

## Chemical remedies in the 18<sup>th</sup> Century: mercury and Alkahest<sup>\*</sup>

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### ABSTRACT

Herman Boerhaave approached chemistry from an intellectual makeup strongly influenced by the latest natural philosophy especially Bacon's brand of induction, prioritizing experiment over rational deduction. Boerhaave rated the alchemical tradition as the one that had more thoroughly studied and explained the natures of physical bodies and the effects they are capable of producing, consequently the alchemists were the closest ones to Bacon's program. Until late in his career, Boerhaave upheld the theory of a metallic principle of metals, mercury in particular; this led to an interest on a mythical universal solvent known as Alkahest and to name mercury as it. Research on mercury had been furthered in Boerhaave's time also due to its use as "specific" in the treatment of syphilis. Application of Boerhaave's notions and methods allowed his disciple Gerard Van Swieten to develop a soluble and thus less toxic preparation of mercury, which was massively applied in the treatment of syphilis during the 18<sup>th</sup> century.

### Keywords:

18<sup>th</sup> century; Medicine; Chemistry; Alchemy; Mercury; Alkahest; Boerhaave.

### RESUMO

Hermann Boerhaave abordou a química a partir de uma perspectiva intelectual fortemente influenciada pela mais recente filosofia natural de sua época, especialmente por uma variante baconiana de indução, priorizando o experimento em relação à dedução racional. Boerhaave considerava a tradição alquímica como aquela que havia estudado e explicado de modo mais extenso e de forma mais intensa as naturezas dos corpos físicos e os efeitos que eram capazes de produzir. Consequentemente, os alquimistas eram aqueles que mais haviam se aproximado do projeto de Bacon. Até quase o final de sua vida, Boerhaave defendeu a idéia da existência de um princípio dos metais, e o mercúrio em particular. Isso o levou a se interessar por um mítico solvente universal conhecido como Alkahest de modo até a postular o mercúrio como tal. O mercúrio era também de grande interesse na época de Boerhaave devido a seu uso como "específico" no tratamento da sífilis. A aplicação das noções e métodos de Boerhaave permitiu que seu discípulo, Gerard Van Swieten, desenvolvesse um preparado solúvel, portanto, uma solução menos tóxica de mercúrio, que foi muito aplicado no tratamento da sífilis ao longo do século XVIII.

### Palavras chave:

Século XVIII, Medicina, Química, Alquimia, Mercurio, Alkahest, Boerhaave.

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### Introduction

Mercury, due to its manifest properties, has been an enigma since the earliest of times. Records show that cinnabar was already known and used in the Neolithic<sup>1</sup>, however, the status of mercury as a metal had not yet been established by the 18<sup>th</sup> century.

Regarding its medical applications, seemingly Celsus used preparations containing cinnabar. Mercury was also mentioned by Aristotle, Dioscorides and Pliny, whereas Galen held it so toxic that he openly admitted he had no experience at all with it either by internal or external administration. Under the weight of such authority, mercury all but vanished from therapeutics until the time of the Arabs, who employed it in external preparations for the treatment of skin diseases.<sup>2</sup>

The outbreak of syphilis in Europe at the end of the 15<sup>th</sup> century called for desperate measures.<sup>3</sup> The old and reliable remedies had systematically failed, opening the path for testing alternative treatments. This was how mercury reentered the materia medica, with a vengeance. The milestones of this story are listed in Table 1<sup>4</sup>.

Table 1. Milestones in Renaissance and early modern use of mercury in syphilis

<b>1488? (before 1496)</b>	First book on syphilis is published: <i>Consilium in Morbum Gallicus/Consilium in Pustulas Malas/De Morbo Gallico</i> , by Conrad Schellig (Heidelberg): warns using mercury cautiously.
<b>16<sup>th</sup> century</b>	<b>Matthioli:</b> probably the first to attempt internal administration of mercury. <b>Paracelsus:</b> the strongest advocate for the use of mercury in syphilis by internal administration <b>Fracastorus:</b> also advises to use mercury and reports the association of its use to salivation 1564: inclusion of mercury in <i>Pharmacopoeia Augustana</i> (unguents)
<b>17<sup>th</sup> century</b>	<b>Sydenham:</b> establishes mercury as specific remedy for syphilis
<b>18<sup>th</sup> century</b>	Search for a soluble preparation of mercury, fit to be fragmented in small doses: mercuric chloride ( <b>Van Swieten</b> ), <i>liquor swietenii</i> .

Several preparations of mercury were developed for medicinal purposes in the course of time. The aim was to find a preparation at the same time effective and less toxic, as the side-effects of treatment with mercury were catastrophic, causing death or affecting the state of health for life. The number of processes and preparations developed by the last quarter of the 18<sup>th</sup> century patently illustrates this concern, as described by Charles Alston (Table 2)<sup>5</sup>.

<sup>1</sup> Leonard J. Goldwater, *A History of Mercury* (Baltimore: York Press, 1972), 72.

<sup>2</sup> Walter Sneader, *Drug Discovery: A History* (West Sussex: John Wiley & Sons, 2005), 44.

<sup>3</sup> Ian Maclean, *Logic, Signs and Nature in the Renaissance: The Case of Learned Medicine* (Cambridge: Cambridge University Press, 2002), 23.

<sup>4</sup> Johanne Astruc, *De morbis venereis libri novem*. Ed. altera (Lutetiae Parisiorum: Guillelmum Cavelier, 1740 ); John Freind, *The History of Physick from the Time of Galen to the Beginning of the Sixteenth Century* (London: J. Walthoe, 1725); Hermann Boerhaave, *Boerhaave's Academical Lectures on the Lues Venerea* (London: J. Rivington, 1763); Gerard van Swieten, *Commentaries upon Boerhaave's Aphorisms concerning the Knowledge and Cure of Diseases* (Edinburgh: Charles Elliot, 1776).

<sup>5</sup> Charles Alston, *Lectures on the Materia Medica* (London: Edward and Charles Dilly and A. Kincaid and J. Bell, 1770).

Table 2. Preparations of mercury.

Crude	Hydrargyrum purificatum E L				
As a vapor	Mercurius ad suffumigia				
Triturated	Alone		Tragea keyferi		
	With honey		Pilulae mercuriales E 1744		
	With balsam		Pilulae mercuriales L		
			Unguentum coeruleum fortis et mitium LE		
			Emplastrum commune cum mercurio L		
			Emplastrum mercuriale E		
	With resin		Pilulae mercuriales E		
			Pilulae aethyopicae E		
	With gum		Solutio mercuriales Plunck		
	With suet		Unguentum mercuriale E		
	With absorbents		Mercurius alcalifatus		
	With sugar		Mercurius saccharatus E		
	With sulfur		Aethyops mineralis LE		
Aethyops antimonialis Ph Paup E.					
Sublimated	With sulfur		Cinnabaris factitia L		
			Cinnabaris antimonio		
Calcinated	Alone		Mercurius calcinatus L		
			Mercurius praecipitatus per se		
	With gold	Mercurius praecipitatus solaris Astruc			
Salinized	With vitriolic acid		Mercurius emeticus flavus L		
			Mercurius praecipitatus flavus L		
			Terpentium minerale E		
	With nitrous acid		Solutio mercurialis E		
			Calx mercurii E		
	With muriatic acid		Mercurius sublimatus corrosivus LE		
			Mercurius praecipitatus albus BH		
			Aqua aluminosa E		
	With vegetal acid		Mercurius violaceus diaphoreticus Astruc		
			Flores ammoniac mercuriales		
			Solutio mercurii per deliquium Astruc		
	Corrected saline preparations	Softened	Abstracting acid	Through calcination	Mercurius corrosivus ruber L
					Mercurius calcinatus E
Mercurius praecipitatus ruber					
By attraction of				Water	Pulvis principis Lewis
				Alcohol	Mercurius corallinus
				Water & alcohol	Panacea mercuri E 44
					Arcanum corallinum Lewis
Camphor				Panacea Mercurii Lewis	
By attraction & precipitation				Of fix acid	Pilulae e turpetho min. Ph Paup E
					Mercurius praecipitatus fuscus E 44
				Of volatile alkali	Mercurius praecipitatus albus L
				Of fix and volatile alkali	Mercurius praecipitatus rubrus L
					Unguento e Mercurio praecipitato L
Of volatile alcohol and copper		Mercurius praecipitatus viridis			
By addition of Mercury		Mercurius sublimatus dulcis LE			
By addition of unguent		Calomelas			
		Aquila alba			
Made and kept acrid	By redissolvent precipitations		Unguentum citrinum E		
	By addition of acid		Mercurius praecipitatus solutus		
	By suspension in ammoniacal salt		Solutio sublimaticum spir. salis		
			Ward's White Drop		
		Mercurius corrosivus muriaticus			

Certainly, the explanations on the possible mode of operation of mercury in syphilis changed in time together with the different conceptions on the nature and workings of matter. The odd features of mercury, allied to the long tradition of alchemical attempts at transmutation of metals and the urgent situation posed by the treatment of syphilis,

conspired to put mercury at the center of the stage of chemical and medical studies in the 18<sup>th</sup> century.

### Boerhaave: experiences, experiments and experimentation

In this context, a key-figure was Hermann Boerhaave (1668-1738), the celebrated professor of medicine, chemistry and botany at Leiden University. His reputation was so esteemed, that Albrecht von Haller called him “*communis Europae preceptor*” – the teacher for all Europe. Students came from all around the world to be taught by him, and his disciples helped to design the map of 18<sup>th</sup> century science.

The reasons for Boerhaave’s smashing success are still a hot topic of debate among scholars<sup>6</sup>, however, an indisputable factor was his primarily practical concerns. Students would be trained in actual clinical practice – which included bedside lectures – as well as in the indication and preparation of prescriptions. Boerhaave’s authentic and spurious works (most commonly, lecture notes published by former students) widely circulated in their Latin originals and in many translations.<sup>7</sup>

Also a subject of intense debate among scholars is Boerhaave’s overall views on nature and the ways to know it.<sup>8</sup> However, it is patent that Boerhaave’s scientific makeup was strongly influenced by the recently developed mechanist framework of natural philosophy, particularly by the current corpuscular theory and in a deeper level, by Francis Bacon’s brand of induction prioritizing experiment over rational deduction. This meant that **fact**<sup>9</sup> – a notion emerging at this time – could only be established through undisputed observations and the immediate consequences inferred from them. Reliable sources were, then: 1) the uncontested experience of both ancients and moderns, requiring extensive and

<sup>6</sup> Harold J. Cook, “Boerhaave’s Flight from Reason in Medicine”, *Bulletin of the History of Medicine* 74 (2000): 221-40.

<sup>7</sup> Boerhaave listed his authorized works in *Elements of Chemistry*. Concerning this work, our main focus of interest in this paper, the authorized edition was published in Latin in 1732. There are several translations into English: we used the one by Timothy Dallowe as root-source (London: J. Pemberton; J. Clarke; A. Millar; and J. Gray, 1735) as well as a 1727 English translation by Peter Shaw and Ephraim Chambers of a non authorized 1724 Latin edition titled *A New Method of Chemistry* (London: J. Osborn & T. Longman, 1727), which is patently consistent with the later authorized edition and supplies the modern scholar further pieces of information on Boerhaave’s chemical ideas, as it will be seen later in this paper. It must be noticed that differences between editions may be at the ground of different modern interpretations, for instance, Bernard Joly – see below – used as source a French 1754 translation by Allamand, where Boerhaave’s final opinion on Alkahest is seemingly not mentioned; Ursula Klein, “Experimental History and Boerhaave’s Chemistry of Plants”, *Studies in the History and Philosophy of Biological and Biomedical Sciences* 34, No 4 (2003): 533-67, on 535-6, used a later edition of Peter Shaw’s “second edition” translation, of 1741, seemingly unaware of Shaw’s 1727 translation (where he had already changed the title of the work); see also G. A. Lindeboom, *Herman Boerhaave: The Man and His Work* (London: Methuen & Co, 1968) and *Bibliographia Boerhaaviana* (Leiden: E. J. Brill, 1959); I. Bernard Cohen, *Benjamin Franklin’s Science* (Cambridge [MA]: Harvard University Press, 1990), 167.

<sup>8</sup> See Cook, “Boerhaave’s Flight”; *Matters of Exchange: Commerce, Medicine, and Science in the Dutch Golden Age* (New Haven: Yale University Press, 2007), esp. ch. 10; Klein; and John C. Powers, “Chemistry without Principles: Herman Boerhaave on Instruments and Elements”, in *New Narratives in Eighteenth Century Chemistry*, ed. L. Principe (Dordrecht: Springer, 2007), 45-62 - relating Boerhaave’s intellectual makeup to the Baconian and Boylean brand of natural philosophy recently developed. Conversely, Andrew Cunningham has seen Eirenism as the ultimate motivation behind Boerhaave’s enterprise, “Medicine to Calm the Mind: Boerhaave’s Medical System, and Why It was Adopted in Edinburgh”, in *The Medical Enlightenment of the 18<sup>th</sup> Century*, ed. A. Cunningham & R. French (Cambridge: Cambridge University Press, 1990), 40-66 and Rina Knoeff, a Calvinist foundation, *Herman Boerhaave (1668-1738), Calvinist Chemist and Physician* (Amsterdam: Koninklijke Nederlandse Akademie van Wetenschappen, 2002) and “Practicing Chemistry ‘After the Hippocratical Manner’: Hippocrates and the Importance of Chemistry for Boerhaave’s Medicine”, in *New Narratives in Eighteenth Century Chemistry*, ed. L. Principe (Dordrecht: Springer, 2007), 63-76.

<sup>9</sup> All emphases in this paper are the authors’.

intensive scanning and sifting of all available literature; 2) direct observation of nature, either spontaneous or induced by intentional interferences.<sup>10</sup>

In previous papers, presented and published since 2002<sup>11</sup>, we have discussed Boerhaave's notions on "experiment", particularly regarding the chemical context. As it was previously remarked by scholars, one of the traits that made Boerhaave's work noticeable was to hold experience as one of the chief instruments for theoretical reflection. This, unfortunately, misguided some scholars into approaching Boerhaave exclusively through the lens of Enlightenment, making thus his apparent alchemical views unexplainable.<sup>12</sup> However the latter are clearly understood when related to the Baconian framework: what Boerhaave sought for in his extensive – and seemingly obsessive, to our modern eyes – search in the literature were "true experiments": chemistry could only admit a theory grounded on "general Propositions", in turn derived from chemical experiments.<sup>13</sup> In this context and in his own words:

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<sup>10</sup>In this context, it has been neglected the actual chronology of sources available to Boerhaave during his period of formation. Powers, "Chemistry Without Principles", 48, believes that works on recent natural philosophy were available while Boerhaave was a student and that his appointment to a position at the university library "allowed him a much greater access to books than the ordinary Leiden student", from where he concludes that this was the context where Boerhaave "first discovered the work of Robert Boyle". Although we agree with Powers, as well as with Cook, *Matters of Exchange*, 386, on that the appointment to the library supplied Boerhaave access to the latest literature, it must be noticed that in fact, Boerhaave got this appointment in 1693, after taking his medical degree (and long after taking his philosophical degree), as he had dropped out from the theology course and the financial support from the university had ended. Jan van der Berg, secretary of the Curators and sponsor of Boerhaave, intervened to arrange this position for him, as Boerhaave had no resources to earn his life. During the nine months in this position, the university acquired the library of Isaac Vossius, that came to update the collection, which had been outdated in science since 1625, see Elfriede Hulshoff, "The Library", in *Leyden University in the Seventeenth Century: An Exchange of Learning*, ed. Th. H. Lunsingh Scheurleer & G.H.M. Posthumus Meyjes (Leiden: Universitair Pers Leiden; E.J. Brill, 1975), 395-449, on 442-4. However, it is premature to state exactly what books Boerhaave had access to, as the catalogue of the Vossiana has not been concluded up to the present time: only a part of the 729 MSS and an insignificant part of the almost 4,000 books that composed it have been catalogued; the part of the library devoted to science and medicine has not yet been approached. Personal communication by Astrid C. Balsem, curator of the Vossiana; see also Hulshoff, 459; K.A. de Meyier, *Codices manuscriptorum/Bibliotheca Universalis Leidensis*, vol. 6 (1955) and vols. 13-16 (1973-1984); P.C. Boeren, vol. 17 (1975), containing the so-called "Vossiana Chymici"; Dirk de Vries, "Atlases and Maps from the Library of Isaac Vossius (1618-1689)", *International Yearbook of Cartography*, 21 (1981): 177-94. 179 books were catalogued by Balsem em "*Libri omissi*" italiani del Cinquecento provenienti dalla Biblioteca di Isaac Vossius: ora nella Biblioteca della Rijksuniversiteit di Leida (Leiden: Bibliotheek der Rijksuniversiteit Leiden, 1994), as well as the "Books from the Library of Andreas Dudith (1533-89) in the Library of Isaac Vossius (1618-89)", in *Books on the Move: Tracking Copies through Collections and the Book Trade*, ed. R. Myers, M. Harris and G. Mandelbrote (New Castle (DE)/ London: Oak Knoll Press/ The British Library, 2007), 69-86.

<sup>11</sup> Ana M. Alfonso-Goldfarb & Márcia H. M. Ferraz, "A Discussão sobre o Princípio Metalífero da Matéria na Royal Society e a Recepção das Memórias de H. Boerhaave sobre o Mercúrio", III Encontro da Associação para Filosofia e História da Ciência do Cone Sul, Águas de Lindóia (SP), 27-30 May 2002; published in *Filosofia e História da Ciência no Cone Sul: 3º Encontro* ed. R. A. Martins et al. (Campinas: AFHIC, 2004), 29-35; Ana M. Alfonso-Goldfarb & Márcia H. M. Ferraz, "Experiências e 'experimentos' alquímicos e a experimentação de Hermann Boerhaave", in *O Saber Fazer e seus Muitos Saberes: Experimentos, Experiências e Experimentações*, ed. Ana M. Alfonso-Goldfarb & M. Helena R. Beltran (São Paulo: Livraria da Física; Educ; Fapesp, 2006), 11-42. On Boerhaave's experiments of plants, a paper presented by Ana M. Alfonso-Goldfarb, Márcia H. M. Ferraz and Sílvia Waisse at the XXIII International Congress of History of Science and Technology, Budapest, 28 July – 2 August 2009 will be published in 2010 in a special issue of *Annals of Philosophy and History of Biology*, ed. Brigitte Hoppe & Nicolas Robin.

<sup>12</sup> Goldfarb & Ferraz, "Experiências", 11-2.

<sup>13</sup> Hermann Boerhaave, "Sermo academicus quem habuit quum honesta missione impetrata botanicam et chymicam professionem publice poneret...", in *Boerhaave's Orations*, trad. & notes E. Kegel-Brinkrave & A. M. Luyendijk Elshout (Leiden: E. J. Brill; Leiden University Press, 1983), 214-36.

“Among all the Writers of Natural Philosophy, it has not yet been my fortune to meet with any, that have more intimately examined, and evidently explain’d the nature of Bodies, and the effects they are capable of producing, than those that have gone by the name of Alchemists [...] So that in reality, these men attempted to found such a Philosophy, as the great Lord Verulam, so earnestly wish’d for; [...]”<sup>14</sup>

Boerhaave’s laboratory work, particularly on chemical subjects, began very early – already as a university student - and lasted until the end of his life. Indeed, as he himself stated, he resigned in 1729 the Chair of Chemistry to have more available time “to indulge in chemical studies”<sup>15</sup>. To our modern eyes, this side of Boerhaave’s activity, viz. experimentation, does not need any justification as it lies at the root of the present-day prevailing model of science. However, an equal devotion to literature study, particularly the older one, strikes an odd chord when understood as “experiment”. However, as stated above, at that time both laboratory work and analysis of extant literature constituted “experiment” and with this idea in mind that we must approach the following discussion.

### The mythical universal solvent

One subject that vividly awakened Boerhaave’s interest was *Alkahest*, the mythical universal solvent, to which he devoted a special section in the chapter on “*menstruums*” of his *Elements of Chemistry*. The reason was that, if actually existent, it would be

“[...] the most excellent favour, that the Divine Being ever indulged Mankind [...] This, without dispute, would be vastly more valuable than any Philosopher’s Stone, and much more to be wished for, as by the help of it might easily be obtained the most certain means both of Health and Riches”<sup>16</sup>.

Boerhaave’s epistemological makeup is clearly evident here: in order to make a true notion on the subject, the best resource was to make a historical account as collected from all authors who had ever dealt with the subject.<sup>17</sup> Coherently, he scanned all available literature to finally admit that the only relevant source were the writings of Jan Baptist Van Helmont (1580-1644).<sup>18</sup> Although seemingly Paracelsus (1493-1541) had been the first introducer of this term, Boerhaave explains that “*no mortal would ever have thought of any such thing [as an universal solvent]*”<sup>19</sup>. Paracelsus had mentioned the term “Alkahest” only once in his writings, describing it as a remedy for liver diseases. In this context, Boerhaave openly admits not to be a “*master of the [this] secret*” and that the only thing he could do was to examine carefully the literature as “*I know no better way of coming at it [...]*”<sup>20</sup>.

Accordingly, he consciously surveys the name, etymology and synonyms of Alkahest, reviews its suggested virtues, modes of operation, physical effects and properties, to close the section with a thorough discussion on the possible identity between Alkahest... and mercury!

This strikes an odd chord, as there are no hints pointing out to Van Helmont ever having established a link between Alkahest and mercury. Much less Paracelsus ever

<sup>14</sup> Boerhaave, *Elements* (1735), I: 72-3.

<sup>15</sup> Boerhaave, “*Sermo academicus*”.

<sup>16</sup> Boerhaave, *Elements* (1735), I: 489.

<sup>17</sup> *Ibid.*

<sup>18</sup> In the 1727 edition of *Elements*, on 363 Boerhaave is quoted saying that indeed “a library might almost be collected of the books written upon the alkahest”, authors include Boyle, Weiderfelt, Philalethes, Pantaleon, Tachenius, Ludovicus “and a thousand others”.

<sup>19</sup> Boerhaave, *Elements* (1735), I:489.

<sup>20</sup> *Ibid.*

attempted to establish such parallel. Bernard Joly suggests that this identification was made by the first generation of Paracelsians in their glossaries and dictionaries, to begin with Michael Toxites' *Onomastica* (1574).<sup>21</sup> Paulo Porto concedes this point, while stressing that this argument is strengthened by the fact that Walter Pagel had earlier shown that to Paracelsus both mercury and Alkahest were also choice remedies for hydrops.<sup>22</sup> This quandary requires a closer look at Boerhaave's construction.

In his view, the alterations introduced by the chemical art in the bodies belonging to the three kingdoms of nature were exclusively due to motion, therefore, the art of Chemistry, in last instance, only did was to unite or separate bodies: to resolve compound bodies into their simples and recombine simples into compounds. In this context, the ultimate boundary in nature were some corpuscles that when perfectly separated from all the others could not be further modified by any known cause and could not be further divided, viz. what the philosophers called "elements": fire (principle of motion), water (diluent and vehicle of nutrition), earth (principle of stability), wine alcohol, **mercury** and the "*Spiritus Rector*" of each individual body.<sup>23</sup> In this paper we focus the attention on the latter two such "elements".

Based on the alchemical tradition, Boerhaave believed that animals and plants possessed a kind of "aura" or vapor peculiar to each particular body and expressing the true nature of the body in which it resided and ruled, distinguishing it from all other bodies, both originating and animating them. So subtle and spirit-like the *Spiritus Rector* was that it could only be recognized by its smell and taste as well as by some particular effects. For this volatile spirit to be confined and remain in its proper body, according to Boerhaave,

*"the all wise Creator has united it with a tenacious, durable Oil, which neither Air, Water, or natural heat can easily dissipate; that by this means, being entangled in its viscosity it might not too readily fly off, and so leave the body it was design to govern, and moderate"*<sup>24</sup>.

To Boerhaave, aromatic plants were an ideal model to study this *Spiritus Rector*,<sup>25</sup> however also minerals and even metals had their own *Spiritus Rector*, the difference being that in the latter it was "locked up [...] and that whenever they can extricate themselves from their fetters, and become free, they then grow vastly active" becoming immensely fine and consequently, able to insinuate within other bodies turning "**exceeding efficacious in the cure of diseases**"<sup>26</sup>.

In Boerhaave's view, metals were the traditional six: gold, silver, copper, lead, iron and tin. The characteristic mark of metals was their weight; besides this, they were substances that melted under fire to unite again after exposure to cold and were ductile under the hammer. Obviously, mercury did not share in the latter picture, however it was the heaviest substance after gold. It was precisely these characteristics that had made it so enigmatic since the earliest of times. According to Boerhaave, mercury was the simplest among bodies, including gold, and even asks if it could be "**the fluid face of gold**". Moreover, he overtly states that mercury is the principle of all metals to the point that chemical combination between mercury and all the other metals would depend on their

<sup>21</sup>Bernard Joly, "L'Alkahest, Dissolvant Universel, ou quand la Théorie Rend Pensable une Pratique Impossible", *Revue d'Histoire des Sciences*, 49, No 2/3 (1996): 305-44, on 315-7.

<sup>22</sup>Paulo A. Porto, "Summus atque felicissimus salium": The Medical Relevance of the Liqueur Alkahest". *Bulletin of the History of Medicine*, 76, No 1 (Spring 2002): 1-29, on 7

<sup>23</sup>Boerhaave, *Elements* (1735), I: 46; 74.

<sup>24</sup>Ibid, I: 47-8.

<sup>25</sup>Goldfarb, Ferraz & Waisse, forthcoming.

<sup>26</sup>Boerhaave, *Elements 1735*, I: 49. On 74, Boerhaave restates: "[...] the Spirits called Rectores are sealed up, and do not appear in Metals so long as they are dead; but that when they are resolv'd, open'd, and vivified, then they manifest themselves, and produce very sudden and wonderful effects [...]".

relative contents in mercury; in this context, and this needs to be kept in mind for the purposes of our discussion, Boerhaave states that, *by natural affinity, mercury unites with itself*.<sup>27</sup>

Elaborating on this idea, Boerhaave explains that mercury and gold are composed of two principles: their matter, which would be common to both, and a “*second principle, which gives its particular form to each one and thus must be of a rather different nature*”<sup>28</sup>. All remaining metals included also a third component: a “*lighter substance, peculiar to each metal, viz. an earth*”<sup>29</sup>. Chemistry allowed one to resolve metals in these components through the use of “*mercury, a resuscitating salt or fire*”, i.e. *metals could be transmuted one into another as an exclusive function of their contents in mercury, including gold itself*.

Coming back to Alkahest, Boerhaave highlights this notion from Van Helmont’s writings:

“[...] this Solution [...] reduces all Bodies into a kind of Salt that may be dissolved in Water, Mercury alone excepted, which on account of its perfect simplicity [...] radically resists all division possible to be effected, either by Art or nature, and for this reason is perfectly indestructible”.<sup>30</sup>

Which he interprets within the context of his **own** chemical framework:

“By this means, therefore, all these Bodies are converted into a saline volatile Matter, which still retains their particular *Spiritus Rector*. Hence it may be intimately mixed with any Humor of the human Body [...] and in its whole passage every where exert those powers which are proper to it, with regard to our Body. These, therefore, where called Potables”<sup>31</sup>.

Despite his many and emphatic claims of merely presenting trustfully the issue of Alkahest as reported in extant literature<sup>32</sup>, from this moment on, analysis of the text clearly shows that Boerhaave builds his own argumentation from selected fragments of Van Helmont’s texts on Alkahest, which as a result, is highly elliptical. As a first piece of evidence, let us see how he introduces the issue:

“[...] of everything we want in Physics, it is vastly the most to be wished for. You will, no doubt, therefore, be mighty solicitous to know in what kind of matter it ought to be sought; for which reason<sup>33</sup>, I will add a few words upon this head, having tried a vast variety of things myself, which I have sometimes repented of with indignation.”<sup>34</sup>

Boerhaave (not Van Helmont) associates Alkahest with two solvents developed by Paracelsus. The first arose from an “*infinitely tedious circulation from Sea Salt*” from which he obtained an oil which he called *Ens primum salium*, *Oleum salis*, *Liquor salis*, *Aqua salis*, *Circulatus Sal-minor* or *Circulatum minus*<sup>35</sup>. To substantiate his interpretation on Van

<sup>27</sup> Ibid, I: 19-21; 23.

<sup>28</sup> Ibid, I: 26.

<sup>29</sup> Ibid.

<sup>30</sup> Ibid, I: 494.

<sup>31</sup> Ibid, I: 495,

<sup>32</sup> Ibid, I: 497.

<sup>33</sup> To notice: to guide his students/readers in this search.

<sup>34</sup> Ibid, I: 497.

<sup>35</sup> Ibid.

Helmont, Boerhaave adds: “*This now agrees exactly with the Opinion of Van Helmont*” who had ascribed to *the Primum Ens Saliuum* the virtues of *Alkabeest*.<sup>36</sup>

The other one, called *Circulatum majus*, *Materies Mercurii Salis* or Living Fire, was even more powerful than the first and incomparably much more difficult to produce. In Boerhaave’s reading, Paracelsus believed that common mercury contained “*the most perfect fire and a latent celestial life*”, i.e. that the quintessence of mercury was “*celestial fire*” when it was dissolved into its “*Mother*” (a salt *Arcanum*). When both were intimately united and purified, made subtle and volatile, they gave rise to the

“wonderful mercurial Water, which he [Paracelsus] describes in the Chapter of *Corrodente specifico*, where he says that Gold so dies there, that it continues to be Gold no longer; whereas in all other corrosions of Gold, the Gold is only divided into very small Particles, but still remains the same true Gold, and by an artificial reduction may be always recovered again.” and can be later recuperated”<sup>37</sup>.

Boerhaave concludes: “*By this art, therefore, there is a perfect union of Water with Water: For there is a two-fold Water, viz. a common one which is in Salt, and a metalline one, which is in Mercury [...]*”<sup>38</sup>.

It is worth to mention that in the 1727 edition of *Elements*, this elaboration is infinitely more direct<sup>39</sup>: Boerhaave states explicitly that Paracelsus’ *Circulatum minus* is a saline *menstruum* obtained from sea-salt and *Circulatum majus*, a mercurial water obtained from mercury through the application of the saline solvent, probably being Alkabeest itself. In this context he adds he tried countless times both procedures to no avail.

At this point, once again Boerhaave calls on Van Helmont to substantiate his own interpretation, by stating: “*Van Helmont seems to have understood [this idea of Paracelsus] in the same way [Boerhaave had done]*”:

“The internal Mercury of Metals, perfectly freed every taint of a metalline Sulphur coheres together with an indissoluble union, so that it radically resists all possible division through either by Nature or Art. Nor could I learn the nature of Water, except under the rod prepared from Mercury’s Wand. And I found the nature of Mercury adequate to Water; For it does not contain the least Earth in it, but is always the Son of Water alone.”

“If I had not seen that Mercury eludes all the labour of the Artists so, that it either flies all off the Fire intire, or else all remains in it, and both ways retains its immutable identity, and the anatic homogeneity of its identity, I should say that the art was not true [...] it is absolutely impossible for either Art or Nature to find any different parts in the homogeneity of Mercury, not even by the *Alkabeest* itself [...] there is in Mercury the *Ratio proxima* of indestructibility [...] all sublunary things are too weak to subdue pure Mercury, or to penetrate, alter, or defile it. It remains secure in Air, Fire, and the acrid Liquor. It is not affected by any Solvent [...] therefore, there is nothing in Nature like this pure Mercury, no not at a distance. it resembles, therefore, the *Ens Metallicum* [...] From these principles, then, we know that **it is [...] changed by its equal alone**. For this anomalous Body in Nature, rose without any commiscible

<sup>36</sup> Ibid.

<sup>37</sup> Ibid, I: 498.

<sup>38</sup> Ibid, I: 498.

<sup>39</sup> Boerhaave, *Elements* 1727, 371-2.

ferment different from itself; but it bit itself, revived from the Poison, and afterwards knows no death.”<sup>40</sup>

As it can be noticed, in this quote there is no mention of any identity between mercury and Alkahest, but an argument for the hypothesis of mercury as the principle of metals, together with the key notion, as mentioned in the beginning of this paper, that “by natural affinity, mercury only unites with its like”.

At this point, Boerhaave states that this is all it can be known about Alkahest from the writings of Paracelsus and Van Helmont to summarize:

“Here, therefore, you see at once that it is in vain to seek for this *Menstruum* in human Urine, or any of its productions [...] in Tartar, or any of its Preparations [...] Nor can Phosphorus ever be reduced to it [...] Glauber too is mistaken, when he seeks it in the fixed Alkali of Nitre: As Zwelfer [...] in the most acid Spirit of Vinegar distilled from Verdegrease. Nor does the famous Guernerus Rolfincius seem to have had a right notion of it, when he supposed it to be threefold from a fixed Alkali as the Basis, viz. on Fossils from an Alkali of Tartar, and Vinegar of Antimony [...]”<sup>41</sup>.

To notice, Boerhaave strengthened his hypothesis by implicitly identifying Paracelsus’ solvents with Alkahest and mixing all this with Van Helmont’s arguments. And in his usual elliptical style, he would quote one more author to state **his** own idea on the nature of Alkahest: “And indeed, no-body in the description of the Alkahest has come nearer to the Sentiments of Paracelsus and Van Helmont, than Peter John Faber, in his Manuscript concerning Alchemy, to the most serene Duke of Holsace [...] out of which these remarkable words *confirm my own opinion*”. Boerhaave made truncated quotes, so we have filled in from Fabre’s manuscript<sup>42</sup>:

“Liquor Alkahest is a pure metallic mercurial spirit, united to its own natural body in such a way that both form one only indissoluble and indestructible substance, which destroys all others and reduces them to their prime matter [...]”

“Liquor Alkahest is nothing but the true Mercury of the Philosophers, [extracted from the mineral kingdom, united to its pure body in such a way that they can never be separated, but subsist together in the form of] a liquor with the appearance of milk or butter which penetrated and dissolves everything.”

“Liquor Alkahest appears under two ways<sup>43</sup>: simple and compound, [but it is one and the same liquor]. As simple, it is prepared from the pure acid of metals and a pure metallic salt volatilized with their spirit. [This is the most important occult reality in all metallic reality] [...] Compound, liquor Alkahest it is even much more difficult to prepare [...] because it is prepared from a mineral acid and a pure animal and vegetal salt.”

“Pure liquor Alkahest, or Mercury of the Philosophers, it is as a fire of incorruptible and inalterable nature, which reduces everything to its prime matter.”

<sup>40</sup> Boerhaave, *Elements* 1735, I: 498-9.

<sup>41</sup> *Ibid*, I: 499.

<sup>42</sup> As reproduced and translated by Bernard Joly, *Rationalité de l’Alchimie au XVIIe Siècle* (Paris: J. Vrin, 1992), 201-7.

<sup>43</sup> Corresponding, thus, to both Paracelsus’ circulated salts.

“[Liquor Alkahest is truly fire, but not elementary fire, but the celestial and central fire, incorruptible and inalterable [...] the natural central fire which is found in everything and that is abundantly concentrated in this liquor Alkahest]”.<sup>44</sup>

Once again it must be highlighted the use Boerhaave made of his sources: in the paragraphs above, Fabre identifies Alkahest with Philosophical Mercury, and not with “material” mercury, and explicitly declares that it is prepared from “*a mineral acid and a pure animal and vegetal salt*”. It must also be remarked the logical game Boerhaave plays in this section of *Elements of Chemistry*: after stating that virtually no information on Alkahest can be obtained from Paracelsus, he ends by referring to “Paracelsus’ and Van Helmont’s Alkahest”.

Boerhaave’s concluding remarks on the Alkahest must be read with the utmost care, as they are a masterpiece of his elliptical style:

“Now, you are ready to listen to my own opinion on this matter and whether I believe that any chemist was ever the master of this Arcanum. To **this** I openly answer: Van Helmont says that he had once a bottle but it was taken from him and could do no experiments. Paracelsus says almost nothing, therefore, I do not know what to say on **this** matter.”<sup>45</sup>

We must insist and stress: Boerhaave clearly states that he could not judge on whether Van Helmont or Paracelsus was ever able to prepare Alkahest. Because, as to himself, he adds:

***“But I will dare to say this, and I advise you to test, examine sea-salt and mercury through all the methods you know: you will never regret this work”***.<sup>46</sup>

It is not superfluous to insist, once again, that interpretations on Boerhaave’s stance regarding Alkahest depend largely from the edition of the *Elements of Chemistry* used as source. Although Boerhaave would authorize only his own 1732 edition of his lecture notes, comparison to unauthorized ones shows that, against Boerhaave’s indignation and warnings, no serious contradictions seem evident and conversely, it suggests that the unauthorized lecture notes published by his students bring information that the master must have conveyed orally but thought wiser to remove from the printed version.

### Epilogue

Indeed, his close disciple Van Swieten would have nothing to regret, as he found the solution to the puzzle of soluble mercury, fit to be divided into very small non toxic doses, making syphilis a treatable disease by employing chloride of mercury.<sup>47</sup>

<sup>44</sup> Boerhaave, *Elements 1735*, I: 499.

<sup>45</sup> Ibid.

<sup>46</sup> Ibid. “Id pro vero dixerim, consuluerimque, Salem marinum, et Mercurium, omni modo Chemico tractate, nunquam poenitebit operare”, Herman Boerhaave, *Elementa chemiae* (Lugduni Batavorum: Joannis Rudolphi Imhof, 1732), vol. 1, 868. Incidentally, Boerhaave was so convinced of the actuality of Alkahest and Van Helmont’s proclaim to possess it that he sent a messenger to the latter’s son, Francis Mercurius, who answered that he did not know whether his father indeed possessed it, but that he had a habit of boasting of more than he could actually perform: Boerhaave, *Elements* (1727), 369. Obviously, this discouraging information did not deter Boerhaave from attempting to obtain Alkahest.

However, this is not the end of this story. Boerhaave's further experiments would eventually lead him to reject the hypothesis of a mercurial principle of metals,<sup>48</sup> and would seek for it in a stranger material known as "Gur", which we will discuss in a separate paper. On the other hand, the history of Alkahest had a most fascinating twist, involving the early Royal Society, the discovery of the lymph system and mysterious characters including Van Helmont's son, Francis... Mercurius.<sup>49</sup>

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<sup>47</sup> Gerard van Swieten, *An Account of the Most Common Diseases Incident to Armies...* (Dublin: John Exshaw, 1766), 121, recipe 66; corrosive sublimate is mercury (II) chloride and became known as "*liquor Swietenii*" due to its mass-scale use after publication of this book.

<sup>48</sup> Goldfarb & Ferraz, "Discussão sobre o Princípio Metalífero"; see also John C. Powers, "Scrutinizing the Alchemists: Herman Boerhaave and the Testing of Chemistry", in *Chymists and Chymistry: Studies in the History of Alchemy and Early Modern Chemistry*, ed. L. Principe (Sagamore Beach [MA]: Watson Publishing International, 2007), 227-38.

<sup>49</sup> A preview of our forthcoming paper was published by Piyo Rattansi, "Rediscovery of Lost Early Royal Society Papers on the Alkahest", *Notes & Records of the Royal Society*, 64 (2008): 407.