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The creation of the history of algebra in the sixteenth century

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La création de l'histoire de l'algèbre au XVI^e^ siècle

L'humanisme et la philologie mathématique humaniste changèrent profondément au cours du XVI^e^ siècle. En particulier, la transformation des idées sur les origines de l'algèbre, une transformation due à l'interaction d'une généalogie de l'algèbre avec des théories contemporaines sur l'histoire en tant que genre spécifique, détacha la discipline de ses origines arabes et de la tradition méditerranéenne des écoles d'abaque. Les motivations procèdent de facteurs à la fois religieux, politiques et économiques.

Cette séparation s'est effectuée d'abord à travers le développement de l'algèbre française, conçue pour un milieu lettré, et trouva son accomplissement dans la réécriture consciente d'une nouvelle histoire de l'algèbre.

Parce que les algébristes cherchaient à acquérir une nouvelle dignité académique, ils souhaitèrent établir l'algèbre comme une discipline théorique en élevant son statut. Il en résulta une recherche sur les notations et sur la structuration de la théorie des équations, typique de la tradition française ; celle-ci devait notamment aboutir à l'algèbre symbolique. En même temps, les algébristes ôtèrent toute référence aux mathématiques écrites en arabe, créant une nouvelle tradition qui désirait se rattacher à Diophante et aux mathématiciens grecs.

En suivant ces thèmes à travers les travaux de Jacques Peletier, Jean Borrel, Ramus, Guillaume Gosselin et François Viète, ainsi que ceux de leurs prédécesseurs italiens, ce chapitre montre les phases de la réalisation de ce double projet ; l'algèbre et les algébristes y changèrent tout à la fois leur position, leur sujet et leur histoire.

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THE FRENCH ALGEBRISTS OF THE SIXTEENTH CENTURY, in particular Jacques Peletier and Guillaume Gosselin, detached algebra from its Arabic origins and from the Mediterranean tradition of the abacus schools. This separation was determined first of all by the development of a French tradition of algebra, conceived for a milieu of learned culture, and it was also consciously accomplished by the writing of a new history of algebra.

Here I shall discuss mainly the second aspect, i.e. the construction of a history of algebra. But I shall also have something to say about the first, since it too contributed to the establishment of algebra as an academic discipline. At the center of this twofold process was the study of Diophantus' *Arithmetic* from a radically new perspective.

Humanism and anti-arabism

Humanism, already in its Italian beginnings, was an attempt to build Western knowledge directly on Western sources, which means ancient Greece and Rome. This project of refoundation was in opposition to the obvious dependence of European knowledge on medieval sciences, the Arabic branches of which were most important.

Consider, for example, a famous illustration of this project of redefinition, the *De rebus expetendis et fugiendis* by Giorgio Valla (VALLA 1501). This is the prototype for those encyclopedias which excluded any account of medieval and Arabic learning, and accordingly it gives the advantage to classical sources.[1] Valla, with his particular erasure of Europe's Arabic past, became one of the main cultural points of reference for the French algebraic tradition of the sixteenth century. From this point of view, it is not surprising that humanists developing a humanist algebra, such as the sixteenth-century French algebrists, tried first of all to disconnect their art from Arabic sources. To accomplish this, they created classical Greek sources for algebra, and in particular, they created an interpretation of Diophantus.

1. See, for the impact on Italian Renaissance mathematicians, ROSE 1975, particularly 48–50.

But this does not tell the whole story. For, both anti-arabism and humanism have a history; they do not mean the same thing through time. As we shall see, taking this into account allows us to follow more closely the interaction between the content of algebraic works and the mathematician's allegiance to an ancient authority or to a theory of history.

To understand the character of anti-arabism in humanism, we should remember that humanism was born within the tradition of Arabic philology. The recovery and translation of Greek works was introduced into Italy in the same context as the transmission of Arabic mathematics and the writings of Fibonacci. For centuries mathematicians divided into two groups: the mathematical philologists and the practitioners. When, in the course of the centuries, especially after the thirteenth, cultural anti-arabism appeared, and acquired the specific tenor of an emancipation from an Arabic heritage, the mathematical philologists adopted it. By contrast, the practitioner counterparts of the philologists (like the Arabs themselves) seldom named their scientific ancestors and, unlike them, did not have an interest in history.

The philologist's interest in history was also an interest in contemporary history. In the fifteenth century, particularly after the fall of Constantinople in 1453, but also earlier,[2] Italian humanism became strictly associated with a group of Greek immigrants who had their own reasons to dissociate themselves from Islamic culture and were actually in search of a Greek revival from which to advance a possible political rebellion against the Ottoman Empire. This is the time and the social context in which Regiomontanus announces the recovery of the Diophantus manuscript.

By the end of the sixteenth century it was clear that Europe had regained a cultural position comparable to its position in classical times. Furthermore, the political changes in the Mediterranean had definitively modified the perception of the southern and oriental worlds. In this respect, the battle of Lepanto, which marked a definite limit to Ottoman expansion, was only the completion of a century-long process of detachment. This undertaking was not unconnected with scientific activity, as is suggested by the presence of the scientist, Guidobaldo dal Monte, in the entourage of Francesco Maria di Urbino, who took part in the Lepanto expedition.[3] This political event was sanctioned by profound cultural changes, about which we know more as far as the southern countries are concerned. In this sense, it is important to see anti-arabism as a contributing factor to, but also distinct from, anti-medievalism, and at the same time to see it as the counterpart of the extensive assimilation of Arabic science at the universities. Avicenna was in fact at the apogee of his influence in Italian universities in the sixteenth century.[4]

2. In fact, as GRAFTON 1981 illustrates, the idea that the fall of Constantinople marked the beginning of humanism as a search for Greek texts was diffused in France by Ramus.

3. "On the way, however, Guidobaldo felt sick and was detained in Messina" (ROSE 1975: 223).

4. See SIRAISI 1981, especially Chapter 4, as well as the recent SIRAISI 1990.

On the other hand, humanism and humanistic mathematical philology also changed significantly in the course of the centuries. Our focus here will be on the transformation of the notion of ancient origins of algebra, a transformation due to the interaction of the genealogy of algebra with the contemporary theory of history. There existed a specific classical, Greek and Hellenistic, genre reconstructing the illustrious origins of inventions, examples of which were characteristically called *De inventoribus* or *De origine artium* (see COPENHAVER 1978a).

In the sixteenth century we find several versions of the various sorts of origins, insofar as the mathematicians used this genre as a repertory of types of genealogy. These transformations are not irrelevant to mathematics, because to each sort of genealogy corresponded a specific style of work or a specific theoretical choice. As the algebrists aimed at academic dignity, they strove to raise the status of algebra to a discipline and to transform it from the merely practical into the contemplative. The result of their endeavour is that research on notation and on the structuring of a theory of equations typical of French algebrists which, in turn, gave rise to symbolic algebra.

At first this use of the genre *de inventoribus* implied reference to an ancient authority. Later, as the new mathematics established itself, the ancient author became more an object of historical criticism than a guide to a no-longer extant but truer science.

Thus there appear in the course of the sixteenth century two mutually reinforcing processes. One the one hand, a history of the discipline (algebra, but also other arts, e.g. medical practices)[5] was constructed through the genre *de inventoribus* and through increasing historical scholarship focussing on the *national* past, while on the other, algebra was transformed into a new discipline, from a practical, 'occult' and secondary art to a discipline of high theoretical status within a specific national context. The development of one increased the credibility of the other. This elevation in status was not only rhetorical but institutional as well.[6]

We may now turn to the construction of the origins of algebra in the texts of mathematicians, starting with Regiomontanus' lecture.

Regiomontanus' Padua lecture

Johann Müller (Regiomontanus), in the course of a public lecture presented in Padua in 1463, announced the existence of the manuscript of Diophantus' *Arithmetic*, while at the same time stating that it contained algebra. It was thus that algebra came to have a Greek origin. Concerning this lecture I shall only mention that, after an expanded version of the usual account of the origin of Greek mathematics (Herodotus, Aristotle), Regiomontanus gives a thorough description of the

5. For the example of Arabic medical learning, see COPENHAVER 1978b.

6. For the combination of illustrious origins and progress in another science, see CRISCIANI 1990.

process of transmission and translation of Euclid, and then of Apollonius.[7] His text is about *de utilitate et de origine artium* and is a typical example of a humanistic piece of the genre, following in particular the standard Aristotelian principle that the theoretical part of mathematics is ascribed to the Greeks, whereas astronomy and practical mathematics are attributed to Oriental sources. So Regiomontanus attributes algebra *also* to the Arabs. This is particularly striking in an author who has extensively used and even 'adopted' Arabic trigonometry. But the latter remained a practical mathematics, while algebra was already beginning to be shifted from the practical to the theoretical. To promote this process was, for Regiomontanus, a priority. Furthermore, the philological genre of the lecture and the social identity of the Greek humanists dealing with the Diophantus manuscript could at least provide a reason for his choice of this author as a source. Finally, we should remember that Regiomontanus must have been struck by the richness of Hellenistic sources for mathematics, being among the first witnesses to their discovery.

Regiomontanus did not give a lengthy description of the manuscript, but it was enough to raise the question of the algebraic content of Diophantus' text, which would be published by Xylander (in translation) only in 1575 (Xylander 1575).

Among the authors who mentioned Regiomontanus' initial attribution of algebra to Diophantus, we should first recall Johann Scheubel, in his successful *Algebræ compendiosa facilisque descriptio*, published in Tübingen in 1550. The scientific publisher, Guillaume Cavellat, had this text reprinted in Paris in 1551 (Scheubel 1551) and thus bestowed on Scheubel the role, in the French milieu, of propagator of Regiomontanus' thesis concerning Diophantus.

The first printed algebraic treatises (1494–1556)

Before turning to our main theme, the sixteenth-century French algebrists, let us consider briefly the group of authors and printed books which preceded them. These authors, who include Luca Pacioli, Étienne de La Roche, Girolamo Cardano, and Nicolò Tartaglia, are mostly Italians, and belong to the period in which some freedom of movement between the abacus schools and the universities was still possible. They were therefore practitioners as well as humanists. Accordingly, they pay attention to the Arabic tradition as well as to an integration of algebra with Euclid. They never mention Diophantus.

Luca Pacioli's beliefs about the history of algebra are suggested by his comments on the origins of the word 'algebra' itself. In his *Summa de arithmetica, proportioni et proportionalita*, published in Venice in 1494, he writes:[8]

7. "There are also the thirteen books of Diophantus," Regiomontanus writes, "very difficult, never translated into Latin, in which the whole flower of arithmetic is hidden, i.e. the *ars rei et census*, which today is called Algebra by an Arabic name." See Regiomontanus, *Opera collectanea*.

8. Gionti con l'aiuto de dio al luogo molto desiderato, cioè la madre de tutti licasi detta dal vulgo la regola de la cosa over Arte magiore: cioè pratica speculativa: altramenti chiamata Algebra e Almucabala in lingua arabica o caldea secondo alcuni che in la nostra sona quanto che adire restaurationis et oppositionis. Algebra idest Restauratio. Almucabala idest Oppositio vel contemptio et Solutio, perche per ditta via si solvano infinite questioni. E quelle che non fossero solubili ancora le si dimostra.

> Having gotten, with God's help, to the very desired place, i.e. the mother of all cases called by the people "the rule of the thing" or the "Greater Art," i.e. speculative practice: otherwise called Algebra and Almucabala in the Arab language or Chaldean according to some, which in our [language] amounts to saying *"restaurationis et oppositionis." Algebra id est Restauratio. Almucabala id est Oppositio vel contemptio et Solutio*, because by this path one solves infinite questions. And one picks out those which cannot yet be solved. (Pacioli 1494: 144.)

It is interesting to note that Pacioli considers the possibility that the name of this art could be of "Chaldean" origin. Pacioli is therefore the first to draw at least a short history of the topic, and does it according to the genre of *de origine artis*.

A contrasting case is provided by Étienne de La Roche, who is still working almost entirely within the abacus school tradition. When he writes the first French manual including algebra in 1520 (La Roche 1520), he does not deal directly with the history of algebra, but stays closer to the style of the masters of abacus, citing the numerous contemporary authors which he has "*colligé et amassé*" but without giving special importance to genealogy.

It is Cardano's text, however, which will serve as the main illustration, since Cardano represented the master link between the practitioners' and the humanist traditions. Moreover, Cardano was also taken as a crucial source by the French algebrists. The *Ars magna* (Cardano 1545) is innovative in genre, insofar as it is entirely devoted to algebra. It is the first algebra text published in Latin. These innovations notwithstanding, Cardano's idea of the history of algebra is very much in continuity with the content of medieval learning. He writes:

> This art originated with Mahomet the son of Moses the Arab. Leonardo of Pisa is a trustworthy source for this statement. There remain, moreover, four propositions of his with their demonstrations, which we will ascribe to him in their proper places. After a long time, three derivative propositions were added to these. They are of uncertain authorship, though they were placed with the principal one by Luca Pacioli. (Edition Witmer 1968: 7 ff.)

Shortly afterwards, there is the attribution of other solution formulas, including one to Scipione dal Ferro and Tartaglia.

Mohammed ibn Musa, or al-Ḫwārizmī, is therefore specifically identified as the inventor of this art. Cardano reaffirms this elsewhere,[9] when he says that in a large paper volume (in fact the *Liber abaci* by Fibonacci) "the name of the author of the book which is called Algebra" is Mahomet.[10] This indicates that Fibonacci's attribution was taken for granted by Cardano, in particular for the section on Algebra.

9. In Problem 39 of his *Ars magna arithmeticæ* (*Opera omnia* IV, 374).

10. In fact, also in the printed version of Leonardo Pisano's *Liber abaci*, appearing in vol. I of Baldassarre Boncompagni's edition of his *Scritti* (Rome, 1857), there is a notation *Maumeht* at the beginning of Part III, entitled *De solutione quarundam quæstionum secundum modum algebræ et almucabalæ*. I take this indication from Witmer 1968: 7.

Nicolò Tartaglia belongs to this same tendency. In his *General trattato di numeri e misure* (TARTAGLIA 1556–1560) he mentions al-Ḫwārizmī prominently at the head of a chapter as the inventor of algebra. Tartaglia is in fact the last major figure who does not demonstrate an awareness of Diophantus and who does not feel the need to distance himself from the Arabs.

At the same time, the German tradition was also developing. Michael Stifel published, in 1543, his *Arithmetica integra*, addressed to a university audience (STIFEL 1543). Again, there is no full-blown history of algebra, but he mentions Geber as the inventor of Algebra; this last is defined as "*cossa seu Ars Gebri*". I want to make clear here that this 'Geber', who appears to be the historical Arab individual of the eleventh century, is the Ǧābir ibn Aflaḥ who had been appropriated by Regiomontanus (see Jens Høyrup's chapter).

The French national style in algebra: Jacques Peletier du Mans

In contrast to what happened in Italy, mathematicians at the end of sixteenth century in France belonged for the most part to the milieu of jurists connected with the court. First the Academies and the publishers, then the Collège Royal and the Parliament, were their institutions. There are two aspects of their national style in algebra: 'heuristic' rhetoric and the creation of a history. Here we shall discuss the history of algebra.

It is known that historical scholarship developed in France through the impulse of classical studies. Humanistic history had originated in Italy, but its French heirs knew the latest, more critical aspects of historiography. Thus, the movement to write the history of France was not only dominated by classical models, but was aware of the need to reconstruct the specificity of this nation, according to the more refined notion of *imitatio*. Among the first authors of the French movement for a national history was Étienne Pasquier, a figure in many ways comparable to Jacques Peletier for his commitment to the founding of a French culture, combined with a profound sense of the classics and an understanding of the limits of French culture itself. In the following years, the historical movement was even more clearly connected to juridical studies. François Hotman, (who had emigrated from France but continued to be very productive), François Baudoin, and Pierre Ayrault are the most typical representatives of this second phase. This period, like the one before it, was characterized by discussions on language and the history of language as a crucial dimension in differentiating ideas and methods in history.

The debate opposing Roman law to customary law involved a discussion of not only differences of circumstance but also different modes of textual representation. This awareness of course had its origins in Italian humanism. In the same way, the national orientation of legal thought confirmed the preexisting movement for the writing of a national history. Furthermore, the interaction between historical and legal thought represents not only a philosophical transition, but is also reflected in the interest of a group. In the second half of the sixteenth century

the great majority of books owned by jurists were history books, and among these, mostly books on national history. Since these jurists were particularly important for the patronage and promotion of mathematics in general and algebra in particular (Cujas is mentioned among the patrons of a Diophantus edition), we can associate this historical culture with the specific genre of the history of algebra.

However, we should remember that this picture corresponds to Paris at the time of Gosselin and Viète. Only at that point do advances in juridical thought determine changes in the notion of history and of historiography. It is worth remembering that this is the time in which the juridical milieu is very powerful. But it is already the second phase of French algebra.

Peletier devoted much of his attention to the question of the history of algebra. This is quite clear from the introduction to his algebra text of 1554, *L'Algebre* (PELETIER 1554), where he goes far beyond the lists, etymologies, and off-hand references of the authors we have seen before.

First of all, he refers to the Arabic sources which have been traditionally acknowledged. To these he adds Pacioli and other writers of the early sixteenth century:

> Le premier inventeur de cet art, selons aucuns, fut Geber Arabe: et se fondent sur la raison du mot, composé d'un nom propre et d'un article Arabiq, qui est Al: lequel se prepose communement aus motz de la langue: comme Alcabice, Albubater, Alcandan, Alquemie; et assez d'autres que nous avons d'eus, principalemant an Astrologie. Selon les autres, fut un Mahommet fíz de Moise Arabe: Lequel, comme dit Gerome Cardan, Millanoes, après un Leonard de Pesare [Leonardo Fibonacci of Pisa], an a lessé quatre chapitres ou regles avec leurs Demonstracions: lequelles ne se trouvent publiquement, que je sache. Frere Lucas Pacciole Florantin, l'a mise an son vulguere, Après lui, Cardan l'a ecritte en Latin: E puis Michel Stifel Allemant, lequel allegue an son livre un Crestofle Ianver [Christoph Rudolff of Jauer] e un Adam Ris, tous deux Allemans, qui l'on redigee an leur langue. I'è ancores ouì dire de Pierre None, Matematicien de Lisbonne an Portugal, qu'il avoèt aussi trettee en son langage Espagnol: Mes je n'è vu son liure, nomplus que des deus Allemans: e croè qu'il n'è ancores publié. Aquez certes èt due grand louange.

Later, Peletier mentions Diophantus, using Scheubel as his source:

> I'è encores vu le liure de Ian Scheubel, Matematicien de Tubingue: lequel attribue l'invancion de cet art à un Diophante Grec, qui an a lessè treze Liures, au rapport de Ian Demonroe [Regiomontanus], fameus Matematicien de notre tans, dines certes, de grande conquisicion, s'iz etoèt d'avanture recouurables.

But Peletier has his own opinion of the subject of the origins:

> An tele diversite d'opinions, me souvient d'an dire la mienne incidammant: C'est que je ne pense point que cet Art, ni la pluspart des autres, doivent leur invention à un seul auteur. Mais bien que quelqu'un en fait l'ouverture fort rude et malpolie, peut-être sans penser qu'il s'en dut ou put faire un Art: et puis de main en main, et par longue circuicion, de tant et continuelles exercitations de l'esprit, les hommes ont donné forme,

> reigle et ordre à ce qui n'avait rien de tel. Et enfin les Arts se sont trouvé rédigés et unis, mais par tant d'intermissions, (car la longue durée a besoin de long ouvrage et de long achevement), que nul des mortels n'en peut avoir seul la preminance. (PELETIER 1554: 3.)

Peletier had already expressed a similar point of view on the accumulation of mathematical knowledge with respect to the history of arithmetic. In his *L'Aritmetique* (PELETIER 1549) he had posed a question of particular importance with respect to the Greek heritage much like the one Descartes raised later in the *Regulæ*: "comment il se peut faire que les anciens ne nous aient laissé par écrit la prattique et usage de l'Arithmétique ?" But where Descartes will claim that the ancients had had analysis and algebra and they had hidden it, for Peletier there was another explanation: "les inventeurs ne tendent pas à écrire suivant l''ordre métodique'", but rather following the order of invention itself. Writing, therefore, came only later, when ease in the art and need in the practice made it possible:

> Mais a la fin, croissans toujours les affaires et traffiques des nations les unes avec les autres, la commodité et nécessité, qui ouvrent les esprits des hommes, leur a enseigné à établir un stile, qu'ils ont disposé par état, peu à peu, quand chacun a apporté sa part d'invention au bureau, pour soulager ceux qui n'avoint loisir de vaquer à la Théorique. (PELETIER 1549: Book 4, proème.)

In fact, Peletier found himself at the juncture of two traditions, and he was quite aware of undertaking to bridge them. Writing in French, he introduced the arithmetic and algebra coming from the abacus schools in Italy and Germany to the cultivated milieu of the court and the university. In his *Dialogue de l'ortografe*, he had written that this was a way of following the example of the Arabs:

> Nos mathématiques ne furent jamais mieux au net, qu'elles sont de présent, ni en plus belle disposition d'être entendues en leur perfection. Et par ce que leur vérité est manifeste, infallible et constante, pensez quelle immortalité elles pourraient porter à une langue, y étant rédigées en bonne et vraie méthode. Regardons même les Arabes, lesquels encore qu'ils soient reculés de nous et presque comme en un autre monde: toutefois ils s'en sont trouvés en notre Europe qui ont voulu apprendre le langage, en principale considération pour l'astrologie, et autres choses secrètes qu'ils ont traité en leur vulgaire, combien qu'assez malheureusement. Car on sait quelle sophisterie ils ont mêlée parmi la médecine et les mathématiques mêmes. Et toutefois ils ont rendu leur langue requise en contemplation de cela. Avisons donc à quoi il peut tenir que nous n'en fassions non pas autant, mais sans comparaison plus de la notre? (PELETIER 1550: 117–118.)

Thus, in writing his own treatise on algebra, Peletier was able to acknowledge that the Arabs, at least as a people, had contributed to the invention of algebra. In this attribution he followed Herodotus' criterion for the invention of the arts, according to which they should be ascribed to a people, and not to an individual, avoiding mythical figures. But besides this philological choice, Peletier shows, here as elsewhere, his awareness of the new French history of law. Étienne Pasquier would publish his *Recherches* only in 1560, but both authors clearly

express similar points of view about history and language. This is what has been later defined as the beginning of cultural relativism, based on an awareness of the specificity of Roman culture and then of French national identity.[11] While the beginnings of this view belong to Italian humanists, they had been introduced in France by Guillaume Budé, and this position will be expanded in the debates about the conflicting traditions in law, the transition being represented by François Hotman, who worked on language, history and law (see in particular KELLEY 1973). The supporters of customary law over Roman law expressed the priority of customary law over the authority of the ancient texts. In this view laws appeared "[...] not as a manifestation of reason, but as the accumulation of many human judgments", as Pierre Ayrault wrote in his *De origine et auctoritate rerum iudicatarum* (AYRAULT 1573). Ayrault's *res iudicatæ* can be compared to the concept introduced by Peletier of "accumulation of knowledge" in the discipline of algebra, without the need for a *universal* ancient authority.[12]

Jean Borrel

Jean Borrel, hellenized as Buteo, published his *Logistica* in Lyon in 1559 (BORREL 1559). Borrel's point of view on the history of algebra is made explicit already by the title of his work, for he used a Greek name. The word 'logistic' had been used by Plato both as the term for calculation and for the theory of calculation (the four operations). By contrast, the Neoplatonists had used it in opposition to 'arithmetic' to indicate the arts of calculating as distinguished from the science of numbers. Buteo uses the term in yet another way. For him, 'logistic' refers to practical arithmetic, i.e. the study of the four operations, a meaning that had become common thanks to the diffusion of treatises in the abacus tradition, where discussions of practical arithmetic included calculation with numbers of all kinds (e.g. fractions) and a special chapter for cossic numbers (what we call monomials). Also at this level, Buteo introduces a new terminology, calling the cossic numbers *quantitates (geometricæ)*. Even the name of the discipline itself, algebra, is changed into *quadratura*. He starts the section on algebra with the following statement:[13]

> There remains to be added to the top, as a crown, that type of reasoning which is called popularly by the Arabic name of Algebra [*qui vulgo et àrabica voce dicitur Algebra*]. I prefer to call it *quadratura*. In fact this is a rare and subtle practice which the Logista takes from the Geometer as a help. (BORREL 1559: 117.)

11. An excellent survey is given in HUPPERT 1970.

12. While Ayrault's statement actually came twenty years later than Peletier's *L'Algebre*, this idea was expressed in a more extended form by earlier authors, such as Étienne Pasquier. The complex process of evolution of these theories is explained in KELLEY 1970.

13. His expeditis quæ sunt ex usu numerationum communi, restat ut eum ratiocinandi modum operi summo veluti coronidem adiiciam, qui vulgo, et arabica voce dicitur Algebra. Ego autem, prout revera est, quadraturam dicere malo. Opus sane rarum, et exquisitum, quod a Geometra Logistices, subsidio quodam mutuatur.

Borrel makes mention of the Arabic origins of the word algebra only to displace it with a distinctively Latin name. Later, his criticism of the Arabs becomes less subtle and he advances a view soon to become a European commonplace: the Arabs are deficient in scientific work, their presentation is obscure and their language impure. Borrel writes:[14]

> The utility and the intelligence of *quadratura* is accompanied by a specific difficulty, which derives more from the defect of the propagators than from the nature of the thing. For those, really ignoring the method of the disciplines, going far in the roughness of words and things, involve and trouble everything to the point that nothing could be more confused, and accumulating the clouds they obscure the senses of the readers. (Borrel 1559: 117–118.)

The "ignorant propagators" here are not only the Arabs, but Pacioli and La Roche, who stand accused of being like Arabs. Thus, by means of a general anti-arabism, Buteo impeaches the whole abacus tradition through its major late representatives. At the same time, the link to the ancients is affirmed by Borrel's faith that Euclid has in fact transmitted the art in his Tenth Book. According to him, this transmission had gone unnoticed because it can only be understood by the reader of the *Elements* who has become proficient in the previous books. In conclusion, Borrel's contribution to our theme is twofold: he hellenizes algebraic terminology, and he considers algebra to be contained, at least implicitly, in Euclid. Furthermore, his anti-arabism is the most explicit: the Arabs are deficient in scientific work, their presentation is obscure and their language is impure, and their faults have been inherited by their abacist successors. In this, Borrel's attitude is similar to that of philologists of the previous centuries. Borrel, like all humanists working on Euclid, had spent a significant portion of his life trying to discern, in the texts, what belonged to Euclid and what was a later addition. In this sense, any transmitter is responsible for corrupting the text.

Ramus

Ramus is, I think, particularly interesting on this matter, and not only because of his importance for mathematical education. His views on the genealogy of algebra are multifaceted and complex, and seem in some respects to be contradictory. Here I want to stress that, when all of his published works are taken into account, including the various editions of the *Algebra*, two rather different views emerge.

The first view seems generally to fit the pattern established by many of his contemporaries, in which Arab authors are displaced in favor of Greeks. The second view revisits an older mythical account of ancient knowledge that is more inclusive, to the point even of including the Gauls among the ancients. On careful inspection we shall see that these two views are not necessarily incompatible.

14. Sed utilitatem, et intelligentiam quadraturæ difficultas præcipua comitatur, magis quidem tradentium vitio, quam rei natura proveniens. Hi nanque disciplinarum methodon prorsus ignorantes, verborum, atque rerum late vaganti barbarie, sic implicant, atque perturbant omnia, ut nihil possit esse confusius, unde legentium sensus, conglobatis veluti nebulis, obumbrant.

Ramus deals with the history of science in many of his texts, but he addresses the history of algebra in only one work published during his life. In his *Scholarum mathematicarum libri unus et triginta* (Ramus 1569), the first Book is devoted to a vast history of the mathematical sciences. Ramus clearly aims to be comprehensive, and it is significant that he includes references to Arabic or Oriental authors, but builds entirely on Greek sources. But among these, he mentions a new one. In a list of (the great) Alexandrian mathematicians, he takes care to inform the reader that there exist the six Books of Diophantus in Greek.[15] This places Ramus squarely within a contemporary tendency which gives great weight to Diophantus.

At the same time, the elimination of all but Greek sources is also a change with respect to the genre of *de origine artium*. From the Greeks came the theoretical sciences, but in the *Scholæ* even the practical sciences are not ascribed to Oriental authors, as they are, for instance, by Regiomontanus and, before him, by Aristotle. Ramus can attribute algebra to the Greeks alone because the distinction between theory and practice is no longer important for him in its classical form. This distinction is rearranged so that each science overlaps with its corresponding art, and thus the *use* of each, which can be *ad contemplandum* or *ad agendum*, becomes the crucial distinction. Furthermore, Ramus remains confident in relying on the Greeks alone because he does not treat them as absolute authorities, but rather as interlocutors to be engaged polemically. This is clear, for example, in the way he criticizes Proclus. On the other hand, Oriental authors are mentioned as possessing original wisdom (Ramus 1569: 5).

Ramus' second version of the genealogy of algebra becomes apparent when we examine the various editions of a treatise, *Algebra*, known to have been written by Ramus but published anonymously. The first date of publication was 1560 (Ramus 1560, henceforth, $Algebra_1$). The book was then reprinted three times posthumously. These three editions (henceforth, taken together, $Algebra_2$) were brought out in 1586, 1592 and 1599 in Frankfurt, by the publisher of the original edition, André Wechel.[16]

What interests us here, however, is that while $Algebra_1$ contains no history of algebra, an elaborate genealogy is included in $Algebra_2$. Considering this second genealogy contained in $Algebra_2$, in contrast to the one in the *Scholæ*, we must proceed with some caution, for we do not know whether Ramus is its author. And if he is not, we have still to ascertain who it is: Schoner, the editor, or an intermediate Ramist. But, despite these qualifications, it is nonetheless significant that we find the following view attributed to Ramus in 1586, which appears to be in partial contrast with the history proposed in the *Scholæ mathematicæ*.

15. Diophantus cuius sex libros, cum tamen autor ipse tredecim polliceatur, græcos habemus de arithmeticis admirandæ subtilitatis artem complexis quæ vulgo Algebra arabico nomine appellatur: cum tamen ex authore hoc antiquo (citatur enim a Theone) antiquitas artis appareat.

16. In fact, the second, third and fourth editions were published by the heirs of André Wechel, de Marne and Aubry, in Frankfurt. The Bibliothèque Nationale has only the 1592 edition, but I was also able to consult the Wolfenbüttel library for the 1586 edition and the New York Public Library for the 1599 edition, and they included corrections by Lazar Schoner.

So, let us now trace this second view. *Algebra*$_2$ ascribes the invention of the art of algebra to a wise man described as 'Geber':[17]

> The name of algebra is thought to be Syriac, signifying the 'art and doctrine of an excellent man'. Now *Geber* in Syriac signifies 'man'; it is often a title of honor, as 'master' or 'doctor' with us. For, there is said to have been some unknown mathematician who sent his algebra, written in the Syriac tongue, to Alexander the Great, and he named it *almucabala*, that is the "Book of Occult Things". Others preferred to call his doctrine algebra. This book is still today very precious among the erudite nations of the East, and it is called by the Indians, who are very studied in these arts, *aliabra* or *alboret*, since they are ignorant of the origin of the proper name. Algebra has been called by some Latin *Ars rei et census*, as in Regiomontanus. By the Italians it is called *ars de la cosa*, by others *cossa*. Many schools today neglect to note how many names, or perhaps even more, algebra has had, in what high regard learned men of all nations have held it and what the loss of the doctrine would mean.

Note that the central character of the first genealogy, Diophantus, is entirely absent here. Instead, the story of the 'Geber', who is not even mentioned in the *Scholæ mathematicæ*, is told in etymological, if not historical, detail.[18]

Our surprise at the absence of Diophantus is amplified by another clue the author provides. The passage where he cites the Latin name for algebra is drawn from the same lecture in which Regiomontanus had announced, a century earlier, the existence of the manuscript of Diophantus. Furthermore, whether the author is Ramus, Schoner, or some other Ramist, he must have known Regiomontanus' lecture, or, at least, Scheubel's *Compendiosa descriptio* or Peletier's *L'Algebre* with their lists of inventors. Both of these important contemporary algebra manuals mention Regiomontanus' reference to Diophantus.

It should be noted that the *Algebra* (in its various editions) is not an innovative manual by comparison with contemporary French algebra manuals. Its author remains within the tradition of the German Coss. Thus, it is all the most surprising that *Algebra*$_2$ introduces as the only new element the treatment of *de origine*.

In following this humanist tradition, the author of *Algebra*$_2$ displays creative flair of a particularly telling sort. The 'Geber' here is no longer the historical

17. De his numeris dictum est 5 cap. de figuratis, ubi eorundem etiam fuit numeratio quædam, cui frequens adhibita est resolutio, sumpto quocunque valore lateris. [...] Nomen Algebra Syriacum putatur, significans artem et doctrinam hominis excellentis. Nam Geber Syris significat virum, idque nomen interdum est honoris, ut apud nos Magister aut Doctor. Etenim insignis mathematicus quidam fuisse fertur, qui suam algebra Syriaca lingua perscriptam ad Alexandrum magnum miserit, eamque nominaverit Almucabalam, hoc est, librum de rebus occultis, cuius doctrinam Algebram alii dicere maluerunt. Is liber hodieque magno precio est apud illas eruditas Orientis nationes, et ab Indis harum artium perstudiosis dicitur Aliabra, item Alboret, tametsi proprium autoris nomen ignoretur. Algebra vero a Latinis quibusdam dicta fuit ars rei et census, ut est apud Regiomontanum. Ab Italis ars de la cosa, ab aliis cossa. Quibus tot nominibus ac fortasse pluribus etiam palam fit, quanti fuerit hæc doctrina apud doctos omnium gentium homines quantaque cum iactura doctrinæ plerisque in scholis hodie negligunt.

18. The most common copies of this text are of the editions by Lazar Schoner from 1586 and 1599. Notice that there are no significant mathematical differences between the Schoner editions and the anonymous edition printed by André Wechel.

and Arab 'Geber' (of the eleventh century) mentioned by Stifel, the author of the trigonometrical works appropriated by Regiomontanus. In this genealogy the 'Geber' is translated as *vir*, i.e. as a man of status; he is interpreted as a *magus*, belonging to the Semitic melting pot which is identified with the *prisca theologia* or Chaldean wisdom (see in particular SCHMITT 1966 and 1970). While the Syriac name could indicate the third century AD, the reference to Alexander transforms him into a mythical figure of the alchemical type (GRIGNASCHI 1993). Chaldean wisdom was a *topos* in the philological genre *de inventoribus*. In particular, Jewish philologists and thinkers such as Philo of Alexandria, as well as some Christians such as Clement, had held Abraham and the Patriarchs in general to be the inventors of all knowledge, which later passed to Egypt and then to Greece (see COPENHAVER 1978a). Arabic thinkers had developed a new branch of this tradition. They treated Alexander as a mediating figure who was thought to have transmitted Mesopotamian knowledge.

Now we come to the main point. The way that the Ramist author willfully 'misreads' Stifel and the German cossic tradition to point in *Algebra*$_2$ towards the mythic 'Geber' is entirely in keeping with Ramus' philosophical standpoint. Simply, Ramus gave great importance to the Oriental Chaldean wisdom, which he understood as the source of Greek knowledge. Already in his *Liber de moribus veterum Gallorum* (RAMUS 1559), he had maintained that the Gauls did not need to *imitate* the ancients, because, from the point of view of the language, the Celtic tradition (and particularly that of the Gauls) was the source of the Chaldean.[19] In this light, the 'Geber' is to be assimilated to the tradition of Chaldeic knowledge insofar as he is associated with Alexander. Diophantus need not be mentioned; he was a transmitter of the algebra rather than an author *per se*.

Ramus' complex view of genealogy may surprise us for another reason. It is quite likely that he was acquainted with the actual content of Diophantus' text, the first manuscript of which came to France and into the hands of his associate Gosselin, around 1570. In this sense, we cannot consider the story of the 'Geber' as if it had been acceptable only before the rediscovery of Diophantus.

However, I want to stress that the attributions actually present in the *Scholæ*, i.e. to Diophantus and to 'Geber', are not incompatible, once the whole picture is taken into consideration. For, again, we should remember that Greek mathematics itself was conceived as dependent on the old Mesopotamian wisdom, and this was the view particularly of Ramus. In the *Scholæ*, for instance, the superiority of the Greeks was seen as depending on a large corpus of extant works. So, while we cannot be sure whether he actually changed his mind about algebra, as Schoner implies, we know that from his point of view the two stories are not in contradiction, but actually can acquire a sense which is closer to sixteenth-century cultural tendencies. In fact, the genealogy provided in *Algebra*$_2$ could indicate a stronger commitment to the construction of a French national past.

19. See, on this sixteenth-century *topos* and its role in Ramus' philosophy, DUBOIS 1972 and 1977, and MEERHOFF 1986.

The genealogy given in *Algebra*$_2$ should be compared with the work of a contemporary author writing in verse about mathematics, Guy Le Fèvre de La Boderie. He was an esoterist and an Orientalist but, like Peletier and many others, wrote philosophical (i.e. scientific) poetry. He published his *Galliade ou de la Revolution des arts et sciences* in Paris in 1578, though from the point of view of the myth of foundation, he collected material that had been common in the Parisian academies for years. That is, simply, a new version of the Gallic myth of Lemaire de Belges.

In the *Galliade*, La Boderie deals extensively with mathematics. He devotes a whole section to Archimedes, and then concludes:

> Donques nos vieux Gaulois, non les Égyptiens,
> De la Mathématique, et des Arts Anciens
> sont premiers inventeurs: et la source gardée
> Es hauts mont d'Arménie, et puis en Chaldée.

La Boderie goes on to explain how knowledge, thanks to Gomer, the Gallic Hercules, went from Gaul to Chaldea, thence to Egypt on the one hand, and to Italy and Gaul on the other. This last passage was, in La Boderie's account, in fact a return to origins. This implies, of course, that Greek knowledge was derivative rather than original (Jung 1966).

We can see that here myth exists in its proper sixteenth-century medium, Neoplatonic scientific poetry. It is fitting that in this context the authors of contemporary French mathematics are mentioned, from Peletier and Forcadel to Ramus. But there is an even more specific point concerning the mythical significance of algebra. According to La Boderie's poem, the Phoenician letters had their origin in Gaul. In recent times, he writes, there is still a new role for

> L'usage et les secrets de la mistique lettre
> Des vieux Pheniciens, et lettres et secrets
> Qu'eurent les Grecs de nous, et non pas nous des Grecs.
> Ainsi au fil des ans ceste Ecriture ornée
> Qui en Gaule nasquit, en Gaule est retournée.

We can see in La Boderie the ultimate representation of the connection between France and classical antiquity. Gaul is the source of Chaldean wisdom, so that what is the oldest is also the closest to home.

There are at least two consequences of this approach. First, the Greek authors are not the inventors, but the depositories and transmitters of ancient wisdom. They can therefore be treated as Ramus treats Aristotle, which is to say, at times as an impostor. Secondly, the French, being heirs of the Gauls, were in the best position to correct the Greeks. They could do what had been impossible for medieval authors, including the Arabs.

In this same period in which La Boderie writes the *Galliade*, however, historical scholarship, and in particular critical philology applied to mathematical texts, was putting in place a new way to evaluate ancient tradition. The idea of a Golden Age, whether represented by the Greeks, the Chaldeans, or the Gauls, was set aside. It might still be admitted that the Greeks created the sciences, but the moderns were, from this developing point of view, taken to be more advanced than even the Greeks. Such a position was expressed by Joseph Scaliger,[20] taking aim precisely against Ramus. As we are about to see, it was also characteristic of the French algebrists, once they set aside the mythical Diophantus and began to work towards the actual recovery of his texts.

Diophantus recovered: Gosselin and Viète

Let us take up again Gosselin's version of Tartaglia, published in 1578 (Gosselin 1578). As we know, Gosselin was connected to the court through the Académie de Baïf, which constituted part of his audience. Thus, we can expect his version of the history of algebra to be closer to Peletier's than to that of La Boderie. But we also know that he studied Diophantus and was more aware of its content than any other Frenchman before him, and thus able to determine whether its content should be considered algebra or not. In the dedicatory letter to Marguerite de France, queen of Navarre, he writes:

> Cette divine Algèbre en laquelle une Royne d'Alexandrie Hypatheie a esté si excellente (ainsi que le dit Suide) qu'elle a osé commenter sur le plus difficile livre, qui pourra jamais estre composé, à savoir sur le Diophante, qui traite de cette partie, neantmoins que ses commentaires ne soyent venus iusques en noz mains.

Hypatia had been recently mentioned by Xylander in his edition of Diophantus, published in Basel in 1575. Howevever, Gosselin did try to go further than Xylander in determining what Hypatia had written, for he gives her more importance than Xylander in his own dedicatory letter.[21] To be sure, Gosselin mentions Hypatia as a woman mathematician, in honor of the queen, Marguerite, to whom the book is dedicated. But it is also a way to remember that algebra existed and flourished in Alexandria, a thesis completely extraneous to Tartaglia's treatise, of which this text was supposed to be the French version. However, Gosselin also gives some space to other authors. He cites al-Ḫwārizmī, "qu'on dit être inventeur de l'algèbre". He also mentions Diophantus, "qu'aucuns aultres disent être inventeur de l'algèbre". Finally, Gosselin criticizes Tartaglia for not having mentioned the *auctores* of the discipline. Tartaglia had in fact mentioned *only* al-Ḫwārizmī. This seems to be, above all, a way to stress the importance, in the new conception of the algebraic treatise, of a section *de origine*, which should be as rich as possible, especially in ancient sources, without excessively privileging the Diophantine origins. Yet, Gosselin was working on Diophantus. He was

20. See Grafton 1983, especially chapter VII: "Scaliger's *Manilius*: from Philology to Cultural History": 180–226.

21. Suidas writes: "Egrapsen hypomnema eis Diophanton [...] tov astronomikon kanona, eis ta konika Apolloniou upomnema." This passage gave rise to diverging interpretations, given that Diophantus did not write on astronomy. The most recent interpretation suggests that Hypatia commented upon Diophantus, Ptolemy, and Apollonius. Suidas goes on to collect classical information about Hypatia's life.

connected to the classical and scientific scholars belonging to the Parliament of Paris. They had commissioned from him an edition of Diophantus, and Davy du Perron had lent him his manuscript of the *Arithmetica*. At the beginning of the *Ars magna*, there is a section on the inventor of algebra. Gosselin writes that some attribute the invention to the historical Geber (the eleventh-century trigonometrist), some others to Mahomet, son of Moses (al-Ḫwārizmī), others to Diophantus the Greek. But he declares himself to be convinced that this art existed before these times, because, by his reasoning, it is the science which should acquire the highest dignity since it allows the algebrist to solve all problems.

Thus he does not take Diophantus as the only source, but mentions a series of principal authors, including the Arabs. It seems that with Gosselin, as it becomes clear later with Viète, Diophantus' text is actually taken into account in such detail that its algebraic content is no longer exaggerated. Instead, the text is used to elaborate and extend the discipline further. In addition, Diophantus' role as mythic founder ceases to be necessary as it had been for Regiomontanus, while the myth of origin of the type brought forward by the Ramist author is no longer appealing. There was more than one reason for this, including the increasing awareness of contemporary technical achievements as well as of philological discoveries, in particular the actual knowledge of the text of Diophantus. In addition, the new conception of history also plays a part; again Gosselin should be understood within the cultural framework of this contemporary historical scholarship. We could say that what gave the French algebrists the self-legitimation to transform Diophantus from a mythical *auctor* into an object for critical analysis was the theory of the independence of French tradition proposed in law and history of law by François Hotman (HOTMAN 1559), Étienne Pasquier (PASQUIER 1560), and François Baudoin (BAUDOIN 1561). As Louis Le Caron put it in his *Réponses et décisions* of 1566, "Frenchmen, you have enough examples in your history without searching those of the Greeks and the Romans".

Whether purists like Cujas, who was also Gosselin's patron, or 'medievalists', sixteenth-century jurists were learning to apply their understanding of geographical and historical relativity to law and customs. This process led to the famous universal histories of Jean Bodin (BODIN 1566) and Louis Leroy (LEROY 1575), who explicitly intended to interpret the differences in things (we could say 'facts') in terms of the differences in places.

When Leroy wrote the *De la vicissitude*, the present and the recent national past had been evaluated and found to be rich enough to allow a magnanimous acknowledgement of the Arabic heritage, while still permitting him to give the greater weight to the role of France, and of Europe, in the development of the sciences. The Arabic heritage had, following Lepanto, become less of a danger in fact and more of a new mythical presence.

As the basis for the actual interpretation of Diophantus' text, this revised historical perception was as important as the increased philological sensibility. Both guided readers to focus on the mathematical content, to develop a critical interpretation of it, and finally to elaborate it in new directions.

This form of humanism, with its particular legal character, typified French mathematicians. And it is, I argue, the main cultural reason for the special events which occurred in French algebra from Gosselin and Viète up to Descartes. If we compare Gosselin's (GOSSELIN 1577) and especially Viète's (VIÈTE 1591) work on algebra to the other contemporary elaborations of Diophantus, those by Bombelli (BOMBELLI 1572) and Stevin (STEVIN 1585), we find important differences worth articulating. In particular, we can see that the French writers work with much greater freedom in separating the algebraic content both from the abacus tradition and from Diophantus' text, in order to introduce it into a totally different context, that of a *subtilior arithmetica* in the case of Gosselin, or of an *ars analytica* in the case of Viète.

Conclusions

The algebrists of sixteenth-century France could have taken seriously the previous Italian tradition, dependent as it was on the abacus schools. Cardano, whom they used directly as a source for algebraic techniques, very clearly represented the Arabic origins of algebra. Accordingly, they could have accepted the Arabic authors as inventors instead of propagators, or they could have taken as a myth of origin the Mediterranean centers of learning, both humanistic and mathematical — for instance, Sicily. This did not happen. The reasons for this can be seen in religious, political and economic history. However, we can see rather clearly the cultural options available to these authors, and the way in which they made their choices. This allows us to connect their scientific and their humanistic work.

Regiomontanus introduced into public knowledge the existence and the content of the Diophantus manuscript, thanks to his connection to Bessarion and to the recovery of manuscripts. But the Italian group of algebrists (and La Roche) were still oriented by their abacus school context. For them, humanism meant making a *summa* of the Arabic tradition and connecting it to the Greek corpus.

What happened, instead, in France? Peletier introduced a form of *medievalism*, insofar as the recovery of a national past allowed for an acknowledgment of the more recent, medieval tradition. Thanks to the beginnings of historical relativism, recent medieval tradition could be admitted without loss of national identity. At the same time, in Peletier's mind, mathematics, like language, was the product of a whole people and not of a single person.

Ramus' thesis on the history of algebra, as expressed in the *Scholæ mathematicæ*, with its familiar emphasis on Diophantus, fits perfectly with that side of his work which stresses his new idea of *discipline* as that which should arise from a profound revision of what the Greeks had transmitted.

In *Algebra*$_2$ we find a 'Ramist' construction of a *mythical* national past. This can be explained first of all on Ramus' own grounds, since his whole philosophy implied the existence of an Oriental knowledge of divine origin as the basis for Plato and Aristotle. Secondly, this myth finds a close parallel in La Boderie's reconstruction of the myth of the Gauls.

The time at which the Diophantus manuscript becomes available in Paris, with Gosselin and Viète, is also the time at which Pasquier's notion of history, which had been 'anticipated' by Peletier, finds a new formulation in universal histories by Bodin and Leroy. The result is cultural relativism, at least for the small group which shared these interests. But, in this perspective, the construction of a national past legitimized the national present, giving value to its contribution to the development of the sciences in Europe. This is the time in which the history of Greece is represented as a part of the history of Western culture; ancient Greece becomes early Europe. This is a time in which the text of Diophantus could be read and discussed in the original. Yet this access to the text came at precisely the moment when his authority started to be less crucial in the legitimation of the discipline.

The interaction between national and *de inventoribus* history and the development of a discipline is typical of the process which changes the status of that discipline. This has happened in other times and places, and for other disciplines. For example, Brian Copenhaver has made similar points concerning the development of medicine in sixteenth-century France.

Historians of science have wondered if the revival of the genre *de inventoribus* or *de origine* is not the sign of a gap between Renaissance humanism and Renaissance science. I hope I have made clear that the appearance of this humanist genre in algebraic treatises reflects a moment of *interaction* between humanism and science. The importance of origins for humanistic authors led, not to a gap, but to a conjunction of historical and mathematical learning.

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Mersenne : sa correspondance et l'*academia parisiensis*

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