existed or if these accounts were simply humorous and plausible fictions. Nevertheless, such stories provide a tantalizing look at one role the figure of the alchemist played in Islamic popular culture. Unfortunately, we have precious few surviving sources—or at least few that are currently known and available—that can tell us much more about this important point in the history of alchemy. We will have to wait until we reach early modern Europe—where sources are more plentiful—to explore that particular topic.

Another insight into the actual lives of alchemists in the Islamic world occurs much later, in a sixteenth-century work by Leo Africanus, a freed slave and Christian convert sent by Pope Leo X to compile a descriptive account of Northern Africa. Leo gives a highly unflattering account of the many alchemists who inhabited the Moroccan city of Fez. They stink of sulfur, and assemble nightly at the chief mosque to debate their processes. Some among them seek the elixir using the works of Jābir, while others seek ways to extend precious metals. "But their chiefest drift is to coin counterfeit money, for which cause you shall see most of them in Fez with their hands cut off."[55] (Leo does not explain exactly how they could persist in practicing alchemy without hands.) Charges of forgery and counterfeiting would continue to vex alchemists in both Muslim and Christian worlds.

Alchemy continued to flourish in the Arabic world long after al-Rāzī and ibn-Sīnā.[56] The historian of alchemy E. J. Holmyard was taken to see a working subterranean alchemical laboratory outside Fez in the 1950s.[57] (Such places continue to exist in Europe and North America as well.) Moreover, I have heard anecdotally from colleagues of their meeting Muslim alchemists still at work on transmutation even today in Egypt and Iran. But having now sampled the theoretical and material sophistication that alchemy acquired in the Islamic world, it is time to move on to alchemy's third cultural context. By the twelfth century, the Dār al-Islām, or Abode of Islam, shared borders with another civilization in three places—Palestine, Sicily, and Spain—and that other culture, Western Christianity, had begun a process of vigorous growth and renewal. Latin Europe was ready to discover, within the vast intellectual wealth of Islam, the golden promises of *al-kīmiyā'*.

THREE

MATURITY

Medieval Latin *Alchemia*

While the origins of Greco-Egyptian *chemeia* and the beginnings of Arabic *al-kīmiyā'* remain cloudy, the entry of alchemy into the European Middle Ages is not—or at least seems not to be. Alchemy, we are told, arrived in Latin Europe on a Friday, the eleventh of February, 1144. That was the day that Robert of Chester, an English monk at work in Spain, completed his translation from Arabic of a book often given the title *De compositione alchemiae* (*On the Composition of Alchemy*). In his prologue, Robert explains that he chose to translate an alchemical text "because our Latin world does not yet know what alchemy is and what its composition is."[1] That situation would soon change, for Robert's Latin world quickly got to know alchemy very well. Transplanted into its third cultural context, alchemy flourished in Europe for nearly six hundred years. It deeply tinctured European culture and thought and made substantial contributions to the foundations of modern science as we know it.

Robert of Chester's translating work was not done in a vacuum. He was living in one of the most intellectually active and exciting periods of

European history—an era often called the "Renaissance of the Twelfth Century."[2] All across Europe, new ideas emerged and flourished. The building of the great cathedrals in a new architectural style—later to be (dismissively) called Gothic—had begun. Reforms in law and advances in agriculture joined new styles of literature and music. Under the protective aegis of the church, cathedral schools prospered and a new institution that would change all of intellectual history began to emerge: the university.

Europe was expanding not only its intellectual and artistic frontiers but its geographic ones as well. To the east, west, and south, Christian Europe had begun to push back against Muslim advances made over three hundred years earlier. Once in closer contact with Islamic civilization, especially in Spain (where the Iberian Peninsula was divided between Christian and Muslim rule), Latin Europeans were awed and undoubtedly a little ashamed by what they found. Among their many discoveries were libraries holding volume after volume of books by revered ancients—such as Aristotle, Galen, and Ptolemy—of which they had previously possessed only fragments or digests. Upon those ancient foundations, Muslim scholars had made their own considerable advances, providing Europeans with a wealth of additional knowledge and ideas in astronomy, medicine, mathematics, physics, mechanics, botany, engineering, and fields completely new to Europe—such as *al-kīmiyā'*. In the twelfth century, Europe not only accepted these new ideas but hungered for them. Scholars trekked west across the Pyrenees to Spain, or south to Sicily, or (much less frequently) east to the crusaders' recently founded Latin Kingdom of Jerusalem to learn Arabic and to translate, sending Arabic knowledge as well as recovered ancient Greek knowledge back to the Latin world as fast as they could. Robert of Chester and his companion Herman of Carinthia (also known as Herman the Dalmatian) were among the translators who journeyed to Spain.

Amusingly enough, it is Morienus the monk who reappears as the flag bearer of alchemy's transmission to Latin Europe. Robert's *De compositione alchemiae* is a translation of the supposed instructions of Morienus (aka Marianos) to Khālid ibn-Yazīd for making the Philosophers' Stone. Here Robert uses his newly coined Latin word *alchemia* (which he calls "unknown and surprising") to mean not the whole subject but rather just the Philosophers' Stone itself—"a material substance compounded out of one thing . . . naturally converting substances into better ones."[3]

Other translations of Arabic alchemical works followed soon after—Jābir, Balīnūs, al-Rāzī, and ibn-Sīnā, among others—and the word would quickly come to refer to the entire discipline, as its cognates had done in Greek and Arabic.[4]

The Recipe Literature in Europe

Although a developed science of alchemy was new to Europe, metallurgical and productive processes were already well established there. European craftsmen and artisans possessed a range of practical know-how for the production of a variety of substances—alloys, pigments, dyes, techniques for metalworking, and so forth. Several early medieval manuscripts record this knowledge. They perpetuate the ancient recipe literature tradition to which the Greco-Egyptian Stockholm and Leiden Papyri and the *Physika kai mystika* of pseudo-Democritus belong. In fact, an Italian text called *Compositiones variae* (*Various Compositions*) and probably dating from around 800 actually contains a word-for-word Latin version of one of the recipes recorded in the Leiden Papyrus. This compilation, as well as the slightly later and more extensive *Mappae clavicula* (*Little Key to the World*), indicates how workshop recipes and practices were handed down for centuries.

While these written texts testify to a transmission of knowledge—in these cases mostly through Byzantium—the texts themselves are predominantly literary compositions. That is to say, the *Compositiones* and *Mappae* were not handbooks for craftsmen; an artisan would not have kept one of them in his workshop as a handy reference guide. These texts were compiled from a variety of sources by scribes who scarcely if ever set foot in a medieval *laboratorium* (workshop), and almost certainly never applied their ink-stained fingers to the artisanal crafts described.[5] Thus, they contain recipes of widely diverse date and origin, quite a few of them garbled by the scribes' unfamiliarity with the techniques and terminology.

One exception to this generalization is the most famous of craft books: *On Diverse Arts* (*De diversis artibus*), written about 1125 by a monk calling himself Theophilus. It describes a wide variety of substances and technical details useful to monastic craftsmen for making pigments, glass, cast metal objects, and alloys.[6] Most of its recipes are so clearly described that they can be replicated fairly readily today. This implies that Theophilus

himself had firsthand knowledge of the operations and processes he describes. Yet amid his otherwise perfectly straightforward processes, there exists a curious recipe that may mark one early percolation of Arabic alchemy into Latin Europe before Robert of Chester's translating activity. Amid descriptions of various kinds of gold, Theophilus includes a recipe for "Spanish gold . . . compounded from red copper, basilisk powder, human blood, and vinegar."[7] Copper, vinegar, and human blood are easy to obtain (although the last perhaps rather unpleasantly), but basilisk powder was probably not readily available in the average monastic workshop, not even in the back of the cupboard. Readers who know their bestiaries (or their *Harry Potter*) will recognize the basilisk as a hideously deadly reptile able to kill with its glance alone. But Theophilus explains that the "gentiles" (that is, Muslims) have commendable skill in making basilisks. They lock up two old roosters in a narrow place and overfeed them until they copulate and lay eggs. The eggs are given to toads, who hatch them into chicks that soon grow serpents' tails and mature into basilisks. The basilisks are raised underground in kettles and later incinerated, their ashes mixed with vinegar and blood, and the paste smeared onto plates of copper. Exposure to fire then turns this copper into fine gold.

What we may be seeing here is a garbled alchemical allegory being taken literally. Perhaps Theophilus included the process on account of its exotic nature—it's doubtful that either he or any of his readers were tempted to try it for themselves. Remarkably, historians of science have recently found a similar recipe for basilisks and the use of their ashes for making gold—possibly translated from some part of the Jābirian corpus—in a Sicilian manuscript, and have even outlined a plausible transmission route between that manuscript and the author of *On Diverse Arts*.[8]

The Emergence of Latin Alchemy and "Geber"

The translation of Arabic alchemical works dwindled to a trickle within a hundred years, around the middle of the thirteenth century. By that time, Latin authors had begun writing their own books on *alchemia*.[9] Centuries earlier, when alchemy was appropriated from the Byzantine world by the Arabs, the first original Arabic compositions appeared under Greek pseudonyms. Now in Europe, an analogous situation prevailed: many of the earliest Latin authors wrote their books under *Arabic* pseudonyms. In both cases, pseudonymous authorship was intended to give books greater authority by making them seem older, more venerable, and part of a culture recognized as more advanced. To add to the sense of déjà vu, the most influential of these thirteenth-century Latin alchemical compositions appeared under a very familiar name, that of Jābir, rendered in medieval Latin spelling as Geber. Thus, the "Jābir problem" discussed in the previous chapter had yet another dimension: whether the Latin books known under the name of Geber were translations of Jābir, or whether they were native Latin productions. Historians of science argued vociferously over whether Geber was really Jābir. Recent scholarship has settled the issue: he was not. Geber was a late thirteenth-century Latin author.

Many writers continue to confuse the two today, and a stubborn few continue to battle in favor of an Arabic identity for Geber. Geber himself did not make settling the issue easy. He cites no sources by name which might allow us to date or place him. He adopts the initiatic style typical of the Jābirian corpus (but only at the very beginning and end of his book) and rewrites sections of Jābir's *Seventy Books* to include in his own treatise. He even peppers his text with what seem to be characteristically Arabic grammatical constructions and expressions translated into Latin.

The author concealed behind the pseudonym of Geber is probably an Italian Franciscan friar and lecturer named Paul of Taranto.[10] Paul wrote a nearly contemporaneous alchemical text that bears a striking similarity in style and content to "Geber"'s. Although Paul's writings draw heavily from Arabic sources, particularly from Jābir and from al-Rāzī's *Book of Secrets* (*Kitāb al-asrār*, translated into Latin as *Liber secretorum*), they also show striking originality and a detailed familiarity with practical alchemical processes. His *Theory and Practice* (*Theorica et practica*) classifies mineral and chemical substances much like al-Rāzī did, but shows more interest in describing and categorizing substances based on their observable chemical and physical properties. Undeniably, Paul's works display the results of extensive practical testing and experimentation, and a level of rigor and theoretical synthesis rarely found in Arabic sources. This difference may come from the Christian West's taking more seriously Aristotle's charge to discover the true natural causes of things than was widely the case in the Islamic world. Typical of Paul's work is a desire to harmonize theory and practice at a deep level by

developing a rigorous physical underpinning that could explain observed phenomena coherently.

Such ideas are more fully expressed in the *Summa perfectionis* (*The Sum of Perfection*). In the Middle Ages, the Latin word *summa* commonly referred to an exhaustive "textbook" of one or more subjects, as in St. Thomas Aquinas's *Summa theologica*. Accordingly, the *Summa perfectionis* is a comprehensive text about alchemy. It begins with arguments for and against the possibility of chrysopoeia (deciding in favor of it), and continues with a detailed summary of the state of knowledge about metals and minerals, including methods for purifying and working with them. Thereafter follow sections addressing practical operations and apparatus, while the last section provides a fascinating examination of the nature and properties of the metals and an account of the different grades of transmuting agents. The book concludes with an account of assaying, that is, how to determine the purity of precious metals—a necessary skill if the alchemist is to test the quality of the gold and silver he hopes to produce. The *Summa* became one of the most influential alchemical books of the Middle Ages and remained an authoritative text until the seventeenth century.

According to Geber, the alchemist may carry out his art using "medicines" (by which he simply means chemical agents) having three degrees of strength. The least potent changes only the superficial appearance of the base metal, making it merely look like gold or silver. Geber provides several practical tests using fire and corrosives to demonstrate that true transmutation has not occurred. Only the most potent medicine, that of the "third order," can truly transmute, and it exists in two forms—one for making silver and the other for making gold. This threefold division is one thing Geber borrows from Jābir.[11] What he does not adopt, however, is Jābir's idea that animal and vegetable substances could be used to make transmuting elixirs—for Geber, as most European alchemists would eventually agree, the Philosophers' Stone must be made from mineral substances only.[12]

More strikingly, the *Summa* incorporates a coherent matter theory that explains laboratory observations and undergirds methods of transmutation. This theory is based on two earlier ideas: the Arabic Mercury-Sulfur theory of the metals, and an idea out of Aristotle. Although the Greek philosopher explicitly denied the existence of indivisible atoms, in two places in his writings he made comments that could be interpreted

to suggest, or at least support, a theory of matter based in the existence of tiny particles of some sort. In one passage, he claims that there was a lower limit of size that any piece of a substance could have and still maintain its identity. A lump of gold, repeatedly divided in half, would eventually become so small that one further cut would no longer result in two smaller pieces of gold; the particle would have become too small to support the properties of gold. These tiniest pieces of a substance came to be called in Latin *minima naturalia* (the smallest natural things). But more important for Geber—and in fact for all alchemists—was the fourth book of the *Meteors*, where Aristotle (or perhaps a follower of his) consistently invokes the idea of "parts" (*onkoi*) and "pores" (*poroi*) that exist within seemingly solid substances. These parts and pores are used to explain a wide range of observations, phenomena, and physical properties.[13]

Geber draws on these ideas, especially the latter, and combines them with the Mercury-Sulfur theory. According to the *Summa*, the metals are produced from the coalescence of minute "parts" of the metallic principles Mercury and Sulfur. In different metals, these minute parts are of different sizes, and in the case of base metals, they are intermingled with earthy particles. Although this system bears some resemblance to an atomic theory, Geber's system is not truly atomic, because the "tiniest parts" (*minimae partes*) he describes are neither indivisible nor permanent.

But Geber does use this system to explain an array of physical properties and chemical changes. Take for example the fact that a piece of gold is far heavier than an equally sized piece of tin; in modern terms, gold has a much higher density. Geber explains this observation based upon the way the constituent particles of Mercury and Sulfur are packed. In gold, they are very small and packed as tightly together as they can be—in what he calls "the strongest putting-together" (*fortissima compositio*)—while in tin they are larger and poorly packed. A piece of gold thus contains more matter, leaving less space between the constituent parts than in an equal volume of tin; thus, the gold weighs more.[14] Geber explains gold's stability with the same theory: because its constituent parts are so tiny and so tightly packed together, no pores or crannies are left open whereby fire or corrosives can attack and penetrate the metal to break it apart. A base metal such as lead, however, is badly "put together" (*compositum*), so when it is roasted on the fire, the fire can enter the pores of the metal and break it down into a powder. (What Geber describes

here is the process of oxidizing lead into powdery lead oxide by means of roasting.)

The same theory also explains chemical operations. Sublimation—the purification of a volatile material by converting it from a solid into a vapor and then recondensing the vapor into a solid—occurs with substances whose particles are not held tightly together. The heat of the fire causes the tiny parts to dissociate from one another; the smallest particles, which Geber considers the purest, rise up as a fume, away from the larger and heavier ones, which are left behind unsublimed as dross at the bottom of the vessel.[15] Although only some subsequent alchemists followed Geber's ideas, his theory would persist and develop as one important thread among the various theoretical traditions of European alchemy.

Alchemy Becomes Controversial

A modern reader of the *Summa* might not realize that the book was written amid a century's worth of intense controversy over the promises and aims of alchemy. At the center of this controversy was that polemical text written against chrysopoeia by ibn-Sīnā almost two centuries earlier and half a world away. Around 1200, an English translator named Alfred of Sareshal rendered that section of ibn-Sīnā's mineralogical text into Latin as *De congelatione et conglutinatione lapidum* (*On the Congelation and Gluing-Together of Stones*). Alfred's translation of this short text ended up being placed in manuscripts at the end of a translation of Aristotle's *Meteors*; pairing the two works made sense, since both deal with the origin of minerals. But, perhaps due to a hasty copyist who did not separate the two texts clearly, many readers thought that ibn-Sīnā's words were part of Aristotle's text. Given the enormous esteem that Aristotle had acquired by the thirteenth century, this mistake greatly enhanced the power of ibn-Sīnā's ideas—for both good and ill. On the one hand, the first part of ibn-Sīnā's text helped establish the Mercury-Sulfur theory of metals firmly in Latin Europe. On the other hand, the closing section presented a powerful rebuff to aspiring transmuters. Thus, Latin Europe heard the declaration that "art is weaker than nature and cannot follow her no matter how much it tries; let the practitioners of alchemy know that the species of metals cannot be transmuted," in what seemed to be the authoritative voice of Aristotle himself.[16]

Responses came swiftly. An early thirteenth-century work titled the *Book of Hermes* refuted *De congelatione* point by point using both logical analysis and practical experience. Its author pointed out that alchemists could in fact make some substances (like salts) that are identical to naturally occurring ones.[17] St. Albert the Great (circa 1200–1280), known as the Universal Doctor because of his broad learning and wide influence, likewise dissented when he wrote his own study of minerals.[18] Albert's most famous student, St. Thomas Aquinas (circa 1225–1274), took *De congelatione* a little more to heart. St. Thomas echoed its words in saying that alchemists can produce only the *appearance* of natural things; their gold is not true gold, nor are the other things they produce the same as natural products, even if they display all the same properties. Nevertheless, St. Thomas elsewhere allows that *if* alchemists are able to harness the powers of nature and use them to produce gold in the same way that nature does, then that gold would be true gold, and could be legitimately sold and used as such.[19] The critical factor lies in the precise method alchemists use—but could alchemists really identify and utilize nature's own means? One of St. Thomas's followers, Giles of Rome (circa 1243–1316), went further. He recognized that *De congelatione* was not Aristotle's but ibn-Sīnā's (as Albert himself had suspected), yet he still used its arguments to declare that no matter how many tests alchemical gold passes, and even if no sensible difference between it and natural gold can be detected, it is still not the same thing as gold from the earth. If alchemy can make gold, he concludes, "it ought not be used as money, because gold and such metals are sometimes used in medicines and other things serviceable to the human body. If therefore such gold were alchemical, it might greatly harm the human complexion."[20]

Some contemporaneous alchemical authors agreed that artificially produced metals show subtle differences from the natural ones. The *Little Book of Alchemy* (*Libellus de alchimia*) attributed to St. Albert the Great claims intriguingly that alchemical metals are "equivalent to all natural ones for all purposes," with the odd exceptions that alchemical iron is not attracted by magnets; alchemical gold lacks medicinal properties; and wounds made by alchemical gold fester while those made by natural gold do not. In the *Book of Minerals*, St. Albert reports, "I have had tests made on some alchemical gold, and likewise silver, that came into my possession, and it endured six or seven firings, but then, all at once, on further firing, it was consumed and lost and reduced into a sort

of dross."[21] One wonders what sort of a substance the Universal Doctor had acquired, and from whom!

Giles of Rome reveals a concern that should sound familiar to modern readers. He is worried about hidden properties and unknown effects. Even if alchemically produced gold conforms in every way to natural gold's properties—in color, density, softness, resistance to corrosion, and so forth—there still might be *something* we do not know about, *something* we cannot foresee, do not think to look for, or cannot detect. Giles bases his thinking on the axiom enunciated by ibn-Sīnā that "art is weaker than nature": the creative and productive activity of human beings simply *cannot* reproduce natural things. Nothing artificially produced can equal what is naturally produced. Such thinking remains very much alive today in the notion that synthetic diamonds are not "real" diamonds, and in concerns that bioengineered crops might have hidden noxious properties. Thus, some issues raised about medieval alchemy regarding technology and the relation between the natural and the artificial remain unresolved today.[22]

The partisans of alchemy did not take these attacks lying down. Indeed, it has been argued that their heated defense of the Noble Art and its power to imitate nature represents the first sustained salvo in favor of the power of human ingenuity and technology. One of the loudest voices raised on behalf of alchemy was that of the Franciscan friar Roger Bacon (circa 1214–1294). In 1266–67, he wrote three books at the request of a friend who, in the meantime, had become Pope Clement IV. These writings contain vigorous arguments favoring the study of languages, mathematics, natural philosophy, and alchemy as a means to reform knowledge and strengthen Christendom. In terms of alchemy, Bacon does not merely oppose the notion that art is weaker than nature—he turns it on its head. Human artifice is *not* weaker than nature; it is *stronger*. Alchemically produced gold is *better* than natural gold. Bacon asserts that the same is true of all laboratory products when properly made. Human copies of naturally occurring substances can be made superior to what nature provides.[23] This kind of thinking also endures today; it undergirds modern chemistry. Organic chemists work diligently (and successfully) toward the synthetic production of naturally occurring substances by quicker, more efficient means or with slight structural changes that make them better pharmaceuticals by increasing their medicinal effects or decreasing their toxicity.

Arguments about the power of alchemy to produce the equivalent of natural substances—gold or otherwise—eventually rose to the highest levels of power. It is reported that Pope John XXII convened a debate where the two sides squared off against each other.[24] We have no direct testimony of what happened at this debate, but if such a forum really took place, the papal decretal John XXII issued in 1317 suggests that the pro-alchemy party must not have defended its cause very well, for it begins thus:

> The impoverished alchemists promise riches that they do not deliver, and they who think themselves wise fall into the ditch they have dug. For indeed the professors of this art of alchemy make fools of one another.[25]

The decretal goes on to say that when the alchemists repeatedly fail in making gold, "in the end they feign true gold and silver with a false transmutation," since the possibility of a real transmutation into gold and silver "does not exist in the nature of things."[26] Then they counterfeit coins and pass them off on honest people. In punishment, the decree stipulates, anyone selling or using alchemical metal as if it were natural gold or silver is sentenced to surrender an equal weight of true gold or silver to the public treasury for distribution to the poor.

Although the pope apparently was not convinced that true gold could be made artificially, his statement was not so much a condemnation of alchemy per se as of counterfeiting. It contains no theoretical or practical arguments against chrysopoeia, only concerns about coinage and fraud. Unfortunately for the alchemists, their art was rarely far from such criminal practices in the public mind. The kings of France and England issued similar regulations banning the practice of transmutational alchemy, as did the ruling council of the Republic of Venice.[27] In all these cases, the fundamental concern was to maintain the purity and value of the precious metals upon which economies rested—the same concern that may have motivated Diocletian a thousand years earlier to command that the books of the Egyptians be burned. In fact, whether chrysopoeia could make real gold or only a good imitation thereof, it remained a perilous practice in terms of economic and political stability. If the gold was false, it would debase and pollute the gold supply, and if true, it would lower the value of gold by increasing the amount available. Similar thoughts led the Arab historian ibn-Khaldūn in 1376 to argue against the

possibility of chrysopoeia on the grounds that if true, it would foil God's plan for maintaining economic stability in the world—namely, His divinely wise choice to create only a limited quantity of gold and silver.[28] Lawyers continued to debate the licitness of alchemy and the legality of its products from the Middle Ages until the eighteenth century.[29]

As with most papal proclamations then as now, John XXII's decree was largely ignored. Alchemists, including many in Holy Orders, continued to work and write. In England, the allure of a domestic supply of gold was too powerful. Henry IV's 1404 statute against gold making was soon modified, in a very English way, by the awarding of licenses from the Crown to practice alchemy, on the condition that the precious metals produced were to be sold directly to the Royal Mint.[30]

Alchemists themselves reacted to the climate of dissension and concern that came to a climax in the fourteenth century. Yet tracing precise lines of influence is difficult, and modern scholars are still striving to obtain a better understanding of fourteenth-century alchemy. Nevertheless, several changes are evident, and two of them can be reasonably (if not yet rigorously) traced to the atmosphere of greater criticism: enhanced secrecy and the construction of linkages between alchemy and Christian theology.

Secrecy and Theology in Latin Alchemy

As far back as Zosimos, alchemical texts carried injunctions to secrecy and deployed various methods of preserving it, such as the use of *Decknamen* and their extension into allegories. Originating in the protection of trade secrets, this tendency was enhanced in the Jābirian writings by alchemy's connection to a secretive and esoteric Shi'ite sect, and by the addition of the dispersion of knowledge technique, which may have served primarily to cloak the multiple authorship of the corpus. Al-Fārābī (died 950), a younger contemporary of al-Rāzī, wrote a work justifying alchemical secrecy on the grounds that unrestricted knowledge of gold making would destroy economies—a common fear throughout most of alchemy's history.[31] In contrast, early European alchemy, such as that described in the *Summa perfectionis*, is remarkably free from overt secrecy, even if Geber mimicked the initiatic style of Jābir at the start of his book. Another sign of alchemy's initial move toward openness in Europe is that the subject began to be incorporated into the curriculum

of the new medieval universities.[32] With the advent of controversy and criticism, increased public and official scrutiny, and legal sanctions, however, Latin alchemy retrenched and withdrew, becoming more secretive, more encoded, more allusive, and consequently more elusive.

This increased secrecy manifested itself partly in a renewed spate of pseudonymous works. Thus, even though the real St. Thomas Aquinas was ambivalent or skeptical about alchemy, in the fourteenth century (well after the Angelic Doctor's death) an allegorical work called *The Rising Dawn* (*Aurora consurgens*) was circulated under his name. New alchemical books were likewise written under the names of revered (and safely dead) figures like Albert the Great, Roger Bacon, Catalan philosopher Ramon Lull, and a host of others—including, amusingly enough, even ibn-Sīnā, whose denial of chrysopoeia had ignited so much controversy in the first place. (In fact, even the Persian's most anti-chrysopoetic sentence would wind up rephrased and attributed to pro-chrysopoetic authors as a "hint" about how to make the Philosophers' Stone!) Pseudonymity both legitimated these writings by attaching them to celebrated names and provided anonymity for their true authors.

Similar motives of legitimation lay, in part, behind the new connections between alchemy and Christianity that were forged at about the same time. The writings of John of Rupescissa and those attributed to Arnald of Villanova provide the best illustrations.

John of Rupescissa (or Jean de Roquetaillade) was born about 1310 in the Auvergne, in central France; he attended the University of Toulouse and then became a Franciscan friar.[33] In doing so he was influenced by the ideas of a branch of the order known as the Spirituals, who opposed the increasing institutionalization of the Franciscan order as it grew, claiming that it had abandoned the ideals and rule of its founder, St. Francis of Assisi (1181/2–1226). The Spirituals, who saw themselves as the true followers of St. Francis, embraced radical poverty and fiercely criticized church hierarchy and the more mainstream Conventual Franciscans. The Spirituals were also caught up in apocalyptic fervor and a fondness for prophecies, believing that the Antichrist was about to appear.

Ecclesiastical authorities viewed the Spiritual Franciscans with distrust and discomfort, and eventually suppressed them.[34] John himself was arrested in 1344 and spent the rest of his life in a series of prisons. While incarcerated he wrote most of his books (both alchemical and prophetic) and received inquiries from numerous visitors, including

high-ranking clerics. Although John's works do describe various sufferings in prison, apparently his confinement was intended not to silence him (otherwise he would not have had access to parchment, ink, and books) but rather to keep a close eye on a potentially troublesome self-styled "prophet." John of Rupescissa's alchemical writings must have been extremely widely circulated and copied in their day, for they are among the most common manuscripts about the subject that survive from the fourteenth and fifteenth centuries.

It might seem incongruous that a man so fervently committed to the ideal of poverty would also devote himself to finding the secret of making gold. Yet at the start of his *Book of Light* (*Liber lucis*), written about 1350, John states clearly why he studied chrysopoeia and why he decided to write about it.

> I considered the coming times predicted by Christ in the Gospels, namely, of the tribulations in the time of the Antichrist, under which the Roman Church shall be tormented and have all her worldly riches despoiled by tyrants. . . . Thus for the sake of liberating the chosen people of God, to whom it is granted to know the ministry of God and the magisterium of truth, I wish to speak of the work of the great Philosophers' Stone without lofty speech. My intention is to be helpful to the good of the holy Roman Church and briefly to explain the whole truth about the Stone.[35]

True to his Spiritual Franciscan views, John says that the tribulation of the Antichrist is at hand, and that the church will need every form of help to withstand it; that help includes alchemy. John was not the only Franciscan who thought this way. The same concern about the coming of the Antichrist lay behind much of what Roger Bacon—also a Franciscan friar—wrote to the pope about sixty years earlier: the church will need mathematical, scientific, technological, medical, and other knowledge to resist and survive the assault of the Antichrist. We are well familiar with the use of science and technology for national security; in the case of John and Roger, we find a medieval precedent that includes alchemy as a means of ecclesiastical security.

John provides a detailed recipe for making the Philosophers' Stone. He holds that it is to be made from a specially purified mercury and a "Philosophical Sulphur." The idea that the stone, like the metals, is composed of Mercury and Sulfur would become a standard notion in European alchemy. The only problem lies in the intentional ambiguity of the names Mercury and Sulfur, both of which, acting as *Decknamen*, might conceivably refer to almost anything. But John is explicit that for him, the Mercury is common mercury carefully freed of its impurities, and the Sulfur is found within "Roman vitriol" (iron sulfate).

John first describes a series of sublimations of mercury with vitriol and saltpeter, followed by various digestions and distillations. Despite the apparently clear directions, however, his first step will not work in a modern laboratory if followed verbatim. The sublimate "white as snow" that John describes making is undoubtedly mercuric chloride; therefore, the starting mixture *must* have included common salt, but this substance is not mentioned in the list of ingredients. There are two possible explanations. First, John's saltpeter might have been quite impure and contained a large quantity of common salt. In fact, his *De confectione* contains an annotation toward the end that notes how crude saltpeter ordinarily contains salt, and gives a method for purifying it by fractional crystallization. The second possibility is that John intentionally left out the crucial ingredient as a way of preserving secrecy. If this is the case, then it is significant that the end of *De confectione* includes a rather out-of-place paragraph describing the general importance of table salt (*sal cibi*, or "salt of food"), its ubiquity, its use in purifying metals, and so forth, and then states that "the whole secret is in salt." Is this an example of the dispersion of knowledge?[36] Whichever of these two explanations is correct, the historical message is the same: alchemical recipes have to be read with care. Those that seem unworkable need not reflect negatively on the author's abilities or veracity, but might rather indicate a "hidden ingredient"—either something present as an unsuspected impurity or something artfully omitted from the recipe.[37]

Once the need to include salt at the beginning is realized, a modern chemist can follow John's procedure quite far, and in fact should be impressed by the level of technical skill and practical knowledge he must have possessed. For example, John uses the concept of "mass balance"—the weight of the products of a reaction must exactly equal the weight of the starting materials—to prove that the "invisible Philosophical Sulphur" he wants to extract from Roman vitriol has in fact combined with the mercury.

> The sign that the spirit of the vitriol is incorporated with the mercury is this: if you put in one pound of mercury you will still get the same amount back [as a sublimate], despite the fact that in being sublimed the mercury leaves behind many earthy dregs. This result would be impossible unless the mercury, whiter than snow [as a sublimate], had carried up with itself the purest spirit of the aforesaid vitriol, which is the invisible Sulphur.[38]

In other words, since the mercury loses the weight of its "dregs," it should weigh less than a pound as a sublimate, but the fact that it still weighs a whole pound means that the lost weight has been compensated by picking up the "invisible Sulphur" that John is striving to obtain. Thus, John makes use of the quantitative test of comparative weights to monitor and follow a substance that is otherwise "invisible" because it is never isolable, only transferred from one substance to another. Such close observation and monitoring of the weights of materials indicate a degree of clearheadedness and care in the laboratory that is often not attributed to alchemists. Given that modern chemistry recognizes that the transmutation of base metals into gold is not possible by chemical means, it has often been too easy to dismiss virtually everything the alchemists did and wrote in their pursuit of that goal. Nonetheless, the more that historians of science inspect alchemical writings carefully and contextually, the more impressive many of these writings become from a scientific and an experimental standpoint.

At a certain point, however, the results John describes no longer correspond to what modern chemistry would predict. The same situation is often encountered when reading alchemical procedures. Sometimes it marks a boundary where the author moves silently from something he has actually performed to something he predicts *should* happen. In other cases, it means that a necessary ingredient or operation has been silently omitted, or that we are not recognizing and interpreting an allegory or *Deckname* properly. There is also the possibility that the author's ingredients had a different composition from our modern equivalents, and so gave results we could not predict. (Chapter 6 addresses this issue further by exploring and exposing the chemistry hidden within early modern alchemical recipes.)

At each stage of his procedure, John references another alchemical author, Arnald of Villanova. The real Arnald of Villanova was a Catalan physician who was born about 1240 and died in 1311. Like John of

Rupescissa and Roger Bacon, Arnald had ties to the Spiritual Franciscans (although he was not a friar himself), and around 1290 wrote a book about the advent of the Antichrist that brought him into conflict with the theology faculty at the University of Paris, who took a very dim view of such prophetic utterances as opposed to their own rational Scholastic theology. Although many alchemical writings are attributed to Arnald, it is very unlikely that he wrote any of them. Some do show attributes of Franciscan spirituality, and some are similar in their approach and use of scripture to Arnald's own theological and medical writings—thus, his name was a reasonable choice to attach to them.[39] These pseudo-Arnaldian writings appeared throughout the 1300s, but only one of them certainly predates John of Rupescissa's work, namely, the *Tractatus parabolicus* (*Metaphorical Treatise*), which John cites by name in his *Book of Light*. This book forges a special connection between alchemy and Christian theology.[40]

The pseudo-Arnald holds, like John, that the Philosophers' Stone is to be prepared starting with mercury. But rather than providing the clear recipes that John does, pseudo-Arnald devotes his book to a comparison of the alchemical treatment of mercury to the life of Christ: "Christ was the example of all things, and our elixir can be understood according to the conception, generation, nativity, and passion of Christ, and can be compared to Christ in regard to the sayings of the prophets."[41] For Arnald, quotations from Old Testament prophets bear witness not only to Jesus Christ as the Messiah but also to mercury as the correct starting material for the stone. Just as Christ bore his torment in four stages—scourging, crowning with thorns, crucifixion, and thirst on the cross—so too must the mercury undergo a fourfold "torment" to be prepared into the stone. Just as Christ was glorified after His tribulation, so mercury is "glorified" by being turned into the stone. As the sufferings of Christ and His glorious Resurrection bring salvation and healing to the fallen world, so too the final chemical transformation of mercury into the Philosophers' Stone brings "healing" to the base metals, converting them into gold. There is probably also a silent comparison here with the Spiritual Franciscan view that the coming tribulations of the Antichrist will prepare the way for the establishment of a new age of peace.

Arnald's comparisons between Christ and mercury perform two functions. They offer allegorical language akin to *Decknamen*, and they serve to elevate the alchemical art by linking it metaphorically with the central

mysteries of Christianity.[42] The prophets speak not only of the Messiah but also of chrysopoeia. The alchemical art is sanctified by association through the similitudes it bears to the life of Christ. Another early fourteenth-century author, Petrus Bonus of Ferrara, claims that such similitudes can work just as well in the opposite direction: a knowledge of alchemy provides knowledge (and even observable proof) of Christian doctrines. In his 1330 book, the *New Pearl of Great Price* (*Margarita pretiosa novella*), Petrus asserts that a knowledge of alchemy allowed the "ancient [pagan] philosophers" to predict the virgin birth of Christ by means of analogy with the preparation of the Philosophers' Stone. "I believe firmly, that should any unbeliever truly know this divine art, it would of necessity make him a believer in the Trinity of God, and he would believe in Jesus Christ our Lord, the Son of God."[43] The very title of Petrus's book links alchemy to Christ's parable of the merchant in Matthew 13:45–46. These linkages enhance the status of alchemy by transforming it into a kind of *holy* knowledge.

On a larger scale, the formulation of such linkages tells us something crucial about premodern ways of thinking. Specifically, premoderns tended to conceive of and visualize the world in multivalent terms, where each individual thing was connected to many others by webs of analogy and metaphor. This view stands in contrast to the modern tendency to compartmentalize and isolate things and ideas into separate disciplines. This crucial feature holds a key to understanding European alchemy more deeply; it is one focus of chapter 7.

While the pseudo-Arnald's *Tractatus parabolicus* provides the earliest-known extended linkage of alchemy with Christian theology, the two would thereafter remain close in many (but not all) alchemical writings. Crucially, John of Rupescissa makes it perfectly clear that allegorical texts like the *Tractatus* were read and deciphered for *practical* information.

> Master Arnald says that it is necessary to raise up the Son of Man in the air by means of the cross, which in literal terms means that the material that was digested in the third operation, after being ground finely, is put at the bottom of a flask to be dissolved, and the purest and most spirituous of what is there is then turned upwards into the air, and is raised up in the cross of the head of the alembic, like Christ, as Master Arnald says, was raised up on the cross.[44]

Thus, the reference to Christ's elevation on the cross signifies a chemical process of volatilization in which the prepared mercury is "raised up" by means of heat from the bottom of the flask into the "head of the alembic" (the highest part of the heating vessel), where the purified material condenses as a crystalline sublimate. "The Son of Man must ascend from the earth into the air, and ascend upon the cross of the alembic like a crystal."[45]

Medieval Latin puns strengthen these theological connections. The vessel used for subjecting metals to high temperatures and corrosives is still known today as a *crucible*, from the original Latin *crucibulum*, translatable as "little place of torment" and originating from the same Latin root (*cruciare*) as *to crucify*. (Recall that centuries earlier, Zosimos had envisioned his own processes as "tortures" of the metals.) Given the usual repertory of chemical operations involving melting, corroding, grinding, vaporizing, hammering, and burning, it does not require a huge imaginative leap to envision them as "painful torments" of material substances. Accordingly, in explaining the pseudo-Arnald's use of a verse from the gospels (John 12:24), John of Rupescissa writes, "Understand by the 'grain of wheat that must die in the earth' the mercury that must die in the earth of saltpeter and Roman vitriol."[46] Here the verb *die* puns on an alternate name for "mercury"—*argentum vivum*, literally "living silver," so called because the silvery liquid seems in constant motion, as if it were alive. Mercury's "death" thus comes about when it is converted into an unmoving solid, which is exactly what happens when it is ground together with saltpeter and vitriol and "disappears" into the powdery mixture.[47]

Alchemy and Medicine

John of Rupescissa wrote another alchemical work while in prison: *On the Consideration of the Fifth Essence of All Things* (*De consideratione quintae essentiae omnium rerum*). With it, he extended alchemy into a new area—medicine.[48] During the Antichrist's reign, Christians would need not only gold but also their full health. Thus, John recounts how he sought a substance that could prevent corruption and decay and thus preserve the body from illness and premature aging. He found such a substance in the distillate of wine—what he called "burning water" or "water of life,"

and what we call alcohol. The Latin alchemical term for this delightful liquid—*aqua vitae*—lives on in the names of several liquors: the Italian *acquavite*, the French *eau-de-vie*, and the Scandinavian *akvavit*.

John considers this "burning water" the "fifth essence" of the wine, its *quinta essentia* in Latin. (*Quintessence* is a word still used to express the finest, purest, and most concentrated essence of a thing.) John borrows the word from Aristotelian natural philosophy, where it represents a substance different from and greater than the four elements (fire, air, water, and earth), namely, the imperishable and eternal material from which everything beyond the moon, such as the stars and planets, is made. The implication is that this terrestrial quintessence of wine is similarly impervious to decay. While this might sound outlandish, John almost certainly based his belief on empirical evidence—he notes how meat left in the open air quickly begins to rot, but when immersed in alcohol it is preserved indefinitely. He may also have noticed that while wine quickly degrades into vinegar, distilled alcohol remains unchanged. It is this stability and preservative power that John wishes to turn to medicinal use.

John was not the first to distill alcohol from wine; distilled spirits had been recommended medicinally by (the real) Arnald of Villanova. Interestingly enough, John writes that he identified alcohol as his sought-after preservative agent seven years after his imprisonment—in other words in 1351, by which time he had been transferred to the prison at the Papal Court in Avignon, where, it so happens, the distillation of wine for medical purposes had been carried out since the 1320s.[49] It is therefore highly plausible that he discovered and witnessed its properties there for the first time.

Yet John goes much further in his employment of this "water of life" than did earlier authors and practitioners. He describes not only its preparation but also its use for making medicinal tinctures. Some of these he produced by simply soaking herbs in alcohol; here he was quite correct that alcohol often works much better than water in extracting the medicinally active compounds from plant matter. John also goes beyond the usual repertory of herbal remedies used in traditional pharmacology in that he recommends using metals and minerals. Gold had long been believed to have therapeutic properties, especially for strengthening the heart, and John describes its preparation for use in alcoholic medicines. (Our modern word *cordial* for a liqueur derives from gold-based remedies for the heart; *cordialis* is the Latin adjective for things related to the heart, or *cor*.) Mercury, antimony, and other metallic substances were then, as now, generally considered toxic, yet John proposes the production of powerfully medicinal quintessences from them as well.

John of Rupescissa made medicinal preparations a key part of alchemical practice; alchemy (and chemistry) would forever after be closely linked to medicine, for both good and ill.[50] His writings exemplify the two major goals of later European alchemy—transmuting metals and preparing medicines. John believed that these twin aims promised the health and wealth that oppressed Christians would need during the reign of the Antichrist. The allure of both rewards persisted long after concern about the Antichrist's appearance had dwindled away. Similarly, while the use of Christian doctrine as a source of allegory, metaphor, and legitimation began with fourteenth-century alchemy, this dimension also continued to develop in succeeding centuries.[51]

The Pseudo-Lull and the Lost Crusade

John's twin goals of transmutation and medicine became more tightly interwoven over the next generation, when his ideas about the quintessence of wine were widely distributed under someone else's name. Soon after *Consideration of the Fifth Essence* began to circulate, another author—whose identity remains unknown—co-opted large sections of the book, combined them with additional materials, and produced the *Book of the Secrets of Nature or of the Quintessence* (*Liber de secretis naturae seu de quinta essentia*). This new author had more interest in chrysopoeia than in medicine, so for him, extracting quintessences provided a step toward preparing the Philosophers' Stone. Whereas John sought the incorruptible quintessence as a preservative of human health, the new author saw such incorruptibility as the logical starting point for producing a substance that could confer incorruptibility to *metals*, that is, transform corrodible base metals into incorruptible gold. The book circulated under the name of Ramon Lull or Llull (1232–1315), a Catalan theologian and philosopher of the previous century who actually wrote negatively about alchemy. In subsequent years, the list of alchemical works bearing Lull's name grew dramatically. Although the real Ramon Lull wrote none of them, many of these compositions contained enough features resembling his authentic writings that the attribution seemed plausible—and remained largely unquestioned—for centuries.[52]

Pseudo-Lullian writings comprise one of the largest and most influential groups of medieval alchemical texts. The longest of them, the *Testamentum* (*Testament*), also appeared first—in 1332, a generation before the *Book of the Secrets of Nature*.[53] Significantly, the *Testamentum* itself never claims Lull as its author; it could scarcely do so, since it mentions dates after Lull's death. Nevertheless, the author of the *Book of the Secrets of Nature* co-opted the *Testamentum* as part of the Lullian corpus he began producing. The fact that the *Testamentum* contains characteristically Lullian elements and was written by a Catalan scholar made it easier to reassign the originally anonymous work to Ramon Lull.

The *Testamentum* defines *alchemy* as "a hidden part of natural philosophy" that teaches three main topics: how to transmute metals, how to enhance human health, and how to improve and produce precious stones. The last of these topics is unusual for alchemical texts of the period, so the *Testamentum* gives a recipe for dissolving small pearls into a paste and then molding the paste into larger artificial pearls.[54] It also contains recipes for medicinal waters. Most of this lengthy book, however, deals with making the Philosophers' Stone, which can provide precious metals, good health, and better gems by itself. The author of the *Testamentum* holds that the stone is a medicine of universal application. It "cures" base metals, turning them into gold; it removes the imperfections of gems; it cures all diseases for both human beings and animals, and even stimulates the growth of plants.[55] The enormous popularity of the pseudo-Lullian corpus codified the notion that the Philosophers' Stone was the "medicine of men and metals." (Although, following Bacon, the pseudo-Lull, and others, the stone was thought able to maintain human health and thus prolong life, it was *not* considered an "elixir of immortality," as some popular treatments of alchemy claim.)[56] Interestingly, the *Testamentum* also states that the stone can render glass malleable—a supreme feat of technology, fabled and rumored since Roman antiquity.[57]

Legends about Lull the alchemist's life and his alchemical exploits began to emerge in the early fifteenth century. According to the full-blown legend current in the seventeenth century, he was converted from skepticism about alchemy by his fellow Catalan, Arnald of Villanova, who also taught him the secrets of the Noble Art. Lull then traveled to England. Some versions say he was invited by one Cremer, the abbot of Westminster and himself a frustrated alchemist who, while searching for a teacher, found Lull in Italy. Once in England, Lull demonstrated

his abilities to King Edward, and said he could make enough gold for the king to launch a new crusade to recover the Holy Land. The king agreed to Lull's proposal, and set him up with a laboratory in the Tower of London, where he transmuted twenty-two tons of lead and tin into pure gold, which was then minted into new coins called rose nobles. But Edward double-crossed Lull; instead of using the gold as promised to finance a crusade, he used it to invade France, and Lull either was imprisoned or, in other versions, left England disgusted and depressed.[58]

Like most alchemical stories, this one accreted around some nuggets of truth. The *Testamentum* does refer to Arnald, and its colophon records that its author wrote it in London near the tower, so at least one of the authors accounted a "pseudo-Lull" was actually in England. He would have been there during the time of Edward III (reigned 1327–77), a king known to have supported alchemists, who *did* issue a new gold coin in 1344 called the noble, and who invaded France shortly thereafter. Yet none of these events could connect with the real Ramon Lull, who died when Edward III was three years old. (Some writers therefore endeavored to identify the deceitful king as Edward I or II.) Furthermore, the true rose nobles (bearing images of a rose and a ship) appeared only in the middle of the next century.[59] Despite all the problems with the legend, other alchemists routinely used the story of Lull's ill-fated dealings with the English king as a cautionary tale for their fellow chrysopoeians: keep quiet about your knowledge, and avoid the deceitful halls of power.

Further New Developments: Florilegia and Images

During the fourteenth and fifteenth centuries, the output of new alchemical writings continued to increase and diversify. The earliest works of Latin alchemy, such as Geber's *Summa*, were predominantly Scholastic in style: organized, logical, and straightforward—like textbooks. This format continued to be used until the seventeenth century, even as other—and ultimately more popular—styles emerged. One new literary form was the *florilegium*. The word literally means a "gathering of flowers," and it refers to a text that picks the choicest excerpts from a wide variety of books and arranges them into a "book of books." Florilegia are anthologies or compendia of short, informative quotations taken from many authors. These excerpts might present explanations of

alchemical theory, or a series of cryptic sentences requiring interpretation, or recipes for various products, including the Philosophers' Stone itself. The florilegium format was not unique to alchemy; authors used it to organize materials and authorities for a wide variety of subjects in the late Middle Ages. Today, florilegia might seem boring or redundant, but we can imagine that in their day, when books were expensive and scarce, they played an important role in summarizing and disseminating information from a broad range of sources.

The late Middle Ages also witnessed the emergence of another alchemical genre—emblematic illustrations. Extended allegorical descriptions of alchemical processes and theories emerged in the Greco-Egyptian period, notably in the "dreams" of Zosimos. But in the fourteenth century, this allegorizing tendency, now firmly established within alchemy, went further by manifesting itself not just in metaphorical *words* but in metaphorical *images*.[60] The sophistication of such images ranges from simple woodcuts to artistic and technical masterpieces of enormous complexity. No popular book on alchemy today fails to reproduce an array of such images. Yet their beauty and allure can prove to be a double-edged sword; many modern writers have wrested them out of context, as if they were somehow independent of both their creators and the texts they were intended to illustrate—independent of the time, place, and cultural conditions under which they were produced. As a result, they have often been interpreted according to the whims of the modern viewer rather than according to the intentions of their original authors and the practices of their original readers. Emblematic images can tell us a great deal about alchemy, but only when treated historically and in context.

Probably the earliest text to incorporate allegorical figures is the *Rosarium philosophorum* (*Rose-Garden of the Philosophers*). Actually, several books with this title were produced in the 1400s and 1500s; the earliest of them is attributed (falsely) to Arnald of Villanova.[61] All of them are florilegia (hence the title), but only one is adorned with images. Curiously, these images appeared first as part of an independent German poem titled *Sun and Moon* (*Sol und Luna*) that was later spliced into the Latin prose text of the *Rosarium*. The *Rosarium*'s text was written first, during the fourteenth century, and the poem was written somewhat later but still before 1400. Whether the two are the products of one author or (more likely) two remains unclear. What is clear is that the poem and its images were used to better organize the original florilegium—each verse

and image summarizes the theme of a section of text—and they probably functioned as a memory aid. The combined assemblage of Latin text, German poem, and woodcut images was first published in 1550.[62]

The *Rosarium*, as its title page proclaims, deals with "the true method of preparing the Philosophers' Stone." It begins with quotations regarding general alchemical themes and theories, the composition of metals, and the production of the elixir from the combination of two substances, here called Sol and Luna. To describe the combination of these two principles, it quotes a section of the *Turba philosophorum*, which counsels the reader to "marry your son Gabritius, dearest to you among all your sons, with his sister Beya who is a shining, smooth, and tender girl."[63] Here the personification of the two ingredients draws on Arabic—the name Gabritius is undoubtedly derived from *kibrīt*, the Arabic word for "sulfur," and Beya from *bayāḍ*, meaning "whiteness" and "brightness," surely referring to mercury. Thus, as with John of Rupescissa, the *Rosarium* presents the theory that the elixir is made from the combination of Mercury and Sulfur. The difficulty, of course, remains in identifying what "Mercury" and "Sulfur" actually mean in this context. The writer of the German poem *Sun and Moon* (here the Sun/Moon pair is equivalent to Sulfur/Mercury and Gabritius/Beya) has the Moon tell the Sun that he has need of her "like the rooster does of the hen," and the illustrator graphically depicts the "conjunction" of Sun and Moon as shown in figure 3.1. "Where there were two," the Latin text continues, "they are made as if one in body." The following illustration (fig. 3.2) accordingly shows the one body with two heads that results from the fusion of Sun and Moon.[64] Subsequent illustrations depict the departure of the "soul" from this hybrid (fig. 3.3), the cleansing of the dead body, the return of the soul to produce the first stage of the Philosophers' Stone, and so forth.

The images of the *Rosarium* are simple and straightforward, as befits pictorial summaries of a preexisting text. Some later examples of alchemical emblems are far more complex, however, and often function as coded—that is, intentionally secretive—communications that require the reader to apply a full measure of interpretative skill in order to grasp their meaning (chapter 6 illustrates how to do this). Yet even the *Rosarium*'s simple images can strike the reader as shocking or outlandish. Sexual intercourse and reproduction are common elements of alchemical imagery, both textual and graphic. But given that alchemy is fundamentally a *generative* and *productive* practice (that is, it makes stuff), comparisons

Figures 3.1–3.3. Conjunction, Conception, and Extraction of the Soul, emblematizations of stages in preparing the Philosophers' Stone. The verses in German are from the poem *Sol und Luna*. From the *Rosarium philosophorum* (Frankfurt, 1550). By courtesy of the Department of Special Collections, Memorial Library, University of Wisconsin–Madison.

to procreation are actually appropriate. Alchemy's aim is to give rise to new substances or new properties by combining existing ones, just as parents give rise to new offspring through their union. Sex and sexuality are among the most universal and common experiences of human beings, and so provide a ready source of similitudes and easily intelligible, descriptive metaphors.[65] The idea or sight of two substances reacting and combining to form a third easily suggests the image of a marital couple to an imaginative mind practiced in drawing metaphors. Even modern chemists frequently conceptualize reacting substances as pairs acting on each other—no longer Mercury and Sulfur, but rather acid and base or oxidant and reductant. Some of these modern pairs even continue to

suggest a kind of sexuality in their etymologies, such as electrophile and nucleophile, based on the Greek verb *philein*, "to love, kiss, or copulate." Even more unavoidable than taxes, death is also a common human experience, and was a part of daily life in the premodern world, though not in our sanitized and euphemistic modern society. Thus death, with all the attendant Christian doctrines of the departure of the soul and of final resurrection, appears in alchemical imagery as prominently as sex.

One exotic being commonly encountered in alchemical imagery but not in daily life is the hermaphrodite. Why would alchemists be seemingly so obsessed with beings that exhibit both male and female physiologies? In the *Rosarium*, a bicephalous hermaphrodite (fig. 3.2) results from the union of Sun and Moon. In some ways, this is quite sensible. Unlike with animals whose procreation produces offspring while leaving the parents intact, the combination of two material substances causes them to unite in a new, third substance with a new identity, losing their own independent identities in the process. Thus, the hermaphrodite actually represents something closer to alchemical processes. St. Albert the Great helpfully explains alchemists' use of this odd image with the clarity characteristic of the thirteenth century. In his book about minerals, the Universal Doctor explains the Mercury-Sulfur theory of the metals, saying that these constituents are

> like father and mother, as alchemical authors say when speaking metaphorically. For Sulfur is like the father and Mercury like the mother, although it is more aptly to be expressed that in the commixture of metals the Sulfur is like the substance of the paternal seed, and the Mercury like the menstrual blood which is coagulated into the substance of embryos.[66]

The basis of this comparison lies in a well-established notion dating to ancient Greek medicine that males (just like Sulfur) are characterized by the qualities of hot and dry, while females (just like Mercury) are qualitatively cold and wet. In some substances, Albert continues, these pairs of qualities are not well segregated, and in such cases "it is to be observed that some hot-dry is joined to a wet-cold in the same complexion, and this complexion is hermaphroditic."[67] Thus, a hermaphrodite in alchemy represents a substance arising from the union of a substance that is "male" (hot-dry) and one that is "female" (cold-wet). Note also how Albert clearly distinguishes between the *metaphorical* usage of "father"

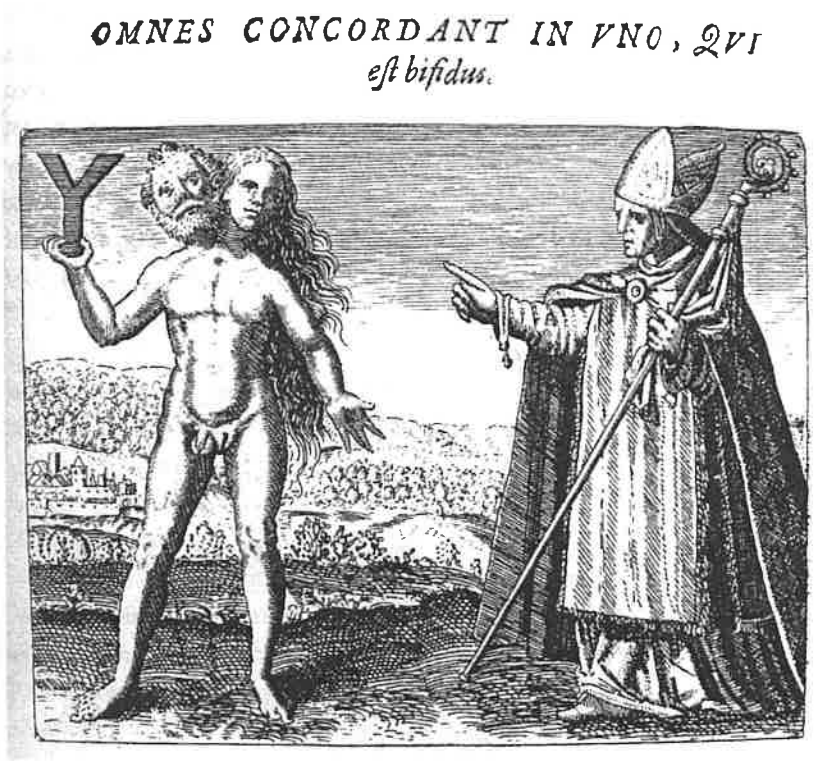

Figure 3.4. St. Albert the Great points to an alchemical hermaphrodite. From Michael Maier, *Symbola aureae mensae duodecim nationum* (Frankfurt, 1617), p. 238. By courtesy of the Department of Special Collections, Memorial Library, University of Wisconsin–Madison.

and "mother" for Sulfur and Mercury, and a "more apt" comparison of them to other *substances*—namely semen and menstrual blood—whose literal combination (according to classical theories of generation) gives rise to an embryo. Albert actually laments the fact that "proper terms" do not exist for talking specifically about the production of material substances (particularly minerals), which is why, he explains, authors find it necessary to discuss them using analogies.[68] His role in explaining the meaning of hermaphrodites in alchemy was not forgotten by his successors. Indeed, two and a half centuries later he appeared in a seventeenth-century alchemical book pointing in explanation to a hermaphrodite (fig. 3.4).[69]

Only a small handful of alchemical works containing emblematic images appeared in the fourteenth and fifteenth centuries. These share some of the procreative or sexual images of the *Rosarium*, but many are drawn as well from theological topics. Accordingly, the printed 1550 version of the *Rosarium* uses two images borrowed from the early fifteenth-century *Book of the Holy Trinity* (*Buch der Heiligen Dreifaltigkeit*)—considered the first alchemical text written in German—which depict the Coronation of

Figure 3.5. The Resurrection of Christ as an emblem of a step in an alchemical process. From the *Rosarium philosophorum* (Frankfurt, 1550). By courtesy of the Department of Special Collections, Memorial Library, University of Wisconsin–Madison.

the Virgin and the Resurrection of Christ (fig. 3.5).[70] The verses under the resurrection scene read, "After my many sufferings and great torments, I am resurrected, clarified, and free from all stain," recalling the expressions of the pseudo-Arnald.

By the start of the sixteenth century, Latin alchemy had developed in many ways beyond the Arabic *al-kīmiyā'* Europe had acquired more than three centuries earlier. The Noble Art's ancient and central interest in chrysopoeia remained undiminished, and the search for the secrets of transmutation continued with increased vigor, aided by a wealth of new concepts, materials, and observations. In fact, multiple "schools" of chrysopoeia had developed by this time, each promoting particular starting materials or particular procedures, and basing themselves on various theories of metallic composition and explanations of how the Philosophers' Stone could bring about transmutation. Yet even though most texts falling within the category of *alchemia* dealt with metallic transmutation, that was by no means the sum total of the field. By 1500, alchemy also included the preparation of medicines, as practitioners promoted an expanding array of chemically produced or enhanced medicaments. Medical alchemy (also known as *iatrochemistry* or *chemiatria*) would expand enormously in the sixteenth century thanks to the influential writings (and rantings) of the iconoclastic Swiss physician Theophrastus von Hohenheim, commonly known as Paracelsus.

Humbler and less visible applications of *alchemia* also flourished. The recipe literature continued to develop as more workshops turned to chemical methods for producing a range of goods useful in arts and manufactures—salts, pigments, dyes, mineral acids, alloys, perfumes, distillates of various sorts, and so on. Alongside these industrious and productive activities, a wealth of new concepts about the hidden nature of matter and its transformations developed. Some stemmed from the quasi-particulate matter theory of Geber, others followed Aristotle more closely, and still others were totally new. The potential of human artifice and the secret workings of the cosmos remained fertile areas for study and for new ideas. At the same time, alchemy achieved an increasingly visible presence in early modern European culture, arousing both admiration and critique. Its ideas, metaphors, products, theories, practices, and practitioners attracted attention from artists, playwrights, preachers,

poets, and philosophers. At the end of the fifteenth century, *alchemia* was entering its golden age. The sixteenth and seventeenth centuries, the age of Copernicus, Galileo, Descartes, Boyle, and Newton, the age often called the Scientific Revolution, would also prove to be alchemy's great age.

FOUR

REDEFINITIONS, REVIVALS, AND REINTERPRETATIONS

Alchemy from the Eighteenth Century to the Present

If I were to follow a strictly chronological sequence, this chapter would delve into alchemy's greatest epoch: the sixteenth and seventeenth centuries. Instead, I am going to leapfrog over that golden age for the time being to recount transmutational alchemy's sharp decline in the early eighteenth century and its subsequent revivals, sometimes in strikingly new forms. Although it might seem confusing to violate chronological order in this way, there is good reason to do so. Most readers probably are aware of several common claims about alchemy—for example, that it is fundamentally distinct from chemistry, that it is inherently a spiritual endeavor or involves self-transformation, that it is akin to magic, or that its practice then or now is essentially deceptive. These ideas about alchemy emerged during the eighteenth century or after. While each of them might have limited validity within a narrow context, none of them is an accurate depiction of alchemy in general. Nevertheless, they have all been put forward as general "definitions" of the subject over its *entire* history. For much of the twentieth century, even many historians of science participated

47. Julius Ruska, "Die Alchemie des Avicenna," *Isis* 21 (1934): 14–51, judged the work to be a Latin forgery, but an Arabic text exists; see H. E. Stapleton, R. F. Azo, Hidayat Husain, and G. L. Lewis, "Two Alchemical Treatises Attributed to Avicenna," *Ambix* 10 (1962): 41–82. The Arabic text, a French translation, and the medieval Latin version are all provided in Georges C. Anawati, "Avicenna et l'alchimie," in *Convegno internazionale, 9–15 aprile 1969: Oriente e occidente nel medioevo: filosofia e scienze* (Rome: Accademia Nazionale dei Lincei, 1971), pp. 285–345.

48. E. J. Holmyard and D. C. Mandeville, eds., *Avicennae de congelatione et conglutinatione lapidum, Being Sections of the Kitāb al-Shifā'* (Paris: Paul Geuthner, 1927), p. 40. This edition contains Latin and Arabic texts with an English translation of the latter, plus notes.

49. Ibid., p. 41.

50. Ibn-Sīnā, quoted in A. F. Mehrens, "Vues d'Avicenne sur astrologie et sur le rapport de la responsabilité humaine avec le destin," *Muséon* 3 (1884): 383–403, quoting from p. 387.

51. Ibn-Sīnā, quoted in Holmyard and Mandeville, *Avicennae de Congelatione*, p. 41.

52. For a summary, see Ullmann, *Natur- und Geheimwissenschaften*, pp. 249–55.

53. One exception is an account of John Isthmeos, who appeared in Antioch in 504, swindling many people there before moving to Constantinople, where he continued his trade until he was exiled; see Mertens, "Graeco-Egyptian Alchemy," pp. 226–27.

54. The text exists in French translation as al-Jawbari, *La voile arraché*, trans. René R. Khawan, 2 vols. (Paris: Phèbus, 1979); the section on chrysopoeia is 1:183–229. A partial English translation appears in Harold J. Abrahams, "Al-Jawbari on False Alchemists," *Ambix* 31 (1984): 84–87.

55. Leo Africanus, *A Geographicall Historie of Africa* (London, 1600), pp. 155–56. The text was originally published in 1526 in Italian. On Fez as a continuing center of alchemy, see José Rodríguez Guerrero, "Some Forgotten Fez Alchemists and the Loss of the Peñon de Vélez de la Gomera in the Sixteenth Century," in *Chymia: Science and Nature in Medieval and Early Modern Europe*, ed. Miguel López-Pérez, Didier Kahn, and Mar Rey Bueno (Newcastle-upon-Tyne: Cambridge Scholars Publishing, 2010), pp. 291–309.

56. For a summary of some of these later alchemical authors, see Ullmann, *Natur- und Geheimwissenschaften*, pp. 224–48.

57. Holmyard, *Alchemy*, p. 104.

Chapter Three

1. Morienus, *De compositione alchemiae*, in *Bibliotheca chemica curiosa*, 1:509–19, quoting from p. 509; this Latin edition is fairly corrupt—I have silently changed its *vestra* to *nostra* in accord with some manuscripts. For an English translation and an alternate Latin text (omitting the prologue), see Morienus, *A Testament of Alchemy*, ed. and trans. Lee Stavenhagen (Hanover, NH: Brandeis University Press, 1974); the translation is not always accurate. The authenticity of the work as a translation from Arabic rather than as an original Latin composition was denied by Julius Ruska, *Arabische Alchemisten I*, pp. 33-35, but partial Arabic versions have since been found: Ullmann, *Natur- und Geheimwissenschaften*, pp. 192–93, and al-Hassan, "The Arabic Original." The authenticity of Robert's prologue as a twelfth-century work has also been called into question, including by Stavenhagen (pp. 52–60), but has been reaffirmed convincingly by Richard Lemay, "L'authenticité de la Préface de Robert de Chester à sa traduction du *Morienus*," *Chrysopoeia* 4 (1990–91): 3–32; see also Didier Kahn, "Note sur deux manuscrits du Prologue attribué à Robert de Chester," ibid., pp. 33–34. A thorough critical edition of the Morienus text remains a desideratum. Of course, my citation of an exact day of the week on which alchemy "arrived" in the Latin world is partly tongue-in-cheek; there were undoubtedly some earlier transfers and multiple points of ingress. Nonetheless, the fact remains that we can trace the origins of Latin alchemy more clearly than those of Greek or Arabic alchemy.

2. The classic source is Charles Homer Haskins, *The Renaissance of the Twelfth Century* (Cambridge, MA: Harvard University Press, 1927); more recently, Robert L. Benson and Giles Constable, eds., *Renaissance and Renewal in the Twelfth Century*, with Carol D. Lanham (Cambridge, MA: Harvard University Press, 1982; reprint, Toronto: Medieval Academy of America, 1991); in regard to the Latin translation movement, see the article by Marie-Thérèse d'Alverny, "Translations and Translators," on pp. 421–62; see also Edward Grant, *The Foundations of Modern Science in the Middle Ages* (Cambridge: Cambridge University Press, 1996), pp. 18–32.

3. Morienus, *De compositione*, in *Bibliotheca chemica curiosa*, 1:509.

4. Hugh of Santalla's twelfth-century translation of Balīnūs is edited in Hudry, "Le *De secretis naturae*."

5. Cyril Stanley Smith and John G. Hawthorne, *Mappae Clavicula: A Little Key to the World of Medieval Techniques*, Transactions of the American Philosophical Society 64 (Philadelphia: American Philosophical Society, 1974); Rozelle Parker Johnson, *Compositiones variae: An Introductory Study*, Illinois Studies in Language and Literature 23 (Urbana, IL, 1939); Heinz Roosen-Runge, *Farbgebung und Technik frümittelalterlicher Buchmalerei: Studien zu den Traktaten "Mappae Clavicula" und "Heraclius,"* 2 vols. (Munich: Deutscher Kunstverlag, 1967).

6. Theophilus is possibly identifiable as Roger of Helmarshausen, a Benedictine monk; his book in available in English translation as *On Divers Arts*, trans. John G. Hawthorne and Cyril Stanley Smith (New York: Dover, 1979).

7. Ibid., pp. 119–20.

8. Carmélia Opsomer and Robert Halleux, "L'Alchimie de Théophile et l'abbaye de Stavelot," in *Comprendre et maîtriser la nature au Moyen Age*, ed. Guy Beaujouan (Geneva: Droz, 1994), pp. 437–59, and Halleux, "La réception de l'alchimie arabe en Occident," in Rashed and Morelon, *Histoire des sciences arabes*, 3:143–51, esp. pp. 143–45.

9. One of the earliest of these is the *Ars alchemie*, dating from the early thirteenth century; see Antony Vinciguerra, "The *Ars alchemie*: The First Latin Text on Practical Alchemy," *Ambix* 56 (2009): 57–67.

10. We owe this identification, and the solution to the "Jābir-Geber" problem, to the painstaking studies of William R. Newman. For a detailed treatment of Geber's identity, see Newman, "New Light on the Identity of Geber," *Sudhoffs Archiv* 69 (1985): 79–90, and "Genesis of the *Summa perfectionis*," *Archives internationales d'histoire des sciences* 35 (1985): 240–302. For an edition, translation, and historical contextualization of the *Summa*, see Newman's *The Summa Perfectionis of Pseudo-Geber*.

11. On such borrowings from Jābir, see Newman, *Summa perfectionis*, pp. 86–99.

12. One notable exception to this generalization is Roger Bacon, who was apparently more deeply influenced by Jābir than were others; see William R. Newman, "The Philosophers' Egg: Theory and Practice in the Alchemy of Roger Bacon," in "Le crisi

dell'alchimia," *Micrologus* 3 (1995): 75–101, and Michela Pereira, "Teorie dell'elixir nell'alchimia latina medievale," in ibid., pp. 103–49.

13. Aristotle, *Physics* 187b14–22, and *Meteors* 385b12–26, 386b1–10 and 387a17–22; for the expansion of these ideas in the Middle Ages, especially in relation to Geber, see Newman, *Summa perfectionis*, pp. 167–90. On *Meteors IV* and its importance to alchemy, see the essays in Viano, *Aristoteles chemicus*, and Craig Martin, "Alchemy and the Renaissance Commentary Tradition on *Meteorologica* IV," *Ambix* 51 (2004): 245–62.

14. Newman, *Summa perfectionis*, pp. 159–62, 471–75, and 725–26.

15. Ibid., pp. 143–92; William R. Newman, *Atoms and Alchemy* (Chicago: University of Chicago Press, 2006), esp. pp. 23–44; Antoine Calvet, "La théorie *per minima* dans les textes alchimiques des XIV^e^ et XV^e^ siècles," in *Chymia: Science and Nature in Medieval and Early Modern Europe*, ed. Miguel López-Pérez, Didier Kahn, and Mar Rey Bueno (Newcastle-upon-Tyne: Cambridge Scholars Publishing, 2010), pp. 41–69.

16. There are many minor variants of the Latin text; see Newman, *Summa perfectionis*, pp. 48–51. Holmyard and Mandeville, *Avicennae de congelatione*, pp. 53–54, gives one version; another is *Avicennae de congelatione et conglutinatione lapidum*, in *Bibliotheca chemica curiosa*, pp. 636–38, quotation from p. 638. In fact, Aristotle actually had a much higher regard for the power of human artifice than did Ibn-Sīnā.

17. Attention was first called to the manuscript by Newman, who published and analyzed a portion of it. See Newman, *Summa perfectionis*, pp. 7–15.

18. On Albert's alchemy, see Pearl Kibre, "Albertus Magnus on Alchemy," in *Albertus Magnus and the Sciences: Commemorative Essays 1980*, ed. James A. Weisheipl (Toronto: Pontifical Institute of Mediaeval Studies, 1980), pp. 187–202; "Alchemical Writings Attributed to Albertus Magnus," *Speculum* 17 (1942): 511–15; and Robert Halleux, "Albert le Grand et l'alchimie," *Revue des sciences philosophiques et théologiques* 66 (1982): 57–80. For his own works on alchemy, *Liber mineralium*, in *Alberti Magni opera omnia*, ed. A. Borgnet (Paris, 1890–99), 5:1–116, and the attributed *Libellus de alchemia*, 37:545–73; English translations: *Book of Minerals*, trans. Dorothy Wyckoff (Oxford: Clarendon Press, 1967), and *"Libellus de Alchemia" Ascribed to Albertus Magnus*, trans. Virginia Heines, SCN (Berkeley: University of California Press, 1958).

19. St. Thomas Aquinas, *Summa theologica*, 2ae 2a, quaestio 77, articulus 2.

20. Giles of Rome, *Quodlibeta*, quaestio 3, quolibet 8, in Sylvain Matton, *Scolastique et Alchimie*, Textes et Travaux de Chrysopoeia 10 (Paris: SÉHA; Milan: Arché, 2009), pp. 77–80; William R. Newman, "Technology and Alchemical Debate in the Late Middle Ages," *Isis* 80 (1989): 423–45, esp. pp. 437–39.

21. *Libellus*, trans. by Heines, p. 19; St. Albert, *Book of Minerals*, p. 179. It is possibly from his teacher St. Albert that Thomas Aquinas took the notion that alchemical gold has different properties from natural gold.

22. William R. Newman explores the connection between technology and alchemy, art and nature more fully in his fascinating and provocative *Promethean Ambitions: Alchemy and the Quest to Perfect Nature* (Chicago: University of Chicago Press, 2004).

23. Aristotle himself could be invoked to support this position, for he wrote that "art completes whatever nature is unable to complete": *Physics* 2.8; 199a 15–16.

24. Reported by Nicholas Eymerich in 1396. See Halleux, *Les textes alchimiques*, p. 126.

25. The full text of *Spondent quas non exhibent* (*They Promise What They Do Not Deliver*) is printed in ibid., pp. 124–26, in original Latin and a French translation.

26. Ibid., p. 124.

27. For Henry IV in 1404 (5 Hen. 4), see A. Luders et al., eds., *The Statutes of the Realm* (London, 1816), 2:144; for Venetian Council of Ten in 1488, see Pantheus, *Voarchadumia*, in *Theatrum chemicum* (Strasbourg, 1659–63), 2:495–549, on pp. 498–99.

28. Ibn-Khaldūn, *The Muqaddimah: An Introduction to History* (New York: Pantheon, 1958), 3:277.

29. A few later examples are Johannes Chrysippus Fanianus, *De jure artis alchimiae*, in *Theatrum chemicum*, 1:48–63; Girolamo de Zanetis, *Conclusio*, in ibid., 4:247–52; and Johann Franz Buddeus, *Quaestionem politicam an alchimistae sint in republica tolerandi?* (Magdeburg, 1702), in German translation as *Untersuchung von der Alchemie*, in *Deutsches Theatrum Chemicum*, ed. Friedrich Roth-Scholtz (Nuremberg, 1728), 1:1–146. For discussion of the topic, see Ku-ming (Kevin) Chang, "Toleration of Alchemists as a Political Question: Transmutation, Disputation, and Early Modern Scholarship on Alchemy," *Ambix* 54 (2007): 245–73, and Jean-Pierre Baud, *Le procès d'alchimie* (Strasbourg: CERDIC, 1983).

30. D. Geoghegan, "A Licence of Henry VI to Practise Alchemy," *Ambix* 6 (1957): 10–17.

31. Eilhard Wiedemann, "Zur Alchemie bei der Arabern," *Journal für Praktische Chemie* 184 (1907): 115–23 provides a German translation of al-Fārābī's work.

32. For example, we have a text dating from 1257 that appears to represent university lectures that include alchemical knowledge; Constantine of Pisa, *The Book of the Secrets of Alchemy*, ed. and trans. Barbara Obrist (Leiden: Brill, 1990). Paul of Taranto was himself a lecturer in a Franciscan school.

33. For the latest publication on John of Rupescissa in English, see Leah DeVun, *Prophecy, Alchemy, and the End of Time: John of Rupescissa in the Late Middle Ages* (New York: Columbia University Press, 2009). Older but more exhaustive sources are Jeanne Bignami-Odier, "Jean de Roquetaillade," in *Histoire litteraire de la France* (Paris: Academie des Inscriptions et Belles-Lettres, 1981), 41:75–240, and Robert Halleux, "Ouvrages alchimiques de Jean de Rupescissa," in ibid., 41:241–77.

34. See David Burr, *The Spiritual Franciscans: From Protest to Persecution in the Century after St. Francis* (University Park: Penn State University Press, 2001).

35. John's text appears under two different titles: John of Rupescissa, *Liber lucis*, in *Bibliotheca chemica curiosa*, 2:84–87, and *De confectione veri lapidis philosophorum*, in ibid., 2:80–83. The two differ in details of wording and also the opening and closing text, but share the same structure, order, ideas, and practical details; the relationship between the two versions remains unresolved. The quotation used here is from the prologue (*Liber lucis*, 2:84), which is lacking in *De confectione*.

36. Rupescissa, *De confectione*, 2:83. Because we lack a critical edition of John's work, I hesitate to assert that the paragraphs about salt are his; they might have been added by a later follower who recognized the need for salt. These sections are absent from the *Liber lucis*.

37. For more on this topic, see chapter 6 and Lawrence M. Principe, "Chemical Translation and the Role of Impurities in Alchemy: Examples from Basil Valentine's *Triumph-Wagen*," *Ambix* 34 (1987): 21–30.

38. Rupescissa, *De confectione*, 2:81; the corresponding version in *Liber lucis* (2:84) is unclear, and may result from the loss of a line of text by a copyist. John is correct in

his observation about the weight gain; we now know that the mercury has combined with the chlorine of the salt, adding to the overall weight of the sublimed mercuric chloride.

39. On the interpenetration of medicine and Christianity in Arnald's genuine writings, analogous to that found with the alchemy of pseudo-Arnaldian texts, see Joseph Ziegler, *Medicine and Religion c. 1300: The Case of Arnau de Vilanova* (Oxford: Clarendon Press, 1998); a useful biographical sketch is on pp. 21–34. See also Chiara Crisciani, "Exemplum Christi e sapere: Sull'epistemologia di Arnoldo da Villanova," *Archives internationales d'histoire des sciences* 28 (1978): 245–87, and Antoine Calvet, "Alchimie et Joachimisme dans les *alchimica* pseudo-Arnaldiens," in *Alchimie et philosophie à la Renaissance*, ed. Jean-Claude Margolin and Sylvain Matton (Paris: Vrin, 1993), pp. 93–107.

40. Pseudo-Arnald of Villanova, *Tractatus parabolicus*, ed. and trans. [into French] Antoine Calvet, *Chrysopoeia* 5 (1992–96): 145–71. For an analysis, see Antoine Calvet, "Un commentaire alchimique du XIV^{e} siècle: Le *Tractatus parabolicus* du ps.-Arnaud de Villaneuve," in *Le Commentaire: Entre tradition et innovation*, ed. Marie-Odile Goulet-Cazé (Paris: Vrin, 2000), pp. 465–74. See also Antoine Calvet, *Les Oeuvres alchimiques attribuées à Arnaud de Villaneuve*, Textes et Travaux de Chrysopoeia 11 (Paris: SÉHA; Milan: Archè, 2011).

41. Pseudo-Arnald, *Tractatus*, p. 160.

42. "Le but poursuivi par l'auteur serait en somme d'asseoir l'alchimie sur un roc afin de confondre ses détracteurs"; Calvet, "Commentaire," p. 471.

43. Petrus Bonus, *Margarita pretiosa novella*, in *Bibliotheca chemica curiosa*, 2:1–80, quoting from pp. 30 and 50.

44. Rupescissa, *De confectione*, 2:81–82.

45. Rupescissa, *Liber lucis*, 2:85.

46. Rupescissa, *De confectione*, 2:81.

47. Upon heating the mixture, assuming common salt is also present, the mercury is converted into solid mercuric chloride. *Argentum vivum* is the source for our own alternate name for mercury, namely "quicksilver," where *quick* carries the archaic English meaning of *alive*.

48. While we lack an easily accessible edition or reprint of the *De consideratione*, there are three early printings: Basel, 1561(?) and 1597, and Ursel, 1602 (in *Theatrum chemicum*, 3:359–485; not present in the later editions). A fifteenth-century English edition is published as *The Book of the Quinte Essence*, ed. F. J. Furnivall (London: Early English Text Society, 1866; reprint, Oxford: Oxford University Press, 1965). A useful overview of the book's contents appears in Halleux, "Ouvrages alchimiques," pp. 245–62, and in Udo Benzenhöfer, *Johannes' de Rupescissa Liber de consideratione quintae essentiae omnium rerum deutsch* (Stuttgart: Franz Steiner Verlag, 1989), pp. 15–21. The latter contains an edition of a fifteenth-century German version of the text. See also Giancarlo Zanier, "Procedimenti farmacologici e pratiche chemioterapeutiche nel *De consideratione quintae essentiae*," in "Alchimia e medicina nel Medioevo," ed. Chiara Crisciani and Agostino Paravicini Bagliani, Micrologus Library 9 (Florence: Sismel, 2003), pp. 161–76.

49. Halleux, "Ouvrages alchimiques," pp. 246–50.

50. There had been several earlier claims that alchemy was useful for medicine, for example by Bernard of Gordon (died circa 1320); see Luke Demaitre, *Doctor Bernard de Gordon: Professor and Practitioner* (Toronto: Pontifical Institute of Medieval Studies, 1980), pp. 19–20. Roger Bacon wrote that the Philosophers' Stone had medicinal virtues; see Michela Pereira, "Un tesoro inestimabile: Elixir e *prolongatio vitae* nell'alchimiae del '300," *Micrologus* 1 (1992): 161–87, and "Teorie dell'elixir."

51. For more on the linkages of alchemy and medicine in the Middle Ages, including some prior to John of Rupescissa, see the essays in Crisciani and Bagliani, "Alchimia e medicina nel Medioevo."

52. Michela Pereira, *The Alchemical Corpus Attributed to Raymond Lull* (London: Warburg Institute, 1989); "Sulla tradizione testuale del *Liber de secretis naturae seu de quinta essentia* attribuito a Raimondo Lullo," *Archives internationales d'histoire des sciences* 36 (1986): 1–16; "*Medicina* in the Alchemical Writings Attributed to Raimond Lull," in *Alchemy and Chemistry in the Sixteenth and Seventeenth Centuries*, ed. Piyo Rattansi and Antonio Clericuzio (Dordrecht: Kluwer, 1994), pp. 1–15.

53. Michela Pereira and Barbara Spaggiari, *Il Testamentum alchemico attribuito a Raimondo Lullo* (Florence: Sismel, 1999), contains critical editions of the Catalan original and a fifteenth-century Latin translation, plus valuable introductory materials.

54. Pseudo-Lull, *Testamentum* 2:1 and 3:7–10, in ibid., pp. 306–7 and 390–97; making precious stones was covered more fully by the same (anonymous) author in his *Liber lapidarius*. The *Book of the Secrets of Nature* contains the same threefold goals of alchemy, which stands to reason, since its author claims (falsely) that he is also the author of the *Testament*.

55. Ibid., 2:30, pp. 376–79.

56. This modern misconception comes possibly from a conflation of Chinese alchemical notions with European ones. Nevertheless, there are a *few* claims in the West of alchemists living to extreme ages. The story of the Nicolas and Pernelle Flamel living to over four hundred by use of the stone (reprised in *Harry Potter and the Philosopher's Stone*) arose in the late eighteenth century. Roger Bacon refers to an Arabic author named Artephius, whom he claims to have lived to the age of 1,025. See Gerald J. Gruman, *A History of Ideas about the Prolongation of Life* (Philadelphia: American Philosophical Society, 1966; reprint, New York: Arno Press, 1977), esp. pp. 28–68; Agostino Paravicini Bagliani, "Ruggero Bacone e l'alchimia di lunga vita: Riflessioni sui testi," in Crisciani and Bagliani, "Alchimia e medicina nel Medioevo," 33–54; and Pereira, "Tesoro inestimabile."

57. Pliny, *Natural History*, book 36, chapter 66. On glass and alchemy, see Beretta, *Alchemy of Glass*.

58. No historical Abbot Cremer has ever been identified; an alchemical treatise purporting to be his and that tells the Lull legend appeared in the seventeenth century: *Testamentum Cremeri*, published by Michael Maier in his *Tripus aureus* (Frankfurt, 1618), republished in *Musaeum hermeticum* (Frankfurt, 1678; reprint, Graz: Akademische Druck, 1970), pp. 533–44. For a lengthy version of the Lull legend, see Nicolas Lenglet du Fresnoy, *Histoire de la philosophie hermetique* (Paris, 1742–44), 1:144–84, 2:6–10, and 3:210–25; for an early version preserved in a Florentine manuscript, see the transcription in Michela Pereira, "La leggenda di Lullo alchimista," *Estudios lulianos* 27 (1987):145–63, on pp. 155–63; for a critical appraisal of its development, Pereira, *Alchemical Corpus*, pp. 38–49.

59. The linkage to the coin and a crusade overlaps with a rumor about George Ripley, a fifteenth-century alchemist and major popularizer of pseudo-Lullian alchemy in England. That story recounts that Ripley, who lived under Edward IV (the king who *did* mint the rose noble in 1464), sent £100,000 worth of alchemical gold

(prepared in the Tower of London) every year to the Knights of St. John at Rhodes to defend themselves against the Turks; see Elias Ashmole, ed., *Theatrum chemicum britannicum* (London, 1652), p. 458.

60. On the origins of these illustrations, see Barbara Obrist, *Les débuts de l'imagerie alchimique* (Paris: Le Sycomore, 1982). Intriguingly, an Arabic alchemical manuscript (falsely attributed to Zosimos) with allegorical images has recently surfaced, the first of its kind. It has been published in fascimile as *The Book of Pictures: Muṣḥaf aṣ-ṣuwar by Zosimos of Panopolis*, ed. Theodore Abt (Zurich: Living Human Heritage Publications, 2007); the editor's commentary is, however, grievously flawed and programmatic; for a scholarly analysis see Benjamin C. Hallum's learned essay review in *Ambix* 56 (2009): 76–88.

61. Pseudo-Arnald of Villanova, *Thesaurus thesaurorum et rosarium philosophorum*, in *Bibliotheca chemica curiosa*, 1:662–676; three others are found in *Bibliotheca chemica curiosa*, 2:87–134. On the first, see Antoine Calvet, "Étude d'un texte alchimique latin du XIV^{e} siècle: Le *Rosarius philosophorum* attribué au medecin Arnaud de Villeneuve," *Early Science and Medicine* 11 (2006): 162–206.

62. A facsimile edition is *Rosarium philosophorum: Ein alchemisches Florilegium des Spätmittelalters*, ed. Joachim Telle, 2 vols. (Weinheim: VCH, 1992). This edition contains a German translation of the text, an excellent essay by Telle, and useful bibliographical information. Telle's essay appears in French translation as "Remarques sur le *Rosarium philosophorum* (1550)," *Chrysopoeia* 5 (1992–96): 265–320.

63. *Rosarium*, pp. 46–47.

64. Ibid., pp. 46 and 55.

65. For more on this topic, see Lawrence M. Principe, "Revealing Analogies: The Descriptive and Deceptive Roles of Sexuality and Gender in Latin Alchemy," in *Hidden Intercourse: Eros and Sexuality in the History of Western Esotericism*, ed. Wouter J. Hanegraaff and Jeffrey J. Kripal (Leiden: Brill, 2008), pp. 208–29.

66. Albert the Great, *Mineralia*, book 4, chapter 1; in *Alberti Magni opera omnia*, 5:83.

67. Ibid., 5:84.

68. Albert, *Physica*, book 1, tractate 3, chapter 12; in *Alberti Magni opera omnia*, 3:72; *Mineralia*, book 1, tractate 1, chapter 5; in ibid., 5:7. See also Obrist, *Débuts*, pp. 31–33.

69. Even Zosimos refers to a substance under the name of hermaphrodite (*arsenothēlu*); Mertens, *Les alchimistes grecs IV, i: Zosime*, p. 21. In that case, he is probably using hermaphrodite as a *Deckname* for mercury, drawing upon well-known astrological ideas that some planets are "male" (Sun, Mars, Jupiter, Saturn) and some "female" (Moon and Venus), while Mercury is common to both genders because it "produces the dry and the moist alike"; see Ptolemy, *Tetrabiblos*, 1:6. For more on this topic, see Achim Aurnhammer, "Zum Hermaphroditen in der Sinnbildkunst der Alchemisten," in *Die Alchemie in der europäischen Kultur- und Wissenschaftsgeschichte*, ed. Christoph Meinel, Wolfenbütteler Forschungen 32 (Wiesbaden: Harrassowitz, 1986), pp. 179–200, and Leah DeVun, "The Jesus Hermaphrodite: Science and Sex Difference in Premodern Europe," *Journal for the History of Ideas* 69 (2008): 193–218.

70. Wilhelm Ganzenmüller, "Das Buch der heiligen Dreifaltigkeit," *Archiv der Kulturgeschichte* 29 (1939): 93–141; Herwig Buntz, "Das *Buch der heiligen Dreifaltigkeit*, sein Autor und seine Überlieferung," *Zeitschrift für deutsches Altertums und deutsche Literatur* 101 (1972): 150–60; Marielene Putscher, "Das *Buch der heiligen Dreifaltigkeit* und seine Bilder in Handschriften des 15. Jahrhunderts," in Meinel, *Die Alchemie in der europäischen Kultur- und Wissenschaftsgeschichte*, pp. 151–78; and Obrist, *Débuts*, pp. 117–82.

Chapter Four

1. On Libavius, see Bruce T. Moran, *Andreas Libavius and the Transformation of Alchemy: Separating Chemical Cultures with Polemical Fire* (Sagamore Beach, MA: Science History Publications, 2007).

2. William R. Newman and Lawrence M. Principe, "Alchemy vs. Chemistry: The Etymological Origins of a Historiographic Mistake," *Early Science and Medicine* 3 (1998): 32–65. See also Halleux, *Les textes alchimiques*, pp. 43–49.

3. Newman and Principe, "Etymological Origins," pp. 43–44. Part of the problem is that in the past, historians have too often assigned historical characters, books, or topics to one category or the other based on arbitrary and anachronistic presuppositions, resulting in the projection into the past of a false dichotomy based on modern ideas, and a consequential skewing of our historical understanding. Once we start talking about an inclusive *chymistry*, many apparent problems and conundrums vanish, and we can better operate within the historical context to come to more accurate understandings. For an example of how this works in the case of Isaac Newton, see Lawrence M. Principe, "Reflections on Newton's Alchemy in Light of the New Historiography of Alchemy," in *Newton and Newtonianism: New Studies*, ed. James E. Force and Sarah Hutton (Dordrecht: Kluwer, 2004), pp. 205–19.

4. Robert Boyle, "Essay on Nitre," from *Certain Physiological Essays* (1661), in *The Works of Robert Boyle*, ed. Michael Hunter and Edward B. Davis, vol. 2 (London: Pickering and Chatto, 1999), 85.

5. The very cursory account given here of the moral attacks on alchemy and their relation to the professionalization of chemistry at this time is treated more fully in Lawrence M. Principe, "A Revolution Nobody Noticed? Changes in Early Eighteenth Century Chymistry," in *New Narratives in Eighteenth-Century Chemistry*, ed. Lawrence M. Principe (Dordrecht: Springer, 2007), pp. 1–22, and at greater length in my forthcoming *Wilhelm Homberg and the Transmutations of Chymistry*. See also John C. Powers, "'Ars sine Arte': Nicholas Lemery and the End of Alchemy in Eighteenth-Century France," *Ambix* 45 (1998): 163–89.

6. Étienne-François Geoffroy, "Des supercheries concernant la pierre philosophale," *Mémoires de l'Académie Royale des Sciences* 24 (1722): 61–70.

7. Principe, *Wilhelm Homberg* (forthcoming), and until that time, "Transmuting Chymistry into Chemistry: Eighteenth-Century Chrysopoeia and Its Repudiation," in *Neighbours and Territories: The Evolving Identity of Chemistry*, ed. José Ramón Bertomeu-Sánchez, Duncan Thorburn Burns, and Brigitte Van Tiggelen (Louvain-la-Neuve, Belgium: Mémosciences, 2008), pp. 21–34.

8. James Price, *An Account of some Experiments on Mercury, Silver and Gold, made in Guildford in May, 1782* (Oxford, 1782); P. J. Hartog and E. L. Scott, "Price, James (1757/8–1783)," *Oxford Dictionary of National Biography* (Oxford: Oxford University Press, 2004), corrects some errors in the longer accounts by Denis Duveen, "James Price (1752–1783) Chemist and Alchemist," *Isis* 41 (1950): 281–83, and H. Charles Cameron, "The Last of the Alchemists," *Notes and Records of the Royal Society* 9 (1951): 109–14; the latter takes a particularly and unhelpfully cynical view of the affair.

9. On the construction of the category of occult sciences and its rejection by the academic establishment, see Wouter J. Hanegraaff, *Esotericism and the Academy:*