Concluding Observations on Communicating Observations

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published in
Communicating observations in early modern letters
2013

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Epistolography and Epistemology in the Age of the Scientific Revolution

Warburg Institute Colloquia
Edited by Charles Burnett and Jill Kraye

23

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Edited by Dirk van Miert

The Warburg Institute – Nino Aragno Editore
London – Turin 2013

Published by
The Warburg Institute
School of Advanced Study
University of London
Woburn Square
London WC1H 0AB
and
Nino Aragno Editore
Strada Rosalia 9
12038 Savigliano
Italy

ISBN 978–1–908590–46–6
ISSN 1352–9986

Typeset by Waveney Typesetters, Wymondham, Norfolk
Printed by Henry Ling, The Dorset Press, Dorchester, Dorset

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Concluding Observations on Communicating Observations

Dirk van Miert

In the introduction to this volume, we asked how early modern scholars established the authority of their own observations and those of others, and how the results of individual observations could be generalized into stable knowledge. Another aim was to look at how epistolographical practices shaped observations. Lastly, the articles collected in this volume give occasion to reassess the notion of a 'scientific revolution'. Before shortly returning to these issues, the contributions collected in this volume are worth reflecting upon at some length. Even if they treat different cases, they deal with the same issues, and some of the more important points deserve to be listed and compared.

OBSERVATIONS IN EARLY MODERN LETTERS

The letter reports by Peter Martyr d'Angleria on scientific and cultural phenomena which the Spaniards observed in the New World were largely not based on autopsy, but on an intermediate source: the report of Ramón Pané, now lost.[1] Where possible, Angleria attempted to verify the accounts, either by cross-checking them with independent reports from other eyewitnesses or by observing himself the objects described in the reports.[2] His privileged position at the Spanish court allowed him to make contact with these various witnesses.

Holk has highlighted some interesting instances where Angleria himself made explicit remarks about the style of his letter reports. Angleria claimed that he 'never lifted my pen to write as a historian, but rather to satisfy, with rapidly-written letters, those whose orders I may not ignore'.[3] Angleria presents two disclaimers here. His conscious refusal to figure as a 'historian' implies a view of history as a well-organized narrative, balanced in its distribution of information and phrased in elegant Latin. He also passes responsibility for his writings to his patrons. It is a commonplace in prefaces to refer to the instigation of others, often friends or publishers. Excusing one's colloquial style is less conventional. This does not mean that his writings were really dashed off and published without due attention. In fact, Angleria's choice of style was well considered. He opted for the epistolary mode precisely because it permitted a colloquial style. Angleria anticipated the criticism that his style was too simple even for the lower style required for the familiar letter. His choice of the epistolary form is rather opportunistic: it did not prevent him from ignoring one of the first principles of the art of letter writing – brevity. His rhetorical strategy of *movere* by condemning the harsh treatment of Hispaniola's

1. Holk, pp. 15–17.
2. Holk, pp. 18, 20 and 24.
3. Holk, p. 11.

Communicating Observations in Early Modern Letters (1500–1675), Warburg Institute Colloquia 23, 2013

natives, and the vivid evocation of contact between Indians and Spaniards, making use of direct speech, gives the impression of spontaneity and so of authenticity and authority.

Authority, too, is silently reinforced by Angleria's use of the verb 'to observe' in the first person, even in descriptions of phenomena he never witnessed. He never went to Florida, yet he writes 'We observe that the properties of various water courses produce various effects', giving the impression of a first-hand observation.[4] Clearly, when he was unable to report from autopsy, he still wanted to give the impression of witnessing, thus conforming to a general idea that autopsy confers more authority than second-hand reporting.

A final noteworthy element is the collectivity of Angleria's project. He had contact with natives, sailors, officers, secretaries, ambassadors and monarchs, and mobilized all of them in order to produce his accounts. Contrary to later examples of cooperation, such as Gessner, Angleria's informers held unequal positions. Whereas Gessner communicated with 'colleagues', Angleria ruled supreme in his network of informers, being the only one with an overview of the information collected, and thus the only one able to present a coherent account. Angleria's network of cooperators reflected Spanish society on a small scale, and his centrality in this network reminds us of Oldenburg.

Gessner's purpose was not to merely inform his addressees and, through them, his readers, but to get something in return. His was a much more sociable network, aimed at the accumulation of observation allowing a permanent development of medical knowledge by means of discussion.[5] He actively encouraged colleagues to experiment with medicines and herbs even if they showed little interest in botany themselves. In order to accumulate and compare information, case narratives had to be standardized into histories.[6] Whereas Angleria regarded his reports (which were the elaborations of raw material) not as belonging to the genre of *historia* (to which he ascribes humanist principles of style), Gessner identified reports of observations as *historiae*. Angleria seems to have placed *historia* further away from direct experience, whereas for Gessner, experience was precisely what occasioned the *historia*. Angleria conceived of *historia* as a narrative mode, a historiographical one, elaborated through rhetorical strategies and perhaps even invested with moral lessons. Gessner took the Greek meaning of *historia* as a report of an investigation. Significantly, he employs the Greek adverb ἱστορικῶς: reports 'belonged to the realm of knowledge defined by experience and senses, rather than by logic'.[7] Gessner's letter reports were *historical*, because they were rhetorically manipulated elaborations of original recordings. *Histories* were case notes turned into case narratives with what Delisle terms 'historical depth'.[8] Still, the narrative was not as elaborate as most

4. Holk, p. 12.
5. Delisle, p. 37.
6. Delisle, pp. 34, 38–9 and 42.
7. Delisle, p. 30.
8. Delisle, p. 33.

published case histories of the time: Gessner gave away the outcome, his successful curing, in the first sentence. His curing was more important than the creation of suspense.

Gessner, like other early modern observers, used the verb 'to observe' to mean the interpretation of a text: 'I'll tell you what I have, these days, observed in Pliny'. He employs here the expression 'these days', which he also uses when he communicates medical cases in his letters, locating his observation in time, as if relating a history of his own act of interpretation.

There is no principal difference in the experience gained from experimentation and from reading, although the latter seems to be a second choice for Gessner, and hence is ranked lower in his epistemological hierarchy. Autopsy was a sign of trustworthiness, investing an observation with authority. Intriguingly, he even annotated the notes in his *Thesaurus* with the words 'expertus sum', as a reminder to himself. According to Egmond, Gessner also interspersed working notes with drawings, so as to underscore his auto-experience.[9]

Delisle points out that the verb *animadvertere* can mean to notice (by chance) and 'to turn one's mind to' (on purpose): as is clear from my discussion of *animadversio* and *observatio*, there is no profound difference between *animadvertere* and *observare*; in both cases, the observer needs to be permanently disposed to observe, whether situations occur unexpectedly or in a manipulated situation.

It is with Gessner that we also find a tension between the letter as a work of *literature* and as a practical document. This contrasts with the cases of Clusius, Scaliger and others, who relegated reports of observations to appendices. The letters which Gessner received were self-contained gifts, containing *historiae* or *experimenta*. Hence, he was forced to cut up what he evidently thought of as working material, wasting no time on transcribing them. The letter-fragments found in his *Thesaurus* were decontextualized *histories*. This implies that, for Gessner, there was no principal difference in status between a case note and a case narrative. Once the rhetorical package of the message had done its job by keeping the attention of the addressee of the letter, it lost its function.

Clusius, on the contrary, kept intact the letters he received: they constitute eighty percent of the approximately 1,500 items comprising his extant correspondence. Nevertheless, he, too, filed part of the information separately.[10] These files were almost exclusively the attachments added to the letters he received: drawings of plants, flowers, seeds, bulbs, leaves, or sometimes even real specimens. He did make use of the natural descriptions from the letters as well, referring back to them or citing from them *verbatim* in his printed works. Cutting loose the attachments from the letters has led almost always to the loss of the attachment and hence to a disruption between image and description. Clusius kept track of his sources meticulously, mentioning informants by name and

9. Egmond pp. 60–61.
10. Egmond, p. 64.

recording the date.[11] By studying his correspondence we can link the letters to the printed images with descriptions. This task is time-consuming but possible, although in many cases it will remain an inconclusive affair.

Whereas the networks of Angleria and Gessner were based on a 'national' scale, the network of Clusius was supranational. Like Angleria's network, Clusius's had an unequal social basis. In both cases, the letters were informative, rather than elegant. Angleria apologized for it; Clusius felt no need. Whereas Angleria had anticipated criticism for using non-Latin vocabulary, Clusius was comfortable with communicating in no fewer than six different languages, although the information was translated into Latin in his published works.

This wide geographical, social and linguistic range maximized the reliability of the information. Thus, the Frenchman Charles de Houchin was able to correct an item in the printed work on the Spanish flora by the Flemish Clusius. Like Angleria and Gessner, Clusius acknowledges the value of autopsy. He shared this criterion with Houchin, who corrected Clusius on the basis of first-hand observation, corroborated by a specimen. By exchanging the results of experiments, authors were able to compare the outcomes.[12] Clusius and his friends were well aware that the critical accumulation of resources expanded knowledge both quantitatively and qualitatively.

Clusius favoured autopsy,[13] but had to admit that it was not always possible. As with Angleria, occasional use was made of the expertise of native inhabitants in translating knowledge from the New World or the Far East.[14] Sometimes Clusius discarded descriptions sent to him, even if these were first-hand; in such cases he thought the descriptions did not meet his own standards.[15] But Clusius and his correspondents were good at creating the illusion of immediacy. As we saw in the case of Angleria, who slipped into the role of observer while reporting from a secondary source, Egmond warns us that some 'visual and textual reports look to us like the result of first-hand observation while they are nothing of the kind'.[16] Autopsy was not always possible, and therefore, one was sometimes forced to rely on intermediaries. In Clusius's case these 'men on the spot' were often merchants.[17] Clusius instructed them 'to get information about exotica as close to the source as possible'.[18] Nameless local artisans who were commissioned to portrait plants had to be carefully selected.[19] Individual descriptions often fell short of Clusius's standards.[20]

11. Egmond, pp. 48 and 64.
12. Egmond, p. 65.
13. Egmond, pp. 56, 60 and 65–8.
14. See the contributions by Holk, p. 14 and Egmond, p. 56.
15. Egmond, p. 65.
16. Egmond, p. 51.
17. Egmond, p. 54.
18. Egmond, p. 56.
19. Egmond, p. 61.
20. Egmond, p. 65.

One of the problems with autopsy is that the phenomena observed were not always easy to control. Botanical trips did not necessarily yield results, much as diseases were uncontrollable. One required 'curiosity' not to miss any chance observations, as Delisle and Egmond point out: the word, then, was certainly not limited to Oldenburg's world a century later, even if it became popular in the titles of books mainly during the second half of the seventeenth century.[21]

In medicine and botany, control could be gained by experimenting on one's own body or by growing simples in one's own garden. To know how to grow specimens, one needed information about the original habitat of plant, hence the attention paid to the surroundings of the plants found in the wild.[22] This 'context' was increasingly part of observation, as is demonstrated by the epigraphic records described by Stenhouse. Even the early Angleria referred to the location and spatial situation of the river valley which he reported to be miraculously fertile.[23]

Personal witnessing had the advantage that a medicine or a plant could not only be inspected by the eyes, but even tasted and smelled.[24] But ocular inspection remained paramount: in the case of tulips, the colours were the most striking features, and much attention was paid to describing the rich variety of colours, even of the same petal. If autopsy was not possible, the visual representation of the specimen or phenomenon was regarded more important than a verbal description.

In discussing autopsy, Egmond draws attention to parallels in anatomical dissection and cosmography, and these subjects can be easily expanded on the basis of other articles collected in this volume, notably epigraphy. But whereas in epigraphy, having recourse to classical antiquity was necessary to reconstruct context, Clusius and his friends felt no obligation to refer to classical sources in their letters. Observations from the distant past had been rendered obsolete. The criteria of authority had shifted from the observer to the observed, from personal reputation sanctioned by tradition, to accountability of the observational process.[25]

But these accounts were still not formalized into research reports in the way they were a century later in the Royal Society. The observations in Clusius's correspondence were an integral part of the epistolography which tied together the citizens of the Republic of Letters, along with other information of a political and personal nature.

In her final section, Egmond discusses some possible implications of the observational practices of Clusius and his circle for this historiography of the scientific revolution, to which attention will be paid below.

21. Delisle, p. 32; Egmond, p. 72; Avramov, p. 203. See also N. Kenny, *Curiosity in Early Modern Europe: Word Histories*, Wiesbaden, 1998, pp. 13–14.
22. Egmond, pp. 54 and 65.
23. Holk, p. 24.
24. Delisle, pp. 31–2; Egmond, p. 68.
25. Egmond, p. 69.

Egmond's portrait of sixteenth-century botany shows many resemblances with antiquarian practices around the same time, notably epigraphy. Stenhouse gives the reader a wide range of examples from the letters of various antiquarians who deal with numismatics or stone inscriptions. He thus aptly presents what Egmond termed a look 'behind the scenes',[26] in particular because not all antiquaries were keen to stage anything at all: 'many prominent antiquaries published little'.[27] Stenhouse interestingly points out that many early antiquarians, living in the fifteenth century, acted alone or in small groups. The results inspired their successors to communicate across geographical and political boundaries, or even, after the Reformation, confessional frontiers. Perhaps even earlier than in the case of botany, in epigraphy, from the 1540s onwards, there is 'evidence of scores of scholars from western and central Europe and beyond sending one another information about objects that they owned or had seen, with their interpretations and ideas about those objects'.[28] Stenhouse quotes some examples of how these antiquaries expected letters to contain inscriptions, in precisely the same way as Delisle has shown Gessner to expect a letter to contain the 'spices of our art'.[29] All the collected information called for systematic presentation. In the case of epigraphy, this eventually materialized in Janus Gruter's *Inscriptiones antiquae* of 1603, the embryonic form of the modern *Corpus inscriptionum Latinarum*. Stenhouse points out that an equivalent of this book for coins was beyond the antiquarians, for the sheer number and variety of surviving examples.[30] Still, the same urge to collect was felt in the case of medicine and botany: Gessner's *Thesaurus Euonymi Philiatri* gathered remedies for diseases, his *Icones animalium* aimed at gathering fauna, and although his *Historia plantarum*, which aimed to do the same for flora, was never completed, the project was in a way taken up by Clusius. Clusius too, however, had to admit defeat when confronted with the sheer number of species: his *Rariorum aliquot stirpium per Hispanias observatarum historia* (1576) was limited geographically to the Iberian peninsula and his *Exoticorum libri decem*, published two years after Gruter's *Inscriptiones*, was limited to non-European plants. At the basis of these encyclopedic projects were the thousands of fragments of knowledge communicated by means of letters.

In numismatics, as in the case of botany, description was ideally accompanied by a visual rendering, but the skills required for drawing coin faces demanded an artistic talent which many antiquarians did not possess. Alternatively, antiquarians sought to reproduce coins by making some sort of cast of it, or by actually sending the object itself,[31] in much the same way as botanists from all over Europe sent specimens to each other. And as in

26. Egmond, p. 48.
27. Stenhouse, p. 73.
28. Stenhouse, pp. 73–4.
29. Stenhouse, p. 74; Delisle, p. 27.
30. Stenhouse, p. 74.
31. Stenhouse, p. 75.

botany, few of these attachments survive. What we do have in many instances are the verbal descriptions. Both Gessner and Aldo Manuzio the Younger cut up the letters they received to isolate the descriptions and rearrange them. This has led to the discovery that letters of Gessner's correspondence are to be found in his *Thesaurus medicae practicae* in precisely the same way as Manuzio's codices in the Vatican Library contain letters which were overlooked by the modern editor of Manuzio's letters.[32] For Manuzio's correspondence, it is now difficult to match letters and the attachments with transcriptions of inscriptions which accompanied them, in precisely the same way as it is difficult in Clusius's case to match letters with the descriptions (and engravings) found in his printed works (for lack of the transmission of the original pictures sent to him as attachments).[33]

When images of coins could not be included, writers had to describe the objects instead.[34] Verbal descriptions had the advantage over images in that they allowed for communication of information concerning the material and the weight of coins.[35] The size of course was also of importance.[36] If drawings of coins were sent instead of casts, these were not scaled. Stenhouse and Egmond, at least, do not refer to remarks in the letters concerning the scale of drawings of coins or simples.

Saying something about the size, weight, colour, material etc., all contributed not only to rendering the picture more accurate, but also to establishing authority. Authority lay in the quantity of detail. Authority was also conveyed by referring to both the skill and the trustworthiness of the copyist: the *diligentia* and the *fides*. Time and again, observers discussed in this volume referred to precisely these two characteristics.[37]

Another way to establish authority, as we have seen, was to emphasize autopsy, as Angleria, Gessner and Clusius and their correspondents did. Autopsy guaranteed *diligentia* and *fides*. Not that the senders always possessed enough *diligentia* to transcribe an inscription, but they did have the *fides* to compare object and image before sending the image off with its accompanying letter. Intriguingly, Stenhouse presents an example of someone who not only tacitly admitted his own inability to draw an accurate picture, but also distrusted his own *fides*: Nicolaus Florentius compared a copy of an inscription with the original in the presence of a witness, Gerard Falckenburg. He then, with all the diligence he possessed, made a new copy himself, again with Falckenburg to check its accuracy. This deferring of authority away from the observing subject is quite remarkable: a man like Scaliger quite naturally thought of himself as the most reliable authority.[38] If the reliability of a copyist was distrusted, one ideally had recourse to an independent

32. Delisle, pp. 38–9; Stenhouse, p. 76.
33. Egmond, p. 65.
34. Stenhouse, pp. 77–8.
35. Stenhouse, pp. 78–9.
36. Stenhouse, p. 79.
37. See the Index, s.vv. *diligentia* and *fides*.
38. Van Miert, pp. 95–6.

second source. This was the case with Lipsius's comparison of two transcriptions of the *Lapis Ancyranus*,[39] as it was with Angleria, who heard eyewitnesses independently in the case of the circumnavigation of the world and who compared the report of Cortés to that of his secretary Ribera with regard to the fertility of a river valley.[40] Epigraphers again seem to be most careful of all scholars: Fulvio Orsini, for example, would rather send Onofrio Panvinio nothing than something unreliable.[41]

Increasingly, epigraphers took into account the material context of the inscriptions: the setting on which their texts appeared.[42] Had they first been focused primarily on letters and words,[43] they later came to record both the shape of the letters,[44] and the size of the stones where the letters had been found on. They even consciously maintained the errors they were confronted with.[45] One cannot but think of images in Clusius's *Fungorum historia*, where the defects of damaged individual fungi were faithfully rendered and not brushed away in an ideal type.[46] In the case of a botanical specimen, individual damage was perhaps more easily identifiable as an 'error' than in the case of an inscription. Stenhouse presents an example of an error in a transcription which was due to the copyist, not to the original. This was only discovered due to the experience of someone who just saw the copy.[47] This experience was a matter of generalized knowledge, a knack derived from numerous individual observations, extrapolated into what one might call, with some caution, a 'theory' about how inscriptions 'behave'.[48] The theory in this case allowed for correction of an error in the observation. Much the same applies to Scaliger's corrections of inscriptions, of which I present cases in my own essay.[49]

Stenhouse notes that the epigraphic letters 'also deal with questions of scholarly credit and observation that are redolent of recent scholarship on scientific practice'.[50] This is underscored by my own paper, in which I try to show that observation and description, before being developed methodically as an empirical part of science, were part and parcel of philology. In both philology and the study of the natural world, scholars engaged in

39. Stenhouse, p. 81.
40. Holk, pp. 24–5.
41. Stenhouse, p. 81.
42. Stenhouse, p. 85.
43. Stenhouse, p. 82.
44. Stenhouse, pp. 83 and 85.
45. Stenhouse, p. 83.
46. See E. van Gelder, *Tussen hof en keizerskroon. Carolus Clusius en de ontwikkeling van de botanie aan Midden-Europese hoven (1573–1593)*, PhD diss., University of Leiden, 2011, pp. 336 and 339; ead., 'Tulpen, tuinen en adellijke verzamelaars: Carolus Clusius in Wenen (1573–1588)', *Neolatinisten Nieuwsbrief*, 23, 2010, pp. 13–24 (18 and 22).
47. Stenhouse, p. 83.
48. For an up-to-date discussion of the difficult notion of experience in relation to experiments, see the special volume of *Republics of Letters: A Journal for the Study of Knowledge, Politics, and the Arts* 1, 2, 2010, at: http://arcade.stanford.edu/journals/rofl/category/fora/between-experience-and-experiment
49. Van Miert, pp. 99 and 101.
50. Stenhouse, p. 88.

gathering, describing, comparing and systematizing.[51] Not that the verb *observare* was univocal: the examples presented show that the vocabulary used to denote observation, note-taking, description, interpretation and correction shared semantic fields. An *observatio* could be everything from a transcription of a text to its interpretation.[52]

The correspondence of Joseph Scaliger confirms many of the insights, voiced by Stenhouse, concerning the establishment of authority. Autopsy reigned as the most reliable witness, but Scaliger, like other epigraphers, also made sure to double-check his sources: he rebuked Janus Gruter for preferring a transcription of Knibbius above his own.[53] Nevertheless, Scaliger was far from infallible, as I have observed myself. Mirroring early modern practices, the reader must believe me when I say that Scaliger made two transcription mistakes. To confirm my 'observation', I have added my own photograph of the stone. But I myself must admit that my transcription cannot be cross-checked with the help of this picture: on the two-dimensional picture, the problematic letters are impossible to read, just as they would have been on an early modern cast. Interestingly, at the Chantemille castle where I made the picture, a postcard was sold with a photograph of the stone, on which the letters were coloured black in order to heighten contrast and enable easy reading (above, p. 98, Fig. 5). This mediated version confirms my observation of Scaliger's transcription mistakes.

Despite digital photographic technology, we still are confronted with the same type of problems as Scaliger and his contemporaries. Then as now, both the abilities and the integrity of the observers were stressed. And then as now, it was hard to make straightforward observations of 'reality'. There were two ways of solving a grammatically incorrect transcription of an inscription: either explaining it as the error of the stonecutter (which would require a historical explanation) or blaming the copyist for misrepresenting the transcription. In either case, the text asked for emendation. As I argue, this involved generalized knowledge of how things behaved: knowledge of grammar, and insight into a silent historical context.[54]

The case of Nautonier underscores that in the field of astronomy, scholar-scientists were also engaged in gathering, describing, comparing, systematizing and exchanging. They confronted the problem of authority in the same way. They detached *schedia*, *schedae*, *chartae* or other attachments, from the letters, just as epigraphers, botanists and physicians had done. In both areas there was a critical attitude to the observations communicated in the texts of authors from antiquity. And philologists and scientists used the same networks. In fact, it would be anachronistic to distinguish between scholars and scientists, even if modern English has no single noun to conflate both: the rather late division of science and humanities is discursively constructed in Anglophone historical

51. Van Miert, p. 104.
52. Van Miert, p. 93.
53. Van Miert, p. 99.
54. Van Miert, p. 103.

studies. The examples of Nautonier and of Popellinière also show how the access to observations or the opportunity to facilitate them depended on social factors: successful contact with well-connected intermediaries was crucial. In botany and astronomy, the gathering of observations was often channeled through merchant routes.

Epistolography continued to exercise the shape of reporting. The Italian attachment which Welser added to his Latin letter recalls the misgivings of Angleria, when he used Taino vocabulary in his letter-reports.[55] Standards had changed since Angleria: humanists were much more accustomed to cite vernacular vocabulary if this was necessary to explain the issue at hand. For Welser this was not the case. He could have translated the Italian into Latin and insert it into the body of his text. But he must have been aware that a translation would necessarily distort at least some of the information.[56] Adding tables, long calculations, drawings, etc. into the body of the letter did happen occasionally, but usually they were attached. There was no epistolographic model for this type of information: the Renaissance manuals on the art of letter writing were silent about them. They did not match the literary model which the Renaissance theorists of epistolography had managed to construct from ancient sources.[57] Yet, letters continued to offer the advantage that they were easily written and circulated. They allowed for the gathering and checking of the building bricks of larger works, and they largely escaped censors.

Yet, letters did not simply precede published works. In the case of discussions concerning astronomy they formed part of a much larger textual and verbal framework, comprising treatises circulated both in print and in manuscript, printed letter collections, and public lectures and debates, as Mosley makes clear in his contribution.[58] That letters often accompanied longer descriptions is something we have also seen in the cases of medicine, botany and epigraphy. These attachments, or the letters themselves, were circulated. Mosley gives an example of a letter which was forwarded three times after its initial sending, passing from the original author to Galileo via three intermediate correspondents.[59] The opposite was also true: Tycho Brahe on occasion kept information he did want to have disseminated outside the body text of the letter and instructed his correspondent to keep the attachment for himself.[60] Early modern letter writers were keenly aware of the fact that their letters could be read by more than just the addressee, and they made strategic use of it. Letters were a useful means of communicating information: epistolographic theory allowed for a variety of purposes and a wide range of contents, making it a flexible genre. However, the brevity prescribed by epistolographic

55. See Holk, p. 13.

56. Van Miert, p. 109.

57. For a recent overview on the art of letter-writing in the Renaissance, see my entry 'Letters, and Epistolography', in *The Classical Tradition*, eds A. Grafton, G. Most and S. Settis, Cambridge, MA, 2010, pp. 520–23.

58. Mosley, pp. 118–20.

59. Mosley, p. 119.

60. Mosley, p. 120.

theory also led correspondents (in particular if they expected a wider reading public) to profess the need to limit themselves. Here, as in the cases of medicine, botany and epigraphy, tables and prose records were relegated to attachments.[61] Epistolography, then, was not only a flexible genre in relation to the range of subjects it could treat within the boundaries of a single page, it also was flexible in its dissemination and reading public. What Mosley makes perfectly clear, is that we should not regard letters as the carriers of observations which were more immediate or spontaneous than the reports in other media: there was no essential difference between information communicated by means of letters or by means of a printed treatise, although letters more often than not preceded the stage of printing. 'Reproduction might affect the neatness and accuracy of this information, but no essential transformation was implicated in the transition from manuscript to print.'[62]

Whereas Angleria thought of a *historia* as a historiographical narrative of some length, and Gessner identified reports of observations as *historiae*, Johannes Kepler's use of the term *historia* came close to the latter's. Observations formed the *historical* part of astronomy. The recorded history of past observations guided the practices of those who looked up at the heavens, if only to establish what to observe and when. If this accumulation of a record of observations was indeed what Kepler meant by the *historical* part of astronomy, then it differed little from practices in other fields of knowledge. After all, Clusius also gave the title *historia* to his overviews of simples in Spain and Hungarian fungi, which stored the collective observations over a sustained period of time of an entire network of scholars. Using the term *historia* for a gathering of 'empirical particulars that might, collectively, give rise to the generalities held to be constitutive of knowledge' was common in the early modern period.[63] In astronomical observation, 'history' was understood to be the part of an observation describing its circumstances,[64] but it also denoted the reconstruction of celestial positions in the distant past. This forced astronomers to rely on the interpretations of professional philologists (as Tycho did on Scaliger's) or to deploy 'the critical skills of the philologist' themselves.[65] It would be nonsensical to give a single interpretation to a term which already in antiquity had several meanings, ranging from 'inquiry' through 'knowledge' to a 'narrative', but in order to prevent confusion, it is useful to point out the different ways it was used by those who made observations.[66]

In astronomy, observation was even less straightforward than in other fields. Botanists, witnessing specimens in particular times and at particular places would have

61. Mosley, p. 121.
62. Mosley, p. 120.
63. Mosley, p. 132.
64. Mosley, p. 132.
65. Mosley, pp. 130–31.
66. See also *Historia. Empiricism and Erudition in Early Modern Europe*, eds G. Pomata and N. G. Siraisi, Cambridge, MA, and London, 2005.

been familiar with the importance of locating observations of passing phenomena in time and space, but the appearance of comets and what we now know to have been (super)novae, were far more circumstantial than the occurrence of plants, which returned periodically and moreover, could be reproduced in controlled environments such as gardens. An epigraphic phenomenon can be so stable that even after more than four hundred years, I myself managed to revisit one and take exactly the same position before the stone as Scaliger did. Contrary to anthropological, medical, botanical and epigraphic observation, observing the heavens required instruments, rethinking optical relations between subject and object, and mathematical techniques.[67] Perhaps making casts of inscriptions involved devising 'instruments' (which were often inaccurate), but these were in no way as sophisticated as the instruments used in astronomical observation. It is almost ironic that phenomena which could be witnessed at the same time by a large number of people depended for precise measurement on the mediation of tables, instruments and calculations. Of course, it was the lack of standards in instrumentation, tabulation and orientation, coupled with the (unknown) distance between observer and phenomenon, that caused the huge discrepancies between different astronomical observations of the same phenomenon at the same time. More than in other fields of knowledge, this led to discussions about how to adjust the observations and interpret them, and letters facilitated this 'gradual process of consensus formation'.[68] The interpretation was more theory-laden than in any other empirical field of knowledge. In astronomy, as in medicine, botany and epigraphy, an epistemological shift took place from relying on ancient authority to relying on one's own observational abilities, but unlike in the other fields mentioned, this shift was followed in astronomy by a much more important paradigmatic shift, involving an alternative cosmology. Furthermore, the interpretation of astronomical phenomena 'extended beyond what we might think of as purely astronomical': prognostication involved the prediction of future political or natural events, in some cases involving attempts at interpreting the perceived divine origins of the phenomena.[69] 'Faith in the divine and faith in the senses could pull, therefore, in different directions', as Mosley puts it.[70] Evidently, there was more at stake in astronomy than in botany.

To these complications was added an epistemological crisis in the value of visual perception.[71] As visual illusions such as atmospheric refraction and parhelia belonged to the domain of astronomy (if not to meteorology), the objects of astronomical observations were more complicated than those of other fields of knowledge discussed in this volume. This led to the process of perception itself becoming a topic in

67. Mosley, pp. 115–16.
68. Mosley, p. 133.
69. Mosley, p. 116.
70. Mosley, p. 125.
71. Mosley, p. 127.

astronomical letters.[72] Here, as with other types of knowledge, 'the capacity to undertake observational work varied from one individual to the next'.[73] But unlike in other 'disciplines', astronomical data were mathematically reduced before being communicated. Of course, reduction was also involved when plants were drawn out or coins were cast, but mathematics played no rôle there. Ironically, celestial phenomena could not simply be viewed but had to be 'read', even more than epigraphic phenomena.[74]

One way of making sense of observations, was by constantly exchanging them: only by repeated comparison could methods and instruments be calibrated systematically. This accumulated experience enhanced researchers' authority: it 'enabled elite practitioners to claim that their work had been corroborated to the highest possible degree'.[75] This involved a constant discussion of the accuracy of instruments.[76]

If any seventeenth-century scholar allows us such a look 'behind the scenes', revealing constant improvement in the results of measurements, it is Peiresc. In fact, Peiresc's entire scholarly life was spent behind the scenes, although he himself acted as a stage-director. This is shown by the enormous quantity of his surviving letters, but his epistolary archive also demonstrates an interplay with notebooks and drafts of larger reports. These testify to his obsession with observations and with everything which came into play with it: 'collecting, describing, comparing, corresponding, reading, note-taking, filing'.[77] Most letters are short, covering one folio only. Longer ones easily run to four pages and almost develop into treatises.

Like Scaliger and his correspondents, Peiresc made almost no distinction between describing and transcribing. In fact, in Peiresc's case, *historia* connoted description. Again, then, historia is linked to the practices of observation, contrary to Angleria's use of the term, but in line with those of Gessner, Clusius and even Kepler. Miller widens the scope of early modern practices of description, by focusing not on anthropology, medicine, botany, epigraphy, or astronomy, but on a field of knowledge closely linked with the latter: geography and chorography. In fact the very suffix *-graphy* already points to the descriptive character of these genres. But it is chorography which is concerned with detailed description,[78] whereas geography accounts for a more generalized, mathematical and comprehensive view of earth and sea. The title of a work like Leandro Alberti's *Descrittione di tutta Italia* shows the near identification of chorography and description. This is not a mere coincidence: Lodovico Guicciardini's *Descrittione di tutti i Paesi Bassi*, William Camden's *Britannia*, subtitled *Chorographica descriptio*, and numerous other titles underscore the link.

72. Mosley, p. 123.
73. Mosley, pp. 123–5.
74. Mosley, p. 128
75. Mosley, p. 121
76. Mosley, pp. 125–6.
77. Miller, p. 135.
78. Miller, pp. 137–9.

Mapping was dependent on astronomy, and, as we have seen in the case of Guillaume le Nautonier and Scaliger, in Peiresc's network, scholar-scientists attempted to make use of commercial networks and trade-routes to facilitate observations.[79] Plans for undertaking such projects were described and commissioned by means of letters. The biggest advantage to merchants was that such observations promised to find a way to measure the longitude at sea, aptly termed a 'holy grail' by Miller.[80] Letters also carried instructions on how to observe more effectively, although Peiresc also trained men in person: this was necessary to assure the *diligentia* of his informers. The outcome of Peiresc's project to devise a celestial 'clock' by simultaneous observation of the Jovian system in Aix and Tripoli failed, because all the circumstances which had to be certain were in fact unstable.[81] His attempts at simultaneous observations of an eclipse in 1635 still proved difficult for lack of diligence and proper instruments. Yet what counts is perhaps not merely the success, but the attempt: Peiresc made an effort to 'standardize observational practice'.[82]

As in anthropology, medicine, botany and epigraphy, Peiresc's project was a highly collective one. His network, like Angleria's, involved not only professionals, but also servants, captains and diplomats. In a way, Columbus's servant Ramón Pané resembles Peiresc's factotum Jean Lombard. Both had to learn certain skills: Pané was to live among the Taino for years, with the mission to learn their language and observe their customs; Lombard (more than a century later) was trained in Peiresc's own protocols. Both had to draw up written reports. Just as Angleria worked up Pané's report in his letters, Peiresc gathered Lombard's material and worked it up into a narrative which was again copied out by his secretary.[83] Unlike in the case of Pané, Lombard's original report is still extant: it is a rather schematic log, containing businesslike descriptions of observations, with the dates and conditions specified. None of this material was actually published: what we are looking at is the world of logs, notebooks, memoranda, letters, parts of letters and complete letters; the boundaries were fluid. Gassendi's report on the 1635 eclipse observation was a summary; a longer and more detailed letter was sent by Gassendi to Elie Diodati, and his printed astronomical diary was published under the title *Commentarii*.[84] It was 'somewhere between a letter and a treatise'. We are reminded of Angleria, who had also styled his letter reports as *commentarii*.[85] The letter itself, then, was not the sole carrier of observations, but one important medium within a variety of other manuscript sources, something which Mosley has also pointed out in the case of astronomers around 1600.

79. Miller, pp. 147–50.
80. Miller, p. 142.
81. Miller, p. 143.
82. Miller, p. 152.
83. Miller, p. 144.
84. Miller, p. 153.
85. Holk, p. 10.

Unlike in the case of the attempts at simultaneous observations around 1600, Peiresc was in a perfect geographical location in Provence, on the border between the Mediterranean and Northern Europe. He also managed to sell his projects and mobilize political support: imperial funding, logistical support from Venice, and above all the merchants and ships of Marseille.[86] Organizing foreign observations was more difficult in the case of astronomy than in other fields, because of the dependence on weather and instruments, and its requirement of larger investments. The costs of maintaining a national network like Gessner's, which depended on the goodwill of colleagues and apothecaries, were incomparably lower than the undertakings of Peiresc, which involved training men, chartering ships and establishing observational posts in non-European lands. Clusius likewise depended on 'men on the spot', as Egmond has called them: but even these well-connected figures were often intermediaries, necessary to help organize collective projects.

Peiresc attempted time and again to improve the conditions for making observations: in 1619 he was involved in no fewer than six geographical projects. Repeated observations and comparisons led, over time, to reliable results. Generalized knowledge was a collective project, but success required an individual coordinator: the observations were still largely private scholarly endeavours, in which one scholar-scientist centralized the knowledge gained through the network he had often built up by himself.

The comparison of astronomical data led to a stabilization of knowledge over time. Here too, time was not merely the direct future, but also the distant past. As Tycho and his men developed philological skills to interpret passages on celestial phenomena in ancient texts, Peiresc attempted to confirm measurements which Ptolemy himself had recorded in his *Geography* and which Pythoeas had made in the time of Alexander the Great.[87] Such a time-scale shows that the past was not easily forgotten. Peiresc's discovery that the relative position of Cyprus to Egypt was wrong on the maps, had already been observed and published half a century before him, and at various times since then. But 'mariners were slower to adopt these changes'.[88]

It was precisely the interference of the past with new knowledge which irritated Descartes, the man famous for dismissing the entire humanist tradition, together with its classical philology. Descartes's revolutionary rational epistemology seems completely at odds with the observational and descriptive practices summarized thus far. After all, he is known for his scepticism towards knowledge gained by sense-perception. As Bos and Verbeek begin their article: 'Descartes' name is not usually associated with the idea of exploring nature by way of experiments'.[89] But his letters show that he experimented himself, made observations and discussed these with others. Much of this remained

86. Miller, pp. 142, 144 and 149–50.
87. Miller, p. 156.
88. Miller, p. 158.
89. Bos and Verbeek, p. 161.

unpublished during Descartes's lifetime, but some of his friends were aware of his practices. Perhaps it was in response to them that he explained his position vis-à-vis experiments. Descartes, in his famous *Discourse on Method*, distinguished between two types of observations. The first kind were general and offered themselves spontaneously to the senses; these enabled Descartes to rationally elaborate a general theory of the world.[90] Only after this stage did specific experiments become useful: these allowed one to explain the causes of certain phenomena against the background of the broader theory. Anachronistically speaking, Descartes sees the observations of experiments always as theory-laden. Unlike contemporary antiquarians, botanists and other collectors, Descartes valued theory positively. The 'curiosity' which people like Gessner so highly esteemed, and which was a 'key word of the time',[91] was denounced by Descartes: the openness of mind required to make chance observations was for him a blindness.[92] But in the world of scholarship and science, Descartes was untypical: whereas in other discourses 'curiosity' was usually negative,[93] Oldenburg and his predecessors thought of it as a positive, indeed a necessary quality.

Precisely because he thought that theoretical notions unavoidably interfered in observations, he dismissed experiments done by others. Still, Descartes was willing to share his knowledge with others. In fact, he 'situated himself in a distinctly Baconian perspective' by characterizing his philosophy as practical and directed at mastering nature.[94] He even conceded that working together made possible 'much greater progress'.[95] However, progress was not made by collective gathering of facts. Bos and Verbeek present a number of examples of how these ideas worked out in practice in Descartes's letters, where Descartes explained particular phenomena. In this respect, he usually preferred his own eyes – a criterion familiar to the 'fact gatherers' treated in this volume. The reason is not so much that he distrusted the senses *per se*, but that he distrusted the position of other experimenters: the same things could be viewed from different angles. What mattered was not only the experimenter, but also the result: these were welcomed if they matched his theory. But even with welcome results, Descartes was eager to replicate experiments for himself.[96]

Letters were prime carriers of observations also for Descartes. An observation by Alexandre Calignon was discussed in a letter from Gassendi to Naudé, which Mersenne sent to Huygens and which Huygens forwarded to Descartes.[97] And Torricelli's report

90. Bos and Verbeek, p. 166.
91. Delisle, p. 32; Egmond, p. 72.
92. Bos and Verbeek, p. 164.
93. Kenny, *The Uses of Curiosity* (n. 21 above), pp. 332–3.
94. Bos and Verbeek, p. 163.
95. Bos and Verbeek, p. 163.
96. Bos and Verbeek, p. 170,
97. Bos and Verbeek, p. 172.

in a letter to Ricci was forwarded to De Verdu who informed Mersenne, who checked it with Torricelli.[98] Such circulations of observations via letters are also noted by Mosley within the community of astronomers and in my own article in the forwarding of copies of epigraphic transcriptions.[99] Miscommunication was of course also involved: the unwelcome results of one experiment reached Descartes, but the welcome result of a second trial did not.[100]

As in other essays in this volume, the example of Descartes shows that the boundaries between letters and treatises was fluid: the description of his observation of two halos around the flame of a candle, first conveyed in a letter to Jacob Golius, was copied out in his *Meteors* without significant changes.[101]

It would appear that for Descartes 'observation' not only involved the gathering of facts and the witnessing of certain effects, but also their explanation. 'In his view an experiment must provide an answer, that is, allow the identification of a cause'.[102] If we accept that the outcome of an experiment needed to be described and reported, i.e. observed, Descartes's view at least would match the semantic field of 'observation' in the philological sense, in which observation can mean anything from description to interpretation.

That early modern scholar-scientists took diverse epistemic positions is shown by the example of James Ussher. Known as a Ramist and an anti-Aristotelian,[103] he was no Cartesian, but not an observer either. As others, he had no principal objections to observations. His correspondence shows that he was in fact happy to receive reports of observations, but he also seems to have taken them for granted and did not pay much attention to the epistemology of observations. Some of the isolated observations which correspondents sent him, were generated by eyewitnesses, based on hearsay, not on direct evidence.[104] But as in the case of countless other observations discussed in this volume, the *fides* of the sources was emphasized or doubted; 'by the best in this towne'; 'a learned Jew (at least soe reputed)'.[105] Most of the observations sent to Ussher were astronomical. Astronomy constituted the foundation of the 'two eyes of history': geography and chronology. The case of Peiresc leaves no doubt as to the importance of astronomy for geography. To Ussher, the subject had little appeal. At the request of William Camden, he did offer a description of Dublin, a piece of chorography in which he first quoted a printed source and then added his own eyewitness description of the city. But the case of Ussher makes us aware that learned correspondences differed in character.

98. Bos and Verbeek, pp. 172–3.
99. Mosley, p. 119.
100. Bos and Verbeek, p. 171.
101. Bos and Verbeek, p. 170.
102. Bos and Verbeek, p. 177.
103. Boran, p. 192.
104. Boran, p. 179.
105. Boran, pp. 179 and 183.

What mattered for Ussher were the observations of others, both ancient authors and contemporaries, and he was aware that contemporary observation could either confirm or refute ancient observations. One of his informants in Aleppo, the merchant Thomas Davies, was unable to establish the dates of the overflow of the river Jordan, although he had 'inquired of divers both Christian and Jews'. Davies did not believe a reputedly learned Jew because his account was not 'agreeing with the text', i.e. with Joshua 3:15. Clearly, natural knowledge found in the Bible was more authoritative than a contemporary witness whose religious background rendered his *fides* morally suspect.

In the same way, Ussher was interested in the possibility of confirming observations of the Autumnal equinoxes or the solstices by the records of past astronomers and those found in astronomical tables. His correspondents 'sought the conjunction of ancient sources and contemporary observation'.[106] This led to long discussions in the letters concerning the calculations involved in making sense of observations recorded by other astronomers: recent, classical and Eastern.[107] One of his star-gazing correspondents, Bainbridge, asked Ussher to instruct his agent in Aleppo to look for Arabic books on mathematics and chronology.[108] Why such focus on recorded observations? It was acknowledged that Ptolemy had depended on second-hand information and bad instruments.[109] Whereas the merchant Davies judged that his Jew's account of the dates of the overflowing of the Jordan had to yield in the face of Biblical authority, Ussher's informant John Greaves felt that he could trump the authority of Ptolemy. The ancient astronomer had been dependent on hearsay, whereas Greaves specified location and the type of instrument he used for his own observation of the latitude of Constantinople. Bainbridge apparently thought it a bridge too far to ask Ussher to instruct his agent in Aleppo to undertake astronomical observation. The passive Ussher, then, only engaged in historical astronomy, or what Kepler might have designated the historical part of astronomy. The astronomers around him did use the observations of ancients and others, but 'tempered through the prism of their own experiments'.[110]

It is striking to see that in the 1630s Peiresc was instructing people to make and record observations in Cairo, and that a decade later Ussher's correspondent John Greaves was measuring the skies at Constantinople. Peiresc and Ussher never corresponded, and it remains to be seen to what extent their vast networks overlapped.

Yet, with Ussher we seem far removed from Peiresc's attempts at systematic recording of observations over a sustained period of time. The information Ussher relied on was rather isolated. He was more interested in piecing together information which was already available, like Scaliger, who also hardly ever looked up at the skies himself. Ussher was

106. Boran, p. 188.
107. Boran, pp. 185–6.
108. Boran, p. 190.
109. Boran, p. 189.
110. Boran, p. 197.

still less of an observer. It was the people around Ussher who made recordings, as for example Gerard Boate, who emphasized the value of experiment and observation and who supplied his observations of Ireland, collected during travels over a period of eight years, to his brother Arnold for the latter's *Ireland's Natural History*.[111] Another observer was Edward Wright, whose logs of daily meteorological observations found their way into Ussher's papers.[112] In the end, it was calculation that mattered most for Ussher. In a way, then, Ussher stood at the theoretical side of 'observation' and not at the Baconian one.

The final paper in this volume deals with the Royal Society, but in an unusual way. The Royal Society formalized the observation of phenomena and built an infrastructure to secure the centralization of observations from different territories and on a wide variety of subjects. But the infrastructure itself was still largely dependent on the personal network of one person, as it had been in the cases of the other networks discussed in this volume – Henry Oldenburg. Through Oldenburg, the Baconian ideal of gathering pieces of information was formalized with the help of questionnaires, which agents elsewhere in the world had to complete. This helped to gather precisely targeted information, enabling comparison at home. Peiresc had used questionnaires as well in order to standardize the reports of observations by informants.[113] But he collected for himself and perhaps a number of friends, while Oldenburg collected for an entire community of scholars. In other words, Oldenburg not only instructed others, but he was instructed himself as well.[114] We know that he had particular users of his information in mind when he drew up his letter reports.[115]

Although Oldenburg was no scholar or scientist himself, it would be misguided to regard Oldenburg as a facilitator or mere intelligencer rather than an observer. Oldenburg had the 'curiosity' for chance observations which people like Gessner and Clusius found so important: 'he was vividly interested in almost everything happening around him'.[116] But Oldenburg also engaged in structural observation: he systematically observed living scholars and scientists. His observations of the learned not only constituted observational practice in itself, but also served to facilitate and improve the communication of all sorts of other observations. Oldenburg was a veritable 'information master', to borrow Jacob Soll's characterization of the French minister Jean-Baptiste Colbert.[117] His keeping track of who was when at which address mirrors the centralizing effect of encyclopaedic works such as Clusius's *Rariorum stirpium historia*, his *Exoticorum libri*, or, in epigraphy, Janus Gruter's edition of the *Inscriptiones antiquae*, or, in medicine and zoology, Gessner's

111. Boran, pp. 193–4.
112. Boran, p. 196.
113. Miller, p. 152; Avramov, pp. 200–201.
114. Avramov, p. 201.
115. Avramov, p. 212.
116. Avramov, p. 203.
117. J. Soll, *The Information Master: Jean-Baptiste Colbert's Secret State Intelligence System*, Ann Arbor, 2009.

Thesaurus Euonymi Philiatri and *Icones animalium*. The difference lies in the fact that the publication of data forced the editors to think about a way to organize their material and to devise a structure underlying their collected knowledge. It is unfortunate that we do not know how Oldenburg's 'snapshots', as Avramov characterizes them,[118] were collected, filed and used by others. The letter was a useful literary form to communicate the portraits which Oldenburg drew. The writer was free to structure his observations, and they could be enlivened by evoking emotions.[119] Angleria, in much the same way, had already tried to stir emotions in his letters in order to draw the reader's attention.

Oldenburg not only observed one-time phenomena. He observed in order to verify information and keep it up-to-date. Using the network he wrought, he tried to stabilize knowledge, recording changes over time.

He reported on the 'naturall and acquired parts' of scholars: these categories correspond to the *fides* (integrity) and *diligentia* (the ability) which observers consistently emphasized.[120] He also acted as broker: he attempted to 'convince scholars to engage in an exchange of knowledge'.[121] In order to keep himself educated about the merits of his contemporaries, he set up a sort of 'peer review' system: he had specialists review the texts of scientists in order to improve his understanding of the people he had to observe. This reliance on the knowledge of others helped him to make choices in his observations. Still, the information was too much. In the end, his tasks expanded to such an extent that he was forced to rely on the information of others. He instructed his informants to report what they themselves had witnessed only: authority was again attached to autopsy.[122]

The success of his endeavour is illustrated by the way in which, at Oldenburg's death, Christiaan Huygens carefully orchestrated the stewardship of his intellectual inheritance by the Royal Society. Out of his own accord, he instructed one of Oldenburg's agents what to do with some of his surviving manuscript works.

In Oldenburg's practices we see the coming-together of almost all questions of observation discussed in this volume: on the epistemic level, how to ensure trustworthy observations; on a rhetorical level, how to establish authority when communicating observations; and on a social level, how to advertise his knowledge. Moreover, he was a central figure of the 'scientific revolution'. It is now time to return to these issues.

OBSERVATION AND AUTHORITY

In their letters, scientists and scholars emphasized the reliability and ability of the observers in order to enhance authority. Primary authority was attached to autopsy, in the silent assumption that the observer, i.e. the interlocutor on paper, was trusted. The

118. Avramov, p. 212.
119. Avramov, p. 222.
120. Avramov, pp. 211 and 215.
121. Avramov, p. 208.
122. Avramov, p. 215.

trust was already established by the very fact that people corresponded. Social status, such as nobility, was in some cases regarded as contributory to trustworthiness, something which brings to mind Steven Shapin's landmark *Social History of Truth*, which emphasizes the codes of conduct in gentlemanly behaviour.[123]

If senders of observations had to rely on second-hand witnesses, the reliability and skills of these witnesses were emphasized: their *fides* and *diligentia*. If need be, organizers or intelligencers sometimes trained the men on whose observations they had to rely. If they distrusted the accounts, they sometimes checked the results for themselves.

Primary authority was conferred upon visual perception, which involved shape, size and colour. In second-hand observations, therefore, drawings were regarded as more trustworthy than descriptions. But taste and weight could also be significant, in the case of medicines, herbs and coins. Location and geographical coordinates were also important, as were weather conditions or natural surroundings during the observation. It has proved difficult to notice an increasing importance attached to these elements over time. Specificity varied from one place to another, in different times and in various disciplines. Precision was often a matter of personal accomplishment and not the result of a conscious formal process. Yet, the questionnaires used by Peiresc and Oldenburg go a long way towards the formalization of the gathering of observations.

Some articles have drawn attention to the difficult status of observation. From a literary point of view, observation shares features with history and report. Semantically, it sometimes includes description and transcription. Epistemologically, it often involves some measure of interpretation and adjustment. In all these cases, observations were not as direct as they seem to be, even if the epistolary form and its prescribed colloquial style appears to convey them as such.

LETTERS AND NETWORKS

Epistolographical practices imposed certain limits on the directness of an observation. It has become clear that a letter should never be studied in isolation, but always as part of a larger apparatus of sources: notebooks, drawings, commonplace books and printed treatises. Small observations were often integrated into the body of a letter, but evidence was often relegated to attachments if they consisted of bullet-point lists, or when they involved non-textual evidence such as tables, diagrams and drawings. Attachments were also added if letters threatened to grow too long. Brevity was an essential aspect of the early modern letter. Typically, a letter would fit on a single folio. But the letter was a flexible genre, as many Renaissance treatises bearing the formal characteristics of a letter (salutation, valediction, date, place) show. Angleria's letter reports are rather long and were not drawn up spontaneously. Clusius's letter usually cover one to three pages, although some are longer. Peiresc's longer letters, typically covering up to four folios, also

123. Van Miert, p. 95; Avramov, p. 209.

seem to have taken the place of treatises he never published. From Scaliger's correspondence, it appears that one thousand words was the natural limit for a familiar letter.

Avramov's article focuses on the observation of the agents in the network surrounding the Royal Society, thus showing how observational practices had implications not merely for the discourse of science, but also for the construction of a social setting. Avramov turns the traditional discourse of observational practices inside out, by explaining how the habit of observation was not limited to science, but also invested the daily management of the Society. Professionalization was not limited to scientific practices and methodological rigour, but also to managing its social setting.

But the careful maintenance of the social setting was already there in the sixteenth century, albeit on another scale. Observing as an act alone did not warrant being noticed by others. This required finding patrons, consolidating friendships and establishing reliable routes for communication. Qualitatively, Oldenburg's observations were not more sophisticated than those of earlier scientists, but the larger scale called for professionalization and the division of labour in the social organization of knowledge-gathering. Oldenburg himself kept an eye open for academically trained professionals and autodidacts – precisely those two groups into which the correspondents of Clusius could, with hindsight, be divided.[124]

The medical, botanical and epigraphic networks of the sixteenth and seventeenth centuries had much in common: observations were centralized and published by a single figure, who turned knowledge of particulars into generalized knowledge which served on the one hand as a standard with which to judge new information, and on the other as a record of the state of affairs which was open to being corrected and updated. Angleria was at the heart of a socially diverse network and digested the observations of others. Gessner was, geographically, more limited. Scaliger and the astronomers cast their information nets wider than previous generations had done, although still within Europe. Clusius sought observations from outside Europe. Peiresc and Ussher recruited observers in the Mediterranean. Descartes's network was rather limited, if compared to that of Oldenburg, whose network was more pan-European. Geographically, no real development can be discerned: Angleria was as cosmopolitan as Ussher. Socially, the networking becomes more sophisticated and more concentrated. Over the decades, letters contributed to the slow formation of consensus on certain aspects of knowledge.

THE SCIENTIFIC REVOLUTION

In the time of Oldenburg, the pursuit and interpretation of historical knowledge, languages and nature was in flux: the 'scientific revolution' was in full swing. But his own practices were by no means new and had been applied across a wide range of disciplines: Egmond's study of Clusius, for example, has pointed out similarities between botanical

124. Egmond, p. 72.

practices in the last quarter of the sixteenth century and scientific practices of the Royal Society a hundred years later. She concludes that the chronology and development of the scientific revolution needs to be reconsidered: there was a long period of time in which practices which today strike us as traditional or modern stood side by side, without necessarily all being pointed towards 'modernity'.

In the historiography of the scientific revolution, primary importance is given to Copernicus, Kepler and the shift from a geocentric to a heliocentric world view. This appears to have been as much a philosophical revolution as a scientific one: compared with epigraphic, botanical and philological observation, astronomical observation was perhaps the least directly empirical of all, since, more than the other types, it was mediated by historical records, instruments, cosmological views and theological contexts. Even then, astronomers were unable to distinguish between hypotheses that were 'observationally equivalent', as Mosley puts it.[125] Tycho Brahe was aware of the poor quality of the instruments used by the imperial physician Thaddaeus Hagecius, but nonetheless continued to ask for reports of his observations. Nicolaus Florentius was aware of his own shortcomings and refused to send an observation of a transcription before checking it with the assistance of a witness (or so he claimed): accuracy may have been more easily obtained in epigraphy than in astronomy, but attempts at precision were no less consciously undertaken in that field. Mosley has remarked that 'as often noted with respect to the experimental histories of the later seventeenth century highly situated reporting seems to have suggested itself as a way of forging agreements about particular facts', but 'the astronomers whose letters I have studied were very much striving, as we might expect, to describe celestial phenomena in terms of a potentially universal visual experience'.[126]

This endeavour dovetails with what Bos and Verbeek conclude: that empiricism and rationalism did not constitute a binary opposition in the philosophy and science of the modern age: 'Descartes is one of the few philosophers of the early period to have clearly grasped the point that experiments and "special observations" become useful only against the background of a general theory'. He might have been of the few *philosophers*, but Mosley's astronomers who, at the turn of the seventeenth century, were confronted with hypotheses that were 'observationally equivalent', were very much aware of the theoretical backdrop against which any observation was necessarily made. When Scaliger set out to emend second-hand epigraphic transcriptions, he too must have been aware of the linguistic prejudices of the observer: understanding mistakes by reconstructing the (misguided) assumptions of scribes had since long been at the centre of textual criticism.

If Peter Dear is correct in arguing that the Royal Society 'embodied science but for lack of a common theoretical framework decided to agree on basing the nature of

125. Mosley, p. 128.
126. Mosley, p. 133.

knowledge in experience',[127] then around 1600 botany was closer than astronomy to late seventeenth-century scientific practices. This is surprising, for astronomy is the discipline usually associated with the acceptance of what is perhaps the most salient paradigm shift marking the 'scientific revolution', the shift from a geocentric to a heliocentric world view.

On the basis of the cases presented in this volume, it would seem that the 'scientific revolution' was a phase in the sixteenth and seventeenth century, rather than a rapid development in the seventeenth century only. It was a phase in which the urge for generalized and centralized knowledge was felt, grounded in networks of specialist knowledge provided by individual *savants*. It was also a period in which attention was chiefly devoted to describing observations and communicating them by means of letters with attachments. Theories were of course proposed and discussed, but not generally accepted. The 'scientific revolution' was a phase of open-ended discussion about the coherent arrangement of particular pieces of knowledge.

EARLY MODERN LETTERS AS A SOURCE

The essays collected in this volume describe only a small selection of the enormous resources of early modern learned correspondences. Slowly, these are being made accesible through modern editions, both on paper and online, and through scans using optical character recognition. Hundreds of thousands of letters have never been published or even studied. The vast quantity of seventeenth-century letters from Germanic territories is only beginning to be studied. No doubt in the future the electronic accessibility of these enormous corpora will allow us to draw a more precise map of early modern scholarly and scientific practices.

But not all of these letters will yield as much evidence as those discussed above. The correspondence of Hugo Grotius, arguably one of the greatest scholars of the first half of the seventeenth century, offers very little in the way of observational evidence.[128] The same applies to the correspondences of many other people associated with 'humanism', such as Gerardus Johannes Vossius. In fact, people like Vossius are bound to be characterized as 'humanists', precisely for their lack of observations and descriptions. But these expectations are guided by the idea that an emendation of a text or a verbal portrait of a man does not count as an observation. The correspondence of Isaac Casaubon does contain philological observations – mostly interpretations of classical texts – but his correspondence could also be mined for descriptions. The correspondence of Justus Lipsius, not known as a 'scientist' either, still offers epigraphic descriptions.

Caveats are necessary. The seventeenth century has been seen as the Golden Age of the publication of correspondences. In this century, we see a gradual shift away from

127. Egmond, p. 71.

128. Grotius's correspondence is freely available online, together with other learned correspondences, in the *ePistolarium*: http://ckcc.huygens.knaw.nl

publishing one's own letters towards posthumous publishing by family members and former students.[129] Most of these collections appeared in the United Provinces and Germany. Of course, it was impossible to edit and publish everything. So there appeared *Epistolae quotquot reperiri potuerunt*, *Epistolae mutuae* and *Epistolae ad Gallos* or *ad Germanos*, *Epistolae medicinales, Epistolae philologicae-criticae*, or, in the vernacular, *Lettres choisis*. Nevertheless, such printed collections still contained letters which had been modified, not by the author, but by the editor. If certain remarks in letters were deemed harmful to the reputation of scholars still alive or to their descendants, editors took care to leave out passages or replace with asterisks proper names or any other information which could reveal the identity of someone mentioned in an unfavourable light. For today's historian, printed letter collections are treacherous grounds: the information appears to be more spontaneously communicated than in other formal genres, but the pitfalls are not clearly marked by the formal characteristics of the genre. Some insight into the status of the letter and its history of transmission is therefore necessary for the interpretation of its contents. Thus, the formal letters which Angleria sent to his superiors require taking into account their function in the system of patronage, whereas Scaliger's letters are rather more the result of a hands-on attitude with regard to collecting and interpreting information. What does become clear from the essays collected here is that across the 'disciplines' letters are equally important as a historical source. It is therefore to be expected that letters will increasingly draw the attention of historians of science and scholarship.

129. See my entry 'Letters, and epistolography' (n. 57 above).