Women in Science

Antiquity through the Nineteenth Century

A Biographical Dictionary with Annotated Bibliography

Marilyn Bailey Ogilvie

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To William T. and Mildred Bailey

Personally I do not agree with sex being brought into science at all. The idea of "women and science" is entirely irrelevant. Either a woman is a good scientist, or she is not; in any case she should be given opportunities, and her work should be studied from the scientific, not the sex, point of view.
Hertha Ayrton

Women breeding up women, one fool breeding up another; and as long as that custom lasts there is no hope of amendment, and ancient customs being a second nature makes folly hereditary in that sex.
Margaret Cavendish

I hope when I get to Heaven I shall not find the women playing second fiddle.
Mary Whitney

Preface

In 1973, when I was an instructor in the history of science at Portland State University, in Portland, Oregon, one of my students chose, as the topic for her assigned paper, "Women in Science." Several days after selecting her project, she returned, explaining that she could find information on only one woman scientist, Marie Curie. "Was Marie Curie the only woman in science?" she asked. This was a mere thirteen years ago. Since then, though excellent research has been done in this area, there has appeared no single source where one can find both information on specific women scientists and a bibliographic tool for further research. This book is designed to fill the void.

Although primarily a biographical dictionary, this work includes other information as well. It has three main sections: an introductory essay, divided into five chronological sections, which places the biographical accounts in a historical context; the biographical accounts themselves; and a classified, briefly annotated bibliography, which may be used both in conjunction with the biographical sketches and by itself, as a research tool for locating sources. Following the bibliography and just before the index, I have included a list of all the subjects of biographical accounts, giving the historical period, scientific field, and nationality of each. My aim has been to create from all these elements a useful resource for a wide group of readers—historians of science, teachers in the field of women's studies, librarians, students, and members of the general public.

The core of the work is the biographical accounts. The articles vary in length. Longer presentations may indicate a greater importance in the history of science or, in some cases, the existence of more material. A short account does not necessarily indicate an unimportant scientist. It may mean only that the source material has not been examined in depth. Certain accounts represent a thorough consideration of primary material, whereas others rely on rather sketchy secondary information. Although the first situation is obviously preferable, the less detailed accounts provide a starting point for additional research.

Several times in the course of the preparation of this work, I have declared it finished, only to be made aware of a multitude of additional names. My alternatives seemed to be these: to spend years fleshing out the materials and, in the meantime, compiling additional names; to ignore these individuals; or to present a minimal amount of information about them. I rejected the first option. Although the second possibility would allow a more consistent level of presentation, I felt that it would limit the usefulness of the book as a resource tool. Consequently, I chose to include both individuals for whom I have a considerable amount of information and those for whom I have very little.

H. J. Mozans's Woman in Science *(***B51***) provided me with an initial list of names. I then examined standard bibliographical sources to expand my list. At this stage I followed the "footnote trail," finding that each source studied provided me with additional references. When it was feasible, I wrote to universities and colleges in the United States for information on women whom I knew had either attended or taught at these institutions. I had to face the* *problem of a "cut-off" time, and chose a rather arbitrary one. I decided to limit the list to women who had made important contributions before 1910, and therefore I included only women who were born before 1885. I should also point out that I have confined my scope to the Western World. My next step was to arrive at a "template" of standard information, to be provided before each woman's biographical account. The standard data include, when available and applicable, the following: dates, nationality and branch of science, birthplace, parents' names, education, professional positions, name(s) of husband(s), number and names of children, place of death, and inclusion in one or more of five generally available reference works—*American Men of Science *(AMS), the* Dictionary of American Biography *(DAB), the British* Dictionary of National Biography *(DNB), the* Dictionary of Scientific Biography *(DSB), and* Notable American Women *(NAW). For some of the subjects most of the standard information was available; for others I collected very little. When my data on nineteenth- and early twentieth-century subjects were especially sparse, rather than omitting them or including them with the others, I have provided an appendix, which I hope will serve as a starting point for further research. The accounts themselves involve first of all an expansion of the biographical information, then a discussion of the subject's science and an assessment of her significance.*

The bibliography has been organized into seven sections, according to type of work and historical period. Section A contains bibliographic and reference works; section B contains mainly general histories with biographical information on women scientists, and collective biographies; sections C through G are divided by chronological period (antiquity; the Middle Ages; fifteenth through seventeenth centuries; eighteenth century; nineteenth and early twentieth centuries). The items in each section of the bibliography are numbered in sequence, with the letter corresponding to that section prefixed to the numbers. In citing sources in the essay and in the biographical accounts, I refer to items in the bibliography by their letter-number codes. At the end of each account may be found a list of major or representative works by the subject and a list of those items in the bibliography that are entirely or in part concerned with the subject of that account. Although many other entries in the bibliography may be relevant, only those that I actually used in composing the account, or that specifically mention the subject of the account, are listed.

Criteria for inclusion among the subjects of biographies were difficult to establish. Science, defined as an attempt to explain natural phenomena through seeking agreement between observational data and theoretical assumptions, is not what every one of these women was practicing. Insisting on a narrow definition of science would have forced the exclusion of women who stressed either the empirical or the theoretical to the neglect of the other element. In times and places where the idea of a woman scientist was unthinkable, an incremental factual addition or a minor theoretical speculation represented a major achievement. Consequently, in order to portray woman's historical involvement in science-related activities, individuals are included whose work spans a broad range of contributions, representative of the participation of women in the science of their time.

A truly comprehensive source book of women in science would be highly desirable but almost impossible to compile. There are two reasons. First, as the centuries passed, the range of science-related activities in which women were permitted to participate gradually expanded. Midwifery, for example, was one of the few activities in which women participated in antiquity, and midwives are therefore included for that time in this volume. For later periods, how-

ever, when female midwives were numerous, they have been omitted; I have included women physicians for these periods, but only if they made special contributions to theoretical medicine or helped to open the medical profession to women.

The second reason is simply numbers. During the latter part of the nineteenth century and the early twentieth, a much larger number of women worked in science and science-related fields. Some have not been included who would have been considered had they lived earlier. Some who should have been included may have been omitted inadvertently. More American women than European women are included for the later periods. This lack of balance may reflect the amount of research on Americans, not the historical situation. It is my intention to continue to work on this biographical dictionary, improving and expanding the essays when necessary, and incorporating corrections and new materials. It is my hope that someone else might be inspired to produce a similar book on women in science for the period 1910 to the present day.

This work has taken me approximately thirteen years to complete. It was possible primarily because of an important resource available at the University of Oklahoma, the History of Science Collections. The original collection, donated by Everett DeGolyer, has been maintained and expanded, and a number of donors have contributed the relevant portions of their libraries to the Collections.

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Women in Science

Introduction
Science and Women: A Historical View

Antiquity

To find scientists in the ranks of the women mentioned by ancient writers requires speculation and imagination. It is conceivable, for instance, that the Theban Aglaonike, who reputedly could "pluck the moon from the heavens," had a means of predicting eclipses, and that Agamede of Elis, who used plants to cure a variety of ills, had a general explanation for her successes. These conclusions cannot be documented, however. Indeed, not only is our identification of these women as scientists unsure, but we must question their very existence. Fable, fantasy, and fact have become hopelessly intertwined. It is difficult to know whether our subjects were old or young, male or female, wealthy or impoverished; whether they were socially acceptable or outcasts, fictitious or real. Nonetheless, enough information exists to allow us to consider the participation of women in the natal days of science.

As traditions clashed and coalesced in the ancient world, science, a novel and fruitful way of explaining the universe, emerged. References to women are sparse in the chronicles of early science; of these, almost all assign women to the more practical and less theoretical aspects of science. Some intriguing exceptions exist—the alchemist Mary the Jewess, for instance, who moved in both spheres. Yet in her work the theoretical and the empirical remained polarized and unrelated; and in the case of all ancient women scientists the fragmentary source material forces our evaluations to be tentative.

Although Western science was a Greek invention, two of its tools, writing and mathematics, were developed in Mesopotamia and Egypt as responses to specific practical problems. In about the middle of the fourth millennium B.C., Mesopotamian scribes invented a syllabic alphabet whose symbols represented phonetic units rather than objects. This revolutionary practice reduced innumerable pictographs to the approximately three hundred sounds in the spoken language. Thus armed with a means to express abstractions, the Mesopotamians could develop new ways of understanding phenomena. A second tool of science, mathematics, also reached a high level of development in Mesopotamia. The earliest tablets, from about 1800 B.C., demonstrate that by that time the Babylonians were operating within a place-value system similar to our own. This development, together with that of writing, provided the means to develop ideas in astronomy. Astronomical predictions reached a high level of sophistication in the cultures of Mesopotamia, coming close to the blending of observation and theory that represents science. These predictions fell short of producing general theories, however.

The evidence that we possess about the social structure of ancient Mesopotamia—the great legal code of Hammurabi (fl. 1792–1750 B.C.), for instance, in which is found the pronouncement that a girl is the legal property of her father until sold by him to her husband—indicates that women probably were not involved in early protoscientific developments there. But if Mesopotamia provided a poor climate for female creativity, another protoscientific culture, ancient Egypt, was much more hospitable. Women traditionally owned property in Egypt, and it was the mother's name that was listed carefully in genealogies. Whereas the father was only a holder of office, the mother provided the family link. Although the Semitic influence of the Nineteenth Dynasty strengthened patriarchal elements in the system, the woman's rights to property persisted until much later (C59 74–75, 119).

Some Egyptian women were literate. A document from the Fifth Dynasty asserts that a woman of high rank should be able to read, but not write, the hieratic script of the time. A later document indicates that literacy was not confined to the upper classes: the daughter of a clerk claims that she can "write with the greatest ease" (C59 124). The precedent for wise women was divinely established. Wisdom was one of the attributes of the goddess Isis, who was described as "Nature, the Universal Mother, Mistress of all the elements, primordial child of Time, Sovereign of all things spiritual, Queen of the dead, Queen also of the immortals, the single manifestation of all gods and goddesses that are" (C67 44). The ubiquitous Isis was also revered as the greatest of physicians, and her medical disciples were often women. Women could either attend medical school with men or patronize their own institution at Saïs. This exclusively female school, not surprisingly, specialized in obstetrics and gynecology.

Beyond their prominence in practical medicine, no conclusion can be reached regarding the involvement of women in other areas peripheral to theoretical science in Egypt. The tradition of women in medicine, particularly in midwifery, has remained independent of the development of other protoscientific fields and of abstract science. Nevertheless, the high level of training accorded female physicians in Egypt suggests the sort of environment in which a woman might have become a scientist.

Although repressive societies may inhibit the development of science among women, permissive ones do not necessarily encourage it. If equality with men were a sufficient condition, the city-state of Sparta should have produced noteworthy women scientists. Yet the Spartan culture was singularly lacking in scientific thinkers of either sex. Nevertheless, Sparta's liberal attitude toward women's rights was a popular topic in other Greek societies that were producing scientists. That the code of the Spartan lawgiver, Lycurgus (ca. 9th century B.C.), "paid all possible attention even to the women" fascinated both Greeks and Romans. Spartan women ran, wrestled, threw the discus and javelin, so that "the fruit of their wombs might have vigorous root in vigorous bodies and come to better maturity" and so that they "might come with vigor to the fulness of their time, and struggle successfully and easily with the pangs of childbirth" (C25 14.1, 2, 3). Even though Lycurgus's code resulted in more freedom for women, his purpose, assuring female welfare for procreative purposes, was hardly liberating.

Aristotle (384–322 B.C.), whose intellect dominated Western thought for two thousand years, contemplated the Spartan educational experiment with disgust; he could not accept the possibility of a woman doing more than interfering mischievously in a man's world. Yet Plato (427–347 B.C.), the other influential thinker of the time, was pro-Spartan in his sentiments and used many Spartan practices in the development of his concept of an ideal state. Thus, although Sparta produced no scientists, her social structure provided a basis for disputation among the intellectual leaders of scientific Greek societies.

Just as the laws of nonscientific Sparta were based on the teachings of the partially mythical Lycurgus, those of scientifically oriented Athens were formed around the works of the lawgiver Solon (ca. 683–599 B.C.). Solon did not suggest educational equality between the sexes, and his attitude became the established position of Athens. The statesman Pericles, in his celebrated funeral oration for the Athenians killed in the Peloponnesian War (430 B.C.), thus summed up the ideal woman: "Greatest will be she who is least talked of among men whether for good or for bad" (C32 2.45).

But a radical philosopher who rejected Pericles' assignment of a woman's place became increasingly well known in Athens. Socrates (ca. 470–399 B.C.) attracted a group of bright young men as students; through his dialectical method he attacked many cherished Athenian beliefs, including those about the role of women in society. Tradition indicates that a woman, Diotima of Mantinea, was a teacher of Socrates. It is through the work of Socrates' most distinguished disciple, Plato, that we are able to glimpse his ideas. Socrates, as a character in Plato's *Republic*, justifies the equal education of boys and girls by pointing to animal societies: are dogs, he asks, "divided into hes and shes," or do they not rather share equally in "hunting and in keeping watch and in the other duties of dogs"? Is it only the males who care for the flocks while the females remain at home, "under the idea that the bearing and suckling of their puppies is labor enough for them"? Socrates concludes that animals can only be used for the same purpose if they are "bred and fed in the same way." If women are to share the responsibilities of the state with men, he continues, they must have the same "nurture and education" (C22 5.3.451).

This was a radical concept in Athens, where it was the custom to bring up a girl child "under the strictest restraint, in order that she might see as little, hear as little, and ask as few questions as possible" (C34 7.4, 5). In the *Republic* Socrates goes on to point out that his adversaries will argue that since men and women have different natures they should engage in different activities. But a difference in their intellectual natures, he insists, has not been demonstrated. If either male or female is superior in any "art or pursuit," then this task should be assigned to the most fit. But "if the difference consists only in women bearing and men begetting children, this does not amount to a proof that a woman differs from a man in respect of the sort of education she should receive; and we shall therefore continue to maintain that our guardians and their wives ought to have the same pursuits" (C22 5.5.454).

Plato's student, Aristotle, had little patience with his teacher's views on women. "[In] the relation of the male to the female," he wrote in the *Politics*, "the inequality is permanent." Although he admitted that men and women could both be courageous, Aristotle saw a difference in the quality of their courage: "the courage of a man is shown in commanding, of a woman in obeying." Even though "there may be exceptions to the order of nature, the male is by nature fitter for command than the female" (C10 1.12.1259–1260). According to Aristotle, the origin of female passivity was biological, for "the female, in fact, is female on account of inability of a sort, viz., it lacks the power to concoct semen." Although "while still within the mother, the female takes longer to develop than the man does," once the child is born, "everything reaches its perfection sooner in females than in males." Females reach puberty, maturity, and old age sooner, because they are "weaker and colder in their nature." Femaleness should be considered "a deformity, though one which occurs in the ordinary course of nature" (C6 1.20.728a.18–20; 4.6.775a.13–15).

The implications of man's biological superiority extend into the ethical realm. In the home, asserts Aristotle, "the man is master, as is right and proper, and manages everything that it falls to him to do as head of the house." One can compare the affection between husband and wife to that between the government and the governed in an aristocracy. Continuing the analogy, he asserts that the degree of affection is determined "by the relative merits of husband and wife, the husband, who is superior in merit, receiving the larger share of affection, and either party receiving what is appropriate to it" (C7 8.10.1160b.32–35; 8.11.20–24).

Although orthodox Athenian men were comfortable with Aristotle's assessment of woman's place and were appalled by the audacity of Plato's educational suggestions, they found their dutiful spouses insufficiently entertaining and inadequately informed. To fill the void, they turned to foreign women called *hetaerae* (companions), often Ionians, who occupied a position between that of an Athenian lady and that of a prostitute. It was from the ranks of the *hetaerae* that Pericles took his famous mistress, Aspasia the Milesian. Even the two women purported to have been students at Plato's academy were not Athenians by origin: Lasthenia was from Mantinea, a city-state in the Peloponnesus that may have absorbed some of the attitudes of Sparta, and Axiothea was from Phlius, another Peloponnesian city with a pro-Spartan bias.

It is generally agreed that the Romans' science was of a lower order that that of their counterparts in Greece. The encyclopedic works of Pliny, Seneca, Celsus, Vitruvius, Mela, Frontinus, and Cato are hardly comparable to the original productions of the Hellenistic thinkers Archimedes, Hipparchus, Aristarchus, Ptolemy, Eratosthenes, Euclid, and Galen. Only in applied science did the Romans excel—they produced better engineers, for example, than did the Greeks, but these engineers acquired the small amount of mathematics they needed without grappling with theory (**C69**). As for the women of this society, many were capable, competent, and practical; but like their brothers they were more interested in the concrete than in the abstract.

During much of their history Roman women had more freedom of action than Greek women. Their political power was demonstrated in 195 B.C. in their successful revolt against the Oppian Law, a holdover from the days of the Punic Wars, which forbade Roman women to wear jewels or fine clothing or to drive in carriages in the city. The continuation of these sumptuary regulations long after the defeat of Carthage infuriated Roman women, especially since the men were not affected. In a mass protest they marched to the Senate to urge the repeal of the law. In spite of the opposition of Cato (the Elder, 234–149 B.C), who predicted that the repeal of the Oppian Law would be the first step toward disaster—"Woman is a violent and uncontrolled animal, and it is no good giving her the reins and expecting her not to kick over the traces"—the women prevailed (**C38** 101–103).

Cato's dire prophecy was not entirely incorrect. The severe patriarchy of the early Roman periods was gradually replaced by women's increasing control over their own affairs and, not rarely, over those of their men. The emancipation of the Roman matron seldom led to creative intellectual pursuits, however. Freedom of person too often in the Roman upper classes resulted in freedom to intrigue rather than freedom to create. As Simone de Beauvoir writes in *The Second Sex*, the Roman woman "was emancipated only in a negative way, since she was offered no concrete employment of her powers" (**B5** 95).

The antifeminism of many of the Christian church fathers grew out of what they perceived to be the immoral and licentious behavior of Roman women. In addition, the early Christians were steeped in the traditions of patriarchal rabbinical Judaism. It was the Apostle Paul, and not the radical Jesus of Nazareth, who chiefly determined the attitudes of his coreligionists toward women. Paul, a Roman citizen, had a view of women colored by his own early experiences, his relationship with rabbinical Judaism, and his observations of the depravity of women in the late Roman Empire.

Not all the church fathers were against education for women. St. Jerome (A.D. 340?–420), who accepted Paul's belief that celibacy was the ideal, developed a system of education for girls that, while exalting virginity and otherworldliness, also stressed scholarly achievement. Jerome attracted a following of wealthy Roman matrons and widows, who, in addition to founding three nunneries and a monastery, aided him in his scholarly work. Jerome's classic text on the education of the Christian woman was written for the instruction of one of his followers in the raising of her daughter, Paula.

To find special favor in the eyes of God, wrote Jerome, a girl must "have no comprehension of foul words, no knowledge of worldly sins, and [her] childish tongue must be imbued with the sweet music of the psalms." She should be kept away from boys and their "wanton frolics" (C46 345). Protected though she must be, Jerome did not think that Paula could best serve God by remaining ignorant. She should be encouraged to learn—and to achieve this her teachers should make her lessons pleasant. Still, "her very dress and outward appearance should remind her of Him to whom she is promised" (C46 351).

Above all, Paula should remain dependent upon her parents. "She should have neither the knowledge nor the power to live without you, and should tremble to be alone." To help her retain her purity, Jerome suggested that she should avoid baths: "For myself I disapprove altogether of baths in the case of a full-grown virgin. She ought to blush at herself and be unable to look at her own nakedness. If she mortifies and enslaves her body by vigils and fasting, if she desires to quench the flame of lust and to check the hot desires of youth by a cold chastity, if she hastens to spoil her natural beauty by a deliberate squalor, why should she rouse a sleeping fire by the incentive of baths?" (C46 363–365). In spite of Jerome's insistence that the body was basically evil, however, several of his female followers, such as Fabiola, were encouraged to become practical physicians, ministering to the poor.

The Christian reaction to the sensuality of the late Empire helped to hasten the decline of rational Greek science. For the church fathers the first priority was salvation. The present transitory life was unsatisfactory, and observation and understanding of the world around them were unimportant. Apathy rather than hostility was the main reason for the atrophy of Greek science during the patristic period.

Christianity was just one of many Eastern mystical religions that invaded the former territory of Greek rationalism. Gnosticism, Manichaeism, and the cults of Isis flourished. Even the popular philosophical systems of Neoplatonism and Neopythagoreanism contained mystical overtones, differing from their rational ancestors. It was in this time of changing ideologies, and in a place—the cosmopolitan city of Alexandria—where many traditions met, that the best-known woman scientist of antiquity, the mathematician and philosopher Hypatia, lived. Hypatia stood at the threshold of the Middle Ages; her changing world reflected differences not only in ways of explaining natural phenomena but in women's participation in the process as well.

The Middle Ages

Like Dante, who strayed from his path and became lost in a dark wood, "where the right road was wholly lost and gone" (D5 71), Europe between the fifth century and the fifteenth has often been considered to have taken a misstep. Another view of the Middle Ages is as a passageway, a long sterile corridor between antiquity and the modern world. The character of medieval science makes it especially susceptible to these interpretations. Preceded by an era of strict rationalism and succeeded by a period of innovation based on that rationalism, the Middle Ages appear to be a cipher in the "progress" of science. Although the modern values reflected in this view cannot be eliminated entirely, an awareness of their existence can help us to appreciate medieval science and woman's role in that science within the context of its own time.

The use of the term "Middle Ages" for a large block of time and for a huge geographical area implies an additional danger, the assumption of either a temporal or a spatial homogeneity. In considering such aspects as the medieval understanding of "courtly love," the Church, and science, one must bear in mind that these varied considerably from one region to another and from one era to another within the boundaries of Europe over a thousand-year span.

During the Middle Ages the Greek scientific tradition took two separate paths, one in the East and the other in the West. Whereas in the Latin West, Greek ideas became so distorted as to become unrecognizable, Islamic scholars in the East continued in the spirit of Greek rationalism. During the late Hellenistic period, centers of Greek thought had developed in the Near East. In the cities of Antioch, Nisibis, and Edessa, scholars had carefully translated entire works from Greek to Syriac, rather than indulging in the simplification so popular among their Roman counterparts. A second development in the East, the maturation of the Islamic culture, ensured the preservation of entire Greek scientific works. By the end of the seventh century, the Islamic faith had swept the Middle East, raced across North Africa, and penetrated Spain and Portugal. Although the initial emphasis of Islam was on the maintenance of religious orthodoxy, during the Abbasid caliphate (749–1258) a vital Arabic-language intellectual life arose. The storehouse of Greek knowledge, translated into Syriac, constituted one source for Arabic scholars. In addition, Greek works were collected and translated directly into Arabic. Thus, by the beginning of the tenth century the whole of the Aristotelian corpus as well as numerous other Greek works were available in Arabic.

Had the Arabs done no more than preserve Greek knowledge, their contribution to modern science would still have been enormous. Not only did they translate, however; they dissected, augmented, and modified these works, developing a "commentary" tradition that became very important in the subsequent development of European science (**D19**).

Nothing approaching the probing depths of Arabic science found its way into Europe in the Middle Ages. The few available books on natural philosophy were superficial, inconsistent, and vague. Although during the early centuries after Christ the works of Greek natural philosophers were ignored by choice, eventually the option to choose ceased to exist. The works were lost to Western scholars. The rise of Christianity during this chaotic period reinforced the neglect of science. Amid the strife of the unpleasant external world, people sought a reality beyond appearances. The emphasis was no longer on explaining the world around them but on transcending that world. Talented individuals turned toward the Church, away from their environment, and away from those Greek writers who had offered explanations about that environment. When the western part of the Empire fell prey to invading Germanic tribes, there was little effort on the part of these guardians of knowledge to preserve artifacts of dubious value from the past. As a result, as the Christian territories expanded into western Europe, the pagan Greek writings were not present to be perpetuated and extended. In contrast, works concerning the vital problem of salvation had been lovingly preserved and copied.

Nevertheless, the medieval churchmen were unable to depart from Greek thinking entirely. The roots of their educational system extended to ancient Greece, where the idea of the liberal arts—those higher studies that distinguished freemen from slaves—originated. During late antiquity the number of the liberal arts had been fixed at seven: grammar, rhetoric, dialectic, arithmetic, geometry, music, and astronomy. Of these the Roman Neoplatonist philosopher Boethius (ca. 480–524) had stressed the importance of the four that were concerned with mathematics: arithmetic, geometry, music, and astronomy. He had named them the *quadrivium*—four roads. Throughout the Middle Ages these systems remained the basis for learning.

The teaching sources for the seven liberal arts were Roman encyclopedic renditions of Greek works. Materials for teaching science-related subjects were particularly scarce. Chief among them was Pliny's multivolume *Natural History*, with its jumble of secondhand information, covering everything from herbal cures to astronomy (**C24**). More important as a source of medieval knowledge was the work of Boethius. In addressing himself to the quadrivium, Boethius attempted to translate all of the manuscripts of Plato and Aristotle into Latin. Although he apparently translated the logical works of Aristotle, these translations were lost and only his renditions of the less important works remained (**C69** 193–202). Finally, the encyclopedist Isidore of Seville (ca. 560–636) gathered and transmitted a wide range of classical writings, although the contradictions in his work hint that he did not understand much of what he copied (**C69** 212–223).

By the late eighth century the doldrums of the early Middle Ages had begun to be disturbed. No longer were scholars so obsessed with thoughts of salvation that they rejected information about natural phenomena. Charlemagne (742–814) brought scholars to his court to establish schools connected with the cathedrals. The inhabitants of monasteries became increasingly interested in the preservation and copying of manuscripts. Yet they had very little to copy. The important Greek manuscripts were no longer available. For lack of material and methodology, the movement stagnated.

If creative science was nearly nonexistent in the West at this time, technology was advancing. Working independently of the scholars, medieval innovators improved upon or invented many new devices, such as wheelbarrows, horse collars, improved ploughs, horse stirrups, and the magnetic compass, many of which required a sophisticated metals technology. Medicine, architecture, and engineering also made progress. In Italy medical schools of note developed and the study of anatomy gained in importance. Architectural and engineering expertise literally soared to new heights in the Gothic cathedrals (**D28**).

Although the two enterprises were independent, as technology advanced the germs of a new intellectualism began to sprout. In the eleventh and twelfth centuries groups of students and teachers sprang up around the cathedral schools. They studied the available books, examined arguments, and engaged in heated debates. As the cathedral schools developed into universities, a receptacle for knowledge became available. All that was missing was the methodology and the works themselves, and scholars seemed to be on the brink of developing the former (**D21**).

The possible results of the evolving intellectualism will never be known, for an outside event changed its course abruptly. In 1085 Toledo was captured from the Arabs by Alfonso VI of Castille. The appearance of learning in western Europe was thereby totally changed. No longer were Western scholars isolated from the Greek works that had been translated into Arabic. The intellectually starved Europeans leaped upon the Arabic translations of the Greek texts and began feverishly to translate them into Latin. Books on religion, politics, law, ethics, literature, and of course science, were rediscovered; by 1261 most of Aristotle's works, including the *Organon* (the vital treatise on methodology and logic), were available in Latin. Scholars could now digest their contents, criticize their views, and eventually create their own interpretations (**D1**).

The participation of women in the science of the time reflected their general status in society. For the landowning classes this status was defined in part through the twin influences of chivalry and courtly love—the codes of behavior for the knight on the battlefield and for men and women in their relationships with each other and with their social institutions. The ways in which this courtly code was implemented varied with time, place, and circumstances. The position of women in the early Middle Ages differed from their position in the later; married women were treated differently from single women, rich women differently from poor, and Italian women differently from those of France or England or Germany (**D9**). In general it can be said that the chivalric system, together