

4 The stemma

Introductory remarks by the chapter editor, Tara Andrews

Thus far in this introduction to stemmatology, the reader has learned about the history of how literature was transmitted across the ages, the principles of text genealogy, and the preparatory work that needs to be done before attempting to reconstruct the genealogy, or transmission history, of a particular text. Now, at the centre of the book, we come to the centrepiece of stemmatology, which is the stemma itself. Where chapters 3 and 6 contain information on how an editor might approach the task of creating a stemma, this chapter is focused on the scholarly intellectual object that is the product of these procedures, what is signified by the parts as well as the whole, and how it relates to the history of the text as well as the editorial decisions that may need to be made in the process of (re-)constructing that text.

The first two sections define the stemma from, respectively, the viewpoints of traditional philology and of mathematical (computational) logic. Philipp Roelli begins in section 4.1 with a discursive definition not only of a stemma, but also of an archetype – the (real or putative) ancestor of all extant copies of a text. After giving a brief overview of the history of the use of stemmata in textual criticism, he moves on to venture a formal definition of the stemma as a hypothesis about the genealogical relationships between manuscript witnesses of a text, making reference to concepts defined elsewhere within the handbook. This is followed by a set of examples in which the reader can see how different sorts of hypotheses might be represented in different stemmata.

The traditional definition of the stemma is complemented in section 4.2 by Armin Hoenen, who approaches the concept from the perspective of constructing a formal model; the value of this is that the stemma then becomes subject to certain forms of computational analysis, and the consequences of the hypothesis that it expresses can also be followed in a formalised fashion. An understanding of the stemma as a computational model, and specifically the ability to differentiate what is implied by calling a structure a “stemma” as opposed to a “graph” or a “tree”, is crucial for any editor working with digital tools that produce these structures. Hoenen sets out the general framework of graph theory and goes on to describe several versions of a stemma model that have been based on that framework. He touches briefly on related models from bioinformatics, which are also covered more thoroughly in chapter 8.

No matter the method chosen to construct a stemma, the vast majority of the steps we use revolve around variation among the text copies. Those who have prior exposure to the field of textual philology will have encountered a perhaps bewildering array of terms having to do with textual variation – “significant error”, “conjunctive error”, “separative error”, “contamination”, and so on – and their consequences for the construction of a stemma. Aidan Conti discusses in section 4.3 two different sorts of categorisation of variants. The first of these covers how a particular

variant is to be understood in relation to constructing the stemma; the second categorisation addresses the different sorts of variation and their potential causes, relating them to Quintilian's four main categories of error (addition, omission, substitution, and transposition).

Although the text-genealogical principles behind stemmatology seem straightforward, even obvious, when they are first encountered, a philologist confronted with real historical texts will soon encounter complications. Foremost among these is the phenomenon of the so-called contaminated witness, which is to say, a text manuscript that was copied with reference to more than one exemplar. Tuomas Heikkilä treats this subject in section 4.4, where he demonstrates how contamination can lead to erroneous stemmata, describes the different modes in which a text might have been copied from multiple sources, and provides some guidelines for how an editor might deal with the situation, gaining insight into the transmission history of the text even if a complete and definitive stemma cannot be drawn.

The transmission history that is represented by a stemma is the subject of section 4.5, the last in this chapter, by Caroline Macé. Here, the reader is treated to a demonstration of the need to study the history of a text not only on the basis of its variant readings, but also in light of the paratextual and contextual knowledge that we have about the documents that carry the text. Macé presents three case studies, each of which shows in a different way the inadequacy of restricting oneself either to historical analysis or to stemmatic analysis. The third case study also discusses issues that arise when the text under examination exists only (or primarily) in translation, which may forestall the use of automated collation software but requires the editor nevertheless to find a way to carry out meaningful comparison of texts in different languages.

In sum, this chapter contains a great deal of information, sometimes presented in an unavoidably dense manner, about the form, function, and significance of what in many cases appears to be a simple diagram. Only with a full understanding of the concepts and complications covered in this chapter, however, can the reader avoid the pitfalls of a naive use of the computational methods that follow in chapter 5.

4.1 Definition of stemma and archetype

Philipp Roelli

This section considers the two key concepts for the genealogical reconstruction of texts, already mentioned in passing in previous chapters, in more depth: stemma and archetype. Their historical context, application, types, and definitions will be examined. The next section will then consider the stemma as a computational model.

4.1.1 Context

“Stemma” and “archetype” are probably the two most important terms in traditional genealogical textual philology. After some preliminary remarks, more formal definitions will be proposed. As a first approximation, one may imagine the stemma as the genealogical tree of all known, extant witnesses of a text and the archetype as their most recent common ancestor, usually lost. In practical terms, the archetype is the uppermost point in a stemma, on which all extant branches converge (on the relation between archetype and original, see 4.1.4), or, seen from the other end, the point beyond which *recensio* of the extant tradition of a text cannot reach (see Trovato 2005, 12). Originally, the main point of devising a stemma for a textual tradition was to reduce the amount of possible choice between variants for its editor: the stemma can in many cases show that a reading was innovated and could not have stood in the archetype (see 2.3.2 for Gaston Paris on this topic). Today, stemmata are also used in many other contexts when studying the transmission of a text. Often, editors who wish to edit a text as closely as possible to the original try to reconstruct the archetype’s text as far as possible (see 2.2). But it is crucial to be aware that the archetype is usually not identical with the author’s original text – in fact, many centuries may lie between these two texts. The archetype may be any witness that acquired this special and important function in the transmission of its text by historical chance; indeed, it may be a witness full of mistakes and deficiencies of all kinds. Faced with a faulty archetype of this kind, the editor will usually try to improve the archetypal text using external data or conjecture (see 6.2.3 on the delicate task of *emendatio*). If there are more than a very few witnesses, the reconstruction of a stemma is usually not a trivial task and is often disputed among editors of the same text. New insights into the text’s transmission and significant changes in the stemma can necessitate an entirely new critical edition. As a rule of thumb, it may be said that, the more witnesses there are, the more difficult it becomes to figure out all relationships between them and to draw an adequate stemma; this problem is aggravated by the fact that the probability of contamination (see 4.4) increases as the number of witnesses does. In some cases, for instance if there are a great number of witnesses – there may be hundreds, occasionally even thousands – it may not be feasible to construct a stemma at all (see 7.1 for examples).

4.1.2 History of the terms

The Latin expression *stemma codicum*, or in short just *stemma* (plural *stemmata*), literally means “genealogical tree of the manuscripts”. The word “stemma” ultimately derives from the Greek word στέμμα (pl. στέμματα), “wreath, garland”,

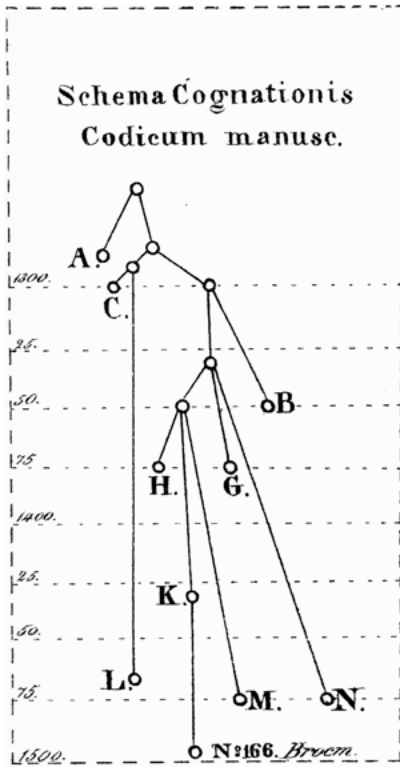


Fig. 4.1-1: Schlyter's *schema cognationis* for the *Västgöotalagen* (Schlyter and Collin 1827, appendix), which may be the first printed stemma.

which is derived from the verb $\sigma\tau\acute{\epsilon}\phi\omega$, “put/hang around”. It is already used figuratively in Latin Antiquity to mean “genealogical tree” (e.g. in Suetonius *De vita caesarum*, Claudius 2). But what we today call a stemma in textual criticism is a recent acquisition: the idea was apparently proposed for the first time in the eighteenth century by Bengel in the context of a hypothetical genealogical tree of witnesses of the New Testament, although he did not use the name (he called it a “*tabula quaedam quasi genealogica*”; Bengel 1763, 20 [a certain, so to speak, genealogical table]). Apparently, it was only in the nineteenth century that such *tabulae* were first printed in editions; the first scholar to print a stemma may have been Carl Johan Schlyter in 1827 (Schlyter and Collin 1827, appendix; he called it a *schema cognationis codicum manuscriptorum* [diagram of relationship of the manuscripts], see fig. 4.1-1), whereas Carl Gottlob Zumpt (1831, xxxviii) may have been the first person to use the designation *stemma codicum manuscriptorum* in 1831 (see Timpanaro 1961, 61). Nevertheless, he still relegated the actual stemma to a footnote. The term becomes the accepted technical term in the wake of Paul Maas's *Textkritik* (1927). Some more details about the early history of scholarly stemmata can be found below in section 6.1.2. When prints, not manuscripts, are the witnesses to be discussed, the full Latin term *stemma editionum* is sometimes used (see examples in 7.8).

The word “archetype” is derived from the classical Greek compound ἀρχέτυπον, “archetype, pattern, model, exemplar”, which was often opposed to ἀπόγραφον, “copy” (see 1.1.5). The compound itself consists of ἀρχή, “beginning”, and τύπος, “the effect of a blow or of pressure” and thus “impression, seal, engraving, etc.”. Renaissance scholarship (written in Latin) tended to use the word *archetypus* in the classical Latin sense as “autograph” (Irigoien 1977); this may cause confusion, as the modern scholarly meaning is rather different. In reality, the situation is even more complicated; Rizzo (1973, 308–318) differentiates at least four different Renaissance meanings of “archetype” and studies the history of the term further.

4.1.3 The *stemma codicum*

The basic, practical method of arriving at a stemma (*constitutio textus*), including a fictitious and a real example, has already been presented above (see 2.2.4–6). The general idea described there can be formalised into a definition such as the one we propose here: a *stemma (codicum)* is an oriented tree-like graph representing a hypothesis about genealogical relationships between witnesses of a text.

This definition uses the terms “tree-like”, “graph”, “witness”, and “text”, some of which come from a traditional philological background, others from a mathematical one. The philological concept of a witness was discussed in section 2.2; while we refrain from attempting to define here the elusive term “text”, some examples of the sometimes fluid boundaries of “texts” are provided in section 3.2. On the other hand, the terms “tree” and “graph” are mathematical ones. A purely computational approach to the concept of the stemma is presented in the next section (4.2). There, the Greg tree as a mathematically defined version of the traditional stemma without contamination (4.2.3.3) is introduced. Section 5.2 explains what “tree” and what the more general term “graph” mean in mathematics; the related terms “DAG” and “polytree” are also introduced there. The term “tree-like” is intentionally fuzzy: it is intended to hint at the fact that the graph can be turned into a tree by removing some edges, the ones accounting for contamination (see 4.4). The defining characteristic of a tree is that any two nodes are connected by exactly one path; this holds only in the traditional, uncontaminated situation in which all witnesses are copied from only one ancestor each. Put another way, if only the main line of descent for each witness is used, the stemma will become a tree. If all transmission of information between witnesses is included, and if there was contamination, the diagram will no longer be a tree. For example, if one witness, say *C*, is a copy of another witness, say *A*, then the graph depicting the two is oriented; in this case, the direction is from *A* to *C*. But if witness *C* was copied partly from *A* and partly from another witness, say *B*, then there will be two (or more) paths from the archetype to witness *C* (one through *A* and the other through *B*), and the stemma will no longer be a tree. In order to turn it back into a tree, either *A* or *B* would have to be regarded as the main line of descent, and the other path would have to be suppressed.

In order to arrive at the stemma most accurately depicting the historical transmission, a philologist will use all available information about the witnesses, including but not limited to the text-state they carry. There will be additional information about the witnesses as objects, such as palaeographical estimates of their age, the identification of different hands writing the text, or information gleaned from the page layout. And, with luck, additional information may also be contained in colophons (see 1.2.2) – scribes may explicitly state what their sources were, when and where they wrote, for instance. For editors, the stemma is crucial in that it helps them reconstruct the archetypal text within certain limits (as detailed in 2.2), but it also has other uses, such as displaying known information about the process of transmission of a text in a compact and formal way. In all of this, it is important not to forget that a stemma is always only a hypothesis, a map that must not be confounded with the mapped territory, as the above definition stresses.

Intermediate witnesses, that is, those that are lost and had exactly one descendant that is extant or gave rise to extant witnesses, cannot be depicted in a stemma unless their existence can be proven (which is rarely the case). Behind every line in a stemma, therefore, many lost intermediary witnesses may be hiding. Usually, one stemma is attempted for an entire text, but there can be cases where different stemmata for several parts of a text are necessary. In strongly contaminated transmissions, variant stemmata, that is, one stemma per *locus criticus* (see 3.3), are sometimes drawn (see 4.2.3.6). Any oriented tree has exactly one root (see 5.2), and the rest of the tradition represented by the tree descends from this root. This root is called the archetype in stemmatology. A stemma that is not a tree but only tree-like (and oriented) may have more than one root. In the case where parts of texts coalesced from various sources, the stemmata of the various components may grow into a “forest” of stemmata attached to one another with several roots. Moreover, indirect witnesses (discussed in 3.2) may provide evidence of texts that were the archetypes earlier in the textual history, before further loss of witnesses, but whose existence can now only be glimpsed in certain passages that happen to be transmitted indirectly. How to deal with such cases in a critical edition can be a difficult question, especially if the text changed significantly between earlier text-states only known incompletely from indirect witnesses and the archetype of the text as it now exists. This situation can arise, for example, in practical, fluid texts such as Latin medical texts of the Middle Ages. In general, it may be better to avoid “patchwork” editions if the text is of a rather fluid nature, and just to indicate the available older readings in an apparatus.

The stemma must not be confounded with what has, since Fourquet (1946, 5), been called the “real tree” or “complete tree” (“un arbre généalogique réel, complet”), by which is meant the (hypothetical) true genealogical tree of all witnesses of a text that have ever existed, including the lost ones (see Trovato 2017, 44–46). This entity is, of course, purely theoretical, as it would contain information that is no longer available (e.g. witnesses that are lost without a trace). In contrast, in a

stemma, only known or traceable witnesses (“junctions” in the tree) can figure. These are often only a small minority, “rari nantes in gurgite vasto” [rare shipwrecks afloat in a raging surge], as Guidi and Trovato (2004, 11) nicely quote from Virgil (*Aeneis* 1.118). The designation “real tree” would seem doubly unfortunate, for this “real” object is completely hypothetical and, moreover, does not have to be a mathematical tree at all, as there may be cycles depicting contamination. This is a typical case of technical terminology from two fields being incompatible. The computer simulations by Weitzman (1982) show nicely how the position of the archetype shifts in the “real tree” as branches are made to die off probabilistically (see fig. 2.4-2 above). This concept will be studied from a modelling point of view below (4.2.3.4).

Examples

A few examples of increasing complexity will illustrate the kinds of stemmata one can expect to encounter in editions of texts. Figure 4.1-2 shows an old stemma (1881) that is completely binary. The archetype is called “Fort.”, indicating the author’s name and thus failing to differentiate between the original and the archetype. Figure 4.1-3 is another old stemma (1917) with two archetypes, or to be more precise, an original and a text reworked by the author that each led to further copies. Extant witnesses are shown by capital letters and numbers. Lost intermediaries are represented by lower-case letters, where today Greek lower-case letters would be more typical (at least in classical philology). This editor chose the manuscript sigla in a

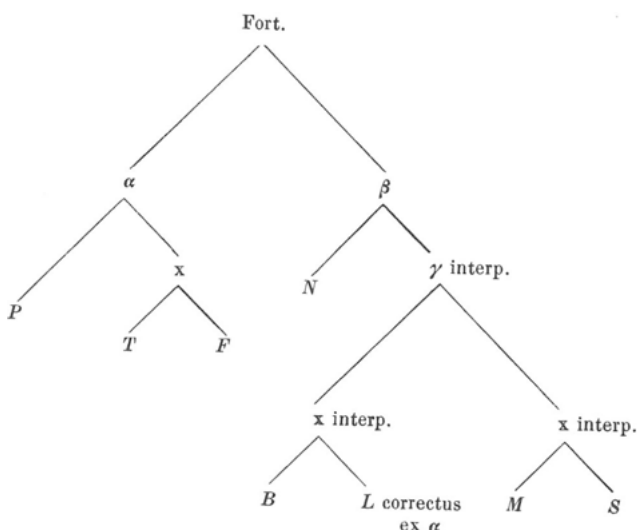


Fig. 4.1-2: Stemma for Venantius Fortunatus, *Opera poetica*, edited by Leo (1881, xxiii). Some lost intermediaries were “interpolated”, that is, contaminated (see 4.4 below); manuscript *L* was corrected from a manuscript from family α and is thus also contaminated. Today, this would more usually be shown by a dotted line between α and *L*.

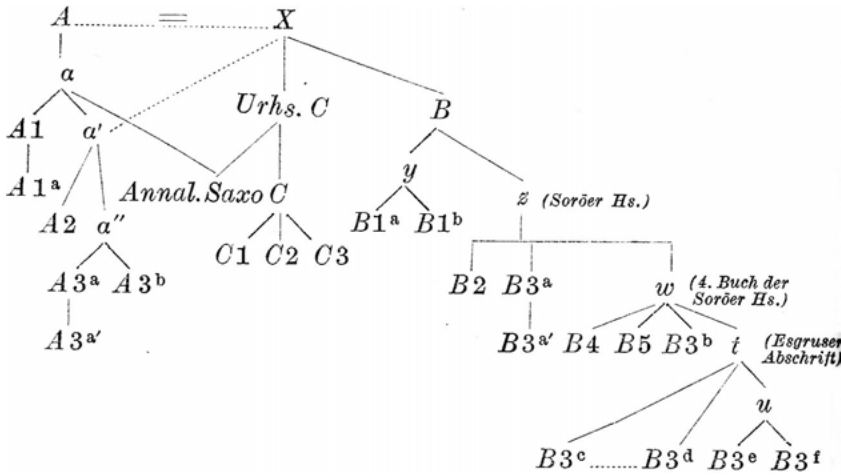


Fig. 4.1-3: Stemma of Adam of Bremen's *Gesta Hamaburgensis ecclesiae pontificum* by Schmeidler (1917, xxxiv). The author reworked his text (from A to X); *a* represents the archetype of the descendants of the first recension, A. Apparently, another author (Annalista Saxo) used both *a* and "Urhs. C" as sources for his own work.

way that fits their stemmatic relations (group A, group B, group C) in his stemma. The problem with this approach is that the sigla will have to be changed if his groups are proved wrong, thus causing confusion. Today, more neutral sigla, often indicating the present location of manuscripts – such as V1, V2 for Vatican ones, or P1, P2 for ones in Paris – are usual. The dotted line leading to *a'* indicates contamination, a convention that is still usual today.

A complicated modern stemma (2011) is depicted in figure 4.1-4. Lost intermediate witnesses are shown in lower-case Greek letters, extant manuscripts in upper-case Latin ones. Dashed lines represent contamination, except for the one between Ω^1 and Ω^2 : Ω^1 represents the archetype, which was corrected after having been copied and gave rise to a Carolingian vulgate text (see 4.1.6), here named Ω^2 . As the text became widely read in Carolingian times, this corrected, more intelligible vulgate text influenced nearly all extant manuscripts. Those older than Ω^2 were corrected ("pc" stands for *post correctionem*). Exceptions are only A and W. The estimated age of the witnesses is provided on the left-hand side.

Finally, figure 4.1-5 shows a stemma of a manuscript tradition with an extant autograph of the author (R; Reims, Bibliothèque municipale, 875). The original text was enlarged several times, producing extant manuscripts B and P. Sheldon-Williams believed both enlargements to be by the author and consequently based his edition on the most recent one, P ("Periphyseon C"); the most recent editor, Jeuneau (1996–2003), disagrees. Since the question is complex, Jeuneau decided to edit the three different versions in parallel, including his own edition in a fourth column.

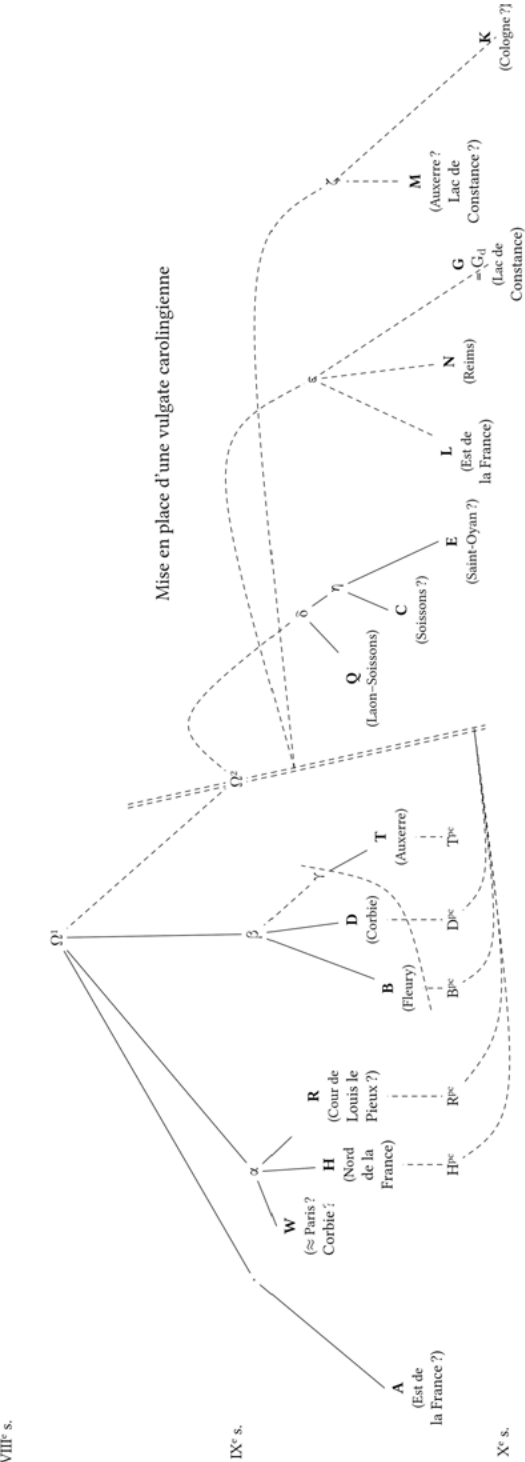


Fig. 4.1-4: Example of a complicated, modern stemma: *Martianus Capella, De nuptiis Philologiae et Mercurii*, proposed by Jean-Baptiste Guillaumin (Guillaumin 2011, cxv; slightly reworked by Guillaumin for this book).

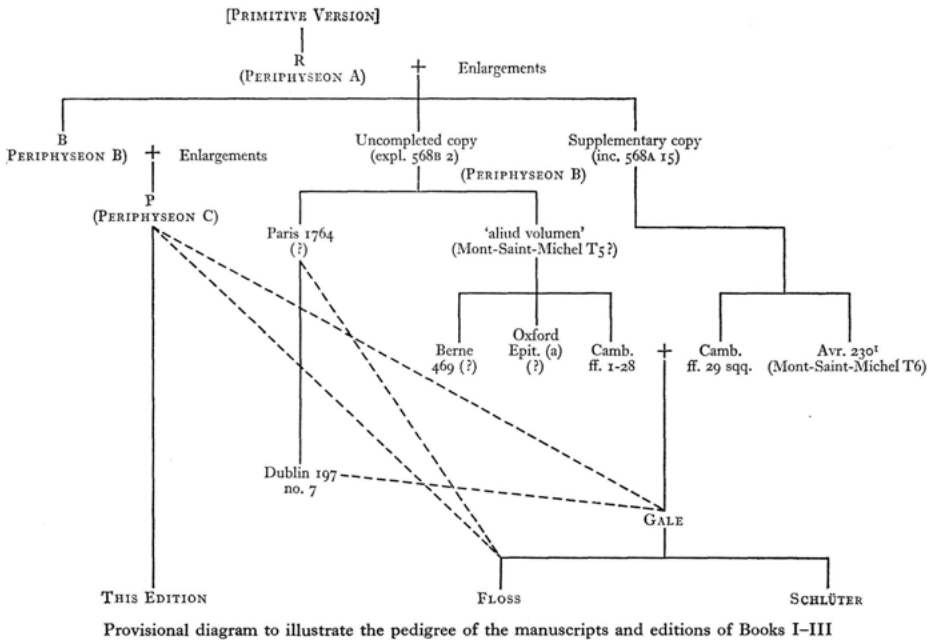


Fig. 4.1-5: Stemma of John Scottus Eriugena's *Periphyseon* by Sheldon-Williams (1968–, 1:29). The text was twice enlarged. Again, contamination is shown by dashed lines; printed editions are named in small capitals. The first print (by Gale) used a composite manuscript whose text source changed at folio 29. © Dublin Institute for Advanced Studies (DIAS).

4.1.4 Branching in stemmata

We have already mentioned above some of the possible types of stemmata one may encounter: there may or may not be contamination, and they may display one or more text-strata (as figs 4.1-3–5 above do). Others, such as variant stemmata (4.2.3.6) or the mathematical concept of the Greg tree (4.2.3.3), will be encountered in the next section. Here, however, we will address one classification scheme that has been the focus of debate for quite some time: the question of bifurcation in stemmata. In the wake of Bédier (e.g. 1928, 11), one often speaks of bifid, binary, bifurcating, or bipartite stemmata. All these adjectives derive from Latin, contain the prefix *bi-*, “two”, and have related meanings. “Bifid” is derived from Latin *bifidus*, “divided into two parts”; *bipartitus* is a Latin synonym for *bifidus*; and *binarius* means anything “that contains or consists of two”. “To bifurcate” stems from Latin *bifurcus*, “having two prongs or points” (all Latin meanings from Lewis and Short 1879).

A bifid stemma is a stemma in which the archetype produces exactly two branches, out of which the entire extant transmission derives. The term was first used by Bédier, who observed that, in the field of Old French manuscript traditions, almost all stemmata he encountered were bifid; this led him to question the validity

of the Lachmannian approach (cf. Bédier 1913, 1928; see 2.3–4 above, 7.3 below). Bédier speaks of a “*silva portentosa*” [monstrous forest] of nearly exclusively bifid trees he had found. Several theories have been proposed to explain or rationalise this phenomenon (starting with Bédier himself); they are based partly on alleged forms of mediaeval text transmission, partly on statistics, partly on psychological grounds. In the latter case, it is argued that editors tend to continue trying to find conjunctive errors until they end up with only two families, in the process possibly mistaking some shared, but polygenetic innovations for conjunctive errors. This has the convenient side effect for the editor that he must (and therefore: may) choose between the two families’ divergent readings, instead of following the criterion, which would be automatic in most cases, of choosing the reading of the majority of families. The psychological argument thus amounts to the idea that the editor wishes to have some freedom in determining his text. On the other hand, Guidi and Trovato (2004) have argued, based on computer simulations, that the higher the loss rate of witnesses, the more likely bifurcations become. They tried to estimate loss rates for some early prints of which the original number of copies is known. These tend to be very high (90–100 %). Weitzman (1987, 303) had already written, referring to his own simulations, that “the present model, for example, overturns Bédier’s assertion that the majority of stemmata cannot be two-branched”. Hoenen, Eger, and Gehrke (2017) put forward a mathematical argument that bifurcating stemmata are indeed the most common kind of stemmata. A further critical discussion of Bédier’s points can be found in Reeve (1986).

A glance at the many (and often complicated) stemmata printed in volume 1 of the *Geschichte der Textüberlieferung* (Hunger et al. 1961–1964) seems to indicate that bifid stemmata are much less prevalent for classical (Greek and Latin) texts; this impression is confirmed when looking at some mediaeval Latin editions printed in the *Corpus Christianorum continuatio mediaevalis* collection. It would be interesting to examine whether these differences are due to the much more standardised classical languages, or different circumstances for the transmission of the texts, or even to different approaches by the editors. In a recent study of stemmata in Old Norse philology, Haugen (2016) arrived at figures for bifid stemmata that were very similar to those in the Old French tradition. The phenomenon needs to be studied further, especially taking into account different kinds of textual traditions (different languages, different witness survival rates, different timespans between original and archetype, and the like). For now, however, it seems safe to say that Bédier uncovered a real phenomenon and not, as he believed, an artefact of a method that does not work.

In contrast to a bifid stemma, a binary stemma or tree is one composed exclusively of nodes with either two children or none (not only, as in bifid stemmata, on the top level). Although real traditions of this kind of any magnitude are unlikely, one not infrequently encounters binary stemmata in editions (e.g. figs 4.1-2, 4.1-6; many examples are also printed in Bédier 1928), and many types of software (see 5.3)

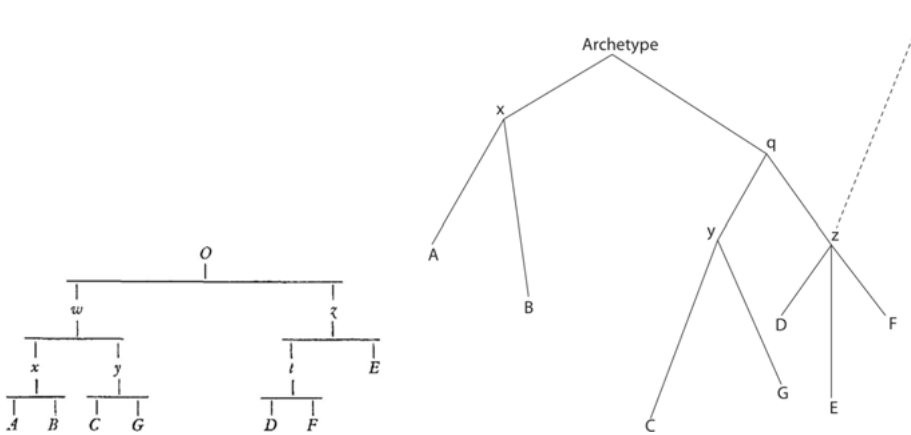


Fig. 4.1-6: (Left) the binary stemma initially proposed for the *Lai de l'ombre* by Bédier (1928; repr. 1970, 6). Bédier later accepted the criticism of Gaston Paris (1890) and modified the stemma to make it tripartite (by moving *E* directly below the archetype) before giving up on the stemmatic method. (Right) according to Trovato (2017, 294), the problem of a lacuna correctly filled in *z* can be solved by assuming extra-stemmatic contamination (see “1963” in 2.4.2). Of course, both *r* and the archetype go back to the original (not depicted).

can by design only produce binary trees, which, however, can easily be remedied by contracting nearby bifurcations into a single node (see 5.2 for more details). “Bifurcating” is a synonym for “binary” in manuscript studies, whereas “bipartite” may be used as a synonym for “bifid” or “binary”. On the whole, the usage of these terms does not seem to be fully fixed yet.

There are, however, also many stemmata with a lot more than two branches issuing from the first node (the archetype). Figure 4.1-7 shows such a case: the stemma of Petrus Alfonsi’s *Dialogus*, exhibiting eight branches directly from the archetype. This case, probably quite rare, of such a high initial filiation (the archetype is close in time to the original – indeed, the two may be identical in this case) is explained by the fact that the book immediately gained great popularity. It may be that the author, who was a travelling scholar, frequently left his abode, which will have made it likely that local disciples wanted to keep a copy (on this hypothesis, see Cardelle de Hartmann, Senekovic, and Ziegler forthcoming, chap. 1).

In graph theory, the term “bipartite” means something entirely different. There, a bipartite graph is a graph whose nodes can be arranged into two disjoint sets such that every edge connects a node in one of them to one in the other (i.e. in each of the two sets, there are no nodes that are connected with one another; Diestel 2005, 17). It can be proved by induction that every tree is a bipartite graph (in this mathematical sense). These two meanings of “bipartite” should not be confused.

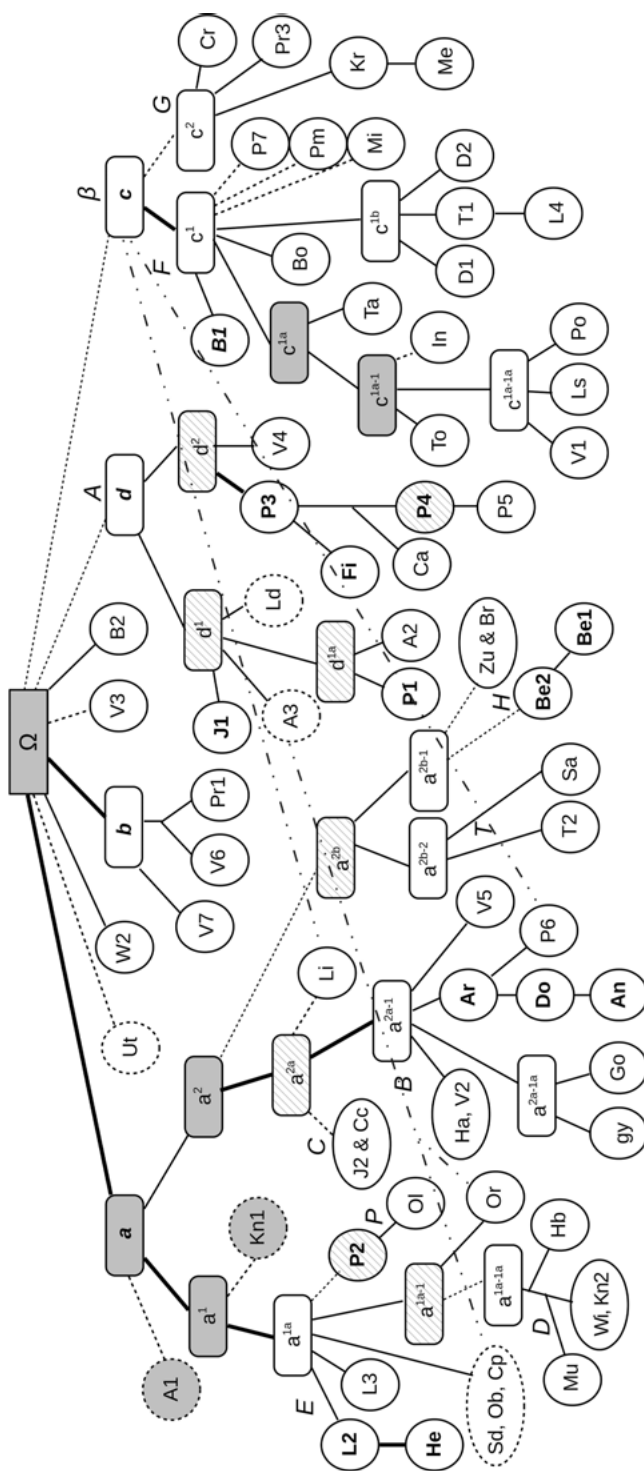


Fig. 4.1-7: A complicated stemma for Petrus Alfonsi's *Dialogus* with strong filiation from the archetype (from Roelli 2014, 55). Thick lines indicate few changes, dashed ones many. Dot-dash lines indicate contamination.

4.1.5 The archetype

Below, it will become clear that the term “archetype” is used in some slightly differing ways today. We would propose the following definition: the archetype is the most recent witness from which all extant witnesses of a text derive.

It follows from this definition that the archetype’s text is as close to the original state of the text as the surviving witnesses can attest. According to this definition, the archetype may in some cases be identical with the original – if the original itself has survived, or if more than one copy of the original has produced extant offspring. For classical or early mediaeval texts, however, this is very rare. An example of a text from the ninth century that has come down to us in the original is the *Periphyseon* by John Scottus Eriugena (Jeauneau and Dutton 1996; see also 1.2.4, and fig. 4.1-5 above). At any rate, the concept of an original is stronger than that of an archetype; in other words, if an archetype of a text can be shown to have been the original, it is usually addressed as the “original” and treated accordingly. For texts from Antiquity or the Middle Ages, the low chances of having an extant archetype are still somewhat higher than those of having an extant original. If the archetype is not extant, one of the aims of *recensio* (see 6.2) is to reconstruct its text as far as possible. Insofar as it has become the archetype by means of historical accident, this witness may have borne a corrupt text and may have been written by an incompetent scribe; in order to arrive at a readable text, the editor may have to resort to *emendatio* (see 6.2.2.1). On the other hand, it may happen that an especially authoritative copy becomes the archetype because other less authoritative copies are discarded or not copied further (see 4.1.6). The quality of the archetype may be an important parameter for gauging the kind of *arbre réel* one has to expect for a textual tradition. For instance, for Varro’s *De lingua Latina* we have an extant but very corrupt archetype from the eleventh century containing five of the original twenty-five books (Firenze, Biblioteca Medicea Laurenziana, li.10).

In a stemma, the archetype is placed immediately below the original (if the latter is depicted at all) and, especially in classical philology, it is often denoted by a Greek letter. Figure 4.1-8 shows the path between the original (X) and the archetype (α), which may have consisted of many and complex branches, all of which are completely lost, as a mere line. As we have seen above in figure 4.1-3, for some works, more than one version of the original may have to be reckoned with (e.g. if the text was reworked by the author); for similar reasons, more than one (state of the) archetype may exist (as in fig. 4.1-4). Several states of an archetype can arise if it was reworked and marginal or *supra lineam* variants were added to it. This will make the reconstruction of the stemma more difficult, as some copyists may simply have omitted these variants while others may have incorporated them (or some of them) into the text while omitting the original readings. In certain traditions (especially very contaminated or fragmentary ones), it may be impossible to arrive at an archetype.

A hyparchetype is a state of the text, often but not necessarily lost, which is situated directly below the archetype in the stemma. The word is derived from

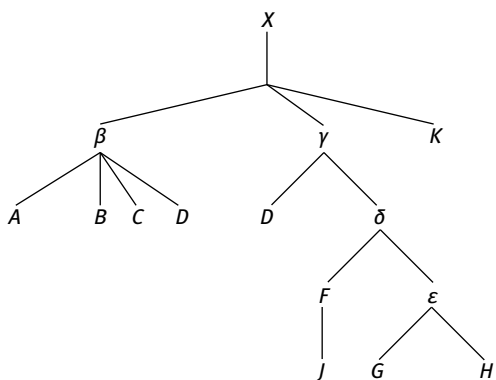


Fig. 4.1-8: Model stemma from Maas (1960, 7), redrawn and slightly simplified.

Greek *ὑπό*, “under, below”, and *ἀρχέτυπον* (see above). Thus, in figure 4.1-8, β and γ are lost hyparchetypes, and K is an extant one. The term is also occasionally used more loosely for ancestors of families that do not go back directly to the archetype, such as δ in our example. Hyparchetypes are thus the ancestors of related families of preserved witnesses. Like the archetype, hyparchetypes are often denoted by Greek characters in the stemma, especially in classical philology. Paul Maas proposed using the term “hyparchetype” in a more exclusive sense to refer to reconstructed variant-carriers (1960, 8), that is, lost witnesses directly below the archetype. He considers as variant only those readings directly below the archetype between which no mechanical choice is possible. The alternative form of the term, “subarchetype” – with *sub*, the Latin synonym for *ὑπό* – is not recommended, but is sometimes found in the literature.

There are many subtly different definitions of the key concept of the archetype in the literature. Reeve (1986) collected a list of about a dozen such definitions, some (but not all) of which are identical or equivalent to the above definition. In particular, there is contention about two points. First, it is disputed whether an extant archetype should still be called an archetype. It may be argued that in such a case all other witnesses can be eliminated (*eliminatio codicum descriptorum*; see 2.2.8) and – at least for the reconstruction of the primordial text – the situation becomes equivalent to that of a *codex unicus* (see 3.3.2) without an archetype. For instance, Montanari would in such a case speak of a “*codex unicus secundario*” (2003, 21). Other opinions differ; Pasquali, for example, was content to address an “*archetipo conservato delle Metamorfosi di Apuleio*” (1934, 33) [the extant archetype of the *Metamorphoses* by Apuleius], and we would prefer to speak at least of a trivial archetype in such cases. Second, in the cases where the same witness is both original and archetype, it will in most cases likewise make little sense to speak of the original as an archetype, and some authors would altogether avoid this. From a practical philological point of view, it is indeed preferable to avoid doing so, as the text has to be treated differently depending on whether it is sanctioned by the author (in the case of an original) or a product of historical chance

(non-original archetype); but from a graph-theoretical point of view, both are MRCAs (most recent common ancestors) and stand in need of a common designation. The existence of an archetype different from the original can be proved by finding at least one error common to the entire tradition, one the author could not have written. One may, therefore, differentiate between a narrower concept of the archetype which excludes originals and extant archetypes and which is especially useful in the context of ecdotics, and a wider, purely positional one that equates “archetype” with “MRCA”. Here, we follow the latter.

In graph-theoretical language, finding the archetype is equivalent to assigning a root in an unrooted tree (see further 4.2). In evolutionary biology, the term “most recent common ancestor” (MRCA) is used similarly to “archetype” in textual criticism. Here, however, the similarity to phylogenetics ends: the concept of an original makes little sense in biology, unless one chooses to go all the way back to the so-called LUCA (last universal common ancestor) of all living beings, to which, however, no urtext of all existing texts ever written can be compared.

No matter whether computerised or traditional approaches are used, deciding where in the tree the archetype is to be located is often the most difficult, but also the most crucial, task for a philologist studying a textual tradition with an interest in the original text. In the traditional method, the problem is usually less pronounced because good significant errors (see 2.2.5) can often be identified. They are, in Greg’s terminology, “substantive variants” (also known as “substantial” ones), which he defined thus:

we need to draw a distinction between the significant, or as I shall call them ‘substantive’, readings of the text, those namely that affect the author’s meaning or the essence of his expression, and others, such in general as spelling, punctuation, word-division, and the like, affecting mainly its formal presentation, which may be regarded as the accidents, or as I shall call them ‘accidentals’, of the text. (Greg 1950–1951, 21)

A subclass of such substantive variants – those that cannot be undone by an intelligent scribe – can serve as significant errors. These tend to be directed; that is, the editor can determine which variant is original (or at least archetypal) and which one(s) are innovated. There are several aids at the philologist’s disposal for this task: old ones such as *lectio difficilior* (see 4.3.2), as well as more recent ones such as diffraction (see “1955–” in 2.4.3). In order to do this correctly, knowledge about the text and its author, or the archetype and its scribe, must be inferred and used. Computerised approaches from biology are not usually helpful for this, as biologists tend to use an outgroup to root their trees. The outgroup, as will be explained more fully below (5.2.1), is an organism distantly related to the group of taxa being studied. The point where its branch exits the tree then corresponds to the MRCA of the studied group. As texts are written at some point in time *ex nihilo*, so to speak, this approach cannot usually be used for rooting the tree (see 3.2.8, 4.5.3 for exceptions). The example in figure 4.1-6 above shows how a stemma can change radically if another node in the tree is designated as the archetype. Such changes lead to a very

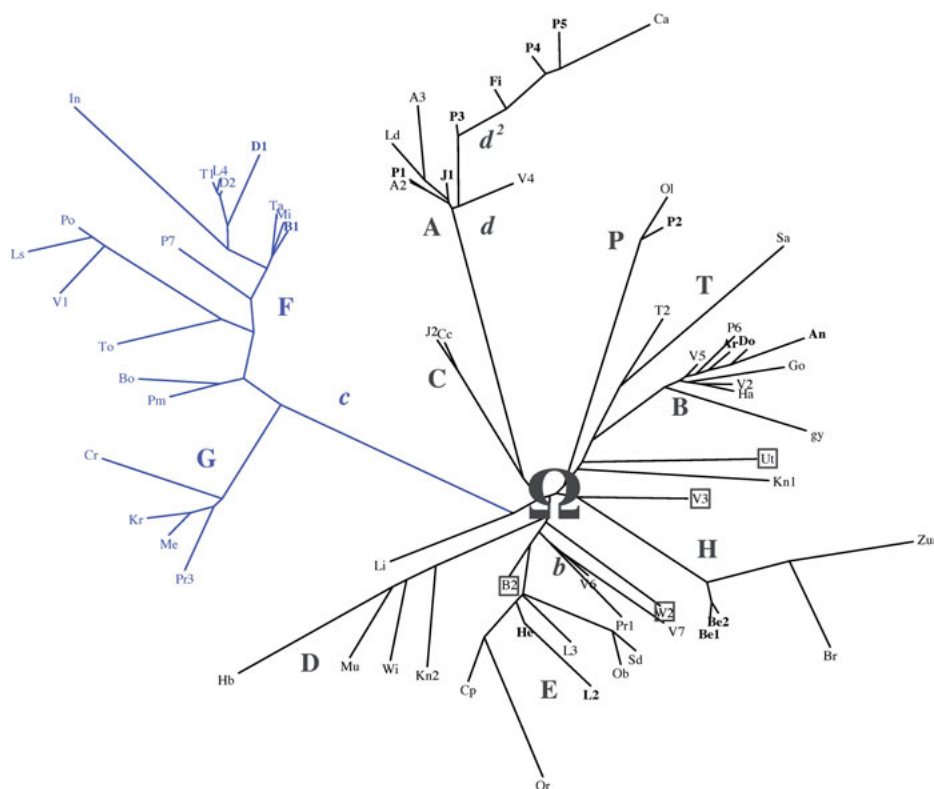


Fig. 4.1-9: How does one find the archetype in an unoriented tree? Example from Roelli (2014, 47) with added blue colour. The tree was drawn fully automatically; only the superimposed letters naming the families were added manually. The boxed witnesses are the oldest ones.

different influence of the witnesses on the reconstruction of the archetypal text. In Bédier's stemma, *E* is the most important witness (with a weighting of 25 %), whereas in Trovato's, *A* and *B* are (with a weighting of 25 % each). Once the philologist, perhaps using software, has arrived at an unrooted tree-graph of the relationships between all extant witnesses, direction in the tree must be provided by discerning for some variants which one is original or archetypal and which one(s) is (or are) innovated. A priori, the archetype may be hiding at any point in the tree, even perhaps on an edge between two nodes. An example from the recent edition of Petrus Alfonsi's *Dialogus* will illustrate the approach. “Leitfehler”-based software (as described in 5.3.7) produced the unrooted tree depicted in figure 4.1-9. In the following passage, the text marked “...” is missing in all witnesses of the *c* group (blue in fig. 4.1-9):

Nunc cognoscere potes quia gradus signi qui est in oriente sole Aren ciuitati apparente °non est idem cum eo qui eadem hora alii ciuitati apparet. Similiter gradus qui est in occidente sole in Aren occumbente° non est idem cum eo qui eadem hora alii apparet ciuitati. (Cardelle de Hartmann, Senekovic, and Ziegler 2019, §56)

Philological judgement is required to observe that the omission is best explained through eye-skip (“non est idem [...] non est idem”; see 4.3.2 for more on this phenomenon) and that, therefore, the *c* group has innovated by accidentally removing the words in question. It follows that the blue parts of the tree cannot contain the archetype. Similar arguments show that, in this case, the archetype is indeed in the middle of the plot (marked as Ω). If editors fail to conduct this step of determining the direction for some variants (the “significant errors” discussed in 2.2.5), it is likely that a wrong place in the tree will be chosen as the would-be archetype. This may be the most “neutral” text or the one most commonly read in some key period, possibly long after the archetype. This leads into the consideration of such textual vulgates.

4.1.6 Vulgates

To conclude this section, we look at a concept related to that of the archetype, that of a textual *vulgate*. The word derives from the Latin *vulgata*, “spread among the multitude (*vulgus*)”; the feminine noun *editio*, “edition”, is implied, so the form is feminine. The same term is more frequently met in biblical studies, but there it denotes something completely unrelated: St Jerome’s Latin translation of the Bible, which became the most widely used one in the Middle Ages and beyond. In textual criticism, a vulgate text is the text form that reached the widest distribution at a time, possibly long after the archetype, when interest in the text experienced an upsurge for one reason or another and many copies were made. When interest in a text is high, it is also likely that some people will compare witnesses in order to arrive at a better text. This is, in fact, nearly the same thing that modern philologists using the genealogical method do, although before the nineteenth century the scientific tools for arriving as close to the archetypal text as possible were not yet in existence and the result depended a lot more on the editor’s intuition. Vulgate texts are thus often a kind of early text edition or, to put it negatively, the product of heavy contamination. Their text may supplant all other text forms and thus eradicate them. Trovato (2017, 299–333) provides an example in his discussion of the transmission of Dante’s *Divina Commedia*. A vulgate reading is a reading present in a vulgate; it can also refer simply to the most frequent reading, and often implies that this reading is not the original one.

If witnesses are grouped based on all undirected variants, instead of exclusively on directed common errors, as might be the case on the part of inexperienced textual editors using software methods, there is a great risk of arriving at a vulgate text instead of the archetype (see Trovato 2017, 138–144). In some cases, it will make sense to edit a vulgate text because it was the most frequently read one, but it is important to be aware of the difference between vulgate and archetypal texts.

4.2 The stemma as a computational model

Armin Hoenen

This section considers the stemma from a computational and mathematical point of view: as a model for the evolution of a text.

4.2.1 Modelling

Devising models is one of the typical activities in the digital domain, and – whether explicit or implicit – is one of the first activities in a computational project. The goal of modelling is to outline a basic, often formal concept of one's research object (in our case, the stemma) and the research process involved in attaining it, which can be used as a framework for implementations, operations, and exchange between scholars using the same model. It follows that, as a conceptual framework, a model is an abstract and structured representation of the research object and process that contains many definitions. However, there are different types of models, depending on how the scholar wants to conceptualise the object of study: for example, a model can be based on the entities involved in what is to be modelled and their relationships (entity-relationship models), or it can be based on the development over time of the object under study (process models). Models can be graphically presented and constructed with specialist software that employs a modelling language, such as the Unified Modelling Language. Furthermore, models differ in their level of abstraction (from conceptual to physical). Obviously, the kind of model which is needed depends strongly on the task at hand. The most basic kind of model to consider in our context is a purely conceptual model of a stemma. We have several cases in the computerised stemmatological literature that explicitly mention a model or are even focused on it (Najock and Heyde 1982; Spencer and Howe 2002; Andrews and Macé 2013). Andrews and Macé (2012), in particular, outline some models connected directly with stemmatology. For a more in-depth general discussion of modelling, see Minsky (1965); for modelling editions, see Vanhoutte (2010) and McCarty (2014).

In practice, since modelling – if undertaken seriously – is time-consuming and resource-intensive, many models are expressed simply as formal sketches using simple graphical elements (such as labelled circles, triangles, and so on) and idiosyncratic mappings of those shapes to entities in the context of the project at hand. Modelling can be a part of the good documentation practice that any project should engage in.

4.2.2 The stemma: A conceptual model

In order to work with a stemma, the general concepts behind what we mathematically intend to be a stemma should be formulated in clear mathematical terms in

order to discuss implications, understand and develop extensions, and to reproduce and ultimately improve results. The process of formulating a concept using mathematical formulae is called *formalisation*, and the result can be a model. The computational aspects of a model can include, among other things, specifications of data structures saved to disk and the sequence and interaction of components, as well as other specifications at the interface of theoretical concepts and practical manifestation. Particularly in computational stemmatology, an explicit model is important as the model is the framework on the basis of which different approaches are evaluated: results may crucially depend on the underlying model. Metaphorically speaking, using different models is roughly comparable to belonging to different schools, for instance, in philosophy. Exchange between studies that use different models is not always possible and requires clearly defined abstractions. A model can be formalised in different ways adhering to different conventions. Van Zundert et al. (2012, 280) remark that a complete lack of formalisation has been blamed for failed attempts to apply computational approaches to questions in the humanities. Typical entities in the humanities tend to be complex in technical terms. The aforementioned lack of formalisation is in part due to this complexity when the object of study is described *expressis verbis* but not *expressis formulis* – in words rather than in formulae – and when those interested in the formulae tend not to be those interested in the words. The texts themselves are often written by philological experts for philological experts, which may create an invisible barrier for non-philologists when trying to formalise the concepts behind, for instance, stemmata and build algorithms on the basis of them. On top of that, van Zundert et al. (2012, 281) point out that different kinds of formalisation exist and that they are not universal across research domains. This explains why models based on formalisation apparatuses carried over from fields such as bioinformatics or mathematics may need some formal adaptation to cover certain aspects of textual criticism. Additionally, in this sense, the concrete meaning of the term “model” may slightly differ and depend on the approach to formalisation one chooses. Formalisation is not a trivial undertaking, but it helps clarify ambiguities and enables programmers to quickly implement approaches and mathematicians to outline general properties and limits within which a model operates. Some philologists have worked, or have tried to work, formally and will be considered in more detail. Some of them have explicitly used well-researched mathematical entities and terminology, while others have created their own notations for the formal representation of stemmatically relevant givens.

Finally, models are sometimes implicit and we have to deduce them from the way in which stemmata are displayed. For instance, one can often immediately see whether a stemma has a distinguished root node or whether it is unrooted, which easily translates into a mathematical property. Such implicit models are not problematic as long as no ambiguity arises concerning their interpretation; but an explicit formalisation could prevent such problems *a priori*. In other words, the model used is often retrievable from the text and the visualisations given in a study, al-

though this may require some interpretation and profound knowledge of stemmatological phenomena and their implications. In this sense, translating or devising a computational model for stemmatology is an interdisciplinary and by no means trivial process.

It might be possible to develop a single model to represent all kinds of stemmata. However, such a model would have to be very general, so general that its concrete usefulness might become debatable. In the rest of this section, we present a theoretical modelling framework for stemmatology; look at the most explicit models which scholars have formulated in their publications, and then at implicit models and ways to deduce and formulate them; and finally summarise and conclude.

4.2.3 General frameworks: Graph theory

Most approaches to formalising stemmata rely on the basics of the mathematical framework of graph theory. In graph theory, we have two basic components: nodes and edges. Nodes represent entities, and edges represent relationships between them. Within graph theory, a stemma can be modelled in a number of different ways. Since section 5.2 introduces the basics of graph theory and gives more precise definitions of graphs and their components, we will only discuss here what kinds of graph-theoretical entities have been used as stemmatic models and how.

4.2.3.1 Graph-theoretical models for a stemma: The directed acyclic graph

A very commonly used entity to model a stemma is the DAG, which stands for “directed acyclic graph”, that is, a directed graph whose paths never start and end at the same node (see further 5.2.1; it is also alluded to in the definition in 4.1.2). For instance, Andrews and Macé (2013, 509) explicitly use the DAG as a principal stemmatic model and elaborate on it at the level of variants. Often, when studies

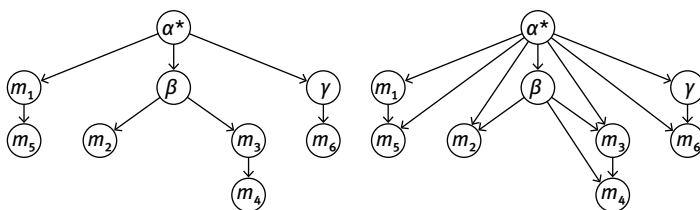


Fig. 4.2-1: (Left) a rooted tree, by necessity also a rooted DAG. Roots can be marked by asterisks, here within the node. The characteristics reflected in the term “rooted DAG” are the root, directed edges (copies from ancestor to descendant, here indicated by arrows), and the absence of cycles (explained in the main text). (Right) a rooted DAG that is not a tree: some nodes have more than one incoming edge, but there are no cycles, since paths can only be traversed in the direction of the edges.

do not explicitly mention their model, a DAG is a good first assumption. Moreover, for stemmata the DAG is often rooted (or oriented) with reference to a single root node. As Andrews and Macé (2012, 86) state, a rooted DAG can be used as a stemmatic model regardless of the amount of horizontal transmission (4.4) present. One can use the more restricted term “tree” (or, if rooted, “rooted tree”) if no node has more than one parent (closed tradition; see 4.4.1). The more specific a model is, the more precise its implications are, but at the same time restrictions to its applicability arise. Thus, some scholars, although dealing in practice with trees, may prefer to model and refer to their stemmata as DAGs, since a tree is by definition a DAG but a DAG does not have to be a tree.

4.2.3.2 Graph-theoretical models for a stemma: Beyond the (usual) DAG

Stemmata may also be modelled with unrooted or undirected graphs, similar to the one depicted in figure 4.2-2 (see Quentin 1926 or Flight 1992, who at times in their work used non-DAG models, where direction comes into play at later stages). In summary, a conventional graph-theoretical stemmatic model can be outlined by more precisely specifying properties of the graph. Terms for such models can be constructed simply by concatenating terms referring to the properties, for instance an “unrooted undirected graph”, a “labelled rooted graph”, and so on. The most important properties commonly used are as follows.

- **Rootedness.** Possible standard configurations of a graph with respect to rootedness are *rooted*, *unrooted* (by default), or *multiply rooted*. “Rooted” simply means we mark one (or more) node(s) as root(s). In the case of a work with oral origins, for instance, a stemma could have multiple roots corresponding to the first dictations of different versions at different places (see Lord 1960).
- **Cyclicity.** Possible standard configurations of a graph with respect to cyclicity are *cyclic* or *acyclic*. It is usually clear a priori that cycles may exist in a graph, so one would usually not explicitly call a graph a “cyclic graph” in order to indicate that it has or can have cycles. The term “cyclic graph” can instead be

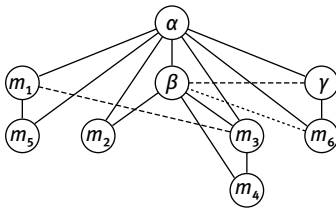


Fig. 4.2-2: A graph that is not a DAG – for instance, there is a path going from α to m_3 and from m_3 to β and then from there back to α since the edges are undirected. This is a cycle and makes the graph a non-DAG. There is no explicit root; the graphical layout suggests that α could be the root, but this is not made explicit, for instance by writing “ α^* ”. This particular graph has three textures (visual styles) of edges, which may correspond to different weights or types of edges.

used in special cases, such as when the entire graph constitutes a single circle. “Acyclic” means that there is no path (succession of adjacent edges) in the graph beginning in one node and ending in the same node. This interacts with the next property of direction insofar as an undirected graph can have cycles removed if direction is introduced. Finally, self-loops are allowed in some graphs; a self-loop is a single edge with the same starting and ending node. Corrections of later passages using earlier passages in the same manuscript may be modelled as self-loops.

- **Direction.** Possible standard configurations of a graph with respect to directedness are directed, undirected, or mixed. Being directed means that an edge does not connect two nodes equally but connects a source node to a target node. A directed edge can only be traversed in its direction; an undirected edge can be traversed in either direction. It is possible to have graphs with both directed and undirected edges, which are then called mixed graphs.
- **Labelling.** Possible standard configurations of a graph with respect to labelling are labelled, unlabelled, or mixed. Edges or nodes are either assigned a concrete name (labelled) or not (unlabelled). Again, partly labelled graphs are possible.

Graphs can have a number of other properties, such as multiple edges between the same two nodes, or indeed edges connecting more than two nodes. Also, nodes and/or edges can be weighted or have types assigned to them (e.g. edge-weighted graphs). This arsenal of additional properties can be exploited to generate more detailed models for stemmata.

Concerning terminology, certain combinations of properties are referred to by established names, as we have seen for “tree”. However, for very specialised terms in particular, there are sometimes two or more empirically implied sets of properties with only subtle differences depending on the author, which is why, in addition to using a term such as “DAG”, one should mention what exactly one means by it. In other words, the terms are not as important as the properties that are defined and used. Such a definition may include mathematical formulae. A brief formal mathematical definition of a graph is $G = \{V, E\}$. This means: a graph G is defined as a set (denoted by the curly brackets) of V and E . V is itself a set, the set of nodes, and E is the set of edges $e_i \in V \times V$. This latter definition says that an edge is a tuple (or set) of two elements of V , thus $\{v_i, v_j\}$, where $i \neq j$ (if self-loops are excluded). In a rooted graph, we simply add an element to our formal definition of G : $G = \{V, E, r\}$, where $r \in V$ (that is, r is an element in the set V). By formulating such definitions, we formalise the model we use.

4.2.3.3 Graph-theoretical models for a stemma: Greg trees and Greg graphs

Flight (1990) uses an important property of nodes for a stemmatic model: labelling. A label can be thought of as a distinct name which distinguishes a node from the

Other scholars, such as Hering (1967), have implicitly worked with this model, especially in connection with the Bédier debate (see 2.3.4). Flight (1992) expands the Greg tree model to Greg graphs. Greg graphs are modelled on the basis of Greg trees, but allow cycles. Flight (1992, 1994) demonstrates how one can derive a Greg graph from a simple matrix of possible agreement between any pair of witnesses. Greg trees (and Greg graphs) represent stemmata as entities which can be reconstructed from surviving witnesses.

Two more types of trees remain to be discussed, which are again different in their model-theoretical features. These are not trees that a stemmatologist tries to reconstruct, which for convenience will be called here reconstructable stemmata, or simply stemmata; instead, they are closely related trees which have been used primarily to make theoretical points in the debates on the stemmatological method. These debates are where modelling and numerical reasoning are most firmly expressed within the field.

4.2.3.4 *Arbre réel*

Fourquet (1946) coined the term *arbre réel* for the entire tree of a tradition (see Trovato 2017, 44–46). This means that an *arbre réel* contains all witnesses that have ever existed in the tradition, including all that are irretrievably lost without a trace. The *arbre réel* was introduced as a purely hypothetical construct for an argument in the bifurcation debate initiated by Bédier. In fact, most publications using this term (which may bear other names) can be seen as part of this debate. But the *arbre réel* has gained new importance since the introduction of artificial benchmark datasets, or artificial traditions, by Lantin, Baret, and Macé (2004), Spencer, Mooney, et al. (2004), Roos and Heikkilä (2009), and Hoenen (2015a). These are texts given to volunteers to copy by hand while it is recorded who copied from which text. The *arbre réel* is, in this case, known to the person who organises the experimental copying, and it ceases to be a purely hypothetical entity. It may also be called a benchmark stemma, benchmark dataset, or simply a ground truth or gold standard under these circumstances.

Deriving a model for an *arbre réel* is in one respect easier than modelling a stemma: it is not necessary to model witness loss. In an *arbre réel*, the rooted labelled tree (as in Hoenen, Eger, and Gehrke 2017) can be used as a base model, since all nodes are distinguishable and present. If the artificial tradition included contamination, the *arbre réel* would instead be modelled as a rooted labelled DAG.

4.2.3.5 True stemma

While an *arbre réel* depicts the whole transmission, the one true stemma is that entity which a perfect philologist would ideally reconstruct. In other words, only one stemma is historically true for any tradition we try to make editions and stemmata for. This true stemma (or “stemma reale”; Timpanaro 2005, 137) is in principle

just as hypothetical as the *arbre réel*, since for historical data we have no way to verify it in all its details. For the artificial datasets, however, we can draw the true stemma.

As we can see in figure 4.2-3, the true stemma is – if the conventions mentioned in section 4.2.3.3 are followed – not a substructure of the *arbre réel*, apart from having the distinction of labelled and unlabelled nodes which the *arbre réel* does not have. The deletion of *codices interpositi* is a non-trivial transformation: as nodes disappear, edges coalesce and change the general structure. In the underlying *arbre réel* in figure 4.2-3, there is no connection between *D'* and the descendant of its lost direct copy in the red box, whereas in the true stemma there must be. This aspect was one of the main points criticised by Fourquet (1946). In general, the same models as those for reconstructable stemmata – that is, DAGs, Greg trees, or Greg graphs – are applicable for the true stemma since it is, in theory, one of the possible reconstructable stemmata. However, a special way of modelling the true stemma on the basis of the *arbre réel* is as the result of a process of birth and death or something similar (see 4.2.3.7 below). In such a model, the *arbre réel* and true stemma are intertwined, with the latter as the ultimate stage of the former. The most sophisticated such model has been proposed by Weitzman (1982, 1985, 1987). He simulates true stemmata using a birth-death process (see below). Hoenen (2016), instead, first simulates complete *arbres réels* and then witness loss in different ways. The outcomes of both simulations are simulated true stemmata. Both are formalised in the respective publications.

4.2.3.6 Variant stemmata and variant graphs

While, so far, we have looked at models where the nodes of a graph stand for witnesses, the second entity they can stand for is the individual variant reading. Variant stemmata as models are less complex than witness stemmata. Between two nodes of such a variant stemma stands a copying process: the source reading (e.g. “clash” on the left-hand side of fig. 4.2-4) is miscopied as the target reading (e.g.

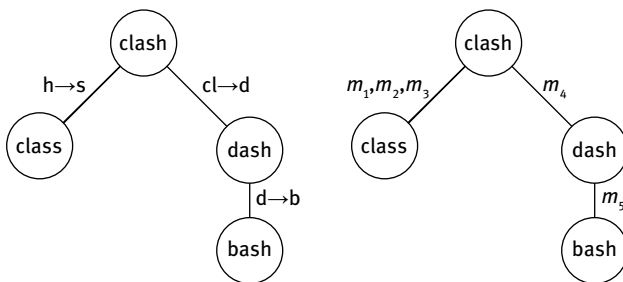


Fig. 4.2-4: (Left) a variant stemma with edges showing the shift events, simplified from Hoenen (2018). (Right) the same stemma, this time listing on the edges witnesses carrying the particular variant at the end of the edge.

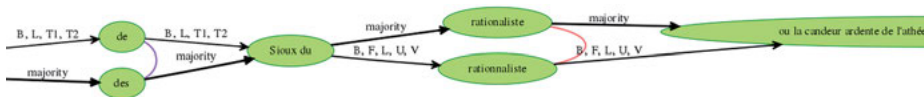


Fig. 4.2-5: Stemmatological variant graph; example from stemmaweb.net (see also 3.4.8 above).

“dash”), perhaps because of the visual similarity of “cl” and “d”. Such a process is, in many cases, more straightforward than the hypothesis in a conventional stemma that witness v_i has been copied directly from witness v_j . Of course, variant stemmata are complicated in their own right and have their own set of problems in comparison to stemmatic trees. Various scholars have used stemmata for single variants; the closeness to historical linguistics and their sound-shift rules or grammatical changes (see 8.2.2) can also be noted. West (1973, 52) calls this kind of stemma a *stemma variantium* and gives some examples. Variant graphs display on the edges either those witnesses which adopt the variant or the particular shift which happened between the ancestor and the descendant. The implicitly underlying model for a variant stemma is almost always the rooted labelled DAG, or at least a labelled graph. Generally, variant stemmata often tend to be trees. It can be difficult to devise a model which combines variant stemmata and the overall *stemma codicum*. To this end, the Coherence-Based Genealogical Method has been designed by Mink (2004; see 4.4.8 below).

On the level between witness stemma and variant stemma lies an entity called the variant graph (fig. 4.2-5), introduced by Schmidt and Colomb (2009). Andrews and Macé (2012) elaborate on how this can be a model for a textual tradition. Their variant graph, in stemmatological fashion, displays the complete collation. The edges carry the names of the manuscripts which exhibit the variants in the following node.

4.2.3.7 Extensions to graph models

Depending on the focus of the task at hand, graph theory may not be the only ingredient of a stemma model. For example, Haigh (1970) models the genesis of a stemma using a Yule–Furry linear birth process in conjunction with graph theory. Except for artificial traditions, which always include a recorded *arbre réel*, the *arbre réel* will be an entity which did not really exist at any point in time, since there will be witnesses which are already lost when others are created. If this aspect of transmission is important to the scholar’s model of an *arbre réel*, one option is to take a genetic approach where birth–death processes constitute the model-theoretical core of the endeavour. Weitzman (1987) and Haigh (1970) have used formulae defining birth (death) processes which they use to generate graphs (for an illustration from Weitzman, see fig. 2.4-2 above). All stages of the graph together may then be taken as the *arbre réel*. For illustration, we refer here to a specific model of an *arbre réel* as a Yule–Furry birth process outlined by Haigh (1970) and give his comment on the model-theoretical fit:

We consider a population which initially has one member, and which increases one individual at a time to a total size of N as follows. When k (≥ 1) members are present, one of them is selected at random (i.e. each member has probability $1/k$ of being selected) to be the parent of the $(k + 1)$ th member. [...] Clearly this model has many deficiencies: it allows no conflation of sources; missing manuscripts complicate matters enormously; the hypothesis of random selection before a copy is made can only be a crude approximation to the real method of selection. Nevertheless, even if these objections render the solution of the mathematical inference problem inappropriate for the manuscript problem, the mathematical problem does arise in other ways. (Haigh 1970, 79–80)

Thus Haigh (1970) also gives a rationale for using an imperfect model even when its imperfections are known. One might add that a best-approximation model can be useful as long as no better model exists. Kleinlogel (1968), Weitzman (1987), and Hoenen (2016) all define models where manuscript birth and loss are explicit. The model of Weitzman in particular (which is similar to Haigh's but more sophisticated) allows for a parametrisation to cover different types of transmission, which he uses to model transmission for different languages, Greek and Latin. Guidi and Trovato (2004) propose an analysis based on probabilities. They take existing stemmata of sixteenth-century printed books (where at least some copies have survived due to the larger overall numbers of copies) as *arbres réels* and consider the survival probabilities of each possible combination of surviving copies. Trovato (2017, 144–146) elaborates on the problem of the stemma vs the *arbre réel*. We have seen that modelling an *arbre réel* can be quite complex in dealing with witness birth and death. Consequently, the existing models are not easily comparable.

Another example of the use of probabilities in conjunction with graph theory is Gjessing and Pierce (1994). Consequently, for the stemma as a computational model, graph theory is not the only, but by far the most important, general framework we are dealing with. Historically, the emergence of graph theory as a discipline precedes the emergence of modern stemmatology. However, not all scholars have used its (formal) language for their stemmatic models. Merivuori and Roos (2009, 1) allude to other ways of conceptualising a stemma, not necessarily using graph theory, stating that such a stemma “corresponds to i) a clustering hierarchy, where joined subgroups make subtrees” and “iii) a network of information flow among the documents”.

4.2.3.8 Criticism

Some explicit or implicit claims have been made that current models are insufficient for displaying some properties of actual stemmata. Irigoin (1954) already addressed a very important point which many models do not take into account – layers, most often encountered as redactions and/or corrections in the manuscript witnesses. He elaborates on an example where one witness was corrected at a certain point in its history, so that copies made before the correction and after it have been assigned misplaced affiliations. This circumstance should be expressed in a good stemmatic

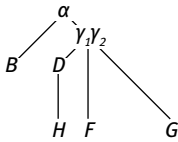


Fig. 4.2-6: Stemma with one node divided into two stages representing layers of the text in the manuscript, by Irigoin (1954, 214).

model, given the widespread occurrence of corrections in manuscripts. New and more holistic models may be required in order to model such phenomena (or, likewise, in the case of marginal notes).

Barabucci, Di Iorio, and Vitali (2014, 131) stated that no computational method of stemma generation has made use of XML-encoded (especially TEI-encoded) data. TEI does allow for the encoding of different strata (i.e. layers of correction) within a witness, but it is an open question in model theory how to reflect this in a stemma. (Identification of strata and hands is complicated in its own right, but an earliest and a latest layer can often be approximated.) Irigoin's graphical depiction shows a side-by-side representation of the labels y_1 and y_2 for the manuscript y and its stages (fig. 4.2-6), but a full formalisation remains to be done.

Yet another problem is text genesis (see also Hoenen and Brüning 2019). A text did not always begin its circulation as one single finalised entity; many different alternative versions or parts of the text may have existed side by side before it was released (see 7.9 for more discussion of such questions). Furthermore, if an author mentions parts of his text in, for example, letters to a fellow author (letters are, after all, as much written products in the age of handwriting as manuscripts, and the distinction drawn between these types of texts is certainly more debatable in that context) and the main text is altered as a result of this exchange, how much of this process should be reflected in a stemma? Can we draw a clear line between text genesis and text transmission, between oral and written transmission, between different strata of witnesses? This may be possible in some cases, but there seems to be no general solution. It would be necessary to formalise an appropriate model for each research question, in most cases the edition of a certain text, anew each time. Similarly, phenomena such as summaries or abbreviations of a text, partial transmission in compendia or florilegia, chapter sequence alternations, and so on are other critical features for much more complex models and still need future work (see 3.2). In this sense, the stemmatic models published to date may be characterised as often still lacking some detail.

4.2.4 Other formalisation frameworks: Stemmatic notation

Some scholars have engaged extensively in modelling by outlining complete frameworks or notations. One example will be briefly described as an approach to formali-

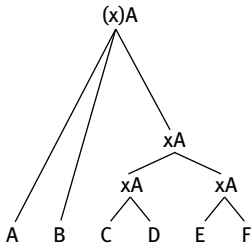


Fig. 4.2-7: A stemma which, in Greg’s notation, can be described as $xA' [A][B][(CD)(EF)]$. xA' unambiguously stands for an unnamed (exclusive) ancestor, making such nodes equivalent to unlabelled nodes in a Greg tree (see 4.2.3.3). The apostrophe is used primarily as a visual separator in Greg’s formulae.

sation that does not rely on existing mathematical frameworks: the stemmatic notation devised by Greg (1927). A notation is a vocabulary and rule inventory for formalisation, and in this sense can be used to describe properties of models. As Flight (1992, 39) put it, Greg “sought to construct a formalised notation which would satisfy all the needs of stemmatic analysis”. Since this notation has subsequently been used only cursorily, and since it does not build on other formal mathematical approaches, we will provide here only a brief summary of it, omitting detail. The basis of the first part of Greg’s notation is that witnesses are denoted by capital letters: A , B , C , and so on. Second, in order to express an ancestor of a group of witnesses, one uses A' in front of the grouping (read “A prime”): $A'AB$, for instance, for the ancestor of A and B . However, the presumably lost latest common ancestor of all witnesses in a group is expressed as xA' , in Greg’s words the “exclusive” ancestor: $xA'ABC$. Now, round and square brackets can be used to add structure. The use of brackets represents an assertion that manuscripts within the same pair of brackets go back to an unnamed exclusive common ancestor (see fig. 4.2-7).

In this way, a formula can be expressed which corresponds to a tree: $(x)A' [A][B][(CD)(EF)]$ (fig. 4.2-7). If the whole stemma is to be represented, the formula will begin with $(x)A'$ instead of xA' , since there is a priori no other common ancestor. Note the parallels to graph representation formats such as Newick (evolution.genetics.washington.edu/phyliip/newicktree.html; see 5.2.2 below, 3.4.9 above), where the ancestor can be written after the brackets and where only round brackets are used: for our example, one possible Newick rendering of the tree in figure 4.2-7 is $(A,B,((C,D)x_{A_3},(E,F)x_{A_2})x_{A_1})x_{A_0}$, where the unnamed ancestors are distinguished by subscripts.

While his notation produces an exchange format for graphs, Greg also devised a formal language for talking about variants. An example might be $xyyx ABC: yxyx DEF$ (Greg 1927, 14). This formula is used to show that the manuscripts ABC agree in the variants $xyyx$ (each standing for one position) while DEF have in the same four positions $yxyx$, that is, different readings. This can be extended to any number of groups, for example: $xyy AB: xyx CD: xxy EF$. In order to avoid enumerating all witnesses for large groups, Greg now (ab)uses the Σ (sigma) sign, which usually stands for a sum in mathematics, to stand for “all other” witnesses, for example: $xyyx \Sigma: yxyx F$. He extends this sigma notation by adding in subscript those manu-

scripts where the concurrent variants are omitted and in superscript those fragmentary manuscripts which are likely to be in the group. A special additional marker is assigned to printed editions, which are to be mentioned first and to be separated by a square bracket, for example: $xyyx] A: yxyx \Sigma$. Further, if it is known or asserted which variant is original, these can be connected by a $>$ sign (Greg 1927, 42); for example, $X>Y>Z$ means that Y was derived from X and Z from Y . Quentin (1926) described in similar terms groups of triples of manuscripts and how they can be connected with the goal of reaching an unrooted graph.

Neither the notation of Greg nor that of Quentin seems to have been applied extensively either in philology or in computational stemmatology, although Quentin's notation was taken up by Zarri (1973). There are many possible reasons for this. Such notations become useful if they facilitate understanding of otherwise complex arguments or if they allow inferences instead of being purely descriptive; otherwise, readers may prefer words or paragraphs that explain the actual argument rather than being made to decipher a shorthand which they would have to acquire (which can pose a difficulty similar to learning complex mathematical notation). Greg may not have been able to persuasively demonstrate the utility of his descriptive shorthand or to make it useful for drawing inferences. However, the author believes that at least one of the reasons Flight (1990) chose the term "Greg tree" was to honour this early attempt by a philologist to model stemmata rigorously with consistent results.

4.2.5 Implicit models

Philologists may not have rigorously formalised all the features of stemmata that make an appearance in their visualisations, but visualisations often strongly imply models, or at least impose model-theoretical limitations. A common visual language in philology has formed over time to a certain degree. In this implicit metamodel, contamination is a common feature (despite the oft-cited difficulty of dealing with it) and so are up to three (seldom more) edge depictions or textures, as well as node depictions that differentiate clearly between extant witnesses and hypothetical nodes (usually through different kinds of labels, such as Greek vs Latin letters for witness sigla). Multiple edges and roots are occasionally found. By implication, very many philological models refrain from requiring a strict tree when modelling stemmata, but rather use a DAG.

4.2.6 Bioinformatic models usable for stemmata

Phylogenetic trees display certain properties distinct from their underlying models. In almost all cases, they are exclusively bifurcating trees (unless some branches

Tab. 4.2-1: A fictitious symmetrical substitution matrix for DNA, which reflects the greater chemical similarity of A with G and C with T. The values are probabilities of substitution during a copying process.

	A	C	G	T
A	0.7	0.05	0.2	0.05
C		0.7	0.05	0.2
G			0.7	0.05
T				0.7

have been collapsed according to some criterion; see 4.1.4, 5.2) and the labelled nodes (this usually means extant species, or in our case extant witnesses) must be placed as leaves of their trees (that is, they have no children). This gives phylogenetic trees some mathematically interesting properties on which Felsenstein (2004) elaborates. These properties are also relevant for the design of heuristic algorithms and for the processing time such an algorithm can take in the worst case. (On the detailed properties of phylogenetic trees, see 8.1.) In order to see that the difference in the underlying entities can lead to complications in the transfer of models between fields and may require intervention, we will look at two basic incongruities between phylogenetic trees in biology and stemmatology.

The first difference with important mathematical implications is that the basic units of DNA are expressed as four letters (or, for proteins, twenty letters) but the number of possible readings per alignment position varies, and can be much larger. At first glance, this may seem negligible and require no intervention. However, some biological algorithms operate on substitution matrices between their basic units. If there are two possible ancestors of a variant, such a matrix facilitates the decision as to which of them is the more likely ancestor. Thus, where one sequence has an A (for adenine) and two possible ancestors have G (guanine) and T (thymine), we can look at the substitution matrix in table 4.2-1 and immediately understand that it is four times as likely that G is the ancestor than T. Certain algorithms can now use this information when building a tree; Bayesian computation, for instance, typically uses substitution probabilities. For variants in stemmata, we can imagine an analogous, similarly fictitious example in which we have the variant “arcus” and the possible ancestors “arctus” and “acus”. The logical process may be similar: we look for some (empirical) clue that allows us to assign the probability of each of the variants being the ancestor, and create a similar matrix. However, if we look at this example in more detail, the analogy to the biological case begins to break down and another model (or model component) is needed. Whereas for DNA, a substitution matrix can easily list all possibilities (A, C, G, T) for mutation at any position in a DNA strand, in our philological example it cannot be ruled out that some lost manuscript had yet another variant besides “arctus”, “arcus”, or “acus”. In order to be as comprehensive as biological substitution matrices, we would need

a matrix of the complete vocabulary, considerably larger than even protein-based matrices. Reducing variants to pseudo-DNA, in which each variant location (see 3.3) is represented by one letter, may seem to be a remedy to the problem, but the letters in such manuscript pseudo-DNA do not have the same meaning across different variant locations. The question that arises from this, when using bioinformatic algorithms which do employ substitution matrices, is what we might usefully provide as a substitution matrix. A typical fallback is to use equiprobability, that is, to assume all substitutions as equally likely. This may be problematic insofar as we would forfeit a clear advantage that the substitution matrices provide in the biological case. Some variants clearly transform more easily into others, but with an assumption of equiprobability, we would lose this information. Another solution would be to provide empirically grounded stemmatological substitution matrices, but these would have to be very large in order to model the transition from every word to every other in an ancient language, including mistakes, pseudo-words, non-words, and so on.

Spencer and Howe (2002) have designed a model for scribal errors, not unlike a biological substitution matrix, which formalises the likelihood that one variant (word) was miscopied as another, but this has not been used to compute stemmata. To sum up, while in biology a substitution matrix can help elaborate the mechanisms for finding more reliable trees, such a device will require considerable work in modelling, algorithmic design, and implementation before it can be applied in stemmatology.

A second example is the strict bifurcation of biological trees. For stemmata, it is clearly desirable to have a model in which a node (witness) can have more than two direct descendants (copies). As Felsenstein (1978b, 31) shows, the tree space (that is, the number of possible trees) for a given set of witnesses grows enormously if one allows multifurcations (except for low numbers of witnesses). This is a problem which does not theoretically affect the modelling but which is a challenge for computation. Maximum parsimony, for instance, ideally scores each (!) possible tree and then chooses the best. Even with the tree space restricted to bifurcating trees, depending on the nature of the data, there are scenarios where the number of trees to score is so large that it cannot be computed in a feasible time. When this occurs, the maximum parsimony implementations resort to heuristic tree-space searches which, however, may not find the best tree but only a locally optimal one. The algorithmic design of many implementations is optimised with regard to bioinformatic data and the traversal of a tree space of bifurcating trees. Thus, while the first incongruity of the bioinformatic model with the stemmatological situation requires a complicated model-theoretical implementation of some form of substitution matrix, this second case would require some complex new algorithm design. To date, these issues have been a constant topic of discussion and further attempts at development.

There is one quite different model-theoretical method that was invented for the avoidance of systematic errors in phylogenetic tree construction from pairwise dis-

tance matrices (5.2.2) in biology: *split decomposition* (Bandelt and Dress 1992). Phylogenetic trees can misleadingly depict some of the relationships encoded in an underlying matrix. If we take two pairs of species, grouped respectively and connected by a phylogenetic relation, say group 1 (*A* and *B*) and group 2 (*C* and *D*), the sum of the distances *A* to *B* and *C* to *D* should be smaller than the sum of the distances *A* to *C* and *B* to *D*, but this is not always the case in the underlying distance matrix. This is the reason why split decomposition and phylogenetic networks (D. Bryant and Moulton 2004) have been developed – as a way to depict more than a simple binary tree derived from the distance matrix (see figs 5.5–9–10, 12 below). Alternatively, phylogenetic networks can be used to display multiple relationships. A fully connected graph showing all pairwise distances is another possible visualisation for a pairwise distance matrix, but it can become quite dense.

To summarise, while the scholarly models for biological gene transmission and philological text transmission may generally have a lot in common, models from other disciplines may not deliver (the best possible) solutions to all problems arising in stemmatology, and some adaptation of models, algorithms, or both will consequently be required.

4.2.7 Future challenges

In this section, we have outlined models which are used implicitly and explicitly for stemmata. We have found graph theory to be the predominant, though not the only framework on which formalisations of a model can be based. The DAG has been discussed as the most widely used model. We have outlined some criticisms of current models and have seen that modelling is by no means a trivial endeavour – many phenomena in stemmatology have yet to be modelled. These include indirect witnesses, translation, different types of contamination, oral transmission, gaps, and so forth. Thus, from a modelling perspective, there still remains a lot of work to be done in the field. Concepts such as *hyperedges* (edges connecting more than two nodes), for example, might be a good way to depict the individual influence of the copyists as authors (see *Il copista come autore*: Canfora 2002). Multiedges and multitrees (allowing more than one edge between the same two nodes) could be used to model different kinds of simultaneous contamination, while self-loops (edges with the same source and target node) can depict, for instance, a copy corrected using an earlier passage repeated in the same text (Andrews 2013), and forests (collections of trees) can depict translation (compare Hoenen 2019a). These properties of models are in some cases already used implicitly, as can be seen from published graphical representations of stemmata, but they are often not formally specified by philologists.

4.3 A typology of variation and error

Aidan Conti

As central concepts within stemmatological and related methods, an understanding of variation, error, and their typologies remains crucial for textual critics as well as those who use critical editions and commentaries. Efforts to understand changes in both the written and spoken transmission of texts have a long history; Quintilian's (ca. 35–ca. 100 CE) handbook on rhetoric, the *Institutio oratoria* (ca. 95 CE), mentions barbarisms in writing such as addition (*adiectio*), omission (*detractio*), substitution (*immutatio*), and transposition (*transmutatio*; Winterbottom 1970, 1:5–6). While premodern textual transmission recognised the importance of errors and variants for grouping textual traditions into families (see 2.1 and also 7.7), within the tradition of academic textual criticism we see a sustained interest in how errors arise in Jean Le Clerc's *Ars critica* (1730 [1697]; Timpanaro 2005, 61–63). Moreover, though error and variation have been important for grouping carriers within traditions (on the history of this, see 2.1–2), it is not until Louis Havet's *Manuel de critique verbale* (1911) that the genesis of errors during the course of transmission receives in-depth treatment. As this section will show, the genesis of variation during the course of transmission is of critical importance because this process helps us assess the likelihood or rarity of a particular reading or segment of text.

4.3.1 Usage and terminology

Differing approaches to textual reconstruction adopt and argue for different terminology, especially with respect to the distinction between variant and error. Critics working with non-normative linguistic traditions frequently prefer to refer to variation, and often employ methods that group variants rather than errors. For example, within a Middle English writing tradition known for its widespread spelling variation, the writing of “pour3t” for the “thurhe” of an exemplar cannot be considered an error. Indeed, other types of variation, such as the use of alternative cases following particular prepositions, which would be regarded as errors within prescriptive linguistic textual traditions, may be acceptable within non-prescriptive traditions.

However, within many linguistic communities that do have prescriptive norms, contemporary critics assume that scribes, who are often educated within the linguistic norms of these same communities, endeavour to uphold the linguistic norms of their groups. In the case of Latin, which had a pronounced grammatical tradition buttressed by educational institutions, the writing of “amabit” [he or she will love] for “amavit” [he or she loved (or has loved)] is an error. The error is orthographical, and likely arises from a phonological development (/b/ > /v/). The effect is to change the grammar (“she will love the boy” to “she loved the boy”), and renders the overall sense of a passage incongruous or difficult to ascertain.

More serious lapses in transmission, however, can produce readings, or segments of text, that are difficult to construe due to syntax, meaning, or a number of other outcomes. For instance, if in the Middle English example above the phrase were “through the dark night”, and the scribe wrote not “þourȝt” (a variant spelling of “through”), but rather “thouȝt” (a variant of “thought”), the subsequent “thought the dark night” would likely be nonsensical in the context of the passage. Within the stemmatological method, this type of variant or error is more important for the analysis of manuscript relations than most orthographical changes.

Given that “error” has been used with decidedly different meanings in a range of textual commentary and that the negative connotations associated with the term can attract criticism, there is good reason to consider the use of two alternative terms, namely “innovation”, any change introduced at some point in the textual tradition, and “secondary reading”, which similarly describes an alteration in the course of textual transmission. The advantage of these terms is that they are polarised, that is, they indicate the direction of the change. For example, the phrase “anno autem domini CCCXXXI Saraceni Siciliam inuadentes” (Maggioni 2007, 926) [In the year of the Lord 331, after the Saracens had invaded Sicily] from the *Legenda aurea* contains an error: it is factually incorrect that Muslim Arabs took control of Sicily at that time – the Emirate of Sicily gained control of the entire island in 831. Nevertheless, the incorrect date seems to be a primary reading for this text, as it was incorporated from source material for the text. Later corrections (to 831) represent secondary readings (or independently arising secondary readings; see Maggioni 2016, 37).

Because it posits nothing about the correctness of a reading, the term “secondary reading” obviates the dispute and the distinction between variant and error. However, two important issues remain to be clarified: (i) how we polarise the reading (or how the textual critic decides the direction of readings), and (ii) what secondary readings are important for determining the relationships among witnesses. Both issues centre around probability. The analysis of witnesses will be concerned with determining which reading is primary as opposed to another. Moreover, one must assess the likelihood of a given secondary reading. Changes that arise independently, also known as *polygenesis* (see 2.2.5 above; Trovato 2017, 97), are of little use in devising a stemma. In other words:

If a variant arose independently many times, distributed over changing groups of manuscripts, it can tell us little about the relationships among manuscripts because its distribution is unlikely to be simply related to the true stemma. On the other hand, a very improbable variant gives strong evidence that all the manuscripts in which it occurs are related by descent. (Spencer, Mooney, et al. 2004, 228)

Secondary readings that allow critics to construct a stemma can be called *relationship-revealing* (Salemans 2000). Maas (1960) labelled errors from which stemmatic inferences can be made as *errores significativi* (indicative/significant errors) or *Leitfehler* (guiding/indicative errors). Within this category of significant errors,

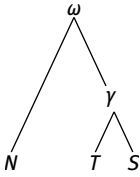


Fig. 4.3-1: The relationship of three manuscripts based on a conjunctive error. This simplified example is based on the manuscripts of Thomas Aquinas's *In librum Beati Dionysii De divinis nominibus expositio* 11.4 (Pera 1950).

traditional stemmatics (namely Maas) distinguished errors that grouped witnesses together and those that separated witnesses from others. Conjunctive errors (*errores coniunctivi*, *Bindefehler*) are errors that show that two or more witnesses can be grouped together against other witnesses. The following example illustrates a conjunctive error within a group of three manuscripts deriving from a single archetype. In this clause, two distinct readings are reported.

- N causa quod omnia existentia sint
- T, S causa quod divina existentia sint

N records the contextually required “omnia”. T and S have the error “divina”. If other readings in T and S provide separative errors that indicate that one does not derive from the other *and* T and S share errors that indicate they cannot be grouped with N, then the conjunctive error demonstrates that the two can be traced back to a common hyparchetype. The relationship between the three manuscripts can be illustrated accordingly (fig. 4.3-1).

Separative errors (*errores separativi*, *Trennfehler*), on the other hand, are errors that indicate that a witness is independent of another witness or of a group of witnesses. A more concrete example may illustrate the point. Two manuscripts, S and T, of a text share a significant number of conjunctive errors and are consequently postulated as deriving from the same hyparchetype. However, in the following sentence, the manuscripts report two different readings.

- S At ille obiit viridis
- T At ille obiit viribus

Here, T reports “viribus” where S correctly has “viridis”, a separative error that indicates S is not derived from T, *provided that* the reading in S does not represent an independent scribal conjecture. In another reading, S records a variant that, while grammatical, is not contextually appropriate and T offers the preferred reading.

- S Sed officia boni civis, boni amici, boni filii secutus est
- T Sed officia boni civis, boni amici, boni filii executus est

In this case, in which S reports “secutus” where T has the contextually required “executus”, the separative error shows T cannot be derived from S (provided that the reading in T does not arise from interposed scribal conjecture).



Fig. 4.3-2: The relationship of two manuscripts based on a separative error. This simplified and emended example is based on the manuscripts of Seneca's *Epistulae morales ad Lucilium* 93.4 (Reynolds 1965).

Because the identification of separative errors indicates that neither of the witnesses derives from the other, the relationship in the following illustration (fig. 4.3-2) can be posited.

Many scholars have noted the difficulty in determining the significance of a secondary reading (or error). As Michael Reeve points out: “Now in the phrase ‘significant error’ you will recognize two serious problems, namely how to decide what readings are errors and then which of these are significant errors” (1986, 68). Given the importance of determining the likelihood of a given secondary reading, it is not surprising that a number of scholars have developed a wide-ranging vocabulary to describe the types of innovations that can arise during the course of transmission (see 4.4.2). Moreover, recent stemmatological studies have explored the “weighting” of variants as a way of assessing significance (or potential for revealing relationships; Macé and Sanspeur 2000; Spencer, Mooney, et al. 2004; Macé, De Vos, and Geuten 2012). There have also been some attempts at partial automation of the procedures to measure the significance of variants (Roelli and Bachmann 2010; Camps and Cafiero 2014). Nevertheless, the evaluation of readings will remain largely a philological task.

4.3.2 Categories and types

As noted above with reference to Quintilian, four broad categories can be used to classify errors in transmission (and indeed secondary readings and innovations). An *addition* is any segment of text not present in the exemplar that a copyist introduces into the copied text. In the process of collating and editing, the term “addition” is a relative one which only indicates that a segment of text which is lacking in the base text is present in some witness(es), without making a judgement about whether the addition is secondary or not. An *omission* is any segment of text that a copyist does not reproduce in the copied text but that is present in the exemplar. Like “addition”, “omission” is a relative term that does not assert whether an omission is secondary or not. *Transposition* is an alteration in the order or a change in the position of letters, syllables, words, phrases, and/or passages between the exemplar and the copy. *Substitution* refers to letters, words, phrases, clauses, or passages present in an exemplar that are replaced by something else in a copy.

“Addition”, “omission”, “transposition”, and “substitution” are relative and descriptive terms. These categories, however, provide little information about the context in which an error can arise. Similarly, objective descriptions of variants or errors – descriptions that do not rely on literary, historical, and geographical argu-

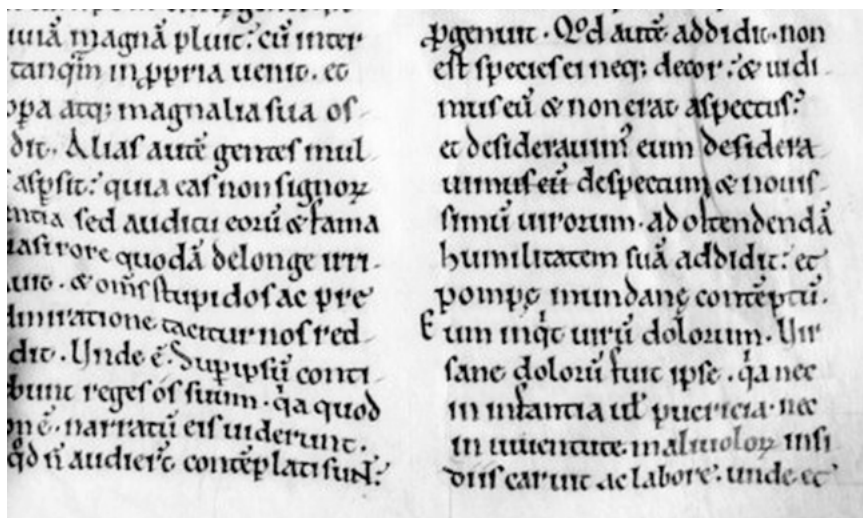


Fig. 4.3-3: An example of dittography: “desideravimus eum desideravimus eum despectum” (column B, lines 4–5). Source: Gallica, Bibliothèque nationale de France, gallica.bnf.fr/ark:/12148/btv1b9072445t/f215.image. Image: CC-BY-NC.

ments to judge the authenticity or trueness of a variant – may assign linguistic categories to classify changes (e.g. orthographical, phonological, morphological, and syntactic). The use of these broad categories, however, has not produced much success in terms of evaluating the significance of an error. Indeed, the categories used to classify errors (secondary readings) are an area that requires further refinement before weightings and likelihood can be properly assessed (Andrews and Macé 2013). For example, the model developed by Andrews and Macé employed a relationship graph but remained agnostic on the directionality of the graph (it could be cyclic, in other words). They noted that a semantic tagging scheme, which would provide information on changes in meaning in the text, might have given clearer results in their analysis.

Within the four broad categories discussed by Quintilian and used in many contemporary studies, there are differences of degree and type. In short, additions may share characteristics but may differ in execution and cause. Consequently, it may be useful to describe more specific types of errors within these broad categories, an undertaking which has a long tradition in textual criticism.

One prominent example is dittography (classified under “addition”): the writing of a word or part of a word twice, for example “renonown” for “renown”. In figure 4.3-3, we can see that a scribe has written the same two words twice; subsequently, someone expunged the repetition.

The opposite of dittography is haplography (a type of omission): the writing of a segment of text once which appears twice (or more) in the exemplar, for example “defendum” instead of “defendendum”.

Other examples of more specific types of errors include *anasyllabism*, or the reanalysis of the syllabification of a source word whereby the word is transformed into another word, such as “domo” for “modo”. This reanalysis is a transposition, that is, an alteration in the order or a change in the position of letters, syllables, words, phrases, and/or passages between the exemplar and the copy. Two types of substitution are *misreading*, the replacement of a letter in the exemplar with a similar-looking, but incorrect, letter, for example the writing of “c” for “e”; and *itacism*, the merger in pronunciation of vowel sounds that are characteristically distinguished in spelling. Similarly, *metathesis* is a type of substitution involving the transposition of sounds or letters in a word, commonly precipitated by a slip of the ear or of the pen. As a linguistic process, metathesis has changed the written form and pronunciation of many words. For example, *bird* is a metathesised form of Old English *bryd*. Usually, the phenomenon refers to contiguous sounds, and is then called adjacent metathesis. Metathesis can also describe the transposition of non-adjacent sounds and/or letters, as in Spanish *palabra* from Latin *parabola*.

Because errors frequently arise due to misreading on the part of the copyist – that is, errors in language processing that affect language production – textual scholars have also developed an elaborate vocabulary for the triggers or precipitators of errors. One important tenet in textual criticism is that scribes were more prone to error when working from an unfamiliar script. The process of copying from one script to another, *transliteration* (or *translitteratio* in Latin) or *meta-charakterismos* (Dain 1964, 124–135), can produce patterns of secondary readings in extant manuscripts which in turn can suggest the script type, and at times the layout, of a lost archetype. For example, by examining patterns of errors, Joseph Scaliger (1577) showed that the archetype of surviving Catullus manuscripts was written in a pre-Caroline minuscule (*langobardicae litterae* in Scaliger’s terminology; see Grafton 1975). Lachmann famously argued that the tradition of Lucretius derived from an archetype in rustic capitals from the fourth or fifth century (Lachmann 1850, 2:3). Nevertheless, despite these well-known examples, Timpanaro, for instance, argues against conceiving of transliteration as an operation performed once and for all (Timpanaro 2005, 172n30).

Further examples of the types of phenomena that precipitate secondary readings include *anticipation*, which suggests a copyist who reads ahead (in the exemplar) of the text being written (in the copy) and therefore omits a section of the exemplar in the copy text; and *arrhythmia*, an irregularity in the reading activity of the copyist which can produce haplography, if the copyist skips ahead in the exemplar, or dittography, if he skips back and rereads part of the exemplar text. Generally, critics speak of *eye-skip*, also known as a *saut du même au même* (literally “jump from the same to the same” in French), where similar words or phrases appear twice on the same page, inducing the copyist to skip unintentionally the passage between the first and the second occurrences of the phrase or, alternatively, to read (and copy) the passage twice. Less commonly, this procedure is referred to

as parablepsis. More specifically, *homoeoarcton* suggests that the impetus for an omission or addition results from eye-skip to or from similar or identical beginnings of a word, whereas *homoeoteleuton* describes eye-skip to or from a similar or identical ending in two words which causes a copyist to produce an omission or an addition.

In some cases, the string of text need not be exactly the same to produce a *saut* or eye-skip. For example, the following sequence is found in a homily, *De Christi passione* (CPG 5526 = Geerard and Noret 1984–2018, 3:74), that describes Judas's betrayal of Jesus: "uenit Iudas ad eos et dedit eis signum" (Salzburg, Stiftsbibliothek St. Peter, a. VII. 5, f. 29v, s. ix²). In this scenario, Judas came to the chief priests (to whom he would betray Jesus) and then gave them a sign (that is, the kiss with which he betrays Jesus). Another manuscript, which represents the same scene in the homily, has "uenit Iudas ad eos et dixit eis, exsurgentes sequimini me et tradam eum uobis. Qui exsurgentes sequebantur eum cum gladiis et fistibus. Et dedit eis signum" (Rand 1904, 274–275) [Judas came to them [the chief priests] and said to them, "Get up and follow, and I will hand him over to you." After they rose, they followed him with swords and clubs. And he gave them a signal]. The shorter text from the Salzburg manuscript, which omits Judas's speech to the priests, seems to have arisen as the result of eye-skip from "et dixit eis" to "et dedit eis", in which case the skip (or *saut*) is not from/to the same string of words (*même au même*), but rather from one to another, very similar, string of text.

A number of terms encompass both the impetus for an innovation and the product of it, such as "assimilation" and "gloss-incorporation". Assimilation can refer to two distinct but similar processes. The first describes the way in which a scribe may write a word so that it resembles another nearby word. An illustration is "an excellent examplic of the rhetoric", in which "example" has been assimilated to the coming "rhetoric" (West 1973, 24).

The second process described as assimilation refers to the incorporation of wording from a parallel narrative, witness, or text into the copy text. This process is sometimes referred to as *contamination*, a term which is viewed as somewhat misleading in its pejorative connotations, or horizontal transmission (see 4.4). Gloss-incorporation is one way of introducing changes in a text transmitted through copying: a reading that was originally intended as a note or remark in an exemplar would be incorporated into the main text of a copy instead. As there were and are different types of *glossae* – like marginal and interlinear glosses – *gloss-incorporation* could happen in various intentional and unintentional ways. The marginal elements may be expository and/or provide commentary on the primary text, in which case the incorporation represents an example of an addition. Alternatively, glosses may provide a correction to a witness, in which case the subsequent incorporation of the gloss represents a case of assimilation or horizontal transmission. "Gloss-incorporation" is frequently used interchangeably with "interpolation" (see 3.2.4).

The range of nomenclature attests to the enduring interest and indeed delight in the complex processes and structures involved in the (re)production of handwritten texts (see further Magnani and Watt 2018). For the construction of a stemma, be it a computational model (4.2) or a historical tool (4.5), the student must not only identify innovations but also assess, as we have seen, their significance, that is, the extent to which a secondary reading is likely to be reproduced, reversed, or arise independently. For this reason, the concept of *lectio difficilior* (“the more difficult reading”; sometimes also expressed as *lectio difficilior potior*, “the more difficult reading is preferable”) has and continues to hold important sway (see 2.1.2 on the early development of the concept and 6.2.3 for further examples). A similar principle is that of *lectio brevior*, or “the shorter reading [is preferable]”, but this is generally regarded as a less valuable rule of thumb. The premise of *lectio difficilior* stipulates that a subsequent copyist is unlikely to restore a difficult reading and more likely to reproduce a simpler reading, or *lectio faciliior*. The following example from the unedited and anonymous Latin homily *De Christi passione* illustrates the principle. Two manuscripts, O (Oxford, Bodleian Library, Bodley 343; s. xii²) and S (Salzburg, Stiftsbibliothek St. Peter, a. VII. 5; s. ix²), present the following readings.

- O uidit me ignis rubens [the red fire saw me]
- S uidit me ignea rumphea [the fiery sword saw me]

The second clause has the *lectio difficilior*, the relatively rare word *rumphea* (alternatively found as *rhomphaea* or *rumpia*), a double-edged sword. The more common *rubens*, “red, ruddy”, likely represents the result of a process in which the more difficult and, over time, less familiar word became rewritten as a more familiar word. In this case, evidence that the Latin text is a translation of a Greek work (CPG 5526 = Geerard and Noret 1984–2018, 3:74), which has ῥομφαία, a long missile weapon associated with the Thracians in Antiquity, confirms the hypothesis.

The external confirmation is important because the principle of *lectio difficilior potior*, as explanatory as it seems, is not unequivocal. In some cases, the more difficult reading may well arise from a series of miscopyings, attempted corrections, and/or perceived improvements, meaning that the *lectio difficilior* may in fact be secondary rather than primary. To take a modern and well-known example, a Melville scholar defended the phrase “soiled fish of the sea” in the second edition of *White-Jacket* and lauded its *discordia concors*, “the unexpected linking of the medium of cleanliness with filth” (see Greetham 1999, 175). The true reading, found in the first edition, was simpler; the “coiled fish of the sea” was a description of eels. Such a misapprehension highlights the fact that the application of the principle of *lectio difficilior potior* is often based on the notion that the authorial text possesses literary qualities, such as the use of elevated rhetoric, learned vocabulary, and literary devices. In cases of simple, less elevated or marked texts, the simpler reading may well be preferred; the more difficult reading may represent attempts by subsequent users to improve a text, to add virtuosity where there was none.

4.3.3 The genesis of secondary readings

The exploration of types of errors and variants represents an effort to understand the dynamics leading to changes in texts, and consequently to present better tools for assessing the likelihood of a secondary reading. In other words, one aims to understand the extent to which a reading approaches irreversibility and non-reproducibility. This understanding is crucial for us to better evaluate the likelihood of any given innovation or secondary reading. There are two possible, yet relatively unexplored, fields that promise significant insights into the processes of textual reproduction which comprises language interpretation and language production. The first is a more in-depth analysis of copyists in contemporary contexts. Artificial traditions have been a positive step in this direction (Baret, Macé, and Robinson 2006; Roos and Heikilä 2009), but they have not been set up to measure the contexts and triggers for the genesis of errors (they have rather been concerned with the outcomes and comparing them), and thus have not been so useful in considering the likelihood of a given error. As a result, scholars continue to struggle with ways to classify errors for the purposes of analysis. In a similar vein, research into reading and writing practices may offer further insight into the nature of errors. For example, more information might be gained from studying the effects of *priming*, that is, how one stimulus can influence a response to a subsequent stimulus, in reading and word recognition. Priming studies can test the time it takes to recognise a word after exposure to, that is priming from, another, often related word. Preliminary studies looking at how children are affected by priming in their first (L1) and second (L2) languages indicate that head-rhyme (or similar initial syllables in a word) is more likely to influence subsequent reading than is end-rhyme (Fitjar 2016). That said, studies to date (as far as I know) have not specifically addressed reading and writing processes during the copying of lengthier texts. Moreover, such studies cannot endeavour (or propose) to replicate the material conditions of premodern copyists who used different writing instruments and material. As such, their greatest promise resides in providing insights into the architecture of reading and writing, but not into the practice *per se*.

The second possible way to investigate copying phenomena is through the analysis of known exemplar–copy pairs. Palaeographers have emphasised the importance of these pairs (Ker 1972, 1979; Parkes 2008; Marchetti 2019) for philologists (both historical linguists and textual critics), but few in-depth studies have been carried out. One reason is that, unfortunately, few exemplar–copy pairs exist. Another reason is that, if a copy comes from a known exemplar, that copy is known within the common-errors method as a *codex descriptus*, irrelevant for *constitutio textus*, and so will usually have been discarded by the editor.

4.3.4 Variation of punctuation

Generally speaking, punctuation and word division have played a secondary role in determining innovations in the transmission of a text. Most mediaeval punc-

tuation conventions differ from modern ones. Moreover, an editor dealing with a large number of witnesses may be confronted with a range of punctuation conventions and an individual witness may reflect the usage of the exemplar and/or the scribe in addition to a later corrector, whose hand may be difficult to determine when it comes to punctuation. Malcolm Parkes notes some of the difficulties:

When considering copies as witnesses to the practices of a particular period in time, it is necessary to determine the status of the punctuation: for example, in a manuscript, whether it is that of the scribe in the same ink as the text, or has been added by a corrector or reader in ink of a different colour. (Parkes 1992, 5)

A detailed and substantive study of the development of punctuation in the Western European tradition is found in Malcolm Parkes, *Pause and Effect* (1992). The development of word division is charted in Paul Saenger's *Space between Words: The*

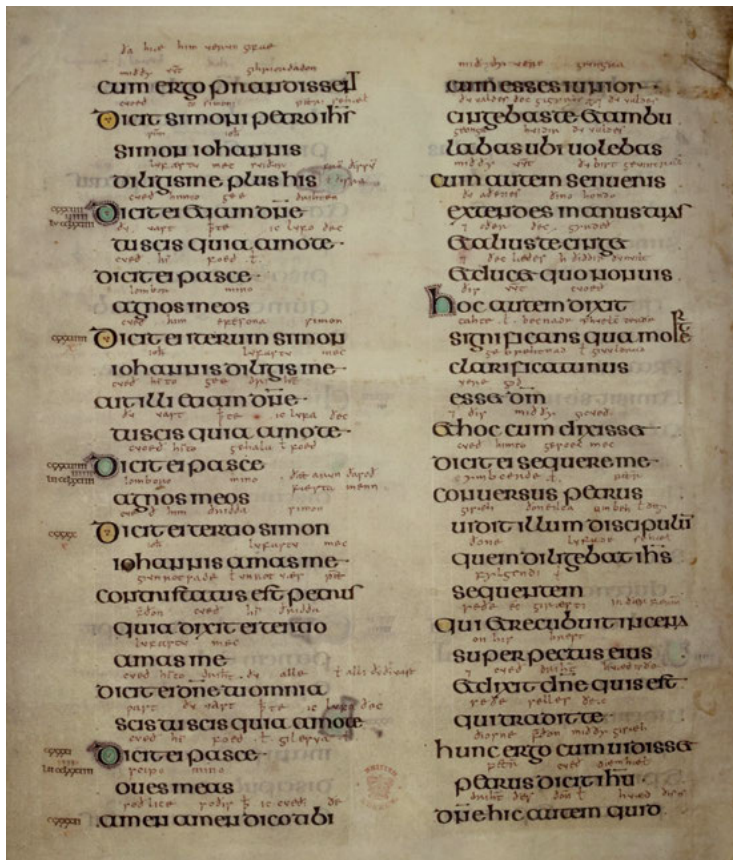


Fig. 4.3-4: *Per cola et commata* layout in the Lindesfarne Gospels (London, British Library, Cotton, Nero D. IV, f. 258v). Source: bl.uk/manuscripts/Viewer.aspx?ref=cotton_ms_nero_d_iv_fs001r. © The British Library Board.

Origins of Silent Reading (1997). Saenger's assertion that word division facilitated silent reading is, however, refuted by a range of classicists who have demonstrated that the ancients read silently in private even when public reading was oral (see Johnson 2010 for a summary of the debate).

In cases where a system of punctuation can be ascertained as authorial or archetypal, the edition will often reproduce the system. For example, Jerome in his preface to Isaiah describes a system of laying out text *per cola et commata* (by sense units) for the ease of reading, a system that is preserved in notable early biblical manuscripts, such as the Lindisfarne Gospels (London, British Library, Cotton, Nero D. IV; see fig. 4.3-4). The *per cola et commata* division is preserved in the present critical edition of the Vulgate (fig. 4.3-5).

Similarly, in the recent edition of Saxo Grammaticus' *Gesta Danorum*, the editor follows, as closely as possible, the system of division found in the *editio princeps*, whereby periods are separated by a full stop followed by a capital letter, which also reflects the tradition found in the mediaeval manuscript fragments (Friis-Jensen 2015, 1:lxix). That said, the punctuation between full stops, such as the placing of commas and the introduction of quotation marks, was modified to facilitate readability for present-day users of the edition. In addition, whereas names are not regularly capitalised in the earlier tradition, the present edition consistently does so.

On the other hand, diplomatic editions which aim to reproduce as faithfully as possible a single witness (see 6.1.1) will reproduce the punctuation of the witness that serves as the basis of the edition.

Acknowledgement

The author would like to thank John Magee (University of Toronto) for his expertise and teaching in Latin textual criticism. The examples of separative and conjunctive errors were adapted from his teaching materials.

1697	SECUNDUM IOHANNEM	Io 21, 12–25
Os 2,20! 6,11; Lc 24,30!	scientes quia Dominus esset 13 CCXXV Et venit Iesus et accepit panem et dat eis et piscem similiter 14 CCXXVI Hoc iam tertio manifestatus est Iesus discipulis cum surrexisset a mortuis 15 cum ergo prandissent dicit Simoni Petro Iesus 1,42; Mt 16,17! Simon Iohannis diligis me plus his dicit ei etiam Domine tu scis quia amo te CCXXVII Dicit ei VIII pasce agnos meos I Pt 5,2! 16 CCXXVIII Dicit ei iterum Mt 16,17! Simon Iohannis diligis me ait illi etiam Domine tu scis quia amo te CCXXVIII Dicit ei VIII pasce agnos meos I Pt 5,2! II Sm 5,2! 17 CCXXX Dicit ei tertio Mt 16,17! Simon Iohannis amas me contristatus est Petrus quia dixit ei tertio amas me et dicit ei Domine tu omnia scis tu scis quia amo te CCXXXI Dicit ei VIII pasce oves meas I Pt 5,2! 18 CCXXXII Amen amen dico tibi cum esses iunior cingebas te et ambulabas ubi volebas cum autem senueris extendes manus tuas et alius te cinget et ducet quo non vis 19 hoc autem dixit significans qua mor-	te clarificaturus esset Deum et hoc cum dixisset dicit ei sequere me 20 conversus Petrus vidit illum discipulum quem diligebat Iesus sequentem 7; 19,26; 20,2 13,23,25 qui et recubuit in cena super pectus eius et dixit Domine quis est qui tradit te 21 hunc ergo cum vidisset Petrus dicit Iesu Domine hic autem quid 22 dicit ei Iesus si sic eum volo manere donec veniam quid ad te tu me sequere 23 exivit ergo sermo iste in fratres quia discipulus ille non moritur et non dixit ei Iesus non moritur sed si sic eum volo manere donec venio quid ad te 24 hic est discipulus qui testimonium perhibet de his 15,27! 19,35; III Io 12 et scripsit haec et scimus quia verum est testimonium eius 25 sunt autem et alia multa quae fecit Iesus 20,30! quae si scribantur per singula nec ipsum arbitror mundum capere eos qui scribendi sunt libros amen EXPLICIT EVANGELIUM SECUNDUM IOHANNEM
12 esset] est sZCΦ c 13 accipit D c 14 discipulis + suis c resurrexisset ADC c S(s)AM(Z) 15 num. 227/9 ad dicit simoni pon. D o, ad simon pon. s, ad dicit ei etiam pon. AZFCΦ, recte ad dicit ei M, cf. vv. 16 et 17 17 et om. A dicit ² dixit c. ~ omnia tu Z scis ¹ nosti c. dicit ³ dixit c. 18 ducit MD quo + tu G c 19 ~ cum hoc ZΦ c 20 con- uersus + autem M [deest Z usque ad v. 25] tradit sA o 6] tradidit F.; tradet cet. 21 dixit c. 22 si sic F o] si M.; sic cet. uenio s. 23 in] inter sΦ c si sic MG o] sic cet. ueniam MCΦ c 24 discipulus + ille c 25 capere + posse c amen om. DC c		

Fig. 4.3-5: The end of the Gospel of John from the *Biblia Sacra Iuxta Vulgatam Versionem*, edited by Weber, Gryson, and Fischer (1994, 1697). Source: © 2007 Deutsche Bibelgesellschaft, Stuttgart. Used by permission.

4.4 Dealing with open textual traditions

Tuomas Heikkilä

“Contamination” sounds threatening in most fields of life. Even in textual criticism, in studying handwritten textual traditions and editing texts, the term bears an ominous tone: “contamination” is the term for the most serious and most frequent phenomenon endangering the reconstruction of the original reading and the understanding of the textual transmission and dissemination.

4.4.1 Challenges of contamination

In the world of texts and their transmission, contamination is understood as the copying of readings from more than one exemplar, resulting in complex and often hard-to-detect relationships between textual witnesses within the transmission of a text. The reconstruction of a stemma describing the relationships of all the textual witnesses of a text is traditionally based on the principle of common errors (see 2.2) – but contamination confuses this principle and distorts the stemma. In a contaminated tradition, it is hard for the *recensio* of textual criticism to reveal if an agreement in error is the result of common descent or of mixture between lines of descent. Moreover, it cannot reveal the direction of textual transmission (see M. W. Holmes 2011, 71–72). It has even been claimed that the presence of contamination is an insurmountable obstacle for shaping a stemma and thus for understanding the textual tradition altogether (West 1973, 14, 36).

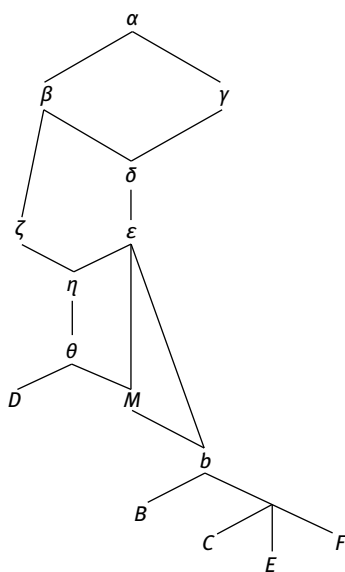


Fig. 4.4-1: Example of an open – i.e. contaminated – tradition. Several of the text versions are copied from more than one exemplar. Redrawn from West (1973, 40).

Let us elucidate the challenge with an example. Suppose we have a textual tradition in which the copyist of version *F* took readings from both *A* (now lost) and *B* (still extant). The true stemma is given (fig. 4.4-2) on the left-hand side. Based on the remaining manuscripts, *B*, *C*, *D*, *E*, and *F*, however, textual criticism would probably arrive at the stemma given on the right-hand side. We would observe that *F* sometimes does not have innovations common to the other witnesses and on the other hand contains its own peculiar readings. *B* would sometimes share *F* readings, sometimes *CDE* readings. We might easily view *F*, in fact a descendant of *B*, as its ancestor, and discard *B* as a contaminated witness offering nothing original (M. W. Holmes 2011, 72; example from West 1973, 35–36). Should we want to reconstruct the archetype *[a]*, we would do so on the basis of *F* and *[b]*, thus giving the text of *F* too much weight. This would result in a reconstruction of the archetype that would not be correct.

The possible consequences can be illustrated with an invented sentence; in real life, of course, innovations must not be so easily reversible if they are to be of any stemmatic value.

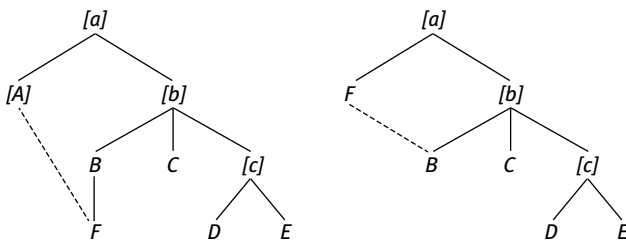


Fig. 4.4-2: Observe the difference between the correct (left) and reconstructed (right) stemmata. Source: West (1973, 35–36).

<i>[a]</i>	This is a fictitious example of contamination.
<i>[A]</i>	This was a fictitious example of contamination.
<i>[b]</i>	It is an example of contamination.
<i>B</i>	It is an example of contamination.
<i>[c]</i>	It is an instance of contamination.
<i>C</i>	It was an example on contamination.
<i>D</i>	It was an instance on contamination.
<i>E</i>	It is an instance on contamination.
<i>F</i>	It is a fictitious example of contamination.

4.4.2 Terminology

Emblematically of the frequency of this challenge in the study of textual traditions, contamination and its various forms have been identified with several, often pejora-

tive terms by scholars. According to the traditional view, a textual tradition in which the content is transmitted by reproducing the text of just one exemplar at a time (i.e. without contamination) has been considered to be “normal”, “pure”, “unmixed”, “virgin”, or “mechanical”. The prevailing idea has been that such a tradition is the norm, and any copy of the text resulting in transmission of two or more exemplars should be considered as suffering from “contamination”, “conflation”, “text bastardry”, “hybridisation”, or “cross-fertilisation” (on the terminology, see esp. M. W. Holmes 2011, 66–68).

However, it should be noted that the very basis of the idea of a “pure” and “non-contaminated” textual tradition as the norm is questionable. The concept is a product of nineteenth- and early twentieth-century scholars who did not know nearly as many ancient or mediaeval manuscripts as we do today. In the light of today’s knowledge of textual traditions transmitted through copying by hand, it may well be that the use of two or more exemplars was far more usual than previously thought (see below). The prevailing terminology of the field and the earliest history of textual criticism, mainly interested in discovering the original readings of ancient texts by purifying them of the “falsifications” of later copyists (see Willis 1972), easily yields a very negative picture of contamination as a phenomenon. Still, it is important to keep in mind that it was normally a result of someone trying to correct rather than to spoil the text and its original readings (see e.g. Zink 2014, 3–7).

Whereas, for instance, the early German editor of Horace, Otto Keller (1838–1927), employed the colourful term “malady” (*Gebrechen*) when discussing the issue, the Italian textual scholar Giorgio Pasquali (1885–1952) introduced more unbiased and descriptive vocabulary. According to him, the textual transmission is vertical and unidirectional when the content is copied from one exemplar, and horizontal (or transverse) in cases in which more than one exemplar is involved (Keller 1879, viii; Pasquali 1934).

Contamination is closely tied to another terminological distinction, also coined by Pasquali: the difference between a closed and an open recension or tradition (Pasquali 1934, 126). According to Pasquali, the readings of a closed tradition can be mechanically reconstructed by the scholar, whereas this is impossible in an open tradition (see “1932–” in 2.4.3). The most typical reason for a textual tradition to be open is, in turn, the use of several exemplars in producing a copy (see Trovato 2017, 74–75; Timpanaro 2005, 137; Alberti 1979). In other words, a closed recension often corresponds to the vertical transmission of the text, an open recension in most cases to a contaminated tradition.

The biased term “contamination” is still widely in use even today, although a more descriptive *terminus technicus* like “horizontal”, “transverse”, or “lateral transmission” would be more accurate and less prejudiced. In fact, I would personally prefer to use the term “mixture” rather than “contamination” (like M. W. Holmes 2011, 67–68), but the two terms will be used interchangeably here. In future, it would be advantageous to strive towards as unbiased and descriptive a terminolo-

gy as possible. In the following, I will follow the example of Giorgio Pasquali, Martin L. West, and Michael W. Holmes and use the term “open” for a “contaminated” textual tradition (M. W. Holmes 2011, 67–68; West 1973, 14; Pasquali 1934, 183).

4.4.3 Extent

The textual tradition of a hand-copied text of any importance or size is bound to be more or less open. It has even been suspected that open traditions were the norm, and purely vertical, closed transmissions the exception (Guglielmetti 2017; Tarrant 2016, 15; see also Guglielmetti and Orlandi 2014, 181–184, with examples from various genres). Perhaps the best example of an open tradition is that of the most popular work of the whole era of hand-copied texts, the Bible. Despite the efforts of the copyists to keep the sacred text as unaltered as possible – leaving aside, that is, the conscious editing of the text during the early centuries – the scribes introduced variants. (See e.g. M. W. Holmes 2002, 77–100; Mink 2004; Mink 2011, 141; Wachtel 2012b, 220–222; Guglielmetti and Orlandi 2014, 185; on the New Testament, see 7.1 below.)

Contamination is a very common phenomenon, probably much more so than most scholars realise. There have been some attempts to estimate the exact degree of mixture within textual traditions. For instance, Elisabetta Tonello and Paolo Trovato have hypothesised that around 14 % of the known manuscripts of Dante’s *Divina Commedia* show signs of successive contamination (i.e. the successive use of different exemplars, the easiest sort of contamination to detect; see below). In addition, the two scholars give a list of known manuscripts with rather hard-to-detect simultaneous contamination. In all, their calculations point out that some 19 % of the *Divina Commedia* manuscripts suffer from some kind of contamination (Tonello and Trovato 2011, 19–31; Trovato 2017, 137). Still, such estimates are possibly considerably lower than the actual number, since contamination is not always easy to detect within a textual tradition.

The scholarly tendency, easy to understand from the viewpoint of work economy, to limit the study of the manuscripts and textual witnesses of a work to the ones considered most relevant by the scholar, has prevented us from seeing the big picture of entire textual traditions. One notable exception is John B. Hall’s study on Claudian’s *De raptu Proserpinae*, in which he collated 132 of the 134 known extant manuscripts and reached the convincing conclusion that the tradition was thoroughly open (Hall 1969, 61–64). The same applies to the *Navigatio Sancti Brendani*, an eighth-century travel account preserved in some 140 manuscripts and studied in detail: the tradition contains much contamination (Guglielmetti and Orlandi 2014). One of the examples used in this contribution, the *Vita et miracula Sancti Symeonis Treverensis*, is known to exist in nearly sixty manuscripts, and the collation of all

of them reveals that the textual tradition contains contamination of versions and successive contamination, if not more. If we had more such comprehensive studies, we would surely understand better the real importance and prevalence of contamination within hand-copied textual traditions.

4.4.4 The mechanics of contamination

How did contamination come about in hand-copied textual traditions? It could take place in various ways. One should distinguish the contamination of readings/variants, resulting from a copyist using several exemplars, from the contamination of versions that occurred as a result of the author(s) editing and revising the text while it was already being disseminated (see Segre 1961, 71).

4.4.4.1 Simultaneous contamination

Simultaneous contamination is the trickiest form of horizontal transmission within a textual tradition to deal with. Paradoxically, it was typically a consequence of the copyists and scribes attempting to improve the content of the text. When a lengthy text is copied by hand, it almost inevitably changes. If the text was dictated, the scribe could mishear or misunderstand a word or a phrase. If it was copied from an exemplar, the copyist was bound to make mistakes. In addition, the copyist might feel the need to make changes in the text of his own accord. As a rule, copying errors in / alterations of the text can be classified in four general categories: addition, omission, transposition, and substitution (see 4.3 above for further descriptive vocabulary). The ancient and mediaeval copyists of a text were by no means naive, and they often had a far better command of the language of their text than many modern-day scholars. Thus, it is safe to assume that many of them recognised and were not indifferent to grammatically incorrect expressions or odd choices of words, and had an interest in improving the quality of the text in their copies. The results of such attempts are probably the most typical – as well as most challenging – form of contamination, called simultaneous (Vårvaro 2010, 191; Trovato 2017, 132, 135; Segre 1961, 71; see also Wattel and van Mulken 1996, 105–106; den Hollander 2004, 99). The obvious tool to correct the text was consulting another exemplar (hence the Italian term *contaminazione di lezioni*). Such an activity, often resulting in deliberate simultaneous contamination, is known to have taken place even in the workshops of copyists in Antiquity. To ascertain the correctness of the newly made copy, the precaution was sometimes taken of checking it not only against its exemplar but also against another copy of the text. There are a number of famous ancient and mediaeval cases in which the copyist elucidates this process by specifying *expressis verbis* which manuscripts he used – for instance, Nicomachus Dexter copying and correcting Livy's first pentad, and Lupus of Ferrières copying Cicero's *Epistulae ad*

familiares (see Tarrant 2016, 14; Reynolds and Wilson 2013, 105). If variants were noticed, they could be introduced into the text or the margins. This could, in fact, be done not only by the copyists but also – and very typically – by the readers (Trovato 2017, 131–132; Vårvaro 2010, 191).

In most cases, the comparison of several copies could naturally provide the text with yet another layer of contamination (see e.g. Tarrant 2016, 14–15; Reynolds and Wilson 2013, 39–43). As the exemplars used for copying could already be contaminated, revisers of the copies probably spotted variation within the textual tradition, but it was exceedingly difficult for them to recover the original readings (Segre 1961, 72). In the case of very popular texts, like the Bible or other much-used ecclesiastical and liturgical works, copyists did not even need another copy to try to improve the content of the exemplar. They could cite the text from their own memory (*mnemonic contamination*), often resulting in contamination that has nothing to do with a physical exemplar of the text and can thus be very misleading for the poor scholar trying to shape a stemma.

One should not envisage a scribe looking constantly at two or more exemplars while copying, but rather understand the birth of contamination within a text as a multilayered process. One set of readings was copied from one exemplar, and alterations were made or added to the text, or in the margins, from another manuscript by the same scribe or by someone deliberately correcting or just reading the text. This might have taken place almost immediately or after a considerable period of time, and it is important to keep in mind that all the variants of a text containing mixture need not derive from the same level of the tradition, neither in terms of time nor in relation to the original state of the text. In the latter respect, very complex circular contamination can even occur, at least in principle. This is possible since “usually a number of the variants of the ancestor in a contaminated tradition are posterior to the corresponding variants of the descendant, and a number of the variants of the descendant are prior to those of the ancestor” (Mink 2004, 50–51, 67–74, fig. 20).

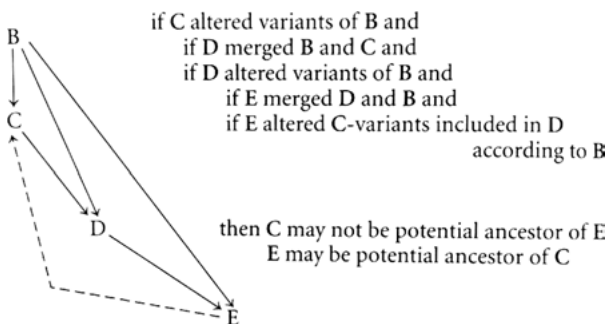


Fig. 4.4-3: The mechanics of an extreme case of contamination, a circular one.
Source: Mink (2004, 50, fig. 20).

It was only during the next phase of textual transmission – when the text was copied again – that these variant readings were really incorporated into the text so that they would no longer be palaeographically or codicologically distinguishable (for an example in the *Navigatio Sancti Brendani*, see P. Chiesa 2016, 56–59). The steps of contamination were normally small, as there was no underlying intention of a scribe to modify the text significantly. This also applies to the cases of seemingly more radical contamination: the steps just seem bigger because there are many links missing (see Mink 2004, 22–24, on New Testament material).

4.4.4.2 Successive contamination

Another frequent form of combining readings from multiple exemplars has been dubbed “consecutive”, “block”, or “successive” contamination. Here, the scribe used different exemplars to copy the content of different parts of the text (hence the Italian term *contaminazione di esemplari*). This mechanism is also called exemplar shift. The reasons behind such a procedure could be anything ranging from incomplete exemplars omitting a passage of the text to the copyist’s zeal to use as high-quality exemplars as possible.

This kind of contamination did not occur only in individual copyists’ work, but also – and apparently rather frequently – in proper *scriptoria*, universities, and professional workshops. We have already acquainted ourselves with the fact that the more popular the text, the more contaminated the tradition is bound to be. This is due to the simple fact that ancient and mediaeval libraries and workshops in which texts were copied may have contained more than one exemplar of a popular work. The *pecia* system (see 2.1.1), applied first at the University of Paris and then elsewhere, is an extreme example of how the assiduous copying of very popular texts resulted in thoroughly contaminated traditions. In order to answer the pressing need for certain works on the part of the general public or customers, it employed several exemplars of the same text, broken down into individual quires that, in turn, were copied gathering by gathering by several copyists. Such a way of working made it possible – or even probable – that the exemplar of the text would be shifted (see Vårvaro 2010, 193; Tonello and Trovato 2011, 18–19). This procedure also explains the high degree of contamination of, for example, university texts but also many of the most popular works, such as the Bible. In New Testament textual criticism, this simplest and least problematic form of contamination has been labelled “block contamination”.

Naturally, there are also cases that combine simultaneous and successive contamination, and it is no wonder that mixture causes headaches for modern scholars – just as it was problematic for contemporary scribes and readers.

4.4.4.3 Contamination of versions

Many texts were disseminated in various versions with slightly differing content. We already have a number of known examples of such a practice from Antiquity

(see West 1973, 15–17). In the Middle Ages, the phenomenon was probably partly encouraged by the more ad-hoc nature of publishing new texts (Guglielmetti and Orlandi 2014, 179–180). In many cases, contamination of versions was closely related to successive contamination.

A good and typical example of a genre that was particularly prone to the mechanics of contamination of versions is that of hagiographical texts and miracle collections, to which new miracles could (and were expected to) be added, even after the first version had begun circulating. On the other hand, hagiographical texts were also often easily abridged to suit the needs of, for example, a collection of saints' lives.

4.4.5 Previous approaches towards contamination

Considering the fact that contamination is obviously a very common phenomenon posing great difficulties for scholars, it is hardly surprising that there have been continuous attempts to find remedies for it. Horizontal transmission was well known to the scribes producing copies of a text in Antiquity and the Middle Ages. With the rise of philology as a scholarly discipline, the phenomenon received new importance, and it was touched upon already by the early philologists, such as Gottlob Heyne (1729–1812) and Johann Jakob Griesbach (1745–1812; see Timpanaro 1961, 44). Paul Maas (1880–1964), who formalised a set of previously well-known practices dealing with a textual tradition into principles often known as the Lachmannian method, considered contamination to be one of the real challenges endangering the mechanical organisation of textual witnesses into a stemma and thus preventing the Lachmannian method from working. Whereas he seems to have been initially hopeful about solving the problem, he grew more pessimistic with time and concluded in the last edition of his influential *Textkritik*: “Gegen die Kontamination ist kein Kraut gewachsen” (Maas 1957, 31; in the first edition of the work, he wrote: “Gegen die Kontamination ist noch kein Kraut gewachsen”; Maas 1937, 294 [No specific has yet been discovered against contamination], trans. Flower 1958, 49). This is a sentiment shared by many modern-day scholars as well.

The exceedingly sceptical view of Paul Maas and others has not prevented scholars from trying to solve the challenge of contamination, for example Avalle (1961), in which very innovative methods were applied. In the 1960s, Jacques Froger proposed a robust method for calculating the relative frequencies of incompatible groups whose combination produces an irregularity in the stemma. Once the frequencies have been calculated, one should choose the most frequent explanation and forget the other ones (Froger 1968, 112–113; Froger 1965; see also 2.3.4.3 above). A contemporary of Froger, Gian Piero Zarri, developed early computational methods for studying complex textual traditions. He shared many of the ideas of Froger and relied heavily on the theories of Henri Quentin (e.g. Zarri 1971, 1973, 1976,

1977; compare Quentin 1926; see also 4.2.4 above). He did, in fact, have at least some success in unravelling very complex textual transmissions, including open traditions (Borsetta and Zarri 1981). For some reason, however, his contribution to the development of the use of computers in the service of textual criticism has largely been forgotten.

A more traditional textual scholar, Martin L. West, published an influential introduction to textual criticism in 1973. He introduced what are known as West tables, which aim to help recognise the proximity of textual versions by quantifying the shared features within the versions (West 1973, 37–47). These tables can also be used to try to track contamination within the tradition. Still, even this approach did not really solve the age-old problems that result in several exemplars. In essence, West tables are closely linked to Froger's previous ideas. In fact, the concept of quantifying the variants of contaminated traditions has been, and is, the prevailing idea of how to deal with contamination. Although this approach does not really tackle the problem, it provides a means to try to circumvent it. Recent textual criticism combines quantifying variants with understanding their emergence. For instance, Paolo Chiesa gives practical examples in the tradition of the *Navigatio Sancti Brendani* on how this helps choose between hypotheses. Here, the leading idea is that the most “economical” explanation is probably the correct one (P. Chiesa 2016, 59–61). This approach, in turn, shares the basic principle of computational approaches: the maximally parsimonious stemma is most probably the correct one.

On the other hand, there are ways to try to interpret the variants in order to decide if there is contamination within the tradition or not. For instance, both graphic traits and linguistic features (like dialects in vernacular texts) can be used to weigh up whether there is contamination or not, since they are more likely to follow vertical rather than horizontal transmission. Similarly, lacunae are normally transferred vertically within a tradition, but very seldom horizontally. In addition, external features such as geographical or other proximity, or otherwise known facts about the history of the tradition, can be useful indicators in its reconstruction (see 4.5).

Despite various attempts, a truly effective remedy against contamination has not been discovered by traditional textual critics. One potentially fruitful approach has scrutinised the few cases in which we can physically see the steps of contamination within extant manuscripts, in order to learn the general principles of how contamination takes place (P. Chiesa 2016, chap. 10). Still, even today, many leading scholars in the field have simply taken comfort in claiming that at least some parts of the stemma of an open tradition can still be reconstructed and original readings can probably be found (P. Chiesa 2016, 60; Trovato 2017, 130, 134; Huygens 2000, 10; West 1973, 38). Although this is a consolation for many philologists aiming to reconstruct the original content and not the whole tradition of the text, such scholars have simultaneously admitted being unable to cope with contamination. For anyone working with the tradition of a popular text, but especially for anyone interested in the tradition of a text in its entirety, this remains a huge problem.

The traditional “Lachmannian” approach quite obviously lacks the means to solve the challenge of mixture except in exceptional cases. The problem is very complicated, and the traditional method of limiting the variants by choosing the most “genealogically informative” ones may, in fact, be counterproductive when it comes to dealing with multiple exemplars. Therefore, answers must be sought elsewhere.

4.4.6 Current ways of dealing with contamination

As mentioned above, mixture is a common phenomenon but not always easy to notice at a glance. In fact, it can normally only be detected once the collation and thus classification of witnesses of a textual tradition is well under way.

4.4.6.1 There is a remedy – for successive contamination

Successive contamination, that is, the use of one exemplar for one part of the text, another for a second part, and so on, is the easiest case to detect. It also poses far fewer problems than simultaneous contamination for an editor of the text or a scholar studying it. In the easiest cases, successive contamination can instantly be seen in palaeographical or codicological traits of the manuscript containing the text: it may have been produced by two or more scribes using their own exemplars or put together from several codicological units. Such examples are numerous, but one should also keep in mind that a change of hand, ruling pattern, quality of parchment, or other feature of manuscript production often has other explanations that have nothing to do with exemplar shift. Even the seemingly obvious cases deserve to be studied thoroughly.

Let us take an example. Trier, Stadtbibliothek, Ms. 1353/132 is a hagiographical collection written in the monastery of Niederwerth in the mid-fifteenth century. It contains, among numerous other texts, the already mentioned eleventh-century hagiography of St Symeon of Trier on f. 27r–35v. A careful reader notices a discontinuity between f. 33v and 34r: one gathering ends on f. 33v and the next begins on the following f. 34r. In addition, the hand changes between the leaves. On top of everything else, the last sentence of f. 33v declares: “Explicit vita sancti Symeonis monachi” [The Life of St Symeon ends [here]]. After weighing up three different testimonies – one codicological, one palaeographical, and one of content – it becomes obvious that the life and miracle collection of Symeon in the manuscript has been put together from two codicological and palaeographical units (see fig. 4.4-4).

Since contamination always has to do with the relationships of the copied text (apograph) with the other witnesses of the textual tradition, any irregularities and changes in these relationships in different parts of the apograph may indicate a change of exemplar. In some cases, the important variants may point in one direction in one part of the text and somewhere else in others, and the successive contamination of the text becomes obvious. In most cases, however, a more thorough

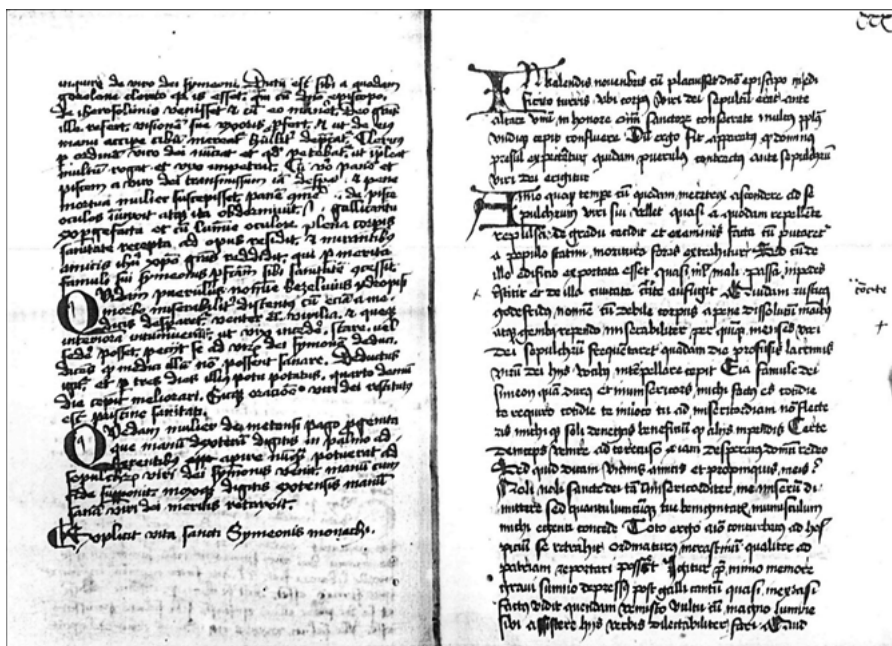


Fig. 4.4-4: Trier, Stadtbibliothek, Ms. 1353/132, f. 33v–34r. This shift in exemplar results in successive mixture in the apograph of the manuscript.

analysis is needed, and it is helpful to visualise the relationships between the witnesses to understand the changes within the textual tradition. One way of doing this is to divide the text into relatively short chunks and scrutinise them. For instance, West tables quantifying the variation between textual witnesses can be used for this. The underlying idea of finding changes in dependencies between textual witnesses is simple and has probably been applied *sub silentio* by an infinite number of scholars using traditional approaches.

While such “non-visual” approaches yield good results in studying successive contamination, drawing hypothetical stemmata of the individual passages of the text can be even more helpful. Today, various computational tools can be used to quickly and easily draw dozens of distance trees visualising the relationships of witnesses in various parts of the text. Should these relationships change significantly and consistently from one part of the text to another, successive contamination is one of the possible explanations that needs to be considered further. As a further advantage of drawing stemmata for various sections of the text, this method provides a scholar with hypotheses on where the exemplars of the apograph can be looked for in the stemma. To follow up on our previous example, let us draw the trees of the St Symeon text in Trier, Stadtbibliothek, Ms. 1353/132 before and after the exemplar shift hypothesised above on palaeographical, codicological, and content grounds (see fig. 4.4-5). The siglum of the Trier manuscript is V, both before

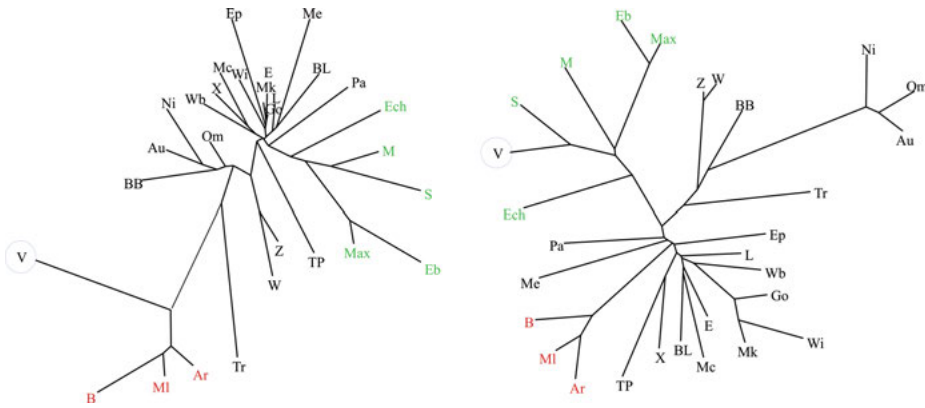


Fig. 4.4-5: Spotting successive contamination: witness *V* changes its location in the tree plots for the first and the second part of the text very conspicuously. (Unrooted trees, plotted with the “*Leitfehler*”-method script described in Roelli and Bachmann 2010, for a sample of twenty-eight witnesses.)

and after the exemplar shift. By comparing the two stemmata it is easy enough to conclude that we are indeed dealing with a case of successive contamination.

There are further methods that help a scholar trace a change of exemplar. In 1996, Evert Wattel and Margot van Mulken proposed a method for making part of the internal structure of the relationships within a textual tradition visible and thus helping to trace successive contamination: what they call a *cardiogram* of the text tradition. By calculating a similarity graph for the witnesses of a given text, it is possible to pinpoint “shock waves”, that is, locations within the text where the similarities/dissimilarities between witnesses change rapidly. This, in turn, may indicate an exemplar shift (Wattel and van Mulken 1996; den Hollander 2004).

A decade later, Heather Windram, Christopher Howe, and Matthew Spencer published an article with promising attempts to tackle successive contamination. They proposed the use of the maximum chi-squared method, a technique borrowed from molecular biology, to analyse the distribution of variants in various parts of *The Wife of Bath’s Prologue* in the *Canterbury Tales* (Windram, Howe, and Spencer 2005; Windram, Spencer, and Howe 2006). Subsequently, the method has been used successfully to study the textual tradition of the Sanskrit *Dyūtaparvan* (Phillips-Rodriguez, Howe, and Windram 2009). The underlying idea is that an exemplar shift is analogous to DNA recombination. Applying the maximum chi-squared method allows a very concrete comparison between pairs of textual witnesses and clearly indicates if an exemplar shift took place. In the *Dyūtaparvan* tradition, the maximum chi-squared value is able to identify an exemplar shift when manuscripts *D5* and *D6* are compared; that is, the highest peak in the chart (fig. 4.4-6) pinpoints the greatest discrepancy between the observed and expected distribution of differences. This is where a change of exemplar is most likely to have occurred (at character 3735).

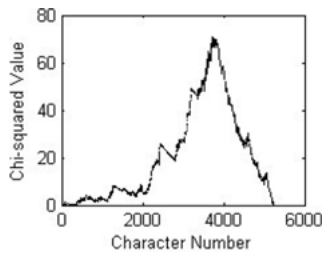


Fig. 4.4-6: Using the maximum chi-squared method to identify an exemplar shift when comparing manuscripts *D5* and *D6* of the *Dyūtaparvan* tradition. Source: Phillips-Rodriguez, Howe, and Windram (2009, 387).

4.4.6.2 How to deal with simultaneous contamination

While there are ways to tackle the consequences of exemplar shift, simultaneous contamination is harder to deal with. The experiments with artificial textual traditions have shown that the hypothesised relationships between the witnesses containing text with simultaneous mixture remain uncertain and often erroneous. This applies to both traditional and computer-assisted methods of textual criticism (Baret, Macé, and Robinson 2006, 264–265; Roos and Heikkilä 2009, 424–427). Still, in the best of cases there may be variants present that point with certitude to one exemplar or group of witnesses. Sometimes, albeit rarely, it is possible to find out all the exemplars used for the apograph in various stages simply due to the fortuitous presence of distinctive variants (see e.g. the methodologically excellent Guglielmetti 2007).

It is a clear indication of simultaneous contamination when the variants of the text point towards a connection with some witnesses here and with other witnesses there, without a clear pattern as in successive mixture. Often, the mere collating of a text reveals links to several other witnesses in such a way that simultaneous contamination can be suspected. If the text of witness *A* shows clear similarities to two or more other witnesses (*B*, *C*, and so on) that are not closely related with each other, it may well be that they were exemplars (or closely related to the exemplars) of *A*. In practice, the scholar tries to look for *Leitfehler* with direction and tries to shape a stemma based on them. The contradicting variants are probable candidates for simultaneous contamination. This is the traditional method in textual criticism for identifying simultaneous contamination in a textual witness.

The challenges do not end when a probably contaminated witness has been found. An open tradition obscures both the direct lines of descent and their direction. In order to put the witness in its proper place in the textual tradition and thus evaluate its significance, it is necessary to find out the direction of relationships between the witness suspected to be contaminated and its closest relatives. In many cases, a derivative witness can appear instead to be the exemplar because of contamination, which may have catastrophic implications for shaping a stemma (see fig. 4.4-2 above; M. W. Holmes 2011, 73–74).

The method of scrutinising the text and the relationships between its witnesses in short passages, so advantageous in finding exemplar shift, is helpful in studying simultaneous contamination, too. What distinguishes simultaneous from successive contamination in this respect is that in the former the links will be present every now and then throughout the text, whereas in the latter there will be distinct blocks of text linked to their respective exemplars. The above-mentioned “shock waves” or West tables can be used as tools to get an insight into the text. Windram, Spencer, and Howe (2006, 153) recommended applying the maximum chi-squared method to detect successive contamination and were sceptical whether the method could be used to trace simultaneous contamination. Still, just like with the “shock waves” or West tables, any further knowledge about the relationships between the witnesses of a textual tradition is welcome and can provide new understanding about contamination.

Previously, it was hoped that applying sophisticated network methods developed by mathematicians and evolutionary biologists to textual traditions could help tackle simultaneous contamination in a better way (Holland et al. 2004; Huson and Bryant 2006; Windram, Spencer, and Howe 2006, 153). Today, the most commonly used network methods include neighbour-joining and NeighborNet (Huson and Bryant 2006; Saitou and Nei 1987). While concretely showing various possible networks representing the relationships within a textual tradition, and thus giving food for thought concerning contamination, the use of network methods has unfortunately not led to a breakthrough (see e.g. Roos and Heikkilä 2009, 426).

One further example from the textual tradition of the life and miracle collection of St Symeon of Trier serves to elucidate the problems we still have. The nearly sixty extant manuscripts of the text can be divided into seven groups according to the variants. In terms of the variants, we can concentrate on just five very distinctive ones, of which every group has a slightly different combination. The writing history of the text makes it obvious that the *Life* and the *Miracles* were edited from very early on partly as separate entities. If we concentrate on just the *Life*, three of the five most distinctive variants are involved. And here comes the problem: of the seven groups, six give a different combination of those three variants, and in none of the variants is it possible to deduct the direction of the change. Consequently, there is no way of representing the groups as a neat tree; we can only assume that the origins of the groups represent various editorial versions that contain mixture with each other. In other words, we have to cope with the simultaneous contamination of versions.

4.4.7 New promises? Computer-assisted methods

As mentioned above, the idea of using computers for “automated textual criticism” stems from the 1960s and 1970s. In spite of some early and encouraging experiments,

mainstream textual scholars remained distrustful, and there was an air of “hostility against the methods of automation which [was] based on rhetorical claims for the uniqueness of the ‘human spirit’” (Timpanaro 2005, 89; see 5.5 below). Since the 1990s, computers have experienced a renaissance within textual scholarship, and various algorithms have been used to study textual traditions. The results have, again, been encouraging: many approaches of computer-assisted stemmatology have proven to be powerful tools not only for the task of reconstructing the archetypes and other early versions, as well as the development of the text, but also in providing insights into the way texts have been disseminated and altered during their history. At the same time, the computational capacity of modern computers has made it unnecessary to limit the number of variants under scrutiny and has thus allowed scholars to let go of the traditional – but inevitably subjective – selection of variants (on the status quo, see e.g. Heikkilä and Roos 2016, with articles by several scholars; the traditional caveats are summarised by e.g. Trovato 2017, 179–224).

There have been many promising attempts in the field of computer-assisted stemmatology, and computers are widely used when studying vast textual traditions (e.g. Barbrook et al. 1998; Spencer, Mooney, et al. 2004; Windram, Howe, and Spencer 2005; Huson and Bryant 2006). Still, even the best computerised methods share the traditional problems of good old-fashioned textual criticism. Most approaches only provide a scholar with bipartite, unrooted trees, that is, with oversimplifications that give a trustworthy hypothesis on the relationships between the witnesses but need to be elaborated further by traditional means. More importantly in the context of this contribution, there is still no computer-assisted method that reliably deals with contamination.

In 2009, Teemu Roos and Tuomas Heikkilä compared the performance of some twenty computer-assisted methods for stemmatology on three artificial datasets (Roos and Heikkilä 2009). Some of the methods were found to perform far better than others, but there were clearly two factors that affected the performance of all the approaches, even the best ones: the number of missing manuscripts (i.e. those withheld by the organisers of the experiment) and the degree of contamination. From a closer look, it becomes evident that the degree of mixture was – and still is – the most important single feature affecting the result of each method. All the methods got their best score on the dataset with no contamination at all (but with 24 % of the witnesses missing). Similarly, all the methods yielded their worst results on the artificial tradition that contained more contamination than the others (Roos and Heikkilä 2009, 420, 422–423).

At first glance, the results are disappointing when it comes to dealing with contamination. We started by analysing the best results of the artificial textual tradition *Notre besoin*, with only fourteen witnesses, of which one was held back and just one was a result of mixture. The most successful approaches – compression-based RHM and phylogeny-based PAUP* – did find out the overall structure of the tradition, but failed to put the only contaminated witness in the correct place (for a brief

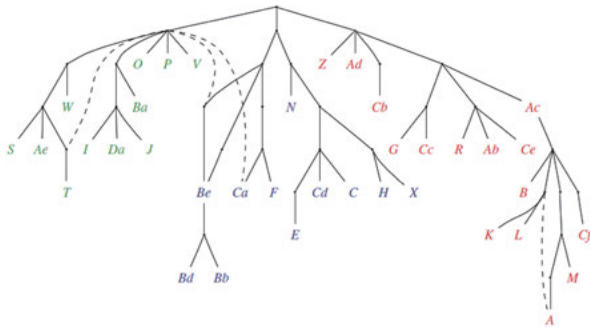


Fig. 4.4-7: The correct stemma of the artificial *Heinrichi* tradition. In the case of mixture, a dashed edge indicates the secondary exemplar.

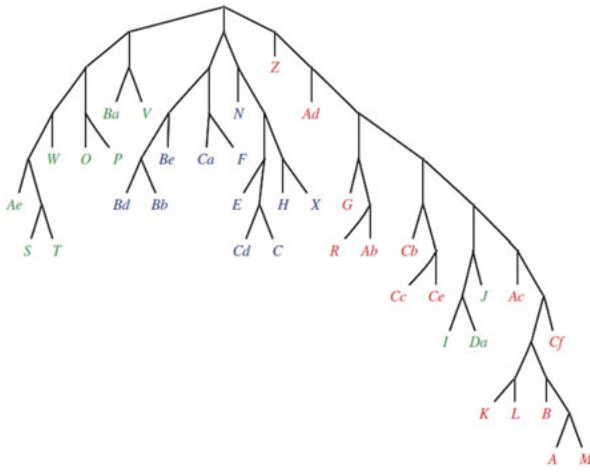


Fig. 4.4-8: The manually rooted stemma obtained by RHM for the artificial *Heinrichi* tradition.

explanation of the methods, see Roos and Heikkilä 2009, 432–433; Swofford 1998; see also 5.3 below) Still, the best results on the most difficult – and thus probably most realistic – textual tradition were not all that discouraging. Let us concentrate on the most complex (i.e. most contaminated and with missing witnesses) of the three artificial datasets, called *Heinrichi*, and compare the trees proposed by the highest-scoring RHM and PAUP* methods with the correct stemma (figs 4.4-7–9).

Our interest lies in the four witnesses that have more than one exemplar: *A*, *Be*, *Ca*, and *T*. It turns out that all of them are reasonably well located in their real context in the hypotheses of RHM and PAUP*. *A* is together with *B*, *K*, *L*, and *M*; *Be* together with *Bb*, *Bd*, and *Ca*; *Ca* with *Be*, *F*, and *N*; and *T* with *Ae* and *S*. The results are by no means perfect, but the relationships of the contaminated witnesses with the others are more or less correct (see also the encouraging results of Marmerola et al. 2016 on *Heinrichi* material). It should also be mentioned here that all four of them represent the more difficult variety of contamination, the continuous one.

In the 2010s, Jean-Baptiste Camps and Florian Cafiero approached contamination from another angle. Their idea is to distinguish genealogical (i.e. non-contaminated,

The recognition that the traditional “Lachmannian” method does not work on textual traditions with simultaneous contamination has led some scholars to question one of the core ideas of the discipline, the elimination of unnecessary witnesses, or *eliminatio codicum descriptorum*. This approach has been developed among scholars of the most commonly copied text (and probably the one with most thoroughly open tradition) of the Middle Ages, the New Testament. Here, it has been found impossible to strive directly towards a stemma of all witnesses. Instead, it has been judged useful to cut the text into a high number of very short passages consisting of single variants that are studied one by one to reconstruct a myriad of local stemmata of the readings. In principle, this should lead to several groups consisting of stemmata pointing in the same direction within the textual tradition, and it should thus be possible to identify the exemplars used in producing a copy. Furthermore, in the best of cases, it should be possible to combine the local stemmata of variants in a global stemma of witnesses. The novelty of the method lies in the fact that it reconstructs stemmata of the readings, based on which the stemma of the witnesses is inferred. In other words, the method applies to each passage individually the very same approach used by textual criticism for the whole tradition. The method builds heavily on Froger’s previous work (see above), but employs a set of computer-based tools to deal with the stemmata (Mink 2004; M. W. Holmes 2011, 75; Wachtel 2012a, 123–138). In the context of this contribution, it is important to stress that the method seems promising in tackling contamination as well. In fact, the idea of building local stemmata based on single variants has many similarities with the use of “shock waves” or the maximum chi-squared method to detect contamination: a big scholarly challenge is divided into several smaller and thus more easily solved problems.

During the past few years, CBGM has been well received among the scholars of biblical exegesis (cf. Gurry 2017; Wasserman and Gurry 2017; Wasserman 2015). With regard to contamination, the method is said to solve the problem by forgoing the mechanical reconstruction of hyparchetypes and allowing multiple ancestors for each witness, and by using coherence to identify the likely ancestors of a witness. Some have even proclaimed that contamination is “a problem no longer” (Parker 2012, 84; Gurry 2017, 206). The most recent studies have shown, however, that even CBGM does not always succeed in tackling mixture, which thus does remain a problem (Gurry 2017, 206–207). Nevertheless, CBGM can be useful for gaining insights into vast and contaminated traditions where it would be virtually impossible to make a stemma using traditional methods. Curiously, the discussion about the applicability of CBGM has mostly been confined to biblical exegesis, and its core ideas have not been widely applied outside the study of the New Testament. This goes to show the importance of collaboration across the traditional boundaries of disciplines. CBGM approaches the challenge of contamination from a very different angle than traditional textual critics or the computer-assisted methods hitherto employed. It would be important to test the method on various artificial textual traditions to

find out its performance in comparison to other approaches. The very same applies to all relevant computer-assisted methods: more tests on artificial datasets should be run before any hopefully watertight conclusions can be drawn.

In spite of the claims of success of some individual scholars in dealing with it in individual cases, contamination remains a challenge. The recent results of some computer-assisted methods and CBGM give reason for at least some optimism: progress has been made in two directions that complement each other. Still, one should not forget the traditional approach either. Computerised methods result only in hypotheses that need to be studied and refined by traditional means: using modern computational methods does not mean abandoning the traditional virtues of textual criticism. At the moment, this combination of traditional and novel approaches is the best way of dealing with mixture. One needs both deep understanding of the text and knowledge of the whole textual tradition.

Although these methods are not able to explain contamination on the level of individual readings yet, they are nevertheless often able to put a contaminated textual witness in its proper context. In other words, we may not yet have – to use Paul Maas’s famous terminology – a “Kraut gegen Kontamination”, but with our present tools, contamination does not make the part of textual tradition in which it occurs totally impossible to study or to reconstruct.

4.5 The stemma as a historical tool

Caroline Macé

The title of Giorgio Pasquali’s book *Storia della tradizione e critica del testo* (1934) suggests a tension between the history of a tradition and textual criticism (see 2.4 above on neo-Lachmannian philology as a synthesis). Indeed, textual scholarship, even if not explicitly neo-Lachmannian, must combine a historical approach to manuscript traditions with a critical-philological approach to textual variation in order to be able to obtain a critical-historical general view of any textual tradition (Irigoin 1981). These two approaches, however, require different skills and methodologies, and there is no handbook explaining how this combination of approaches should work. This lack of a clear and simple recipe may be one of the reasons why several scholarly trends tend to keep both approaches separated, or even to make them oppose one another, like the so-called New Philology (see 2.3.4.4). De facto, it may prove methodologically sound to carry out either type of research – on the textual variation and on the history of the manuscripts – separately at first and then to combine and compare the results of both investigations, even though this comparison may lead, in an iterative process, to revising some of the results obtained in each of the two parts of the research. In text-critical practice, the very word “manuscript” is often ambiguous, as it may designate both the physical object

carrying textual content and that content itself, that is, a text-state. The distinction between *traditio textus* and *traditio codicum* is somewhat artificial, since the history of the transmission of text-states and the history of the evolution and dissemination of text-carriers should ultimately correspond and be synthesised in one and the same *stemma codicum*. The concise expression “history of the text” is sometimes used in different languages (*histoire du texte*, *storia del testo*, *Textgeschichte*, and so on) to mean “history of the tradition of a work”. The work (defined by its identification in repertories, histories of literature, and so on) exists through different textual states present in direct and indirect witnesses (see 3.1–2).

4.5.1 Types of evidence for the history of a manuscript tradition

In most cases, a tree-graph drawn using statistical or computational methods will represent only affinities (similarities) between the text-states contained in extant witnesses. If the tree can be oriented or rooted, the tree-graph will represent genealogical relationships between the text-states (see 4.1.3, 4.1.5, and in general 4.2). The situation is not so different when no computational methods are used, as the philologist will normally base his tree primarily on kinship-revealing (significant) secondary readings (“errors” in the text-critical sense; see 4.3.1). This tree will therefore also represent genealogical relationships between text-states, and not yet be a *stemma codicum* in the full sense (see 4.1.3). In all cases, the determination of the secondary readings or of the root is the most difficult part of the work (see 4.5.3).

In order for the tree to become a *stemma codicum*, other types of information should be added. The *stemma codicum*, thus conceived, summarises the history of the manuscript tradition. This history will be explained in the introduction to the edition or even as a separate book (e.g. Irigoin 1952 on the history of the tradition of Pindar’s work). The critical edition must be based on the history of the tradition, but this is not the only possible use of that history. Combined, histories of different traditions will contribute greatly to the intellectual history of a given period, especially those periods in which manuscripts and philology have played an eminent role, for example Alexandrian philology or the Renaissance (see 2.1.4, 2.1.5).

Amongst the types of evidence that can be taken into account to depict the history of a given tradition, the following ones are the most important:

- (i) material evidence: date and place of copy, palaeographical analysis, codicological analysis, and so on (see 1.4 above; see also Irigoin 2000);
- (ii) “environmental” evidence: history of the transmission of other works contained in the same manuscripts (see the collection of essays on “multiple-text manuscripts” in Friedrich and Schwarke 2016); arrangement of a “collection” or “corpus” of works or subworks (chapters, sermons, letters, and so on) in a book or in a collection of books;

- (iii) paratextual evidence: titles, divisions of the text, marginalia, and so on;
- (iv) indirect tradition: ancient and mediaeval translations, citations of the work in anthologies; and
- (v) transmission of the work in another material support than manuscripts, like graffiti, papyri, and so on (see 3.2 above; see also Macé et al. 2015, 328–329).

In order to illustrate how these different types of evidence can be combined with philological insights to draw up the history of a textual tradition, a few case studies are examined in the remainder of this section. In the first one (4.5.2), the manuscript tradition is extremely fragmentary and the determination of “errors” is made very difficult by the existence of various layers of corrections and contaminations; nevertheless, it was possible to draw a stemma manually. In the second case study (4.5.3), the situation is rather different, as the work is preserved in a very large number of witnesses. However, as is almost always the case for ancient and early mediaeval works, no direct witnesses are preserved from the early stages of the transmission, and therefore the top of the tree is missing and rooting is very difficult. It was feasible to produce some statistical representations of the relative proximity of the witnesses, but orienting the tree was possible only thanks to the use of an “outgroup” (this concept will be explained below). In this case, as well, material evidence was of crucial importance in order to consolidate a philological hypothesis about the transmission of the texts. In the final case study (4.5.4), no attempt at drawing a stemma of the transmission of the work was made, because the work is not transmitted through direct witnesses (it has disappeared in its original language) but only through indirect witnesses (translations). It was possible to infer some elements in the history of the tradition of the work from the application of textual criticism to comparison of the versions of the work in other languages and from what is known about the literary contacts between the languages in question. A genealogical study of the variation between the versions is a preliminary to any study of the versions in their individual context.

4.5.2 Proclus’ Commentary on Plato’s *Parmenides*

This commentary was composed in the fifth century CE by Proclus Diadochus (the “Successor”), one of the last pagan philosophers active in Athens. As Platonist philosophy was not allowed in the Byzantine Empire, or only in disguise, like the work of Pseudo-Dionysius Areopagita (see Steel 1997), only a few works by Proclus have survived, in scarce and late manuscripts. Of all the commentaries on Plato that Proclus must have written, the following are preserved: those on the *Alcibiades* (mutilated at the end), on the *Parmenides* (mutilated at the end), on the *Republic*, on the *Timaeus* (with the largest manuscript tradition, from the beginning of the

twelfth century onwards), and on the *Cratylus*. The commentary on the *Republic* is preserved in a single manuscript dated to the end of the ninth or the beginning of the tenth century, and in Renaissance copies of that manuscript. For the commentary on the *Alcibiades*, we also have only one manuscript, copied by George Pachymeres in the thirteenth century. The manuscripts preserving the commentary on the *Cratylus* are relatively numerous, but none is dated prior to the twelfth century. For Proclus' own works, the *Platonic Theology* and the *Elements of Theology*, no manuscript is older than the thirteenth century. The *Tria opuscula* are known only through the translation of William of Moerbeke in the thirteenth century and through a plagiarism by Isaac Sebastokrator in the second half of the eleventh century (see 4.5.2.3).

Thirteenth century

A Paris, Bibliothèque nationale de France, gr. 1810

Fourteenth century

M Milano, Biblioteca Ambrosiana, B 165 sup. (159) (ca. 1340)

L Firenze, Biblioteca Medicea Laurenziana, Conv. Soppr. 103 (a. 1358)

Fifteenth century

F Firenze, Biblioteca Medicea Laurenziana, Plut. 85.8 (a. 1489)

V Venezia, Biblioteca Marciana, gr. Z 191

Sixteenth century

W Wien, Österreichische Nationalbibliothek, phil. gr. 7 (a. 1561)

G Escorial, Real Biblioteca de San Lorenzo, T. II. 8 (gr. 147)

P München, Bayerische Staatsbibliothek, gr. 425

R Città del Vaticano, Biblioteca Apostolica Vaticana, Ross. 962

Fig. 4.5-1: *Conspectus siglorum* of Proclus' Commentary on Plato's *Parmenides*.

Proclus' commentary on the *Parmenides* met a similar fate. Although it is preserved in several manuscripts, most of them were copied in Italy or in Spain during the Renaissance, and only three came into existence before the end of the Byzantine Empire (i.e. 1453). Before the work of Carlos Steel (Steel and Macé 2006), it was believed that this manuscript tradition was to be divided into two families: on the one hand, a late thirteenth-century manuscript, which received the siglum A, and its descendants; on the other hand, some fifteenth- and sixteenth-century descendants (F, G, P, R, W) of a lost manuscript Σ. The *conspectus siglorum* in figure 4.5-1 gives the names and sigla of the main manuscripts. For the stemma as it was traditionally conceived, see figure 4.5-2.

In addition to the Greek manuscripts, a very literal Latin translation was made by William of Moerbeke at the end of the thirteenth century (g). This indirect witness is precious because it must have been made on the basis of a lost Greek manuscript containing a longer text of the commentary (f); see the edition of the Latin text by Steel (1982–1985) and a back-translation into Greek of the missing part in Steel and van Campe (2009, 279–355). The Latin translation preserves some read-

ings that are obviously better than those of *A* and of the descendants of Σ , so that we must conclude that *A* and Σ share some secondary readings (errors). The stemma in figure 4.5-2 is therefore to be corrected as shown in figure 4.5-3.

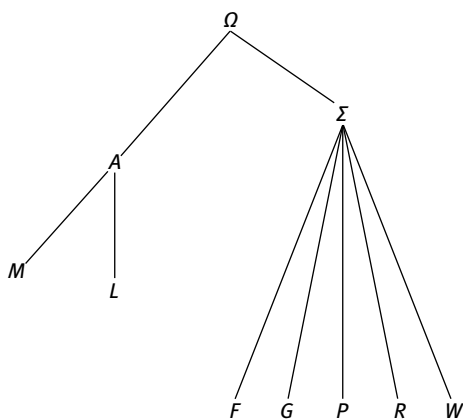


Fig. 4.5-2: Stemma 1 of the tradition of Proclus' *In Parmenidem*. The Greek letters represent lost manuscripts.

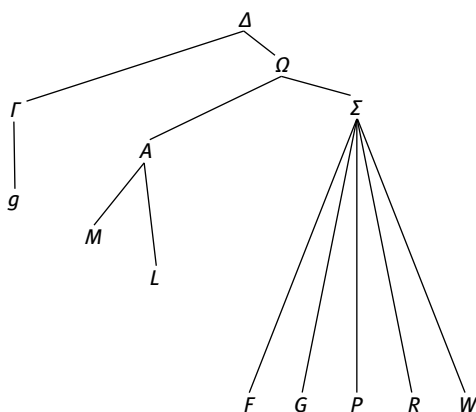


Fig. 4.5-3: Stemma 2 of the tradition of Proclus' *In Parmenidem*, with the translation of William of Moerbeke (*g*) and its lost Greek model (*Γ*).

Further, a philological comparison of the Latin translation with the Greek manuscripts allowed us to detect some apparent common mistakes of *g* and Σ against *A* – which is stemmatically impossible. In fact, those apparently better readings of *A* are not to be seen as primary readings but as corrections made by the copyist of *A*, George Pachymeres (1241–ca. 1310), himself a philosopher (see Golitsis 2010 on the activity of Pachymeres as philosopher, teacher, copyist, and philologist). Pachymeres not only thoroughly corrected the text he copied (not always successfully) but also adapted the text of Plato present as lemmata in the commentary (Steel 1999; see fig. 4.5-5 below: the lemmata are in red ink). Moreover, he wrote a sequel to the incomplete text of Proclus (Westerink et al. 1989). We were led to conclude that Pachymeres' model was actually Σ , the very same manuscript as the one used

later by several copyists in Italy and Spain (*F*, *G*, *P*, *R*, *W*). The stemma must therefore be further modified as shown in figure 4.5-4. Obviously, Σ was still in a better state of conservation in the thirteenth century than it was in the fifteenth and sixteenth centuries, because in all those late copies there are lacunae, blank spaces, and obviously erroneous readings due to the difficulty of deciphering their exemplar; these lacunae and erroneous readings are not found in *A*. The fact that manuscripts evolve in the course of time must be taken into account when trying to understand the history of a textual tradition (for other cases, see Irigoin 1954).

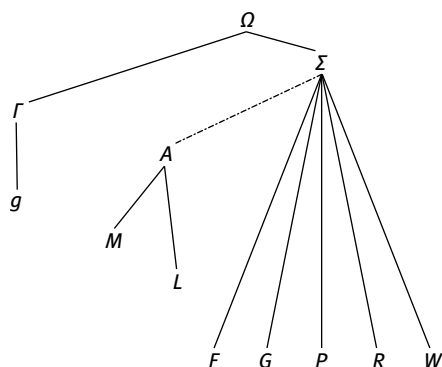


Fig. 4.5-4: Stemma 3 of the tradition of Proclus' *In Parmenidem*; the dot-dash line indicates that the copyist of *A* did not only copy the text of Σ but also heavily modified it.

Manuscript *A* was copied at least twice when it was still in Constantinople. The oldest copy, *M*, a fourteenth-century manuscript, was bought around 1445 by Cardinal Bessarion, a Greek intellectual converted to Catholicism, and entered his library in Italy. The second copy (*L*) was made not long after the first one (1358), but at that time manuscript *A* had suffered heavily from water damage and the upper external corner of most pages had become barely legible, especially towards the end of the book. In some cases, the copyist of *L* tried to restore the faded text in *A* (see fig. 4.5-5).

The text copied in *M* was of poor quality, full of mistakes and omissions, and its new owner, Bessarion, could not be satisfied with that. Therefore, he carefully corrected the text of his manuscript, and he even did so twice, as can be seen from the two different layers (made using different inks) of marginal and interlinear notes in his hand (see Macé, Steel, and d'Hoine 2009; fig. 4.5-6 below). At first, Bessarion corrected the text using his own excellent command of the Greek language and deep knowledge of Proclus' thought. But this was obviously not enough, because he looked for another manuscript containing Proclus' commentary to collate it against his own. There was indeed another manuscript of Proclus' *In Parmenidem* in Italy at that time, none other than manuscript Σ , which was then probably kept in Rome, where Bessarion, due to his work at the papal court, often resided. Indeed, the oldest known Italian copy of Σ was made by John Rhosos, a professional Greek copyist, in Rome in 1489, for Lorenzo de' Medici, as is known from the colophon of manuscript *F* (see fig. 4.5-7). Most of the changes made by Bessarion during the second phase of correction (at any event, before his death in 1472) were inspired by

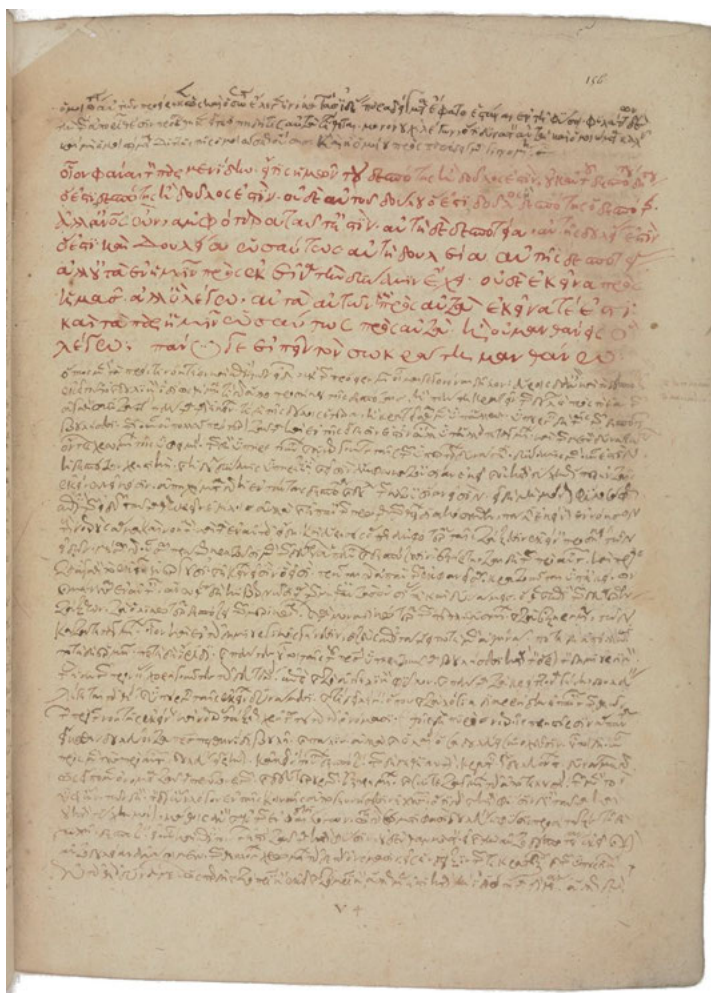


Fig. 4.5-5: Paris, Bibliothèque nationale de France, gr. 1810, f. 156r (A). Source: Gallica, Bibliothèque nationale de France, gallica.bnf.fr/ark:/12148/btv1b10507219n/f319.image. Image: CC-BY-NC.

Σ, to which Bessarion's marginal and interlinear notes are therefore the oldest preserved witness after A (before the copy by John Rhosos). Furthermore, professional copyists, such as Rhosos and the copyists of the other *recentiores*, were not always very accurate and, for financial reasons, speed sometimes prevailed over care, at the cost of several grave omissions. Most likely for the same pecuniary reasons, the margins of F are very large (and empty), presumably because Rhosos was paid by the page (see fig. 4.5-7; other reasons may be put forward, but in this context this seems the most obvious one). The way Bessarion made his corrections on the basis of Σ also tells us something about the form of that manuscript – so that, in this case, philology is an aid to codicology. Indeed, every time a new quire of Σ starts,

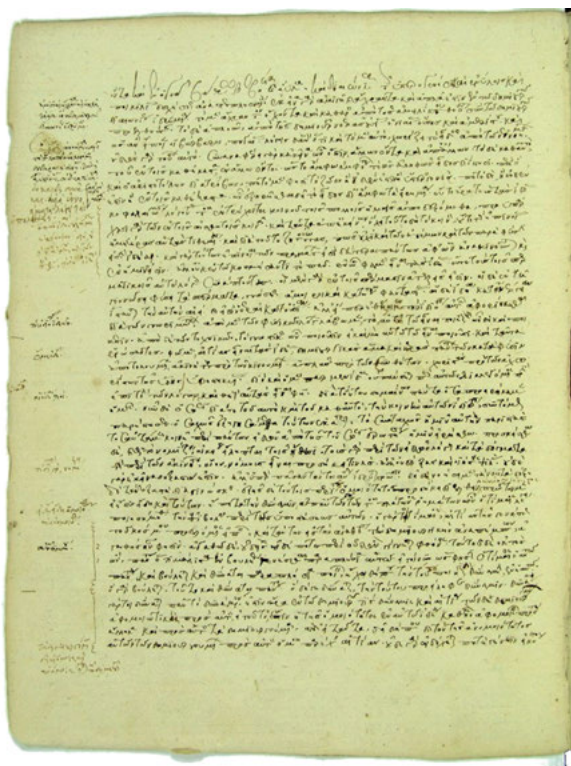


Fig. 4.5-6: Milano, Biblioteca Ambrosiana, B 165 sup. (159), f. 36v (*M*) – already published in Macé, Steel, and d’Hoine (2009). Apart from Bessarion, another, anonymous, reader left notes in the manuscript, sometimes discussing Bessarion’s interpretations, as here.

Bessarion drew a line in the text of *M* and wrote “ἐνταῦθα” [here] in the margin. From that we can estimate the length of the quires in Σ .

Bessarion ordered a new copy to be made from *M*, incorporating his corrections into the text: this is manuscript *V*, now in the Biblioteca Marciana in Venice, like most of Bessarion’s manuscripts. Manuscript *M*, however, was borrowed from the Marciana by Niccolò Leonico Tomeo (1456–1531), who also left a few notes in its margins. Tomeo never returned the manuscript to the library, and it was bought from his *Nachlass* in Padova by Vincenzo Pinelli (1535–1601), and then again by Federico Borromeo, who bequeathed it to the Biblioteca Ambrosiana in Milan (for all details concerning the manuscripts, see Luna and Segonds 2007–, vol. 1.1, and the introduction in Steel, Macé, and d’Hoine 2007). Had *M* not been preserved, it would have been very hard, perhaps impossible, to understand the position of *V* in the stemma (this is a very special case of contamination; see 4.4).

It was not only manuscript *M* that travelled quite a lot, first from Constantinople to Italy, then within Italy: manuscript Σ ’s journeys can also be traced to some extent. We know it was in Constantinople at the end of the thirteenth century, because

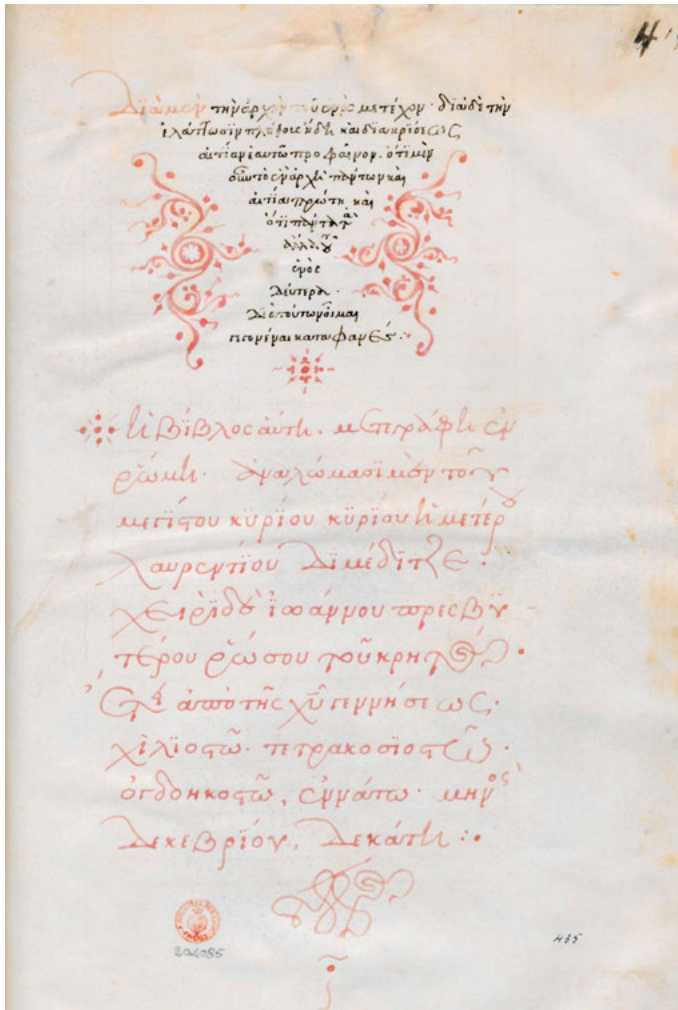


Fig. 4.5-7: Firenze, Biblioteca Medicea Laurenziana, Plut. 85.8, f. 435r, colophon (F).
Source: mss.bmlonline.it/Catalogo.aspx?Shelfmark=Plut.85.8.

Pachymeres copied it there. We know it was in Rome at the end of the fifteenth century, because John Rhosos completed his copy in that city in 1489 (and Bessarion used it some time before). Around the middle of the sixteenth century, it must have been in Venice, because manuscript G was copied before 1570 in Andreas Darmarios' workshop in that city. Philological analysis shows that two manuscripts were copied in their first part from *M*, or from its descendant *V*, and in their second part from *Σ*, or the other way around: *P* (books 1–3 from *M* and books 4–7 from *Σ*) and *W* (book 1 to the beginning of book 4 from *Σ*, and the end of book 4 to book 7 from *V*). This anomaly can be explained only if the first exemplar from which each copy

was made suddenly became unavailable (or was defective, but we know this is not the case); otherwise, there is no reason why a copyist would change his model in the course of copying. *P* was copied in the workshop of Darmarios. *W* was copied in 1561 by Cornelius Murmuris of Nauplia (f. 359v, colophon), who was active in Venice. This is highly speculative, but one could imagine that Cornelius Murmuris used Σ as his model in Venice but could not finish his copy because Σ was taken away to another place (Spain), and that he had to look for another model available in Venice, *V*. One could also hypothesise that the copy of *P* was begun in Venice and completed in Spain, where Darmarios worked between 1571 and 1580 (Martínez Manzano 2008): for the first part of *P*, which was still copied in Venice, the copyists could use *M*, but for the second part they had to use another model, present in Spain – perhaps Σ was bought, like so many manuscripts, by the Spanish ambassador in Venice, Diego Hurtado de Mendoza (1503–1575), presumably before 1561. As mentioned previously, there is no trace left of Σ any more: it is not impossible that Σ disappeared, along with so many other manuscripts, in the great fire that destroyed the Escorial library in 1671.

The whole history of the tradition of Proclus' *In Parmenidem*, based on philological analysis, material and paratextual evidence, and the indirect tradition, is summarised in figure 4.5-8. I am very much indebted to Carlos Steel, with whom I have discussed the history of this tradition many times (see Steel 2010).

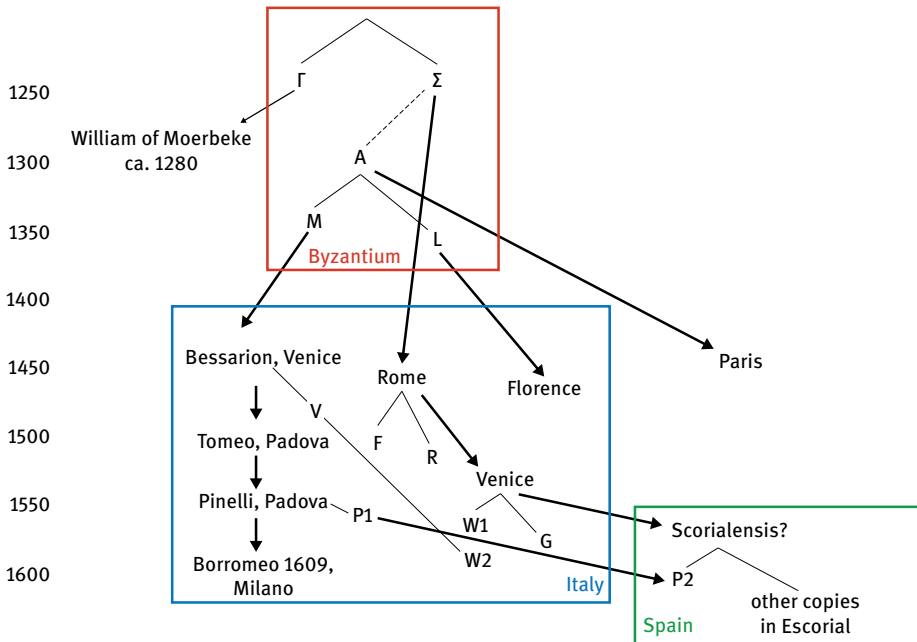


Fig. 4.5-8: Final stemma of the manuscript tradition of Proclus' *In Parmenidem* (previously unpublished). The arrows do not indicate filiations between text-states, but geographical relocations or changes of owners of manuscripts.

4.5.3 Gregory of Nazianzus' *Homilies*

The second example stands in many respects in contrast with the first one: Gregory of Nazianzus (ca. 330–390 CE), called “the Theologian”, was a bishop and a Father of the Church; his homilies were therefore preserved in hundreds of manuscripts, translated into several languages at an early stage, and continuously quoted in many Byzantine works. This overabundance of witnesses poses methodological problems which are very different from those encountered in the first example (see Treu 1969; Amand de Mendieta 1987). In both cases, however, we are dealing with authorial works, even if the level of authority attributed to Gregory of Nazianzus was much higher. Copyists and scholars tended to preserve the text of Gregory untouched, *ne varietur*, as much as possible. In addition, the sociology of the copyists in the two cases under consideration is quite different. Gregory's manuscripts were mostly copied by monks, more or less educated, whereas Proclus' works were copied almost exclusively for, and often by, Byzantine intellectuals or Renaissance-era professional copyists. Gregory's homilies were found in every library, sometimes probably in several copies. The manuscripts containing his homilies are of very different types: poor manuscripts on bad parchment, written by not particularly skilled monks (sometimes in disastrous orthography); copies obviously made for the purpose of the study of the text, with copious explanations in the margins (see fig. 4.5-9); and luxuriously illustrated and perfectly executed copies meant to be displayed rather than read, such as the beautiful copy made for the imperial library, Paris, Bibliothèque nationale de France, gr. 510 (see fig. 4.5-10). This last manuscript, copied in a late uncial script around 880 CE, is one of the oldest preserved manuscripts of Gregory, but its text is of poor quality, with many omissions and traces of contamination.

I have presented elsewhere a sketch of the history of this very large tradition (see Macé et al. 2015, 424–429). I will not repeat it here, but only point out some possibly interesting elements.

As in several other traditions, scholars have tried to provide a first classification of the manuscripts based not on textual but on paratextual evidence, which is more readily apparent and less time-consuming to collect and analyse than the textual variants (see 3.3 on the transcription and collation of witnesses). In the present case, the main criterion used was the order of the homilies in the manuscripts (see 7.2.3 for an example of the same use of the order of works in Lucian manuscripts). In 1917, Tadeusz Sinko showed that two main sequences of the forty-five homilies (and some other texts) were found in the manuscripts he knew of that contained a “complete” collection of the homilies. Accordingly, he proposed to divide the tradition into two branches, which he called *M* and *N* (fig. 4.5-11).

This hypothesis held for about eighty years and served as a basis for the choice of the manuscripts to be used for the editions of the homilies in the *Sources Chrétiennes* collection. An exhaustive census, completed in 1998, revealed 1,500 manu-

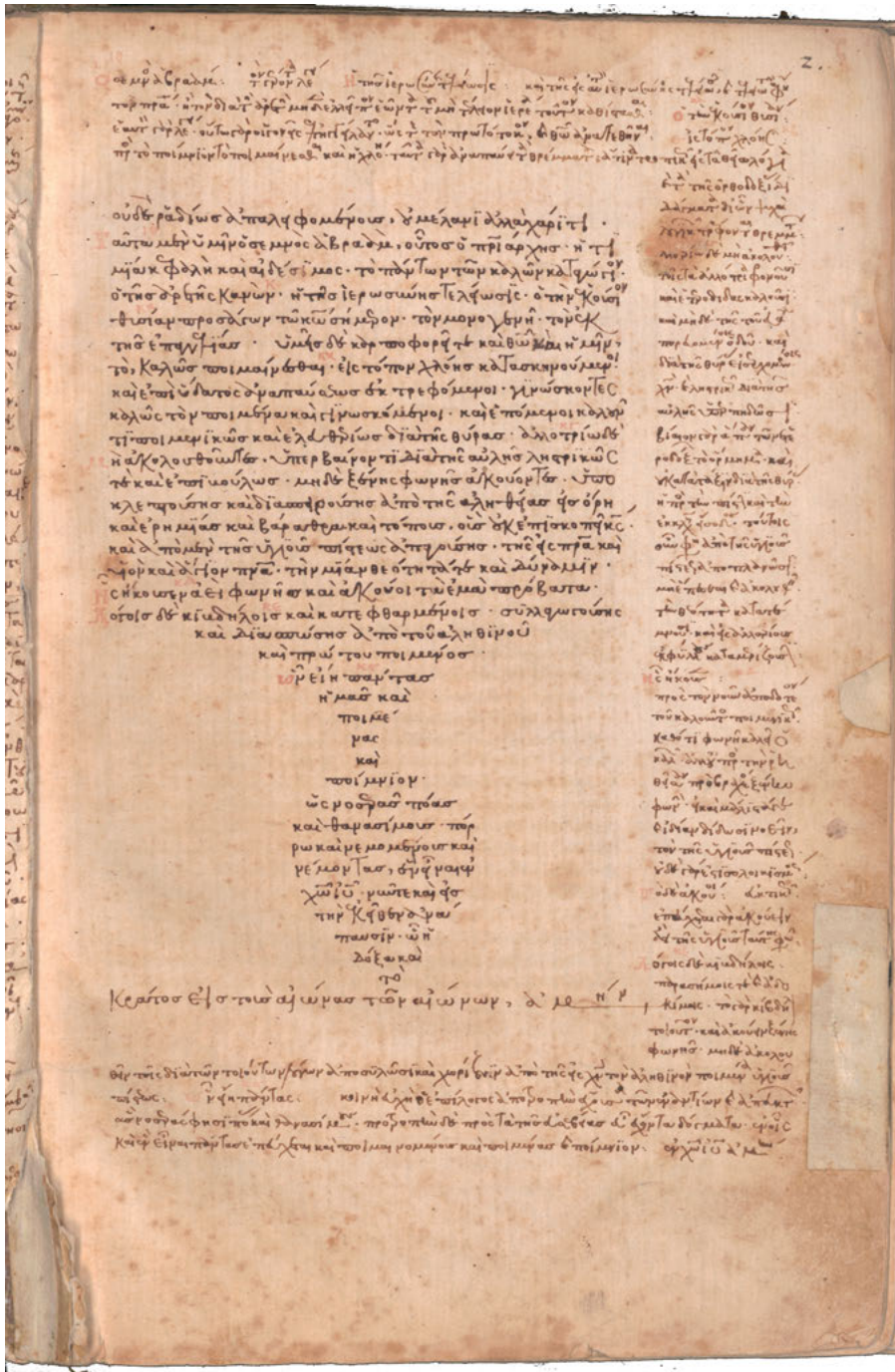


Fig. 4.5-9: München, Bayerische Staatsbibliothek, gr. 204, f. 2r. Source: digitale-sammlungen.de (urn:nbn:de:bvb:12-bsb00076037-2). Image: CC-BY-NC-SA 4.0.



Fig. 4.5-10: Paris, Bibliothèque nationale de France, gr. 510, f. 3r. Source: Gallica, Bibliothèque nationale de France, gallica.bnf.fr/ark:/12148/btv1b84522082/f19.image. Image: CC-BY-NC.

N (31 manuscripts) – 52 items

- vol. 1: Or. 1, 2, 3, 7, 8, 6, 23, 9, 10, 11, 12, 16, 18, 19, 17, 43, 14, 21, 24, 15, 25, 34, 20, 27, 28.
- vol. 2: Or. 29, 30, 31, 38, 39, 40, 45, 44, 41, 33, 22, 32, 26, 36, 42 – Ep. 101, 102, 202 – Or. 4, 5, 37, 13 – Vg. – Doxo. – Ep. 243 – Ez. – Eccl.

M (25 manuscripts) – 49 items

- vol. 1: Or. 2, 12, 9, 10, 11, 3, 19, 17, 16, 7, 8, 18, 6, 23, 22, 38, 39, 40, 1, 45, 44, 41, 32, 33, 27.
- vol. 2: Or. 29, 30, 31, 20, 28, 34, 14 – Ep. 101, 102 – Or. 36, 26, 25, 24, 21, 15, 42, 43, 4, 5, 37 – Ep. 202 – Or. 13 – Vg. – Doxo.

Fig. 4.5-11: Order of the homilies in the two main types of complete collection.

scripts containing one or more homilies of Gregory (pot-pourri.fltr.ucl.ac.be/manuscripts/nazianze/default.cfm), and a thorough examination of the complete collections amongst them – around a hundred – showed that about 50 % did not follow any of the orders prevalent in the *M* or *N* manuscripts, but different ones peculiar to each manuscript (Somers 1997). This pointed to the necessity of revising the history of the tradition of the collections on the basis not only of paratextual elements, but also and primarily on the basis of a philological evaluation of the variant readings – a work which I have started, but so far completed only for one of the forty-five homilies, homily 27 (on theology). The phylogenetic tree shown below (fig. 4.5-12) is so far the best representation of the relationships between the 130 manuscripts containing homily 27 (Macé, Baret, and Lantin 2004).

This tree (fig. 4.5-12) shows only the relative textual proximity of the witnesses; it is not a stemma, and it cannot be used for any kind of *eliminatio codicum descriptorum* (see 2.2.8) or for the *constitutio textus* (see 6.2). Rooting the tree is not an easy task. Traditionally, as we have seen above, the tradition was divided into two main families: *M* and *N*. In the phylogenetic tree (fig. 4.5-12) a group of *M* manuscripts seems to emerge, with different sub-branches: *M1*, *M6*, *M10*, *M11*, *M12*, *M20*, *M21*; *M22*, *M23* with *V26*, *V35*; *M15*, *M16*, *M17*, *M17* with *V57*; and *M14*, *M24* with *V29*. But is this a “family” – that is, is it characterised by secondary significant variants? And what about the rest of the tree? The text of homily 27 is relatively short (2,000 words), and there is variation between the manuscripts (556 variant locations were defined, some of them with more than two variants), but significant variant locations are relatively rare and difficult to polarise, because the variants are often equally likely to be “original”. As usual, the lowest parts of the stemma are easier to determine, since it is possible to find shared secondary readings in small groups of manuscripts that clearly identify them as separate branches. For example, in figure 4.5-12 (at the bottom of the tree), *N10* (thirteenth century) can be proved to be a descendant of *N6* (mid-eleventh century), and *N6* a descendant of *N17* (early eleventh century), from which *N13* (fourteenth century) also stems (the dating of the manuscripts is consistent with this hypothesis). The same could be done for other small groups, such as *V40*, *V40*, *V45* at the lower-left corner of the tree. But how can we then relate those small sub-trees to each other?

In the case of Gregory’s homilies, it was possible to use what in biology is called an outgroup (see 5.2.1). This is rather unusual in philology, but it occasionally happens that an indirect witness (a translation or another recension of the work) can be proved to be independent from the archetype of the direct tradition and can therefore be used as an outgroup (see 3.2.8). In this instance, we observed that translations into Latin (ca. 400, made by Rufinus of Aquileia) and Armenian (ca. 500) had preserved shared readings that must be seen as primary and which are absent from all the Greek manuscripts (Macé 2011). This discovery has enormous consequences for the stemma and for the history of the tradition. It means that all Greek manuscripts (and the Syriac translation) share secondary readings and there-

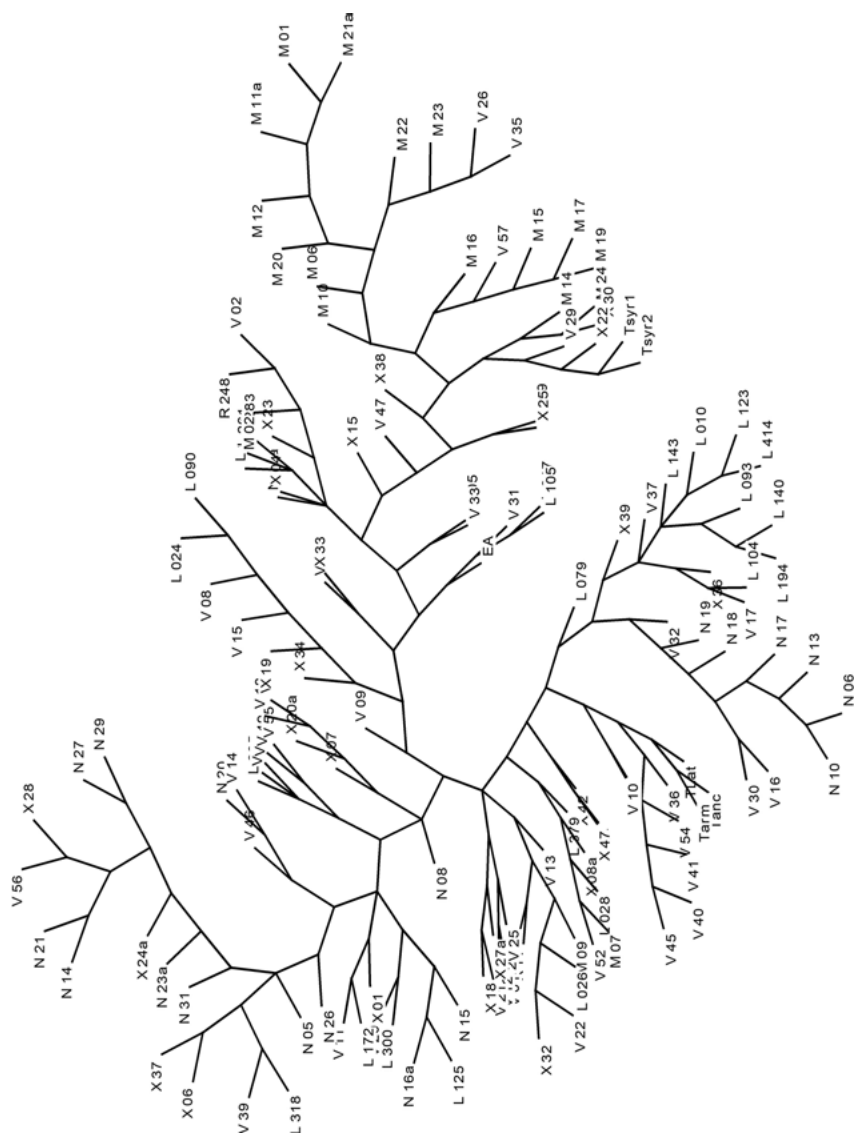


Fig. 4.5-12: Unrooted phylogenetic graph (maximum parsimony) of the 126 manuscripts and 4 ancient translations (*Tarm*, *Tlat*, *Tsyr1*, *Tsyr2*) of homily 27.

fore depend upon a hyparchetype φ (fig. 4.5-13). This hyparchetype must be dated before the Syriac translation, which was reworked and completed around 625 in Cyprus. However plentiful the direct manuscript tradition of Gregory's homilies may be, philological analysis shows that it ultimately goes back to one single point in time (φ). That point, φ , may itself have been preceded by a larger tradition, of which we have but indirect traces in the Latin and Armenian translations. The evolution of textual traditions can be seen as a succession of phases of extension and of reduction, thus following a bow-tie rather than a bottleneck model.

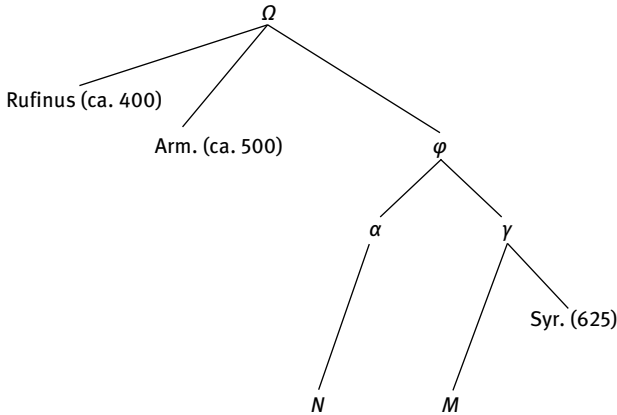


Fig. 4.5-13: Schema of the early history of the textual tradition of the homilies.

It was therefore possible to root the phylogenetic tree using *Tarm* and *Tlat* as the root (see fig. 4.5-14). The branches that are defined after the rooting are more solid candidates to become “families”, and the agreement of *Tlat* and *Tarm* against one of the branches certainly points to the presence of secondary variants in that branch.

Material evidence and knowledge about the history of the Byzantine Empire allow for consolidation of some of the hypotheses made on the basis of the textual evidence alone. For example, it is clear in the different phylogenetic trees that the two Syriac translations (the oldest one, preserved only fragmentarily, and its revision in 625) are close to the *M* manuscripts. Some of these *M* manuscripts were copied in southern Italy in the tenth or eleventh century, or are at least related to southern Italy (*M1*, *M6*, *M10*, *M11*, *M12*, *M20*, *M21*). It is well known that southern Italy is a kind of “ecological niche” for Greek texts or text-states: as it was always at the periphery of the Empire, it sometimes preserved archaic or dissident types of texts. It is also known that there were cultural contacts between southern Italy and some Syriac-speaking regions of the Byzantine world (Macé 2004). The close textual relationship of the Syriac translations to a family of mostly southern Italian Greek manuscripts is therefore not surprising.

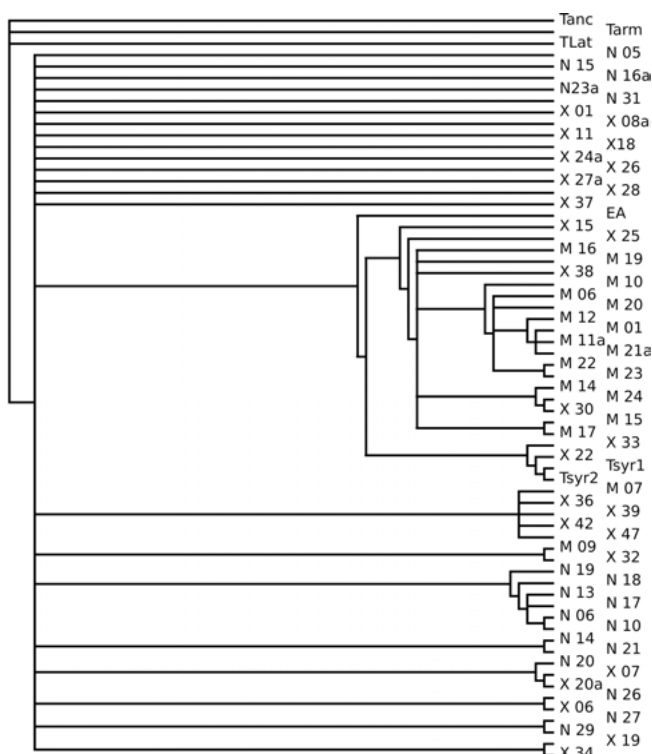


Fig. 4.5-14: Phylogenetic tree of manuscripts with a complete collection (fifty-nine manuscripts) containing homily 27 (branch length is not represented in the plot), rooted on *Tarm/Tlat*.

4.5.4 Pseudo-Dionysius the Areopagite's *Epistola de morte apostolorum*

The third case examined in this section deals with a work lost in its original language and preserved only through translations. In 1883, Jean-Baptiste Pitra and Paulin Martin edited the Syriac, Latin, and Armenian versions of a letter attributed to Dionysius, who was converted by Paul in Athens, and which was addressed to Timothy, Paul's disciple. The letter narrates the death of Paul and Peter, who were martyred together in Rome under Nero, and the miracles which the author witnessed on that occasion (Pitra 1883, 241–276). No trace of that letter could be found in Greek, either in the *Corpus Dionysiacum* (Suchla 2008, 55–61), or in hagiographical or apocryphal collections. The attribution to Pseudo-Dionysius the Areopagite, although attested by all witnesses, is to be rejected: the text has nothing to do with the *Corpus Dionysiacum* (a Neo-Platonist forgery from the end of the fifth century).

In the framework of an ongoing edition project at the Göttingen Academy of Sciences and Humanities, carried out by Ekkehard Mühlenberg, Michael Muthreich, and me, new critical editions of the known versions of the work are in preparation. Pitra almost exclusively used manuscripts from Paris, whereas we have been able

to find more witnesses in other libraries. Other translations of what appears to be the same work exist in Arabic, Ethiopic, and Georgian. The Ethiopic translation was made from the Arabic, which was in turn based upon the Syriac (Muthreich 2013), but the Georgian version is related neither to the Armenian nor to the Arabic (late antique and mediaeval Georgian literary works, when not original, were mostly translated from Greek, Armenian, or Arabic). In fact, the Georgian and Latin versions share redactional features which distinguish them from the Armenian and Syriac versions: after the address to Timothy, they add a list of Paul's and Timothy's sufferings in the service of Christ, and at the end of the letter, they add a miraculous account of the discovery of Paul's skull some centuries later (the *inventio capitis Pauli*). In general, the Armenian and Syriac versions prove to be relatively close to one another, whereas the Georgian and Latin texts are practically identical (Macé and Muthreich forthcoming).

Examination of the biblical quotations shows that the Armenian and Syriac versions were both independently translated from two slightly different Greek *Vorlagen* (source texts for the translation), because the form of the quotations normally reflects a Greek model, sometimes differing from the Septuagint translation, and not the biblical text as it is known in the Armenian or Syriac traditions (Macé and Muthreich 2019). The comparison of the Georgian and Latin texts did not lead to clear conclusions, but the two versions are so similar, even in their word order, that they must have been translated from the same source. There is some evidence that the Georgian text was translated from Greek: the use of the demonstrative pronoun to render the Greek definite article; and the use of Georgian words typical of translations from Greek, and also of newly created calques for words like φακεόλιον, “face-cloth, turban, towel”, a borrowing from the Latin *faciale*, which the Latin translator of the *Epistola* rendered with “velum quo operitur caput tuum” [a veil by which your head is covered]; or φώσσατον, “trench”, again a borrowing from Latin *fossatum*, again strangely rendered by the Latin translator as *vallis*, “valley”. There are at least two lacunae in the Latin in comparison with the Georgian version, obviously due to a *saut du même au même*. Although the possibility cannot yet be totally ruled out that the Georgian version may have served as a *Vorlage* for the Latin text, the case would be so exceptional, in fact unparalleled, that the hypothesis that both versions were made from a Greek model remains far more likely.

Therefore, two different Greek recensions of the same letter about the death of Peter and Paul must have existed, and they must have both disappeared in their original language (see fig. 4.5-15). It is very difficult to date their appearance and the disappearance, because it is also very difficult to date the four translations. The oldest manuscript is Syriac and dated to the ninth century; the Georgian version is preserved in collections of sermons and saints' lives for the liturgical year which date from the tenth and eleventh centuries. The oldest Armenian manuscripts preserving the *Epistola* are from the beginning of the thirteenth century, a situation which is not unusual for Armenian manuscripts, which suffered several periods of mass destruction

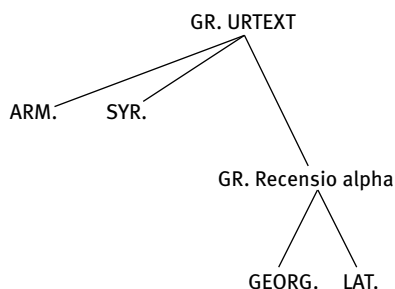


Fig. 4.5-15: Schema of the relationships between the four versions of the work.

throughout the tragic history of the Armenian people. As for Latin manuscripts, on the contrary, the absence of any trace of the text, in manuscript or in quotation, before the thirteenth century makes me suspect that the Latin text came into existence not so long before the time of the oldest preserved manuscripts, that is, the end of the twelfth century. The Latin text enjoyed some popularity: it was very frequently copied, and it was used by Jacobus de Voragine in his *Legenda aurea* before the end of the thirteenth century and, for example, by William Flete in the second half of the fourteenth century in his sermon on Catherine of Siena (Muessig 2012, 204–205).

It is also difficult to guess at the reasons for and circumstances of the disappearance of the *Epistola* in Greek. Obviously, its attribution to Pseudo-Dionysius the Areopagite did not protect it against censorship or accidents. Perhaps its emphasis on the religious pre-eminence of Rome, and its claim that Timothy was the true heir of Paul's religious charisma, made it unpopular in the Byzantine Empire. A closer look at the liturgical development of the common feast of Peter and Paul in the Middle Ages, and at the relationships between the *Epistola* and the apocryphal dossier of Paul's martyrdom which exists in several languages, may help us to better understand these questions.

In the meantime, the four texts in Armenian, Georgian, Latin, and Syriac will be critically edited, after a close examination of their manuscript traditions. It will not be possible to draw a stemma of the manuscripts for any of those four texts, because they are mostly preserved (except in the case of the Syriac) in liturgical manuscripts whose textual history is notoriously complicated (see Macé et al. 2015, 462–465). Nevertheless, the manuscript basis will be sufficient to establish reliable editions of the four versions. These editions will be a prerequisite for any comparison of the texts, and thus for assessing what their Greek models might have looked like – this has so far not been possible on the basis of Pitra's deficient editions.

4.5.5 The evolution of textual traditions

Textual traditions evolve under historical, ideological, and material conditions. They are subject to human interventions and also to chance. The passage of time

has destroyed most of the early evidence concerning any textual tradition, even those with a large manuscript basis. Scholars can only reconstruct some snapshots from a complex history, by combining a philological analysis of the textual evidence and a historical analysis of the material and external evidence. Stemmatata are, perforce, incomplete (see 4.1.3, 4.2.3.4, 4.2.3.5 for the difference between a stemma and the *arbre réel*) because they are based on fragmentary evidence. They are also by nature hypothetical – however, they become less and less hypothetical as more material, “environmental”, paratextual, and “indirect” evidence is brought into the picture.