In this paper we present three newly rediscovered documents from the Royal Society archives that, together with the four described in our previous publications, constitute a set on a cognate theme. The documents were written by, or addressed to, members of the early Royal Society, and their subject is several magisterial formulae, including J. B. van Helmont’s *alkahest* and *Ludus*. In addition to the interest in those formulae as medicines for various grave illnesses, our analysis showed that some seventeenth-century scholars sought to explain operations of the animal body by invoking similar but natural substances, while attempting to assimilate the latest anatomical discoveries into a novel framework. The complete set of documents sheds some new light on the interests of seventeenth-century networks of scholars concerned with *experimenta*.

**Keywords:** magisterial formulae; ‘animal alkahest’; *experimenta*; Helmont, Oldenburg; Dubois

### Introduction

Three meetings of the early Royal Society discussed an *experimentum* claiming that an animal analogue of the Helmontian *alkahest*, or universal solvent, existed within the newly discovered lymphatic vessels. That *experimentum* was intended to solve a classic problem in physiology, that of digestion and nutrition, in the light of recent anatomical discoveries. In our 2010 paper we announced the discovery of three documents linked to that debate, the first describing the *experimentum* and providing evidence for the claim; the second, by Dr Jonathan Goddard (1617–1675), questioning the claim in a set of ‘Queries’, and a third one furnishing a recipe for the *alkahest* itself. Although its author is

*Author for correspondence (ucrhpmr@ucl.ac.uk).*
not explicitly named in the first document, we identified him as the Thuringian physician Tobias Ludwig Kohlhans (1624–1705). Nevertheless, at least three questions remained unresolved. One was that of locating Kohlhans’s answer to Goddard’s criticism, which was referred to in the Society’s minutes. Another was to search for any traces left by the debate in other contemporaneous records. The final one was that of identifying the author or copier of the alkahest recipe.

In this paper we announce the discovery of three new documents that throw further light on the aforementioned questions: one contains Kohlhans’s detailed response to each of the points raised by Goddard. The second is a list that includes the ‘animal alkahest’ among experimenta discussed at meetings of the Society during the presidency of Sir Robert Moray (1608–73). Finally, we are also now able to establish the identity of the person who copied the alkahest recipe, through a third document that includes both political intelligence and another recipe much sought after at the time.

SUMMARY OF KOHLHANS’S REPLIES TO GODDARD’S QUERIES

During the 1650s the post-Vesalian anatomical discoveries brought to light a major defect in the time-honoured explanation for the digestion of food and its conversion into blood in animals. Galen had given primacy to the liver as the main organ of sanguification. The new discoveries revealed that there was no direct pathway from the duodenum to the liver, and that the absorption of the nutritional materials involved, among other considerations, a hitherto unknown set of vessels. Their acknowledged discoverer, Thomas Bartholinus (1614–80), had called the fluid contained in them lymph and the vessels the lymphatics.

Among the many solutions soon advanced to replace the Galenic views, the one suggested by Kohlhans drew upon a prominent challenger of traditional natural philosophy and medicine, J. B. van Helmont (1579–1644). He had offered a new account of digestion in place of the Galenic one, substituting fermentation and acid–alkali reactions for ‘innate heat’. Kohlhans’s experimentum (figures 1 and 2) read by H. Oldenburg (ca. 1617–77) at the Royal Society accepted that view, but went further by suggesting that the fluid contained in the lymphatic vessels was an ‘animal counterpart’ of a famous preparation that Helmont himself had claimed to possess: an alkahest or universal solvent. Helmont attributed to it the power to dissolve any material whatsoever, separating its essential constituents, and withdrawing itself immediately after having accomplished its task, ready to resume it once more. According to Kohlhans, that same power ought to be assigned also to the fluid contained in the lymphatic vessels. The claim was supported by an account of experiments on canine subjects and the testimony of witnesses, in close accordance with the rules laid down by the Society.

Kohlhans’s experimentum was based on methods associated with Leyden University, in particular with Johannes Hornius (1621–70), Thomas Bartholinus and Johannes Walaeus (1604–49), and consisted of dissection and vivisectional experiments on animal subjects. Goddard’s central objection was to the taste that Kohlhans had attributed to the fluid he had found in the lymphatic vessels. Whereas he consistently employed for it the expression grata aciditas (a pleasant sourness), Goddard took it as ascribing ‘acidity’ to that fluid. It was an important issue for the debate, because the action of an ‘animal alkahest’ was not expected to leave behind it an acidic taste.
Goddard took up that issue in his very first query. Bartholinus had named the fluid ‘lymph’, specifically because it was ‘meer water’, quite distinct from any ‘serose, acidic or acrimonious humour’, and those who had subsequently investigated the lymphatic vessels had found no reason for departing from that view. In his reply, Kohlhans again used the expression *grata aciditas* and drew on the testimony of ‘four or five others’ that had confirmed his impression.

In his second query, Goddard made out a case for an alternative explanation for any ‘acidity’ found in the lymphatic organs, drawing analogies from familiar processes. If the animals in Kohlhans’s *experimentum* had been starved for a long time, there would be greater ‘acrimony’ in their blood and humours, as took place in honey or any sweetened liquor stored for a long time, unless a ‘potent spirit’ had been added to them. Was not...
that a far more likely explanation than ‘separation and mixture of one and the same seminiall
matter’ from ingested food?

In his reply\(^{17}\) Kohlhans challenged Goddard’s analogy, claiming that experience
confirmed that honey and other liquors could be preserved without deteriorating,\(^{18}\) unless
they contained a ‘ferment’.

He also suggested that in considering this question, attention
ought not to be confined to the vessels but also to the parts surrounding them.
Kohlhans conceded that the fluid might have tasted insipid to some, because after the *alkahest* had acted on the material present in it and extracted the nutrient portion, it took time for it to recover its original perfection and its ‘pleasant sourness’. That conjecture was supported by the absence of any immediate arousal of hunger in the animals, despite having been starved for a long time (in his recollection for up to 24 hours), during which their stomachs were in continuous movement. Nevertheless, fasting could have promoted only a slightly greater, but by no means excessive, acridity.

In his third query Goddard argued that if such liquor existed in an animal body, it would vary in no important respect from the other humours to be found therein, sharing with them a constant variation in quantity. If an additional power was assigned to that liquor, namely that of regenerating itself after each completion of its task, so did the ferment employed daily in breadmaking and brewing. That made it quite unnecessary to invoke a ‘seminiall’ ferment with extraordinary powers to explain digestion.

Kohlhans replied that quantitative variations in the ‘animal ferment’ ought not to be considered until all the parts involved in the process had, without increase or diminution, been subjected to a ‘sequence of digestions’. He agreed that the ferment involved would maintain itself quantitatively, more or less as took place in the familiar processes of breadmaking and brewing. But the comparison was faulty in two respects. In the first place, the fermentative process involved in baking differed from that in brewing. In brewing, the material added to the already fermenting beer did not unite physically with it but rather ‘aroused’ in it something similar to itself, resulting in a fermentative agitation. At the completion of the process, the ferment separated itself, and was ready for use indefinitely. The second distinction was between ferments prepared through art and the ‘purely natural’ ones working in our bodies, because the latter are prepared and conserved by us and could be augmented at will by us. Nature, however, followed a more consistent course.

Kohlhans then reverted to an earlier reply, by adding a further distinction between the action of the ferment involved in baking and brewing respectively, and between them and the ‘animal ferment’. The ferment used for baking was ineffective unless it penetrated and impregnated the dough, whereas the one added to beer not only penetrated the material but also separated the impure from the pure. The ‘animal liquor’, by contrast, not only penetrated and dissolved, as it separated pure from impure in the stomach, but also carried away with itself the pure and ‘congruent portion of the aliment’. In any event, the ferment of the bread, as it penetrated and dissolved the dough, joined it and remained so. But the ferment of the beer, after dissolving, separated itself entirely and rose to the surface. Kohlhans then returned to his earlier remark about the ‘animal ferment’, to add that the ferment in the [gastric] ventricle, after dissolving, separating and purifying, transported the residual material through the veins and the heart. Finally, discharged from its duties, it separated itself and was ready to undertake that task anew.

Goddard’s fourth query concerned the size of the corals placed in the liquor (as a colour indicator for acidity) and whether their colour was altered only superficially or deeply throughout. Kohlhans replied that they were of the size of peas, remained colourless both inside and outside, and were friable at the touch of a finger.

Goddard also suggested that more experiments were needed to establish the ‘animal *alkahest*’ claim. If such a liquor existed, it would possess a very ‘peculiar property’, that of dissolving alimentary matter within animal bodies and extracting from it what the body needed. Had the claim been tested by applying the liquor to the particular food items...
eaten by various sorts of animals, and, if so, with what success? When acting on food, did it dissolve it as a whole, or did it extract a milky liquor from it, like that present in the receptacula chyli?

Kohlhans, in concluding his replies, made some mocking comments on the task he was being urged to undertake. He freely admitted that he had not performed any such experiments but cast doubt on their value. Would they have any chance of success, because any liquor, parted from the containing vessel, was lifeless and turned ‘cadaverous’ very soon, losing its original potency? Yet he was being asked to clarify the issues raised in the queries and engage in a supposedly ‘worthwhile labour’ by performing numerous experiments, not only on dogs, but also on hares, that were thin and debilitated after a long period of starvation. His considerable familiarity with such experimentation compelled him to ask: would this liquor even be present in vessels that were now enfolded ‘in the sleep of death’? Was he expected to determine whether the matter of this liquor was a seminal principle, by pushing his inquiries as far back as its generation in the first conformations of a fetus?

The arrangement and style of Kohlhans’s reply is of interest, because it began as a point-by-point answer to each of Goddard’s queries, but then contained some abrupt shifts to add further considerations bearing on earlier queries, and ended with more than a hint of irritation. In this regard it is worth observing that the documents describing the experimentum and the reply to Goddard are in Oldenburg’s handwriting. It is therefore safe to assume that the latter presented them at the Royal Society meetings on behalf of the visiting ‘stranger’. In turn, the style of the reply tends to suggest that the comments were not embodied formally in a document by Kohlhans but instead were delivered verbally to Oldenburg and written up as an aide-mémoire by him.

KOHLHANS’S ANIMAL ALKAHEST IN CONTEMPORARY RECORDS

Because the polemical exchange between Kohlhans and Goddard was so rich in experimental data, for which the Royal Society had always declared a marked preference, our next question, which rose almost naturally, was: Would one not expect to find at least traces of the discussions on the ‘animal alkahest’ in contemporaneous records?

Bartholinus notified of ‘animal alkahest’ (1654)

Indeed, well before the Royal Society discussions in 1661, the ‘animal alkahest’ suggestion and the experimental evidence presented by Kohlhans had already attracted the attention of Thomas Bartholinus, the purported discoverer of the lymphatic vessels. It reached Bartholinus in a letter dated 15 November 1654 (n.s.) from a former student and later a champion of his priority claims, Georg Segerus, very shortly after Kohlhans had put forward the suggestion in the dissertation for his medical licentiateship with summi in Medicina honores at Heidelberg University.

The news had reached Segerus himself through another intermediary, Johann Christian Agricola (1590–1668), who wrote to him soon after attending the disputation and personally witnessing two dissections performed by Kohlhans. Although Segerus was in Copenhagen at that time, Bartholinus was away in Roskilde, and Segerus asked his pardon for interrupting the ‘weighty affairs’ (gravissima negotia) that claimed his attention. Segerus drew his attention to the section on the lymphatic vessels, forming the
second part of Kohlhans’s thesis, and to the novel *primogenitura* he had asserted therein concerning ‘your lymph’, and in particular to the *grata aciditas* ascribed therein to that fluid. He supplemented it with excerpts from the dissertation, provided by Agricola, and with dates and other details concerning the experimental support that Kohlhans had offered for his ‘animal alkahest’ claim.

The theses excerpted included verbatim those in which Kohlhans made his ‘animal alkahest’ claim. It was initially raised as a possibility in Thesis 5932 and developed as a longer account in Thesis 65.33 The others were anatomical descriptions based on dissections (Theses 53–56),34 and Thesis 6035 described a ligature experiment. Agricola furnished two dates for experimental vivisectional support: the first was 31 October (N.S.) and the second was 4 November (N.S.). In the first dissection Kohlhans had displayed four broad and large lymphatic vessels above the gall bladder. His skill in dissection was also evident during the second canine dissection when he displayed below the liver a certain part from which water dripped when it was sectioned, although it was not possible to see any vessel inserted in it.

Finally, Thesis 63,36 a very short one, was probably cited because it referred to *iste humor acidus*. As has already been discussed previously, although Goddard had challenged the ‘acidity’ attributed by Kohlhans to the fluid in the lymphatic vessels, Kohlhans was always very careful to maintain a distinction between ‘acidity’ as such and a *grata aciditas*. When replying to Goddard’s queries, he cited the testimony of ‘three or four others’ who had also tasted the fluid and confirmed his observation. Agricola was apparently among those witnesses because he noted that, during Kohlhans’s dissection on 31 October (N.S.) the lymph extracted from it, when tasted, verged on acidity, but quite unlike the acidity ‘inhering in the spleen’, thus amplifying the dissimilarity that Kohlhans was at great pains to maintain. He insisted on that distinction because, to sustain the analogy between the workings of an *alkahest* within animal bodies and of the Helmontian *alkahest* when it acted on any material substance, it must in both instances be the result of a perfectly ‘natural’ process, and must in no way involve an ‘acrimonious’ liquor or humour.

Some points of particular interest emerge from the Segerus letter and the selections that he and Agricola made from among the theses that constituted Kohlhans’s dissertation. One is their choice of observations and conclusions supported by anatomical dissection and experiments, which seems to have involved Agricola as a participant or at least as a witness. Another is the close similarity between the points highlighted for particular attention by Segerus and Agricola on the one hand, and by Jonathan Goddard on the other, when entrusted with that task by the Royal Society. The first and most important is the *grata aciditas* attributed by Kohlhans to the lymphatic fluid. Goddard tried his best to raise doubts about that claim. Agricola, in contrast, highlighted it and specified a date on which experimental support was provided for it.

Although no reply has yet been found that casts more light on Bartholinus’s own response to Kohlhans’s animal *alkahest* claim, it is surely significant that Bartholinus chose it from among his vast correspondence for inclusion among those to be published in the first volume of his scholarly collection of medical letters. Whether by chance or not, it was published in 1663, not long after the Royal Society devoted no fewer than three sessions to it.

‘La liste’ of experimenta at the Royal Society

Our further researches brought to light another document from the very same period as Kohlhans’s reply to Goddard, which also mentions the *alkahest*. Written in French, it is a
list of ‘experiences’ presented at Royal Society meetings during the presidency of Sir Robert Moray (figures 3–5). Item 52 in it bears the title: ‘De la Liqueur dans les vases Lymphatyques, et s’il a quelqu[e] affinité avec l’Alkahest de van Helmont’ (‘On the liquor contained in the lymphatic vessels, and whether it bears any affinity to van Helmont’s Alkahest’).37

The document is entirely in French, and a thorough analysis of the handwriting allowed us to establish its author as Oldenburg, who habitually wrote personal notes to himself in that language. Its title is ‘La liste des Experiences faites dans la Société royale d’Angleterre durant la Presidence du Chevalier Mourray’ (‘The list of experiments carried out at the Royal Society of England under the presidency of Sir [Robert] Moray’). When checked against Thomas Birch’s edition (1756) and other documents, its itemization agrees with a significant number of the experiments mentioned in the minutes for the sessions held in 1661 and 1662,38 under Moray’s provisional presidency.39

At first sight the list seems like an aide-mémoire or draft that Oldenburg had prepared for later inclusion in the minutes of the corresponding sessions. However, Oldenburg customarily wrote drafts and personal reminders to himself in his diary,40 whereas this selection of experiments, drawn from sessions held at the Royal Society over a period of two years, seems to have been written down all at once and on a separate sheet of paper.41 On those grounds, one may conjecture that those experiments had attracted Oldenburg’s, or the Royal Society’s, attention for some particular reason.

However, the wide variation between the experiments mentioned across the 91 items that compose the list makes it difficult to set them apart from those routinely reported in the minutes. Moreover, several studies, notably those by Marie Boas Hall, have drawn attention to the great variation between the observations and experiments recorded in the Society’s minutes, ranging from those that were never tested to ones that had actually been performed (whether at the Society’s request or not). Some were performed at premises other than the Society’s, although under its supervision, depending on their complexity, the means employed or the experimenter’s convenience. Many examples of this category of experiments are related to studies in barometry, ballistics and anatomy.42 Hence the ‘animal alkahest experimentum’ as reported by Kohlhans, and subjected to thoroughgoing scrutiny by such a dependable member as Goddard, belongs to that category.

To sum up, it is difficult to pick out any particular reason for Oldenburg’s choice of Kohlhans’s presentation and others from among a great mass of different experiments for his ‘liste’. Nevertheless, the very fact that he chose Kohlhans’s contribution and summarized it at some length in the title strongly indicates his particular interest in its content. That conclusion is supported by other evidence bearing witness to his sustained interest in the alkahest and other universal remedies, from his first arrival in England until the end of his life.43

That interest in magisterial formulae was almost always accompanied by a concern with their reproducibility, as well as with other issues related to laboratory processes and experimentation as a whole. Some such issues were openly raised by a significant number of Royal Society Fellows, for instance about the starting materials, which represented one of the few laboratory parameters known at that time. One particular focus of interest in that regard was the possible presence of impurities in the materials, and how they could interfere with the actual or expected final products. Those concerns, which appear frequently in Oldenburg’s papers on Royal Society matters,44 contributed in time to paving the road for the formulation of parameters for laboratory work relative to both processes and materials. That
Figure 3. "La liste des Expériences faites dans la Société royale d'Angleterre durant la Présidence du Chevalier Mourray". (Classified Papers 174, 'Miscellaneous Papers', f. 1r, Royal Society Archives.)
Figure 4. ‘La liste des Experiences faites dans la Société royale d’Angleterre durant la Presidency du Chevalier Mourray’. (Classified Papers 17/4, ‘Miscellaneous Papers’, f. 1v, Royal Society Archives.)
road, however, reached its destination only many centuries later, when present-day concepts such as high-purity standard chemicals (pro analysi reagents) were formulated.\textsuperscript{45}

\textbf{Identification of the Handwriting of the Alkahest Recipe and Discovery of Further Records}

Our third question proved even more difficult to answer: who wrote, or brought to England, the recipe for the \textit{alkahest} mentioned in the minute for 30 October 1661?\textsuperscript{46} It differed from
the other documents in that neither the one containing the recipe nor the minutes of sessions in which it was discussed mentioned any name that could assist our researches. However, because the record in the minutes stated ‘the description of the liquor alkahest [is to] be transcribed and kept’, the manuscript could be either the original ‘description’ or its transcription, as directed. Hence, the first place to start our search was in the ‘Classified Papers 11’ volume on ‘Pharmacy and Chemistry’, where we had first discovered the recipe for the alkahest. In fact, the volume contains a large number of recipes of a similar kind, and among them was located one that, although not the one that we were looking for, consisted of notes handwritten by the very same person who had copied the recipe for the alkahest.

The title of that recipe is ‘Processus de Bois’ (figures 6 and 7). The marginalia appended to it, in French, dealt with the delicate political situation in England following...
the death of Lord Protector Oliver Cromwell (1599–1658) and the short-lived government of his son Richard (1626–1712), more particularly with the Wallingford House meetings. At those meetings, some senior officers of the New Model Army were appointed, on 26 October 1659, to the second and last of the two ‘Committees of Safety’ pending the formation of a new Council of State. The notes provide an accurate list of the 23 persons appointed to that ‘Comité pour la Securite de la republique’ at the chapel of Wallingford House:

That record allows one to date the annotations exactly to 2 November 1659 (N.S.), and their content clearly shows that the recipient of the information was someone that was not currently in England but was nevertheless directly involved in, or highly concerned with, the ongoing political situation in Britain. Was this person a Frenchman? If so, who was he? But then, could a Frenchman have been considered so trustworthy as to be sent sensitive information on the English political situation? Was he a spy or, perhaps, one of the many English exiles in France? To make things even more complicated, it was the same person who had copied the recipe for the *alkahest* that had been filed in the Royal Society archives.\(^{51}\)

To summarize the positive data that we have: this person was someone highly trusted in England who wrote his personal notes in French and therefore was most probably not an Englishman. Analysis and cross-checking of documents available at the Royal Society allowed us to conclude that this foreigner, who was closely involved not only in English affairs but also with the group that led to the founding of the Royal Society, was none other than Henry Oldenburg himself.

Oldenburg’s handwriting in his *Commonplace Book* (MS/1), and more particularly in the section that corresponds to the period discussed here, as well as in letters he seemingly wrote in a hurry,\(^{52}\) is exactly the same as the one in the notations added to the recipe described in document C1.P/11i/11. We would, moreover, emphasize that the handwriting in such letters is strikingly different from the one in the copies made by Oldenburg, or in formal documents that he wrote as Secretary of the Royal Society. These documents also bear witness to Oldenburg’s habit of writing personal notes to himself in French, as in the case of ‘La liste’ mentioned above. Moreover, in 1659 Oldenburg was in France accompanying his tutee, Richard Jones (1641–1712), while being continuously updated concerning the English situation, as is very evident from his correspondence.\(^{53}\)

We say more below on the identity of the author who gave Oldenburg the document that he later felt free to annotate with political intelligence, and on why Oldenburg was engaged in a search for such recipes after first discussing the possible origin of the recipe described in that document.

**Dubois’s Recipe in the Royal Society Archives and Related Documents**

This recipe bears the title ‘Processus de Bois’, and, as mentioned above, is included in C1.P/11i, a volume devoted to pharmacy and chemistry. The story behind this recipe is intriguing and concerns someone regarded for several centuries as one of the oddest characters of the seventeenth century, namely Noel Picard, also known as Dubois (?–1637), born at Coulommiers in France.\(^{54}\) His story was told and retold not only in his own time but also long afterwards. The main biographical source on Dubois seems to be a letter written on 6 December 1659 (N.S.), by Jean-Baptiste Hullon (*fl.* 1618–49), the prior of Cassans, in Languedoc,\(^ {55}\) to Phillibert de la Mare (1615–87), a councillor at the Parlement de Dijon.\(^{56}\) Hullon was clearly not friendly to Dubois, whom he considered a ‘fraud’ interested only in accumulating riches and fame. Almost the whole content of Hullon’s
letter served as the basis for a long article on Dubois in the so-called Encyclopediana, a volume of the Encyclopédie méthodique devoted to amusing subjects. Dubois was celebrated in his time for the same reason that he provoked Hullon’s condemnation, and he motivated ironic comments in the Encyclopediana. The reason was that he claimed not only to possess the secret of transmutation but also to own a quantity of the ‘powder of projection’ necessary for transmutation. In other words, he claimed to be able to transform common metals such as lead into noble ones, particularly gold, and also to prepare the ‘elixir of life’. He used a recipe that, according to Hullon, he copied and sold to whoever would purchase it, while resorting to all kinds of deceptions to prevent it from falling into the hands of authorities. Nevertheless, he was ultimately hanged, and according to some authors it was because he did not deliver to the deeply indebted French government as much gold as it expected, nor the recipe for the ‘Philosopher’s Stone’ to the Minister of State, Cardinal Richelieu (1585–1642), who consequently sentenced him to death. Dubois’s claims gained notoriety all over Europe; according to Hullon, countless copies of the recipe were transcribed. It was only natural for it to become an object of covetous interest in England, too, as we discuss next.

**Interest in England in Dubois’s recipe**

Records of the wide interest in Dubois’s recipe may be found in documents antedating by several years Hullon’s letter to de la Mare, for example in the correspondence of the famous intelligencer, Samuel Hartlib (1600–62), and more particularly in the letters that Erasmus Rasch (1618–65) sent to him from Paris from March to July 1655. Rasch (or Rash, Rass or Raschius) was a Dane who had travelled to, and studied at, some of the chief seventeenth-century scholarly centres, including Leyden and Basle, and he met several members of Hartlib’s circle. Although his first studies had been on theology and law, they came to centre on laboratory practices. In his letters to Hartlib, Rasch narrates Dubois’s many adventures before meeting his death on the gallows; he then goes on to observe, contrary to Hullon’s later assertions, that the French alchemist would not give his celebrated recipe away easily and, consequently, no effort or resources ought to be spared to obtain it.

Entries in the Ephemerides, and also many of the publications sponsored by Hartlib, bear witness to the long-standing and continued interest of the members of his circle in preparations such as the ‘Philosophers’ Stone’ and similar magisterial formulae devoted to secret operations, including the transmutation of metals, and to arcana for the treatment of diseases considered incurable at that time. Their interest notwithstanding, the members of Hartlib’s circle seem to have found more reliable ways to obtain Dubois’s recipe only in 1659. One of those ways is indicated in a letter sent by Joachim Polemann (fl. 1653–61) to Hartlib on 14 October. A German doctor recognized as a knowledgeable follower of van Helmont’s (one of his books was often considered the best guide to Helmont’s complex ideas), Polemann came to be appointed counsellor to Christian August (1622–1708), the Duke of Sulzbach, for which position he had been recommended by none other than Francis Mercurius van Helmont (1614–98). The extant evidence suggests that the above-mentioned letter was merely one in an active exchange between him and Hartlib, probably initiated by Oldenburg. Hartlib not only exchanged many letters with Polemann but also found a way of bringing him to England shortly afterwards. From correspondents including Rasch, it seems that Hartlib had been inquiring about Polemann’s work for some time.
Whether or not this was by coincidence, Polemann informed Hartlib that his best hope of obtaining the recipe was through Rasch, because he had obtained it earlier than some of those who boasted of having it, notably Peter Stahl (?–1675).\footnote{71} According to Poleman, Stahl had allegedly obtained the recipe only during his latest journey in mainland Europe, and his promise of delivering it to the group around Hartlib was not to be relied upon. In any case, Polemann admitted to preferring other recipes over that of Dubois, and his doubts about Stahl seem to have proved correct because, despite much to-ing and fro-ing, Hartlib continued his quest.\footnote{72}

Eventually, the precious and much-coveted Dubois’s recipe does not seem to have reached Hartlib through either Rasch, Polemann or Stahl. The extant documents are very informative concerning the hints that led Hartlib to follow another path, in which a key figure seems to have been Nicolaus Mercator. Also known as Nicolas Kauffmann (ca. 1620–87), he was a German astronomer and astrologer who showed an interest in the laboratory arts and maintained correspondence with Hartlib over several years. Probably not entirely by chance, during a visit to Paris Mercator sent Hartlib a copy of an anonymous letter that included specific details concerning Dubois’s recipe. This letter, dated 9 November 1659, mentions Frederick Clodius (1629–70), Hartlib’s ‘chymical son-in-law’, as inquiring about that formulation. Its author apologizes for his having failed to have the recipe copied, because he had not found a proficient and trustworthy amanuensis who could both copy the text faithfully and maintain its secrecy totally. It is clear that the author either possessed the recipe or was so well acquainted with it that he could even suggest several possible variations of Dubois’s recipe.\footnote{73}

In any case, Mercator had apparently succeeded in procuring an appropriate amanuensis even before he sent a copy of the anonymous letter to Hartlib. As proof of that assertion, another of Hartlib’s correspondents had also secured a copy of Dubois’s recipe, in Latin, made by the same amanuensis as the one engaged by Mercator. On 2 November 1659 (n.s.) that correspondent felt free to write in the margins of the recipe some disquieting news that had just reached him from England. In short, Mercator had at last made available to Oldenburg Dubois’s recipe for the ‘powder of projection’.

**Dubois’s recipe and its copies**

The copies currently available of Dubois’s recipe can be traced back to a longer version written in French, although the one we discuss here seems to be the only extant specimen of a shorter version in Latin. The other copies can be found at various European libraries or archives, for example at the Bibliothèque de l’Arsenal in Paris, namely the one that holds the most complete version of the aforementioned document on Dubois.\footnote{74} A comparison of the short Latin version with several copies of the longer one in French demonstrates that the materials, processes, sequence of steps and additional details (for example the duration of the steps and other necessities) are the same.

The Latin recipe describes in a direct manner—that is, without much concealment or circumlocution—how to obtain the ‘powder of projection’, which in a small amount was said to be able to ‘open’ all metals and reduce them to their primary matter. The starting material was a lead mineral that was subjected to multiple distillations under various ‘degrees’ of fire (mainly very elevated ones), calcinations, evaporations, digestions, dissolutions and so forth, until the ‘Philosophers’ Mercury’ was obtained as the culminating result. To complete the ‘Work’, the ‘Philosophers’ Mercury’ was heated again, first over a
low fire for about 40 days, at the end of which a black-hued matter appeared. The black-hued matter was then heated over a ‘strong fire’, resulting in a whitish matter that afterwards turned red. At this point the ‘stone’ or ‘powder of projection’ was almost ready. The last step consisted of dissolving the ‘Philosophers’ Mercury’ in one of the ‘waters’ separated in the course of the process. Then it was mixed with gold, culminating in the production of a fine ‘red powder’, or, in other words, the ‘powder of projection’.

Analysis of the long version of the recipe allowed us to elucidate several features that the author of the short Latin version had evidently judged unnecessary to clarify, for instance the nature of the starting material. Further examination showed that whereas the Latin copy in the Royal Society archives states that a ‘transparent and recently smelted lead mineral’ must be used, the one at the Arsenal Library states: ‘Take the crystalline stones that surround and feed the lead mines, the most transparent and recently taken from the water of mines, whenever possible, provided they had not be exposed to the sun at all’. Another copy provides even more detail on the raw material required to prepare the ‘Philosopher’s Stone’: ‘The true philosophical matter is a mineral substance properly named Saturn’s sperm, since it is mainly found at the places in which lead grows.’

The French versions also explain the role of gold in the preparation of the ‘Philosophers’ Stone’:

Without gold one cannot prepare the universal medicine; because the Seed of gold that is absolutely necessary to us is only found in gold; to tell the truth, any gold is nothing but a seed reduced to its primary matter . . . the Philosophers’ Mercury which is the key to open our metallic gold. The full process made gold ‘alive and vegetating’: Because it is gold as such that acts on metals: the powder only [serves] to convey power of action to it.

Naturally, and as may be expected, in both the short Latin and the many long French versions of the recipe, particular emphasis is placed on the medicinal effects of this philosophical gold. In fact, as seen above, in the French long version this special preparation of gold is considered a type of ‘universal medicine’, and hence we are once again dealing with a magisterial formula, like the alkahest with which we began this paper.

CONCLUSIONS

Together with our two earlier papers, one on the animal alkahest and the other on the Helmontian Ludus, the three rediscovered documents presented in this paper form and complete a set devoted to a cognate theme and connecting previous loose ends. When considered as part of an ensemble they provide some novel insights.

This may be illustrated by considering the first (Kohlhans’s replies to Goddard) and the second (‘La liste’) documents, which are not only perfectly linked to the debate on the ‘animal alkahest’ and are related to themes discussed in our two previous papers but also confer a deeper sense of the European network of information associated with some of the latest medical discoveries and innovations of the seventeenth century.

No less can be said about the third document presented above. The discovery of Dubois’s recipe, together with marginal annotations on the same document, finally permitted us to identify the author or copier of the alkahest recipe, which a Royal Society minute had linked to the debate on the animal alkahest. However, it did more than that: it connected
such debate in time and place to the future founders of the Royal Society and demonstrated a
continuity between their preoccupations at that time and through the early years of the
Society, in other words a continuity between their interest in recipes for the stone of
stones, in van Helmont’s *alkahest*, and in Kohlhans’s animal *alkahest*.

In short, the picture that emerges from this now complete set of documents, discussed in
our three papers, is that of a European network of information for which the new medical
discoveries and recipes that present-day scholars consider to belong to an older style of
thought (such as Dubois’s stone and Helmont’s *alkahest*) were of equal interest. This is a
picture in which some well-known figures from the early Royal Society, together with
others such as Kohlhans, seem to emerge as representative of a prevailing interweaving of
diverse ideas. It was not by chance that Kohlhans relied on state-of-the-art vivisection and
dissection to provide indispensable support for his conclusions, while regarding himself as
entirely at liberty to draw alternatively from Descartes or Helmont when framing them.
Last but not least, once the full set of documents was reunited, we were provided with a
glimpse of the intricate process that, starting in the 1600s, led to the formulation of
acceptable standards for laboratory work and experimentation as a whole.

Finally, the research underpinning this paper confirms and even reinforces the central
significance of direct archival investigation in solving the sorts of complex puzzles with
which historical researchers are continually confronted.

**ACKNOWLEDGEMENTS**

We thank Silvia Waissé MD PhD for invaluable help and support at all stages of the
preparation of the paper; Floriano Jonas Cesar PhD for his support and revision of our
Latin translations; Mr Keith Moore, Head Librarian, and his staff for kindly supporting
our archival researches at the Royal Society and providing photographic images of the
rediscovered manuscripts; and University College London, Fundação de Amparo à
Pesquisa do Estado de São Paulo (FAPESP) and Conselho Nacional de Desenvolvimento
Científico e Tecnológico (CNPq) for research support.

**NOTES**

1 A. M. Alfonso-Goldfarb, M. H. M. Ferraz and P. M. Rattansi, ‘Lost Royal Society documents on
4 ‘Ad Questiones Circa Lymphaticorum vasorum Liquorem, Responsio’, Classified Papers 14i/24,
‘Physick’, Royal Society Archives. Goddard’s queries have already been discussed in Alfonso-
Goldfarb et al., *op. cit.* (note 1).
5 ‘La liste des Experiences faites dans la Societé royale d’Angleterre durant la Presence du
We also included a supplementary document that revealed that Kohlhans’s claim was quickly
brought to the attention of the discoverer of the lymphatic system, Thomas Bartholinus; letter
from Georg Segerus to Thomas Bartholin, 15 November 1654 (N.S.), ‘De Lymphe aciditate ex
Kolhansio’, in *Epistolarum Medicinalium à Doctis vel ad Docto scriptarum, Centuria I & II*
bym. T. Bartholin (Tipis Mathiae Godicchenii, Impensis Petri Haubold, Bib., Havniae
[Copenhagen], 1663), Centuria II, Epistola LI, pp. 572–576.

Oldenburg’s first appointment in England was as the diplomatic agent of his native city of Bremen to the court of Cromwell during the Protectorate (1653–59). He met Lady Ranelagh, one of Robert Boyle’s sisters, and was appointed tutor to her son Richard Jones. Boyle secured Oldenburg’s entry into the scientific group that flourished in Oxford. Oldenburg continued to concern himself with scientific matters when he guided Richard during his continental tour. After his appointment as Secretary of the Royal Society in 1662 he began a vast correspondence at home and abroad, and the publication of *Philosophical Transactions* from 1665 until his sudden death in 1677; see R. K. Bluhm, ‘Henry Oldenburg, FRS (ca. 1615–1677)’, *Notes Rec. R. Soc. Lond.* 15, 183–197 (1960); M. Boas Hall, *Henry Oldenburg: shaping the Royal Society* (Oxford University Press, 2002).


Whenever an expression appears in Latin in the documents, we have used the nominative case, as it is customary. However, it is worth noting that ‘ad gratam aciditatem’ also appears in the documents that we analysed. Meaning ‘to a pleasant sourness’, it was a technical syntagm used in medical prescriptions until the nineteenth century at least, eventually abbreviated as ‘Ad grat. Acid.’. For a seventeenth-century example, see ‘Robert Boyle (1627–91): Work-diary IX (Medical and chymical recipes, 1654?)’, from Royal Society, Boyle Papers 25, pp. 347–358, at http://www.bbklondon.ac.uk/boyle/workdiaries/WD9Clean.html; see also T. Redwood, *Supplement to the Pharmacopeia*, third edn (Longman/Simpkin/Churchill/Bohn/Renshaw, London, 1857), p. 95.


‘Ad Questiones . . . Responsio’, *op. cit.* (note 4), f. 1r.


‘Qaieries [Queries]’, *op. cit.* (note 13), f. 1r.

‘Ad Questiones . . . Responsio’, *op. cit.* (note 4), f. 1r.


‘Qaieries [Queries]’, *op. cit.* (note 13), ff. 1r–1v.

‘Ad Questiones . . . Responsio’, *op. cit.* (note 4), ff. 1r–1v.

On the seventeenth-century role of acids and fermentes to explain digestion in, for example, van Helmont, see W. Pagel, ‘Van Helmont’s ideas on gastric digestion and the gastric acid’, *Bull. Hist. Med.* 30, 524–536 (1956), and *idem*, *Joan Baptista Van Helmont, reformer of science and medicine* (Cambridge University Press, 1982), pp. 129–140.


‘Qaieries [Queries]’, *op. cit.* (note 13), f. 1v.

‘Qaieries [Queries]’, op. cit. (note 13), f. 1v.


T. Bartholin, Epistolarum Medicinalium, op. cit. (note 5), pp. 572–576. Because the documents discussed in this paper are mostly related, in some way, to the Royal Society and to England, the seventeenth-century dates are generally transcribed as old style, following The correspondence of Henry Oldenburg (ed. and tr. A. R. Hall and M. B. Hall), vol. 1, p. xxiv (University of Wisconsin Press, Madison, 1965–86) (hereafter Oldenburg correspondence), except in a few cases where the correspondence was between those in mainland Europe, where the new style is retained and indicated as ‘(N.S.)’.


Agricola, like Segerus, kept in close touch with Thomas Bartholinus during his travels, which included one to England during the Protectorate, where he was close to the Hartlib circle. See C. Webster, ‘The Helmontian George Thomson and William Harvey: the revival & application of splenectomy to physiological research’, Med. Hist. 15, 154–167 (1971). Agricola met Robert Boyle during his stay in London, and wrote in 1668 to remind Boyle that ‘almost ten years ago’ he ‘had the happiness and honour to see your nobleness, and to wait upon you in our laboratory’; see Robert Boyle, The Works of the Honorable Robert Boyle (Rivington et al., London, 1772), p. 650, and B. J. T. Dobbs, The foundations of Newton’s alchemy: or, the hunting of the greene lyon (Cambridge University Press, 1975), p. 77.

Kolhans, op. cit. (note 10), p. 11.

Ibid., p. 12.

Ibid., p. 9–10.

Ibid., p. 11.

Ibid., p. 12.

‘La liste des Experiences’, op. cit. (note 5), f. 1v; on the whole, this list is very relevant for a more thorough understanding of the early Royal Society, and we intend to subject it in future to a detailed and comparative analysis.


For the early regulations of the Royal Society and mention of Moray as president, see Birch, op. cit. (note 38), pp. 6, 17, 22, 34, 43, 75, 85, 86 and 87.


It is worth noting that this list is entirely devoted to experimental work, which was one of the distinctive features of the Royal Society since its very inception, as numerous studies have confirmed; see, for example, M. B. Hall, Promoting experimental learning: experiment and the Royal Society (1660–1727) (Cambridge University Press, 1991); M. C. W. Hunter, Establishing the new science: the experience of the early Royal Society (The Boydell Press, Woodbridge, 1989); S. Shapin, The scientific revolution (University of Chicago Press, 1996); S. Shapin and S. Schaffer, Leviathan and the air-pump: Hobbes, Boyle, and the experimental life: including a translation of Thomas Hobbes, Dialogus physicus de natura aeris (Princeton University Press, 1985); see also S. Shapin, ‘The house of experiment in seventeenth-century England’, Isis 79, 373–404 (1988).

M. B. Hall, op. cit. (note 41), especially chs 2 and 3, pp. 9–49.

Oldenburg correspondence; see, for example, vol. 1, letter 41, Oldenburg to Thomas Sherley, April 1656, pp. 96–98; letter 112, Oldenburg to Hartlib, April 1659, pp. 212–213; letter 114,

These and other issues are mentioned in the correspondence exchanged in 1675 by Oldenburg and Francesco Travagino, an illustrious Venetian physician (who was later elected a Fellow of the Royal Society). The subject of that correspondence was an unusual formulation elaborated by Travagino. Letters from Oldenburg to Travagino, 26 April 1675, EL/O/155; 11 October 1675, EL/O2/157; letters from Travagino to Oldenburg, 26 June 1675, El/T/13; 11 November 1675, EL/T/14; Oldenburg correspondence, vol. 11, pp. 290–293 and 350–356, and vol. 12, pp. 7–11 and 51–53; Federico Gualdi, Philosophia hermetica: seguita dall’Opus philosophicum dello stesso autore (ed. A. Boellea and A. Galli), pp. 57–58 (Edizione Mediterranee, Roma, 2008); G. Leti, L’Italia regnante o vero nova descrizione dello stato presente di tutti Prencipati e Republiche d’Italia (Appresso Guglielmo, e Pietto de la Pietta, 1676), vol. 4, pp. 150–153 (vol. 4 was dedicated to the Royal Society); for further detail, see S. Shapin, A social history of truth: civility and science in seventeenth-century England (University of Chicago Press, 1994), p. 343, where the correspondence between Oldenburg and Travagino is mentioned in a footnote.

See, for example, the much-celebrated synthesis of mauveine by the mid nineteenth century, which could only be obtained by using a starting material that did not meet contemporary purity standards for a reagent. W. Perkin, ‘On the Aniline or Coal Tar Colours’, J. Soc. Arts 841, 99–105 (1869); A. S. Travis, ‘Anilines: historical background’, in The chemistry of anilines (ed. Z. Rappoport), pp. 1–73 (Wiley, Chichester, 2007); S. Garfield, Mauve: how one man invented a color that changed the world (W. W. Norton, New York, 2001).


‘The liquor Alchahest’, op. cit. (note 46); see also our 2010 paper, A. M. Alfonso-Goldfarb, op. cit. (note 1).

‘Processus de Bois’, op. cit. (note 6).

‘Processus de Bois’, op. cit. (note 6), f. 1v; the corresponding entry in the card catalogue is ‘Anon., Chemistry, Receipts in Latin with additions in French’, and lists several members of the second Parliament.

‘The liquor Alchahest’, op. cit. (note 46).

‘Liber epistolaris’, op. cit. (note 40); see, for instance, f. 56v.

Oldenburg Correspondence, vol. 1, pp. 119 et sqq.


55 ‘Lettre de Jean-Baptiste Hullon, prieur de Cassan, touchant les fourbes de Noé¨l Picard, dit du Bois’, Bibliothèque de l’Arsenal (Bibliothèque nationale de France), ‘LXIIIe. portefeuille de Philibert de La Mare, Tome Ier’, MS 2890, ff. 396r–399v. Hullon’s biography is interesting and deserves a separate study; some of the biographical information is included in Gallia christiana in provincias ecclesiasticas distributa (J.-B. Coignard, Paris, 1739), vol. 6, column 419.

56 Phillibert de la Mare’s papers were purchased by C. M. Fevret de Fontette (1710–72), a scholar who intended to write a history of France. The papers were then purchased by the Marquis de Paulmy and provided the basis for the collection in the Bibliothèque de l’Arsenal (Bibliothèque nationale de France). H. Martin, Histoire de la Bibliothe`que de l’Arsenal (Plon, Nourrit et Cie., Paris, 1900), part I, chap. 2, pp. 57 and 210–213.


64 Letters, Erasmus Rasch to Hartlib, 17 March 1655, 7 July 1655 and 21 July 1655, op. cit. (note 62).


66 ‘Copy Extracts in Hands of Hartlib & Scribe?, Polemann to ?’, Hartlib papers, 16/1/29A.

67 A. P. Coudert, The impact of the Kabbalah in the seventeenth century: the life and thought of Francis Mercury van Helmont (1614–1698) (Brill, Leiden, 1998), p. 172; Oldenburg, in a letter dated 3 March 1658/59 (Oldenburg Correspondence, vol. 1, pp. 201–203), noted that three important books had just appeared in Amsterdam, one of which was Polemann’s;
compare with J. Poleman, *Novum lumen medicum: In welchem die vortrefliche und hochnötige Lehre des hochbegabten Philosophi Helmontii* (Henrico Betkio, Amsterdam, 1659) (English translation: *Novum lumen medicum: wherein the excellent and most necessary doctrine of the highly-gifted philosopher Helmont concerning the great mystery of the philosopher's sulphur* (J. C. for J. Crook, London, 1662)).

Letter 138, Oldenburg to Hartlib, 2 July 1659, *Oldenburg Correspondence*, vol. 1, pp. 277–280; Polemann is mentioned in Hartlib’s *Ephemerides*, at the beginning of 1659, on the basis of information provided by Petr Figulus (1619–70) [who acted as a scribe to John Dury in Hamburg, 1638; also an amanuensis to and son-in-law of Jan Amos Comenius], *Hartlib papers*, Ephemerides, 1659, 29/8/3A; several letters sent to Hartlib that same year mention the presence of Figulus, Polemann and A. Comenius at the house of the Amsterdam watchmaker Stephen Keus; see *Hartlib papers*, Copy Extracts in Hartlib’s hand & hand ?, Figulus et al. to ?, 1659–60, 8/9/1A–17B, at 1B, 10A–B, 15B–17B. Polemann’s letters are included in Hartlib’s ‘Extracts’; see, for example, *Hartlib papers*, Extracts from Poleman on *Ludus Helmontii* in Hartlib’s hand, 24 June 1659 – 9 December 1659, 60/4/27A–28B, at 28A–B; Copy extract in scribal hand A, 8 July 1659, 39/2/80A–B; Copy extracts in hands of Hartlib & ?, Polemann to Hartlib?, 8 July 1659 – 9 September 1659, 16/1/13A–14B; Copy extracts in hands of Hartlib, Mercator & Scribe?, Polemann to ?, 8 July 1659 – 25 November 1659, 16/1/33A–40B, at 38B, 39B–40B.

Oldenburg was on a long continental journey during which he kept members of his English group informed about those he met and selected individuals of particular relevance as potential contacts for them. One of them was Polemann, who, according to Oldenburg, was widely known in mainland Europe, hence his satisfaction with the onset of an epistolary exchange between Polemann and Hartlib, as evident in his letter of 23 July 1659 to Hartlib (*Oldenburg Correspondence*, letter 147, vol. 1, pp. 288–290); that Polemann visited England a little later can be inferred from a letter included in Hartlib’s ‘Extracts’: Copy extract in Hartlib’s hand, Joachim Poleman; 3 July 1660; ‘Ex literis Polemanni Erles-Cout’, *Hartlib papers*, 29/8/16A. In addition, Polemann sent from London, in 1661, a letter dealing with transmutation to an unknown addressee: Copy letter in scribal hand H, Joachim Polemann to ?, 26 January 1660/1, *Hartlib papers*, 67/4/1A, 1B, 2B.

It is worth noting that many Englishmen often referred to Stahl as ‘Sthael’.

See *Ephemerides, 1659; Hartlib papers*, 29/8/6A, where Hartlib seems quite enthusiastic about Dubois’s recipe, which Stahl had allegedly given to his son-in-law, Frederick Clodius; nevertheless, Hartlib concludes in the same Ephemerides that, as a matter of fact, the celebrated product of that recipe had never reached Clodius, *Hartlib papers*, 29/8/6B.

See note 55; the following manuscripts associated with Dubois are to be found at the Bibliothèque de l’Arsenal (Bibliothèque nationale de France): ‘Duboys: Première colonne contenant les 2 œuvres phisiques ou l’œuvre phisique en 2 manières avec la branche en general’, MS 3011/1 (numbered from 16 to 58), ff. 16r–30v; ‘Duboys: Première colonne contenant les 2 œuvres phisiques ou l’œuvre phisique en 2 manières, avec la branche en général’, MS 3023/1, ff. 1r–12r; ‘Oeuve de Duboys donnee par luy-mesme’, MS 3023/2, ff. 13r–23r; ‘Autre traite d’alchimie de Duboys’, MS 3023/3, ff. 24r–29v. All of them date from the seventeenth century and originate in the Marquis de Paulmy’s library. De Paulmy was a bibliophile and Louis XV’s Grand Master of Artillery; in 1781 he moved to the Arsenal, taking his impressive library with him, which
included many books and manuscripts dealing with alchemy. De Paulmy’s collection was purchased by Count Artois (who later became the French King Charles X) and forms the kernel of the present-day Bibliothèque de l’Arsenal; see Ferraz and Alfonso-Goldfarb, *op. cit.* (note 54), p. 6. See also, in England, Wellcome Library, ‘Processus saturninus desumptus ex quodam scripto Domini du Bois; Operation physique sur le Sperme de [plomb] et sur l’[or]’, MS 528/10, ff. 82r–94v, a seventeenth-century copy; MS 528 comprises 24 pages and 145 folios, continuously numbered in pencil on the right upper corner of each folio recto starting from the original page 1. This is the pagination we have used in the citations. For other copies see Principe, *op. cit.* (note 54).

75 ‘Prenez des pierres cristalines qui entourent et nourrissent la mine de plomb les plus transparentes prises actuellement dans l’eau des mines s’il se peut au moins qu’elles n’ayent point été exposées au soleil…’, MS 3023/1, *op. cit.* (note 74), f. 2v.

76 ‘La vraye matiere philosophique est une substance minerale appelee proprement sperme de Saturne d’autant qu’elle se trouve principalement dans les lieux ou croit le [plomb]’, MS 528/10, *op. cit.* (note 74), f. 83r; in this particular manuscript, those observations are not included within the text of the long version of the recipe as such but in an introductory part, which includes comments on several features of the ‘Work’, such as the material used and the choice of operations at the various stages of the process. Neither the ‘introduction’ nor the text, appended at the end of the ‘practical’ part (with some variations in its content), which are present in the French versions, appear in the document discovered in the Royal Society archives. The crystalline matter mentioned in the recipes may refer to the white lead spar that is sometimes found in crystalline and transparent form as galena gangue; for instance, in his *Dictionnaire de Chimie*, 2nd edn (Théophile Barrois, Paris, 1778), J. P. Macquer states that the white lead is an example: ‘of very rich species of lead ores that are quite far from the state of mineralization in strict sense’ (vol. 2, p. 629). We have enclosed the name of the metal here and in similar instances in square brackets, because in the original it was represented by the symbol customarily used at the time when the MS was copied.

77 ‘Sans [or] on ne peut faire la medicine universelle: car la Semence de l’[or] qui nous y est absolument necessaire ne se trouve que dans l’[or]: et pour dire vray tout l’[or] n’est qu’une pure semence estant reduit en sa premiere matiere… le [mercure] des Ph[ilosoph]es, qui est la cles pour ouvrir n[ot]re [or] metallique’, ‘Processus saturninus desumptus ex quodam scripto Domini du Bois’, MS 528/10, *op. cit.* (note 74), ff. 82v–83r.


79 ‘Vif et vegetant: Car c’est proprement l’[or] qui agit sur les metaux: la poudre n’est seulement que pour luy donner la force d’agir’, ‘Processus saturninus desumptus ex quodam scripto Domini du Bois’, MS 528/10, *op. cit.* (note 74), f. 85v.

80 See note 77.