

DIE EDELGEBORNE JUNGFER ALCHYMIA: THE FINAL STAGE OF EUROPEAN ALCHEMY

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Introduction

The term “alchemy” encompasses a broad spectrum of activities that appeared in the Hellenistic world in the first centuries of our era and then, through Arabic mediation, reached Latin Europe by the mid 12th century. Out of numerous attempts to define this science, that proposed by Sheppard (1) appears the most suitable because it includes the two main goals of alchemy: the enhancement of matter and the improvement of human existence. Concerning the former, it should be achieved by the transmutation of base metals into precious ones, while the second main direction strove for improvement of humans by extending their life, the further stage of which was seen as attaining a higher spiritual level. Sheppard’s definition marks off both extreme limits, encompassing everything that can be included in alchemy; in reality, the spectrum of various alchemical activities was a continuum, situated between both extremes.

Alchemists continued their efforts surprisingly long in Europe, in spite of the failure of alchemy to fulfill its promises. The ultimate decline is observed here as late as the 18th century, but scholarly works defending this science appeared even in the beginning of the following century (2). A statistical approach (3) to alchemical literature is revealing: at least two, if not three, marked flourishes of alchemy occurred between the introduction of book printing and 1800. One is apparent in the second half of the 16th century, the second one in the beginning of the 17th century and, eventually a third one

followed the Thirty Years War. German titles represent one third out of all alchemical books that appeared over the whole studied period (4). This is a witness of the live interest paid to alchemy in Central Europe; the majority of these books are still awaiting scholarly research.

Alchemical literature underwent gradual change, being at the beginning often theoretical explanations of the composition of matter and recipes for the preparation of philosopher’s stone, elixirs, etc. Yet none of these miracles was effected; no true transmutation of metals succeeded. An example of the fate of alchemical claims to cure all illnesses was their failure during epidemics of plague that broke out in Europe by the mid 14th century. As a result of this continuous series of failures, defenses of alchemy began to appear. Well-known are short testimonies of such recognized personalities as Helvetius or van Helmont (5), but even entire books were written with the same intent: to testify that transmutation is a real and feasible process. This kind of alchemical work, particularly common in the 17th and 18th centuries, can be roughly divided into two main groups. In the first, the author compiled important ideas from older sources, as did Kelley in his treatise (6), to mention a typical example. In the second, the author collected stories about successful transmutations to prove the truth of his claims, while also including a thorough and penetrating analysis of alchemy. The book *Die Edelgeborne Jungfer Alchymia* discussed in the present paper belongs to the second group. Familiar with arguments in opposition to alchemy, its author led a polemic against them;

thus, this book is not only a passive description of alleged successes, but an active explanation of alchemy as a science; hence, *Die Edelgeborne Jungfer Alchymia* is an extraordinary work in late European alchemy.

This book appeared in 1730, too late to exert significant influence on science in general and alchemy in particular. By then new chemical discoveries, including the first known chemical elements (cobalt, 1737/8; nickel, 1751), had changed the scene (7). Moreover, the relatively high number of alchemical books still in print at that time produced an informational noise in which *Die Edelgeborne Jungfer Alchymia* was lost (8). Yet this book of limited influence on the 18th century scientists is of interest to present scholars for the following reasons. It is an illustration of the state of late alchemy, written by a practicing, erudite alchemist. Some of his descriptions of experiments reflect doubts as to the possibility of transmutation, which had developed even among believers like himself. In defense of alchemy, key arguments of its opponents are summarized, and the attempts of the author to disprove them reflect the alchemical way of thinking. It is one of a large collection of alchemical stories. In the present work, important details of this book will be discussed within the broader framework of alchemy in general and its late European stage in particular.

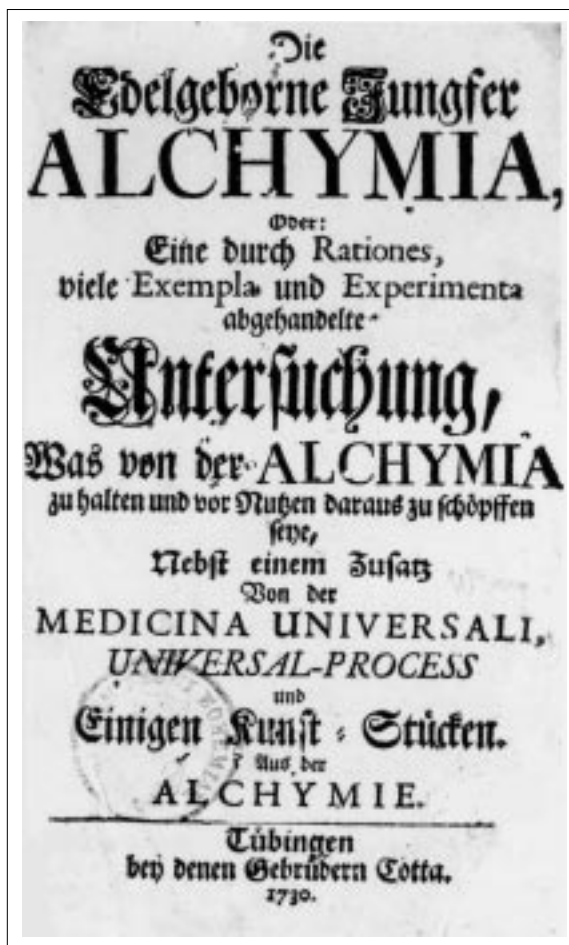
The Book and the Author

The history of this book is quite extraordinary, and its origin is still not explained completely. Originally, there appeared an anonymous, 424-page book entitled *Die Edelgeborne Jungfer Alchymia* (9) [referred to hereafter as *Die Edelgeborne*], dated 1730. In this same year, the identical German text was published by Samuel

Roth-Scholz under a different title, *Ehren-Rettung der Alchemie* (10). Ferguson (11), analyzing the origin of this book, found yet a third, identical version from the same year, entitled *V.F.S.P. Edelgeborne Jungfer Alchymia* (12). Further searching led him to conclude that the author was J. C. Creiling (13), and that the manuscript which appeared simultaneously under three different titles was completed as early as 1717. The title page and list of contents were included in Roth-Scholz's *Bibliotheca Chemica*. In Ferguson's opinion, the title *Ehren-Rettung der Alchemie* must have been withdrawn or canceled almost immediately, because copies bearing this title are extremely rare. Creiling's authorship was confirmed by Frick (14), who rediscovered the manuscript mentioned by Roth-Scholz in the archives of Bochum, Germany. This manuscript had been presented to Carl Arnold Kortum (1745 - 1824) by Creiling's daughter-in-law in 1784. Kortum confirmed that it was that one which appeared as *Ehren-Rettung der Alchemie*. No explanation has been found as to why this book appeared under the name *Die Edelgeborne*, not

to mention its third title. According to Ferguson, all three books are identical.

Johann Konrad Creiling (born July 9, 1673, Löchgau, Württemberg; died September 13, 1752, Tübingen) was a talented son of a parish priest. He studied theology, history, anatomy, botany, and mathematics at the Tübinger Seminarium, where he obtained the degree "eines Magisters der Weltweisheit" in 1692. He then pursued mathematics, studying in Basel with Bernoulli, in Paris with l'Hôpital and de la Hire, and with other scientists. Creiling then spent 44 years as a professor of natural science [Naturlehre] and geometry [Meßkunst] at the University of Tübingen. According to Kortum, Creiling was an extraordinarily learned man with a deep interest in "der Höheren Chemie," alchemy. He employed several assistants in his private laboratory,



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and kept a detailed diary between 1737 and 1751, a resource Frick did not find in the Bochum archive. Ferguson also cites Creiling's further works on mathematics (15) and alchemy (16).

Creiling explains his reason for writing this book in the preface. As a young scholar studying nature, he came across processes concerning changes in metals. In his search for experts in this field he found some, but they turned out to be swindlers. Later he met "a doctor," almost 80 years old, said to be a "master," who accepted Creiling as his "filius artis;" but after fifteen years it became evident that he also was a fraudulent alchemist. Disappointed by this experience, Creiling decided to search independently for cases of successful transmutation and to study original alchemical literature. This narration is a classical alchemical story involving an anonymous master, who, having donated the philosopher's stone and presided over successful transmutations, disappeared, leaving no traces (17). Later, when the fortunate adept had used up his precious gift, he was at a loss because he did not know the recipe. An exceptional example is the attempt by the alchemist von Richthausen to solve this problem when he had depleted his supply of the tincture, allegedly received from a stranger. An announcement was officially published seeking the unknown master. Should the producer of this miraculous substance appear before the court of Austrian Emperor Ferdinand III (1608 - 1657), he was promised a reward of 100,000 thalers (18). Creiling's version of his study of alchemy is a typical account in which both mysterious teachers and impostors appear.

As is apparent from the second mentioned title of Creiling's book [*Die Ehren-Rettung*], it was written in defense of a science that "was given to people, as a gift from God and a celestial wisdom under the disdainful name alchemy." The intention to purge alchemy of its bad image apparently led the author to symbolize it as an innocent virgin. This symbol was widely used in alchemy: the assumption and coronation of the Virgin were understood as the glorification of matter (19); and, as pointed out by Gebelein (20), St. Mary was identified sometimes with Sophia, the personification of wisdom. Distillation, a process so crucial in alchemy, was given the sign of the Virgin (21). It may be significant that the word "alchemy," die Alchemie, is feminine in the German language.

The Contents of the Book

Die Edelgeborne is divided into five chapters:

I. Ob die Verwandlung der Metallen möglich seye? (Whether a change of metals is possible?); pp 1 - 19). This chapter is devoted to the most common objections against alchemy. Their rejection by the author illustrates the typical argumentation of alchemists.

II. Ob die Verwandlung der Metallen irgendwo würcklich geschehen? (Whether a change of metals has really happened anywhere?); pp 20 - 306. Among the characteristic arguments alchemists used to defend their science were stories of alleged successful transmutations. Testimonials by renowned scholars were popular (5); but also various artifacts of precious metals, allegedly produced by transmutation, kept in cabinets of curiosities, were common in European castles since the Renaissance (22). The major part of *Die Edelgeborne* deals with stories of this kind. From the most widely known episodes are those about Helvetius [Johann Friedrich Schweitzer], Johann Böttger, Alexander Seton, Paracelsus, Nicolas Flamel, Arnald from Villanova, Albertus Magnus, Johann Kunckel, Basil Valentin, Robert Boyle, the Saxonian Elector Augustus and his wife Anna, and David Beuthers. Particular attention is paid to the Emperor Rudolf II and two outstanding figures of his time, Edward Kelley and John Dee; but even the impostor Domenico Manuel Caetano is included in this chapter. Baron von Chaos, Wenzel Seyler, Ramon Lully, and General Paykull are involved in accounts of coins or medals being struck from the alleged alchemical metal. Cited from Reyher (23) are cases of coinage from the cities of Erfurt, Mainz, and Gotha.

III. Ob man einige experimenta habe, aus welchen die Möglichkeit der Verwandlung der Metallen kan abgenommen werden? (Whether there are any experiments from which a possibility of change of metals can be deduced?); pp 307 - 349. Creiling, a practicing alchemist himself, cites some experiments from other sources; but more valuable are the comments based on his own observations. In expounding on his own view of the composition of matter, Creiling describes the state of alchemy in its final stage.

IV. Was von der Medicina Universali, dem Auro potabili, u.d.g. zu halten seye? (What should be thought of Medicina Universalis, Auro potabili, and the like?); pp 350 - 384). Creiling's discussion of the medicinal properties and the use of the "universal medicine," as he denoted the potable gold, is not quite clear; his inter-

est was primarily focused on the transmutation of metals.

V. *Ob die Alchymia jemanden, und besonders grossen Herren zu rathen seye?* (Whether Alchymia should be recommended to anybody, particularly to lords?); pp 385 - 396). For centuries, alchemy had been the domain of the aristocracy; only later did wealthy burghers participate. Here Creiling poses the general question of the position of alchemy in his time. This science, considered as *donum dei*, was supposed to be accessible solely to those chosen by God. At the end of the book two short descriptions of alchemical processes are given (24), followed by the list (25) enumerating allegedly successful acts performed through the art of alchemy.

Creiling's Defense of Alchemy

It was a difficult task to defend alchemy in the first half of the 18th century, for strong arguments posed by its opponents had gradually prevailed by that time. Creiling chose to respond to five of the most common objections by opponents of this science that appeared with increasing frequency in the previous few centuries. Each of Creiling's arguments will be dealt with separately below.

The first objection against alchemy entertained by Creiling was the claim that different species created by God cannot be mutually changed. For example, the opponents say that an apple tree cannot be transformed into a cherry tree (26). Creiling's argument on this point is crucial, because it touches on the very basic tenet of alchemy: whether transmutation is indeed possible at all. In an effort to provide a convincing positive answer, alchemists had collected arguments for support of transmutation over centuries.

In the Hellenistic world (27, 28), it was believed that the Aristotelian elements, the supposed constituents of matter, could be mutually transformed by the change of one quality. Jabir (who will be considered the author of Jabirian corpus in this paper) defended a similar approach in his detailed explanation of the "inner" and "outer" qualities of metals (29). Theoretically, transmutation was thus considered a quite possible process, but this led to a second question: could everything indeed be mutually transformed, or are there certain limits? Along with this theoretical support alchemists needed practical proof that transmutation can be *achieved by humans*. Alchemical literature abounds in discussions

of transmutations effected by some external intervention, usually by a miraculous substance such as the philosopher's stone, elixir, etc. These examples pertained almost exclusively to metals. As stated by Al-Iraqi (active in the 13th cent. AD) (30):

We say and maintain that two species of natural things which differ radically and essentially cannot be changed and converted into the other by the Art, as, for example, man and the horse. But these six bodies can be mutually converted: thus lead may be converted into silver,..." [as the six bodies gold, silver, copper, iron, lead, and tin are enumerated in the preceding paragraph of the text].

While there was no doubt that the mutual change of metals occurred with an external agent, other chemical reactions which could be performed without any such agent were mistakenly understood as transmutations. The striking example of the reduction of metallic copper on the surface of iron from cupric solutions misled even as highly skilled a craftsman as Lazarus Ercker (1528/30 - 1594) (31). Another process that could have supported belief in transmutation was cupellation (32), because it could be misinterpreted as the change of a part of lead into silver. In Renaissance Europe, cupellation was already a very sensitive method to detect even small impurities in precious metals declared by some alchemists to be the purest preparation [for the methods of the alleged transmutation see Karpenko (33)]. Even more intriguing is the fact that alchemy attained one of its greatest efflorescences by that time: it is enough to remember the Rudolfian era in Bohemia (34). A seemingly unlimited possibility for the transmutation of metals was thus confirmed.

Later, however, doubts about transmutation arose from the realm of chemical reactions. For example, Alexander von Suchten (? 1520 - ? 1590) (35) excluded the possibility of transmutation of copper to gold, and lead to tin (36), but without explaining why. The erroneous explanation of valid observations led Robert Boyle (1627 - 1691) to the conclusion that there exist chemical reactions, such as the alloying of metals, in which the components forming a given substance remain unchanged, as, for example, when various metals are alloyed. On the other hand, he explained the synthesis of lead acetate as a transmutation, because it did not decompose into the original constituents in subsequent distillation (37). This approach to argumentation in favor of alchemy, based on gaps in contemporary chemical knowledge, persisted until the 19th century. An excellent example is given by Schmieder (38), who claimed that alchemists must not be misled by the argument their

opponents usually use: *Species in speciem non mutatur*. According to him the opponents say that it is unlikely that oxygen could be changed into carbon, and therefore, the same should be valid for the probability that lead or silver could become gold. In Schmieder's opinion, the fact that pure metals [regulinische Metalle] are not divisible [he means into their supposed elementary constituents] is nothing more than an assumption based solely on experience; but it is far from the truth (39):

The inability to decompose them [metals] does not mean the impossibility.

He further gives the argument that bodies belonging to one class have something in common. Acids, for example, extracted from plants all contain oxygen, carbon, and hydrogen. The proportion of these elements, and of possible additional elements, determine the resulting type of acid. Likewise, nobody doubts the chemical similarity in the family of metals, and thus there must be something common contained in them as well. It is, according to Schmieder (40), "Mercurius, or however we want to call it."

While the intervention of an external agent seemed to prevail in the transmutation of metals, quite a different kind of process could be invoked by nature. Even in ancient times, a belief existed that flies are born from fouling flesh, and this phenomenon entered alchemical literature as an example of transmutation. Latin Geber (41) writes that a strangled calf changes into bees and a dead dog into worms. Later, less extreme and thus more convincing examples were brought in as arguments, the most spectacular being van Helmont's (1577 - 1644) experiment with a willow tree, seemingly proof that water can be transmuted into wood (42). Boyle, who repeated the same experiment, but with a shorter duration, arrived at a somewhat less optimistic conclusion (43). Quite another kind of example of a change induced by nature appears in the treatise of Fabre (1588-1658) (44, 45). The author observes that for millennia people accepted as a matter of fact that all food and drinks taken into their bodies are transformed either into red human flesh or to blood of the same color. This, according to Fabre, supports the idea that a stone exists which is able to produce a red or white color in metals.

These second kinds of processes, induced by nature, were modeled from the observation of living matter, when no apparent external intervention of a mysterious substance was involved, unlike the transmutation of metals with the aid of the philosopher's stone. Yet the natural processes were less readily accepted, as ex-

emplified in Schmieder's words (46); he found it more surprising when apricots are found growing on a grafted plum tree than when metals are made more precious. In using natural phenomena to argue against transmutation, Nicolas Guibert (? 1547 - ? 1620) stated that various members, even of the same species, cannot be changed, either by nature or by art (47). He compared the disappearance of members of the animal and mineral kingdom, using as representative examples, respectively, a horse and the metal lead. The horse disappears through death, an irreversible process; conversely, the death of lead is its calcination, which is reversible because the metal can be recovered from its oxide.

From the above examples it can be seen that alchemists could defend their ideas by citing natural or externally induced transformations; and this is what Creiling actually did when he defended alchemy. In his comments (48), he stressed that the words "species" and "genus" are "school-words" [Schulwörter] that should be understood as technical terms only, not as symbols of limits of possible changes. When an animal, say a cow, feeds on grass, some amount of this grass is transformed into the flesh of this animal. There occurs thus a certain kind of transmutation. Because the differences between metals are much smaller than those between living things, the transmutation of metals should be easier, and therefore, quite a plausible process. The analogy with a cow is due to Fabre (45), although Creiling does not mention this author. Either he did not know Fabre's book, or else this kind of argument was so widely accepted among the contemporary alchemical community that he felt no need to cite a source.

Over the whole span of alchemy, divine influence was considered as playing an important, sometimes even crucial, role in this activity. Surprisingly, Creiling, as late as the first half of the 18th century, emphasizes strongly the religious aspects in the three remaining arguments in defense of alchemy.

The second objection addressed by Creiling is the observation that the alchemical literature contains many contradictory assertions concerning the possibility of transmutation. This literature indeed abounds with contradictions: the philosopher's stone is described by some as a solid substance, by others as a liquid; information about the duration of transmutation varied widely (from days to months); and statements on the technical details of the "Great Work" itself were often conflicting. While Creiling acknowledges the existence of discrepancies, he argues that there are discrepancies even in the words

of God in Scriptures and yet nobody doubts their truth. According to him the same is true with alchemy; in this science the discrepancies are only illusory, and there is one truth hidden behind them. Discrepancies and illegible segments in alchemical texts, dating from early times, is usually explained as an intentional device to limit use of the treatises to initiated readers, and purposely to make the texts inaccessible to outsiders. The Chinese Taoist scholar Ko Hung (approx. 280 - 340 AD) expressed this attitude quite clearly many centuries ago (49):

I therefore compose this book solely to inform connoisseurs.

Creiling does not comment on discrepancies as an intentional corruption of information but rather takes recourse in a unique religious argument, which seems outdated at the dawn of the European Enlightenment. According to him even the most sacred text is an example of confusion; but he pursues the idea no further. Shortly before Creiling, in his comments on the later edition (1725) of Fabre's book, Horlacher used the classical alchemical explanation (50):

...one has not to look at and to take notice of the recipe (or process), but of the secret meaning of the philosophical sentences of this teaching...

This was a typical approach used since Ko Hung's time; the potential adept has to search behind the letters of the text.

It was not an easy task to reject the third objection to alchemy: centuries of failures. According to nonbelievers, "this science has been nothing but a sweet dream." To counter this argument, Creiling repeats traditional claims of the alchemists but includes two conditions. First, none can learn alchemy alone but must be initiated by a Master of the Art, who can decipher the secret language. Here Creiling, who describes himself as a true alchemist, seemingly contradicts his claims from the introductory part of his book: namely, that, having revealed his teacher as a deceiver, he continued to study alone. This apparent contradiction is explained by the second condition: good fortune with the teacher alone does not guarantee eventual success, because alchemy is a gift of God. Thus, only God selects the people who will succeed in the Great Art. This motif of alchemy as *donum dei*, which appeared in the Hellenistic world, played an important role during the whole alchemical era (51). According to his own claims, Creiling ranked himself among those who had been selected by God, for he was able to succeed solely by studying books (52).

The fourth objection to alchemy is a religious one. Is it not a sin to perform alchemy? If indeed, according to Old Testament doctrine, *everything* created by God was good (53), any attempt to improve it could be looked upon as claiming oneself to be higher than God, or in other words, that God's work was not perfect. If, however, alchemy is seen as *donum dei*, to what extent are mortals allowed to use this divine gift, if at all? Intense religious alchemical views are given in Siebmacher's treatise. This author rejects the idea that alchemy could have been a sort of black art exercised by the powers of hell (54). He nevertheless warns that Satan, "that grim pseudo-alchemist" lies in wait; that only true faith in God leads to success. It is an obvious attempt to distance alchemy from everything that smacked of sorcery and black magic, at the time of the last wave of witch hunts in central Europe (55). Siebmacher even went so far as to identify the philosopher's stone with Jesus Christ (56):

We shall thus understand that the earthly philosophical Stone is the true image of the real, spiritual, and heavenly Stone Jesus Christ.

Creiling responds to this religious objection with a practical example (57). Would it be a sin if gold were made from iron, which, like other metals, is in itself already perfect because it serves people? His negative answer is justified by the creation of a yet more noble metal. He chooses two other examples which he describes as transmutations: the formation of beautiful red cinnabar from mercury and sulfur and creation of a deep blue color from black cobalt. Such processes are not sinful, according to Creiling, because nobody objects to them. He still regarded as transmutations the very same chemical processes that many of his contemporaries already explained as changes different from transmutation. In fact, it was the synthesis of cinnabar and production of other salts that eventually led researchers to the idea of a chemical compound. Yet Creiling rejects as transmutation attempts where alloys are made only to resemble gold, calling them "a common practice." The "true" alchemy is thus the real transmutation, the change of the substance.

The last point is not an objection against alchemy because it is based upon the *a priori* principle of the transmutation of metals. Rather it raises the question of the efficiency of alchemists over nature. While nature needs millennia to bring metals to full perfection, the alchemist claims to simulate in a laboratory the same metallic processes within a substantially shorter time, the length of a human life. The ancient conception of

ripening of metals in the bowels of earth (58) was reflected in the writings of as skilled an expert as Vannoccio Birunguccio (1480 - 1539), who, in his *Pirotechnia*, comments on the formation of antimony (59):

.....it might be a material that is about to reach metallic perfection, but is hindered from doing so by being mined too soon.

Georgius Agricola (1494 - 1555) writes in *De Re Metallica* in a similar way about the generation of metals by nature (60).

Creiling's comment on this point (61) is not quite convincing. While he stresses the necessity of artificial intervention, in this case by an alchemist, he carefully avoids the very basis of this objection: the acceleration of the human over the natural processes. He compares the intervention of an alchemist to that of a gardener, both striving to bring conditions to perfection faster than nature does. Creiling's rather reserved response may have reflected opposing opinions (62) which appeared in the 18th century. Common metals do form within the earth, but nature then leaves them in a form unchanged until the end ("until the end of the world") and "does not work them further into gold."

Creiling's View of the Composition of Metals and of Transmutation

The composition of metals, indeed of matter in general, was a key question for alchemists, because they constructed their theories of transmutation on its answer. Three main theories were gradually proposed and worked out: the Aristotelian theory of four elements, the sulfur-mercury theory attributed to Arabic alchemists, and, eventually, the Paracelsian tria prima: mercury, sulfur, and salt [for details see Leicester (63)]. Over time, intertwined and more or less confused views developed in which the important role was attributed to mercury, as a rule in its vaguely characterized "philosophical" form and later, in the 17th century, also to antimony (64). Although significant progress in the chemical treatment of metals, especially in the production of their salts, developed from the 16th century onward, yet the absence of a consistent theory of the composition of metals led inevitably to two opposing explanations of these transformations. Either they were alchemical transmutations or some process other than transmutation. It was during this transitional period that Creiling wrote his book, and in his discussion he had to deal with the fundamental question of metallic composition. Perhaps

it is surprising that Creiling, an experienced and dedicated alchemist, does not propose any theory of his own but instead chooses among those already existing. He was attracted to authors who proposed the existence of a larger number of basic principles than the classical three or four in order to solve the misunderstanding of the nature of chemical reactions. Creiling writes in the introductory part of his Chapter III (65) that many alchemists are "blind" and do not understand anything about the real composition of metals. He recommends the work of Andrea de Solea (66) as a correct explanation. According to Solea the body of metals [Metallische Corpus] consisted of seven constituents: 1 earth [eine Erde], 2 stone [Stein], 3 earth-ashes [Erd-Asche], 4 earth-liquids [Erden-Flüsse], 5 glass of earth refuse [Glas des Erden Müll], 6 color of earth [die Erden-Farb], 7 soot of earth (der Erden-Ruß). After enumerating these constituents, Creiling continues (65):

...And when this Corpus, that is composed from these seven pieces, is brought by the smelter's hand from fragile state to the ductile of metal, it [metal] comes back to the hand of the alchemist, who decomposes it again in its Cinereum, Calicem, Laterem, Vitrum, Colorem, Fulginem, Subterraneas.

This sentence illustrates the status of late alchemists, who actually studied the reactivity of metals. They considered salts and oxides produced in these reactions to be the constituents present originally in metals. Creiling judged that the author who explained this "anatomia metallorum" in an excellent way was F. Clinge (67); therefore, he reproduces in full the passage on copper anatomy from that work, a set of chemical reactions that are difficult to characterize now because of the obscure language of the alchemists. These reactions led to eight alleged constituents of copper; the additional one to Solea's classification being the caput mortuum. Clinge, however, supposed that the true basic constituents of metals were solely the three Paracelsian principles. His classification of "anatomia veneris" was as follows: 1 soul [Anima], 2 terra benedicta of the soul, or the soul of Mercurius [der Anima Terra benedicta, nemlich die Anima oder Mercurius], 3 sulfur, or the other principle, 4 its earth-color that shows which dress sulfur carries concealed under its blue color [seine Erd=farbe, die da anzeigt, was vor Kleidung der Schwefel unter seiner blauen Farbe verborgen trage], 5 the earthglass-flux [das Erdglas-Flux], 6 soot of metals [den Metallen Ruß], 7 salt, or the third principle, 8 caput mortuum, or terra damnata. According to Clinge, there were three principles that actually comprise a metal, while the rest of the enumerated components were "excrementa." Their

number varied among different metals: gold was pure; it consisted solely of the three principles, while silver contained a bit of earth, and iron much more coarse earth.

In their attempts to save their science, alchemists could not ignore the similar works done by chemists, and Creiling was no exception. That he was also acquainted with contemporary trends in chemistry is shown in his comment (68):

At our time Becher has devised his Terras, and famous Mr Stahl explained them better than Becher could do, but the obscurity of principles (Principiorum) and confusion of names persist like before: some used to call Arsenic what others call Mercurium, the third [ones] Sulfur, the fourth [ones] Alumen Fumosum, or some call it even Sal Metallicum,... What, after all, depends on a name?

Creiling took Becher's terra pinguis to be only one further species among many "earths" that confused alchemists and chemists and thus did not warrant much attention. After Creiling describes at length this view of the composition of metals, the question remains as to what he actually understands metallic transmutation to be. In his words, he, as a true philosopher, does not care about the wrangle over words [Wort=gezänck] when alchemists try to describe transmutation because most of them know nothing about it. He gives this definition (69):

I understand under transmutation of metals nothing else, than an extraordinary gift from God, or the Art, through which one gets another [metal] instead of the [original] one, should it happen through the immediate change, or not, be this metal present before hidden in the other [metal], or be it through composition, or another transposition of particles [particulen], or coarctation and a change of Pororum, or [through] a violent action of a common substance, or a substance that penetrates metallic spirit, which [substance] can separate the heterogeneity and collect homogeneous [being], or even through the almighty miraculous hand of God, or in any known or unknown way.

In his polemic against opponents of alchemy, called here "philosophi," Creiling recommends (70):

Should these Herren Philosophi also creep once into those ore mines and try to pay a little attention to the way metals are growing, they would find with all [ores] a fatty mercurialish-metallic, I would say a goldish nature,....

He was convinced that the ability to ripen into gold was hidden in all metals as an *a priori* attribute of inherent "goldish nature." Transmutation was hence simply a process that served to enhance this ability.

Creiling's comment on the possibility of mutual changes of metals (Chapter III) is based on gilding by amalgam (71). Yet, as he notes, gilding is only a mechanical action that does not touch the interior of a metal. When, however, a metal is attenuated [attenuirt] through the action of Mercurium Physice (no detailed explanation of this process is given), then even a minute amount of the tincture can penetrate its pores [Poros]. According to Creiling, this tincture is nothing other than a purified and liquefied gold, attenuated through the action of mercury. This substance should then penetrate the "minimas atomos" of liquid metals like wax or oil and turn these metals into gold.

These comments of Creiling deserve particular attention because they are a reflection of corpuscular views that had already appeared in the works of the Latin Geber (72). The idea that some substance, by entering the pores of another substance, changes the latter into something new was to Creiling a process that could be compared with the coloring of white wine with a dark juice from red grapes. As Creiling points out, however, it could be objected that in this case the substance being changed was wine from the very beginning, unlike mercury, lead, tin, copper, or silver, which are not types of gold. Creiling counters this objection by the argument that all the enumerated substances are metals, just as wine is always wine, whether red or white. Thus, according to Creiling, the transmutation of metals is possible just as the conversion of white to red wine. At the same time, Creiling nevertheless rejects Becher's speculation that gilded silver wire when extended can be transmuted into gold. He explains that in this case it is only a mechanical action during which nothing enters the pores of silver and, therefore, no transmutation can occur.

Creiling between Alchemy and Chemistry

From his writing Creiling appeared to vacillate between defending and doubting alchemy, a reflection of the state of matters in the 18th century, a period in which alchemy was still sufficiently strong to afford some convincing arguments in favor of transmutation. At the same time there was a growing number of observations that forced even such devoted alchemists as Creiling to "alter" or "adjust" their opinions. Several examples from Chapter III of *Die Edelgeborne* will be presented in more detail in order to shed light on Creiling's tenuous position between alchemy and chemistry.

Creiling (73) repeats the story noted by Morhof (74), according to which "through the action of a com-

mon sulfur, gold is extracted from copper, or it even ripens within copper." This story tells of an artisan who melted down one *zentner* [old unit; in Creiling's time usually 51 - 58 kg] of copper and added sulfur repeatedly to the molten metal in order to bring it to "ripeness." When he returned sometime later, he found ten ounces of the purest gold. Creiling accepts this story as proof of transmutation, but the account is actually second-, if not third-hand, perhaps being originally a real and reasonable method, namely the separation of metals with sulfur. As early as the 12th century Theophilus, in his treatise *On Divers Arts* (75), described a method to separate gold from silver by use of sulfur, which was to be added to the molten mixture of both metals "for the sulfur does not consume any of the gold, but only the silver..." Here, there is a metallurgical technique which could have been misinterpreted and eventually transformed into the account described by Creiling. Extraction of gold from silver with sulfur and a small amount of copper, described, for example, by Biringuccio (76), could well be the basis for another purported transmutation.

The second account in Chapter III illustrates Creiling's exact approach to experiments; it is based on his attempt to verify a supposed transmutation process he found elsewhere, the heating of cinnabar [HgS] with fine silver filings, as described in 1684 by Freiherr (Baron) Wilhelm von Schröder, who stood in high esteem in the German alchemical community (77). In spite of the obscure style, a reader can surmise that during the heating, a material sublimes and a black substance appears. The blackish substance, supposed to be cinnabar by Schröder, was apparently black Ag₂S. As a certain amount of cinnabar decomposed, mercury sublimed. Von Schröder found the products of this reaction to be "peculiar," but nevertheless, he considered the process to be the transmutation of cinnabar into silver. The recipe gains importance by virtue of Creiling's commentary as a result of his own experimentation. Creiling, the firm believer in transmutation of metals, was sure that, contrary to von Schröder's opinion, no transmutation occurred in this particular case. He writes (78):

...some 20 years ago being curious I performed this last experiment and found that no transmutation of cinnabar is happening here (as is usually supposed, and Herr Schröder seems to cling to this opinion), but solely silver precipitates in the shape of cinnabar particles, and of the whole silver as much goes off as the little particles weigh, I will not keep it from an interested reader, but will faithfully remind so that nobody here can be deceived by it...

Creiling's experiment bore a feature of modern chemistry, a quantitative approach, less than half a century after Schröder's recipe. Creiling had happened upon a quantitative approach as is obvious from his statement "... as the little particles weigh..." and was convinced it was not transmutation, not the change of the essence of silver, as is expressed from his words that "*silver precipitates in the shape of cinnabar.*" In other words, no silver was lost. Creiling might have applied the same quantitative approach to other reactions as well and arrived at the general conclusion against transmutation. The time was not yet ripe for such discovery, however, and Creiling did not view this one exception sufficient to shatter his conviction. Creiling tried to explain the reaction of cinnabar by comparing it to that between iron and copper (II) sulfate, one of the pillars of alchemy, seemingly an unshakable proof of transmutation (79). Surprisingly, Creiling the fervent alchemist did not consider this crucial reaction to be transmutation, although he does not explain how he arrived at such a revolutionary conclusion. The first attempts to prove that this reaction is not transmutation appeared in the beginning of the 17th century, but they remained unnoticed (80). Even later, Boyle's explanation (81) of this process did not shatter the belief of loyal alchemists so that, for example, Horlacher (82) held firmly to the position that iron can be transmuted into copper. Nearly 70 years later, a treatise appeared dealing exclusively with vitriol; here, in the sixteenth experiment, this reaction is characterized correctly as the precipitation of copper on the surface of iron (83). Yet at about the same time Baron Tschoudy, in his *Alchemical Catechism* (84), wrote that "Mars can be easily converted into Venus" but "not Venus into Mars."

Further on in Chapter III (85) Creiling cites "an easy experiment" from Laurentius Meisner (86), which should convince any skeptic of the validity of alchemy. A mixture of galmei [ZnCO₃], vitriol [CuSO₄], and sulfur should be distilled and the "water" prepared in this way should be poured to "solutio Lunae." A black powder precipitated from this solution should produce gold when melted with borras [borax ?]. In this typical alchemical recipe, quite difficult to decipher, one can only speculate that the black powder is the highly insoluble Ag₂S. Yet, the recipe continues: "Pour common water under the other water and throw a sheet of copper into it, whereupon a beautiful deposit of silver calx falls to the bottom; pour the water out, so thou hast thine silver again..." This text apparently describes the reduction of silver from its solution by metallic copper, as expected from the electrochemical potentials of the two metals.

Creiling writes that the deposited metal is silver, thus the “water” used for this second experiment was a part of “solutio Lunae.” The last sentence of this paragraph explains the aim of these experiments “.....quod Alchymia & Metallorum transmutatio sit ars verissima.” In contrast to Creiling’s conclusion that this is a transmutation, N. Guibert (47) carried out a similar experiment with the intention of disproving transmutation.

In another experiment (87) described by Creiling in Chapter III, he presents himself as a devout alchemist. When a mixture of Luna cornea [AgCl] and half its weight of sal ammoniac [NH₄Cl] is sublimed, there is produced a light-yellow “flores,” a sublimate ascending to the top of the vessel and deposited there. When tapped at the top, these “flowers” fall into the melted luna cornea which turns immediately to “the most beautiful goldish color.” This is nothing more than the melting of silver chloride whose fused form, as “luna cornea” or “horn silver,” turns from a yellow substance into a transparent, viscous orange-yellow liquid (88). At most the addition of ammonium chloride to the dry substance might make the color less intense because of its own white color. According to Creiling, pure gold can be extracted from this luna cornea after its reduction, although he gives no details of this process and offers no quantitative data. Perhaps this experienced chemist considered the process to be transmutation because he isolated minute amounts of gold, present as impurity in his sample of luna cornea. He closes this paragraph with the telling words, “Yet, one has not to expect any profit of it, but only the exploration of truth and a stimulus to further philosophical observations.”

In Chapter IV of his book, Creiling discusses “medicina universalis (89).” He is willing to accept a substance as a “universal medicine” provided it removes everything harmful from the body and blood. He thinks, however, that there is not just one, but there may be many such medicines; and that such a medicine, contrary to the claim of Arnald from Villanova (90), can not cure all illnesses simultaneously. In Creiling’s opinion, significant differences between “universal medicines” exist; there is only one that cures and purifies metals from their imperfect state to the “health of gold” (Gesundheit des Goldes), but he doubts whether one medicine could exist which would act similarly on the human body, the reason being that, contrary to metals, scientists do not know the actual cause of human life or understand what keeps humans alive.

This last point shows Creiling to be a man who stood at the threshold between alchemy and chemistry and

apparently interested in iatrochemistry. Rather careful concerning the possibilities of universal medicine, he was of the opinion that, contrary to metals, the composition and function of the human body are not sufficiently understood. He could not suspect that the same was true for metals as well in his time.

Conclusions

Die Edelgeborne Jungfer Alchymia belongs to those works that allow deeper insight into the final stage of European alchemy. In the closing chapter of his book, Creiling, a believer in alchemy, did not search for causes of its failures within alchemy itself. In his opinion, the cause was not in this science, but in the supposed results of alchemical activities, in promised material riches, and longevity. No wonder that anybody who knew the Art was not willing to reveal its secret to those not familiar with alchemy. Therefore, the only way was to study on one’s own and try to understand the secret of the Great Art; but whom will God enlighten that he will understand? A motif of alchemy as *donum dei* appears here once again and completes the circle. Can it be expected that anybody so enlightened, selected by God, would readily disclose this highest secret? Creiling’s answer is at once negative but contradictory, because he indeed discloses the secrets.

A further point to be stressed here is the question of experimental results and the disposition of products from the recipes he describes. Warning that no riches can be expected, only a deeper understanding of natural phenomena, he opines (91):

.....a journey to America has already helped many 100 people to great fortunes,... (while)...one should expect much less from one or other lucky effects, which he gets through alchemy...one lucky among 100,000 unlucky laborants [alchemists] can be counted.

This is a marked retreat from the position alchemy had occupied in the late European Renaissance, when alchemists were cautious in their promises and sought support from rich aristocracy. There is no longer danger in 1730, as there was three centuries before, when a Czech alchemist wrote (92):

.....beware thee of lords and of high [standing] people, lest thou shouldst not do anything [together] with them nor to rely upon their promises, because they upon seeing the immense work, nobody will do justice to thee, because who has a power, that has a law....

In Creiling's time, as he complains, not many wealthy people were willing to support alchemical studies, exceptions being those of Becher and Stahl. Creiling considered Becher's theory to be a partial work ["particular-Arbeit"] only, which did not explain the essence of the problem. The lack of rich supporters was for Creiling only one of the obstacles; the other was the lack of honest laborants [alchemists]. Although Creiling did not express it openly, he implies that alchemy has come around again to its beginning and that it was necessary to purge this science and return it to its former glory.

Not understanding fully all the changes in European science of his time, Creiling repeated several experiments from older sources but clung tenaciously to the alchemical idea of transmutation, even though he sometimes observed conflicting results. He never advanced to the idea of a chemical compound. Contradictory statements in his book are a reflection of doubts he felt. *Die Edelgeborne Jungfer Alchymia* documents how the deep roots of alchemy still persisted in Europe in the first half of the 18th century.



Medal struck by the Austrian Emperor Ferdinand III in 1648 from gold produced allegedly by the alchemist Richthausen (see Ref. 22)

REFERENCES AND NOTES

- H. J. Sheppard, "European Alchemy in the Context of a Universal Definition", *Wolfenbütteler Forschungen*, **1986**, 32, 13 - 17: "Alchemy is the art of liberating parts of the Cosmos from temporal existence and achieving perfection which, for metals is gold, and for man, longevity, then immortality and, finally, redemption. Material perfection was sought through the action of a preparation (Philosopher's Stone for metals; Elixir of Life for humans), while spiritual ennoblement resulted from some form of inner revelation or other enlightenment (Gnosis, for example, in Hellenistic and western practices)."
- In the present paper alchemical activities of the last 150 years will not be considered.
- <http://www.levity.com/alchemy/referlib.html>; here data about printed alchemical works are summarized.
- According to Ref. 3, out of the total 4,675 books listed there were 1,703 Latin (36%), and 1,667 German (36%) texts.
- F. S. Taylor, *The Alchemists*, Paladin, Frogmore, 1976, 133ff.
- Johannis Ticinensis, eines Böhmischen Priesters/ Anthonii de Abbatia, eines in der Kunst erfahrenen Mönchs/ und Edoardi Kellaei eines Welt-berühmten Engländers vortreffliche und ausführliche chymische Bücher; Allen der Geheimen und Hohen Kunst-Liebhabern zu Nutz und mercklichen Unterricht in Teutscher Sprach übersetzt/und herausgegeben durch einen/der niemahls genug gepriesenen Wissenschaft sonderbaren Beförderer. Mit einer Warnung-Vorrede wider die Sophisten und Betrüger. Hamburg, 1691.
- M. E. Weeks and H. M. Leicester, *Discovery of the Elements*, J. Chem. Educ., Easton PA, 7th ed., 1968, 148ff.
- According to the chart mentioned in Ref. 3, approximately 15 new titles appeared annually between 1725 and 1750.

9. *Die Edelgeborne Jungfer Alchymia*, oder: Eine durch Rationes, viele Exempla und Experimenta abgehandelte Untersuchung, Was von der Alchymia zu halten und vor Nutzen daraus zu schöpfen seye, Nebst einem Zusatz von der Medicina Universali, Universal-Process und einigen Kunst=Stücken aus der Alchymie. Tübingen bey denen Gebrüder Cotta. 1730.
10. *Ehren-Rettung der Alchymie*, oder Vernünftige Untersuchung, was von der herrlichen Gabe, welche die himmlische Weisheit denen Menschen geschencket, und insgemein mit dem verächtlichen Namen der Alchymie belegt wird, zu halten seye. Durch rationes, auch viele curiosa Exempla und Experimenta abgehandelt. Wobey noch von der Medicina Universali Meldung geschiehet. Sammt einem Anhang des Universal-Processes zweyer alten wahrhafften Philosophorum, und kurtzer Consignation etlicher Kunst=Stücke aus der Alchymie. Nicht nur denen Liebhabern dieser edlen Wissenschaften, sondern auch allen andern, was Standes seyn mögen, nützlich und vergnüglich zu lesen. Ehedessen geschrieben von einem bekannten Philosopho. Nun aber auf vieler verlangen an Tag gegeben von einem Liebhaber der Chymie. Herrenstadt, bey Samuel Rothscoltzen, MDCCXXX.
11. J. Ferguson, *Bibliotheca Chemica*, J. Maclehose & Sons, Glasgow, 1906, Vol. I, 182-184.
12. *V.F.S.P. Edelgeborne Jungfer Alchymia*, nebst einem Zusatz von der Medizina universali, Universalprocess und einigen Kunststücken aus der Alchymie. Tübingen, 1730, 8°. (The initial letters stand here for Victrix Fortunæ SaPientia).
13. M. Holzmann, H. Bohatta, *Deutsches Anonymes-Lexikon*, G. Olms, Hildesheim, 1961, Bd. VI, 18.
14. K. Frick, "The rediscovered original MS. 'Ehrenrettung der Alchymie' of the Tübingen alchemist Johann Conrad Creiling (1673 - 1752)," *Ambix*, **1959**, 7, 164 - 167.
15. The mathematical works include *Methodus de maximis et minimis* (1701), and *Polemiken gegen die Leibnitzsche Monadologie* (1722); Creiling's further book on alchemy is entitled *De possibilitate transmutationis metallorum* (1737).
16. K. Frick, "Der Tübinger Alchemist und Professor der Mathematik Johann Conrad Creiling (1673 - 1752)," *Sudhoffs Archiv*, **1960**, 44/3, 223 - 228; Frick mentions another of Creiling's books, *De Erroribus chemicis*, not cited by Ferguson.
17. Popular was a story of G. Stolle, an apothecary from Leipzig; he witnessed the transmutation performed by an unknown stranger allegedly in October 1704; see S. Ch. Kundmann, *Numi Singularies*, Breslau, 1734, 148. David Beuthers (active in the second half of the 16th century) was said to have received the secret from a dying cardinal (again, no name is given): see the introduction [not paginated] by J. Ch. Sproegels, *Universal und Particularia*, bey Samuel Heyl in der St. Johannis Kirche, Hamburg, 1718.
18. A. Bauer, *Chemie und Alchemie in Österreich bis zum beginnenden XIX. Jahrhundert*, Verlag von Rudolf Lechner, Wien, 1883, 126.
19. G. Roberts, *The Mirror of Alchemy*, The British Library, London, 1994, 81.
20. H. Gebelein, *Alchemie*, E. Diederichs, München, 1991, 189.
21. J. Read, *Prelude to Chemistry*, G. Bell & Sons, London, 1961, 137.
22. V. Karpenko, *Alchemical Coins and Medals*, Hermetic Studies No.2, A. McLean, Glasgow, 1998.
23. Samuelis Reyheri, Jc. Antecessoris & Mathematicum Professoris in Academia Christian-Albertina Juridico-Philosophica Dissertatio de Nummis quibusdam ex Chymico Metallo factis, Kiliae Holsatorum, 1692.
24. The first process (pp 396 - 406), written in French, is from the work [title not cited] of D. Zecaire (Zachaire) dated 1567, the second one (pp 407 - 416) in German is a process ascribed to Trevisanus.
25. This list begins: "The old philosophi wrote that it is not their work to make gold and silver, but to perform greater miracles..." These miracles are then described in 59 numbered sentences; the last one is as follows: "Minera perpetua, or to have a gold and silver mine on the oven, from which can be taken at any time *as required*, unceasingly, and without END." The last word END (ENDE) is in capital letters and denotes simultaneously the end of the whole book.
26. Ref. 9, p 2.
27. A. J. Hopkins, *Alchemy, Child of Greek Philosophy*, Columbia University Press, New York, 1934.
28. J. Lindsay, *The Origin of Alchemy in Graeco-Roman Egypt*, Frederick Muller, London, 1970.
29. Syed Nomanul Haq, *Names, Natures and Things. The Alchemist Jabir ibn Hayyan and his Kitab al-Ahjar (Book of Stones)*, Kluwer Academic Publishers, Dordrecht, 1994, Ch. 2.
30. 'Kitab al-'ilm al-muktasab fa zira' at adh-dhahab, "Book of Knowledge Acquired Concerning the Cultivation of Gold by Abu'l-Qasim Muhammad ibn Ahmad al-Iraqi," transl. by E. J. Holmyard, *Hamdard*, **1977**, 20, 7-68.
31. *Beschreibung Allerfürnemsten Mineralischen Erzt unnd Berckwerksarten / wie dieselbigen / und eine jede in sonderheit / irer natur und eigenschafft nach / auff alle Metaln Probirt / und im kleinem feuer sollen versucht werden / mit erklerung etlicher fürnehmen nützlichen Schmelzwercken im grossen feuer / auch Schaidung Goldt / silber / und ander Metalln / sampt einem bericht des Kupffer saigens / Messing brennens / unnd Salpeter siedens / auch aller saltzigen Minerischen proben / und was denen allen anhengig in fünf Bücher verfast / Dergleichen zuvor niemals in Druck kommen. Allen liebhabern der Feuerkünst / jungen probirern und Berckleuten zu nutz / mit schönen Figuren oft abriß der Instrument / trewlich und fleissig an Tag geben. Durch Lazarus Ercker. Gedruckt zu Prag inn der Alten Stadt /*

- durch Georgen Schwartz MDLXXIII, Das dritte Buch, Fol. CV.
32. V. Karpenko, "Transmutation: The Roots of the Dream," *J. Chem. Educ.*, **1995**, *72*, 383-385.
 33. V. Karpenko, "The Chemistry and Metallurgy of Transmutation," *Ambix*, **1992**, *39*, 47-62.
 34. R. J. W. Evans, *Rudolf II and His World*, Oxford University Press, Oxford, 1973.
 35. For details about his life see C. Priesner "Suchten, Alexander von, in C. Priesner and K. Figala, Ed., *Alchemie-Lexikon einer hermetischen Wissenschaft*, C. H. Beck Verlag, München, 1998, 351.
 36. Alexandri von Suchten/ Eines wahren Philosophi und der Arzneyen Doctoris Chymische Schrifften/ all/ so viel deren vorhanden/ Zum erstenmahl zusammen gedruckt/ mit sonderbahren Fleiß von vielen Druckfehlern gesäubert/ vermehret/ und in zwey Theile/ als die Teutschen und Lateinischen/ verfasst. Franckfurt am Mayn/ In Verlegung Georg Wolffs/ Buch. in Hamburg/ Druckts Johann Görlin. Anno MDCLXXX, p 281.
 37. U. Klein, *Verbindung und Affinität*, Birkhäuser Verlag, Basel, 1994, 73, 88.
 38. Ch. Schmieder, *Geschichte der Alchemie*, Verlag der Buchhandlung des Waisenhauses, Halle, 1832, 13.
 39. Ref. 38, p 10.
 40. Ref. 38, p 11.
 41. "Summa perfectionis magisterii," in *Die Alchemie des Gebers*, transl. by E. Darmstaedter, Springer Verlag, Berlin, 1922, 27.
 42. E. J. Holmyard, *Makers of Chemistry*, Oxford University Press, Oxford, 1953, 120.
 43. R. Boyle, *The Sceptical Chymist*, J.M.Dent & Sons, London, 1967, 65, 188; later Boyle found that van Helmont had done the same experiment earlier (p 67).
 44. For details about his life see: B. Joly, "Fabre, Pierre-Jean," in C. Priesner and K. Figala, Ed., *Alchemie-Lexikon einer hermetischen Wissenschaft*, C. H. Beck Verlag, München, 1998, 129.
 45. *Die hell-scheinende Sonne am Alchymistischen Firmament des Hochteutschen Horizonts*. Das ist D. Petri Joh. Fabri, ehmaligen Königl. Französischen hochberühmten Leib-Medici Manuscriptum, oder Sonderbares noch niemahlen Teutsch Heraus=gegebenes Buch/...Durch Conrad Horlacher/...Mit sehr nützlich und oft bewährten Anmerkungen/ auch andern dergleichen raren Schrifften vermehret/ und zum Druck befördert. Nürnberg, 1705, point 24 of unpaginated Introduction.
 46. Ref. 38, p 13.
 47. F. Rex, "Nicolas Guibert—eine Art chemischer Kopernikus," *Chem. Un. Zeit*, **1980**, *14*, 191-196.
 48. Ref. 9, p 4.
 49. *Alchemy, Medicine, Religion in the China of A.D. 320: The Nei P'ien of Ko Hung (Pao-p'u tzu)*, transl. by J. R. Ware, MIT Press, Cambridge MA, 1966, 73. The same attitude persisted over the whole existence of alchemy; in the introduction to Beuthers' book (Ref. 17, p 3) we read that "... der grosse König der Araber/ Geber/ nur zu seiner Nachricht/ und fuer die Filios Artis ...auffgeschrieben."
 50. Ref. 45, p 44.
 51. V. Karpenko, "Alchemy as *donum dei*," *HYLE*, **1998**, *4*, 63-80.
 52. Creiling expresses it openly on the very first page of the preface: "daß der Auctor durch sonderbahre Schickung Gottes vor vielen Jahren in eine solche Profession gesetzt worden, krafft deren derselbe die Natur und Ursachen der natürlichen Dinge erforschen sollte."
 53. Genesis 1:31: "And God saw every thing that he had made, and, behold, it was very good."
 54. Wasserstein der Weysen, das ist, ein Chymisch Tractätlein, darin der weg gezeigt, die Materia genennet, vnd der Process beschrieben wird, zu dem hohen geheymnuss der Vniversal Tinctur zukommen, vor diesem niemalen gesehen. Darbey auch zwey sehr nützliche andere Büchlein der gleichformigkeit vnd Concordanz wegen angehenckt, Nemlich: I. Iohan von Mesung; II. Via veritatis der einigen warheit. Zum verschub in offenen truck gefertigt. Francofurti. Bey Lucas Jennis zu finden. Anno 1619. This book is also mentioned by Schmieder (Ref. 38, p 352). According to Ferguson (Ref. 11, p 383 ff) most historians agree that the author of this book was Johann Ambrosius Siebmacher (or Johann Antonio). He lived in Nürnberg and Augsburg around the beginning of the 17th century. His popular book appeared in further editions 1661, 1670, 1703, 1704, 1709, 1710, 1743, and 1760. Ferguson (p 385) mentions that Kopp quoted the 1736 edition under the letters J. S. N., perhaps meaning Johann Siebmacher Nürnbergensis. In the present paper Part IV, p. 12 of the text is cited from the internet translation: <http://www.levity.com./alchemy/hydrolit.html>.
 55. R. Cavendish, *A History of Magic*, Weidenfeld & Nicolson, London, 1987, Ch. 3; M. Eliade, *Occultism, Witchcraft and Cultural Fashions*, University of Chicago Press, Chicago, IL, 1976, Ch. 5.
 56. This claim of Siebmacher is repeatedly supported by citations from both Old and New Testament, for example: "Behold, I lay in Zion for a foundation a corner stone a tried stone, a sure foundation:..." [Isaiah 28:16]; "Have ye never read in the Scriptures, the Stone that the builders rejected become the head of the corner?" [Matthew 21:42; Mark 12:10; Luke 20:17].
 57. Ref. 9, p 13.
 58. M. Eliade, *The Forge and the Crucible*, Harper & Row, New York, 1962, Ch. 4.
 59. *The Pirotechnia of Vannoccio Biringuccio*, transl. by C. S. Smith and M. T. Gnudi, Dover Publications, New York, 1990, 91.
 60. Georgius Agricola, *De Re Metallica*, transl. by H. C. and L. H. Hoover, Dover Publications, New York, 1950, 12.
 61. Ref. 9, p16.

62. Der Hermetische Philosophus oder Haupt=Schlüssel Derer Zu der Chymie gehörigen Materien/ Ursprung/ und Herkommen aller Metallen und Mineralien, Johann Gabriel Grahl Buchhandlung, Frankfurt und Leipzig, 1709, 24.
63. H. M. Leicester, *The Historical Background of Chemistry*, Dover Publications, New York, 1956.
64. Von Suchten, Ref. 35; yet, the best known is *Triumph Wagen Antimonii, Fratr. Basilii Valentini Benedicti Ordens/Allen/ so den grund suchen der uhralten Medicin/ Auch zu der Hermetischen Philosophy beliebt zu tragen/ Zu gut publiciret/und an Tag geben/ Durch Johann Thölden Hessum. Mit einer Vorrede/Doctoris Joachimi Tanckij, Anatomes & Cheirurgiae Professoris in der Universitet Leipzig, Leipzig, 1604.*
65. Ref. 9, p 309.
66. Although Creiling does not give the title of this work, it is obviously *Philosophische Grund-Sätze von Verbesserung der Metallen* which appeared, according to Ferguson (Ref. 11), as Part II of *Drey curieuse bishergantz geheim gehaltene nun aber denen Liebhabern der Kunst zum besten an das Tages-Licht gegebene Chymische Schrifften*, J. S. Strauss, Leipzig, 1723, Franckfurt am Mayn, 1733. Almost nothing is known about the author except that he published under the name Basil Valentin. Ferguson wrote his name Solea (Nicolaus), while in Christian Gottlieb Jöcher's *Allgemeines Gelehrten=Lexicon*, Leipzig, 1751, Theil IV, p 662, the name is Solea Andreas.
67. As in the previous case with Solea, Creiling does not give the title of this work. It was presumably Franciscus Clinge, *Richtige Weg=Weiser zu der einigen Wahrheit in Erforschung der verborgenen Heimlichkeiten der Natur*, Berlin, 1701. Clinge was a Prussian privy-councilor who completed his studies in 1688. Ferguson (Ref. 11) also failed to find any details about him.
68. Ref. 9, p 323.
69. Ref. 9, p 17.
70. Ref. 9, p 19.
71. Ref. 9, p 325.
72. W. R. Newman, *The Gehennical Fire. Lives of George Starkey, an American Alchemist in the Scientific Revolution*, Harvard University Press, Cambridge, MA, 1994, Ch. 4.
73. Ref. 9, p 339.
74. Daniel Georg Morhof, 1639 - 1691; professor of history in Kiel, Germany, not an alchemist, treated this science as an historian.
75. J. G. Hawthorne and C. S. Smith (transl.), *Theophilus, On Divers Arts*, Dover Publications, New York, 1979, 147.
76. Ref. 59, p 202.
77. W. von Schröder, *Nothwendiger Unterricht vom Goldmachen, den Buccinatoribus oder so sich nennenden Foederatis Hermeticis auf Ihre drey Episteln zur freundlichen Nachricht*, Gerdasio, Leipzig, 1684.
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