the prediction of solar and lunar eclipses. He also compiled valuable tables of latitude and longitude.

Another important scholar was al-Bitruji, who developed a new theory of stellar movement, based on Aristotle's thinking, in his Book of Form, a work that was later popular in the West. The names of many stars are still those given them by Muslim astronomers, such as Altair (from al-tair, "the flier"), Deneb (from dhanab, "tail"), and Betelgeuse (from bayt al-jawza, "the house of the twins" or "Gemini"). Other terms still in use today such as zenith, nadir, and azimuth are also derived from Arabic and so reflect the work of the Muslim astronomers of al-Andalus and their impact on the West.

Scientists of Islamic Spain also contributed to medicine, the Muslim science par excellence. Interest in medicine goes back to the very earliest times (the Prophet himself stated that there was a remedy for every illness), and although the greatest Muslim physicians practiced in Baghdad, those in al-Andalus made important contributions too. Ibn al-Nafis, for example, discovered the pulmonary circulation of blood.

During the tenth century in particular, al-Andalus produced a large number of excellent physicians, some of whom studied Greek medical works translated at the famous House of Wisdom in Baghdad. Among them was Ibn Shuhayd, who in a fundamental work recommended drugs be used only if the patient did not respond to diet and urged that only simple drugs be employed in all cases but the most serious. Another important figure was Abu al-Qasim al-Zahrawi, the most famous surgeon of the Middle Ages. Known in the West as Abulcasis and Al-bucasis, he was the author of the *Tasrif*, a book that, translated into Latin, became the leading medical text European universities during the later Middle Ages. Its section on surgery contains illustrations of surgical instruments of elegant, functional design and great precision.

Other chapters describe amputations, ophthalmic and dental surgery, and the treatment of wounds and fractures. Ibn Zuhr, known as Avenzoar, was the first to describe pericardial abscesses and to recommend tracheotomy when necessary as well as being a skilled practical physician, and Ibn Rushd wrote an important book on medical theories and precepts. The last of the great Andalusian physicians, Ibn al-Khatib, also a noted historian, poet, and statesman, wrote an important book on the theory of contagion in which he said: "The fact infection becomes clear to the investigator, whereas he who is not in contact remains safe," and described how transmission is effected through garments, vessels, and earrings.

Islamic Spain made contributions to medical ethics and hygiene as well. One of the most eminent theologians and jurists, Ibn Hazm, insisted that moral qualities were mandatory in a physician. A doctor, he wrote, should be kind, understanding, friendly, and able to endure insults and adverse criticism. Furthermore, he went on,

a doctor should keep his hair and fingernails short, wear clean clothes, and behave with dignity.

As an outgrowth of medicine, Andalusian scientists also interested themselves in botany. Ibn al-Baytar, for example, the most famous Andalusian botanist, wrote a book called *Simple Drugs and Food*, an alphabetically arranged compendium of medicinal plants, most of which were native to Spain and North Africa, and which he had spent a lifetime gathering. In another treatise Ibn al-'Awwam lists hundreds of species of plants and gives precise instructions regarding their cultivation and use. He writes, for example, of how to graft trees, produce hybrids, stop blights and insect pests, and make perfume.

Photo: Al-Idrisi's planisphere is considered the first scientific map of the world.



Another important field of study in al-Andalus was the study of geography. Partly out of economic and political considerations, but mostly out of an all-consuming curiosity about the world and its inhabitants, the scholars of Islamic Spain started with works from Baghdad and went on to add such contributions as a basic geography of al-Andalus by Ahmad ibn Muhammad al-Razi and a description of the topography of North Africa by Muhammad ibn Yusuf al-Warraaq. Another contributor to geography was al-Bakri, an important minister at the court of Seville but also an accomplished linguist and litterateur. One of his two important geographical works is devoted to the geography of the Arabian Peninsula, with particular attention to the elucidation of its place-names. It is arranged alphabetically, and lists the names of villages, towns, wadis, and monuments which he culled from the hadith and from histories. The other was an encyclopedia of the entire world, arranged by country, with each entry preceded by a short historical introduction. It included descriptions of the people, customs, and climate of each country, the principal features, the major cities, and even anecdotes.

In the study of geography such figures as Ibn Jubayr, an Andalusian traveler, and the most famous traveler of all Ibn Battutah, also made important contributions. Born in North Africa, then in the cultural orbit of Islamic Spain, Ibn Battutah traveled extensively for twenty-eight years and produced a travel book that proved to be a rich source for both historians and geographers. It included invaluable information on people, places, navigation, caravan routes, roads, and inns. But the most famous geographer of the period was al-Idrisi, who studied in Cordoba. After traveling widely, al-Idrisi settled in Sicily and wrote a systematic geography of the world, usually known as the *Book of Roger* after his patron Roger II, the Norman King of Sicily. The information contained in the *Book of Roger* was also engraved on a silver planisphere, a disc-shaped map that was one of the wonders of the age.

Innumerable scholars in al-Andalus also devoted themselves to the study of history and linguistic sciences, the prime "social sciences" cultivated by the Arabs, and brought them to a high level. Ibn al-Khatib, for example, who distinguished himself in almost all branches of learning, produced more than fifty works on travel, medicine, poetry, music, politics, and theology, as well as writing the finest history of

Granada that has survived. The most original mind of the period, however, was undoubtedly Ibn Khaldun, the first historian to develop and explicate general laws governing the rise and decline of civilizations. In the Prolegomena, an introduction to a huge, seven volume universal history - an introduction longer than some of the volumes - Ibn Khaldun approached history as to a science and challenged the logic of many accepted historical accounts. In a sense, he was the first modern philosopher of history.

Another great area of Andalusian intellectual activity was philosophy, where an attempt was made to deal with intellectual problems posed by the introduction of Greek philosophy into the context of Islam. One of the first to deal with this was Ibn Hazm, who as the author of more than four hundred books has been described as "one of the giants of the intellectual history of Islam." There were other philosophers too, such as Ibn Bajjah, known to the West as Avempace, who was also a physician and Ibn Tufayl, the author of Hayy ibn Yaqzan, the story of a child growing up in complete solitude on a desert island who, entirely by his own intellectual efforts, discovers for himself the highest physical and metaphysical realities. It was however, Averroes - Ibn Rushd - who earned the greatest reputation. He was an ardent Aristotelian and his works had a lasting effect, in their Latin translation, on the development of Western philosophy.

The list of Islamic Spain's contributions to the West, in fact, is almost endless. In addition to Islamic Spain's contributions in mathematics, economy, medicine, botany, geography, history, and philosophy, al-Andalus also developed and applied important technological innovations: the windmill and new techniques in the crafts of metalworking, weaving, and building.