4.4 Dealing with open textual traditions

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"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, c o n t a m i n a t i o n 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).

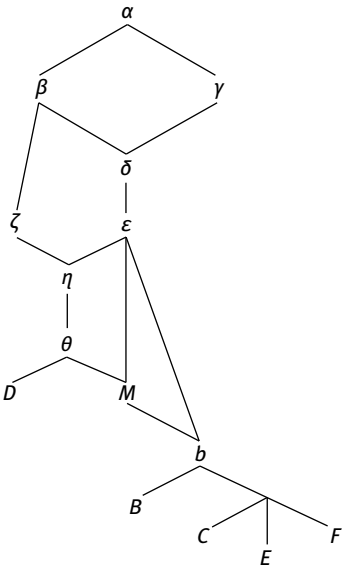

Fig. 4.4-1: Example of an open – i.e. contaminated – tradition. Several of the text versions are copied from more than one exemplar. Redrawn from West (1973, 40).

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.

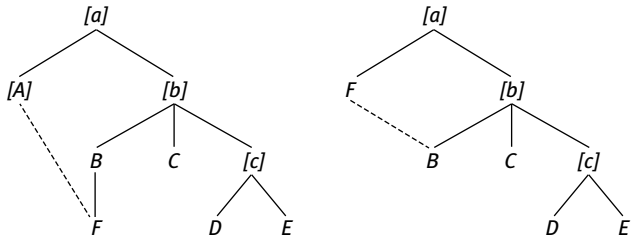

Fig. 4.4-2: Observe the difference between the correct (left) and reconstructed (right) stemmata. Source: West (1973, 35–36).

[a]	This is a fictitious example of contamination.
[A]	This was a fictitious example of contamination.
[b]	It is an example of contamination.
B	It is an example of contamination.
[c]	It is an instance of contamination.
C	It was an example on contamination.
D	It was an instance on contamination.
E	It is an instance on contamination.
F	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 v e r t i c a l and u n i d i r e c t i o n a l when the content is copied from one exemplar, and h o r i z o n t a l (or t r a n s v e r s e) 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 c l o s e d and an o p e n r e c e n s i o n 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 "m i x t u r e" 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 (Vàrvaro 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; Vàrvaro 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).

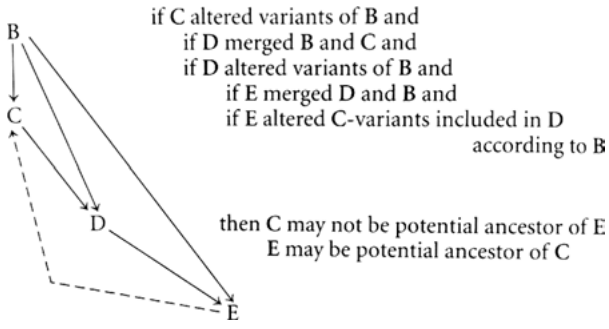

Fig. 4.4-3: The mechanics of an extreme case of contamination, a circular one.
Source: Mink (2004, 50, fig. 20).

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 Vàrvaro 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

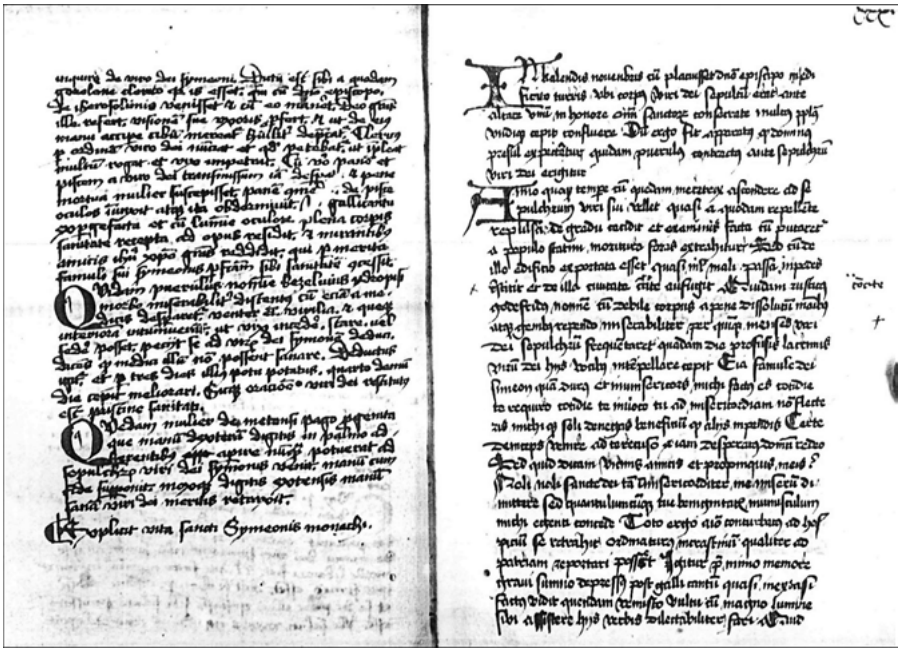

Fig. 4.4-4: Trier, Stadtbibliothek, Ms. 1353/132, f. 33v–34r. This shift in exemplar results in successive mixture in the apograph of the manuscript.

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

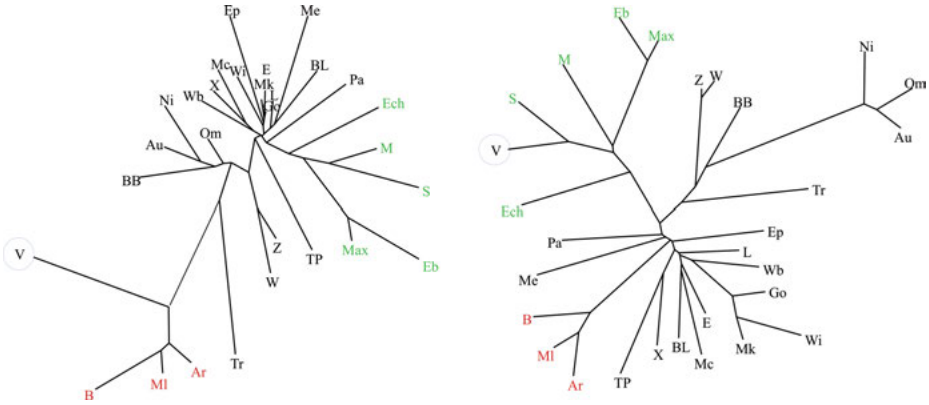

Fig. 4.4-5: Spotting successive contamination: witness *V* changes its location in the tree plots for the first and the second part of the text very conspicuously. (Unrooted trees, plotted with the "*Leitfehler*"-method script described in Roelli and Bachmann 2010, for a sample of twenty-eight witnesses.)

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).

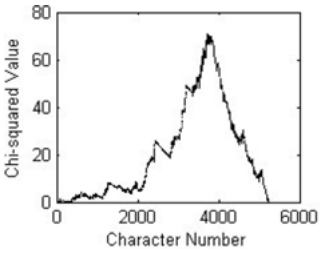

Fig. 4.4-6: Using the maximum chi-squared method to identify an exemplar shift when comparing manuscripts *D5* and *D6* of the *Dyūtaparvan* tradition. Source: Phillips-Rodriguez, Howe, and Windram (2009, 387).

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

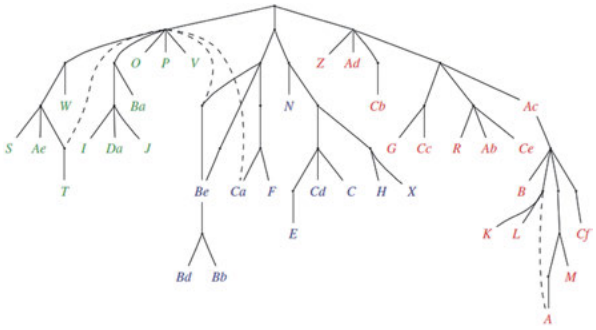

Fig. 4.4-7: The correct stemma of the artificial *Heinrichi* tradition. In the case of mixture, a dashed edge indicates the secondary exemplar.

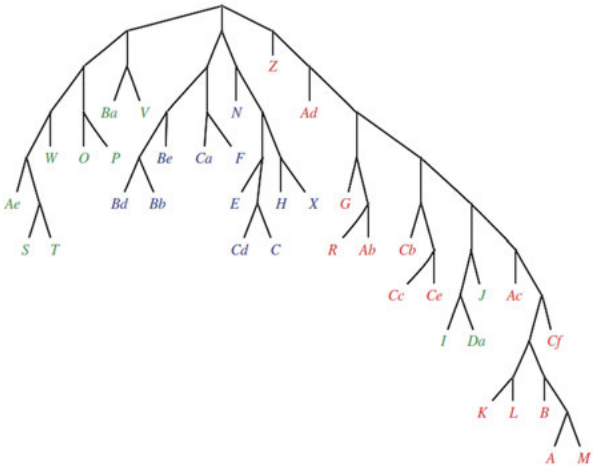

Fig. 4.4-8: The manually rooted stemma obtained by RHM for the artificial *Heinrichi* tradition.

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,

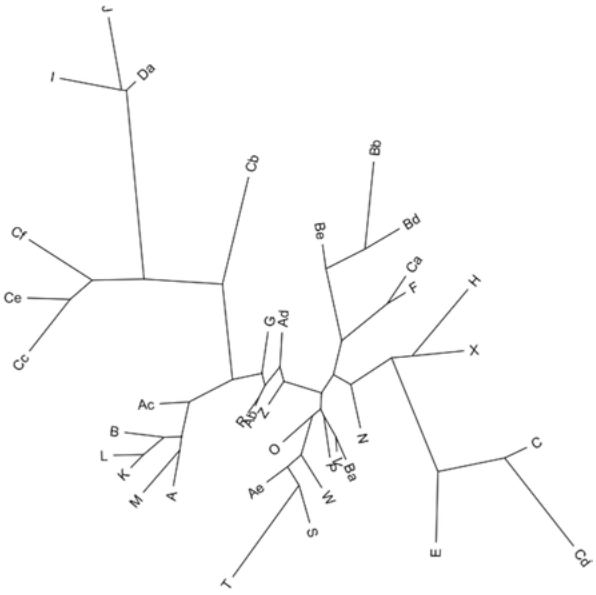

Fig. 4.4-9: The unrooted tree obtained by PAUP* (parsimony criterion) for the *Heinrichi* tradition.

according to them) and other (i.e. resulting from polygenesis or contamination of readings) variants from each other. To do this, they compare variant locations two by two. If the variants cannot be represented in a logical genealogical stemma, this points towards polygenesis or contamination. Despite their contribution to creating a new stemmatological algorithm, even Camps and Cafiero (2014, esp. 75–76, 90) do not really find a way to take mixture into account.

Marina Buzzoni et al. (2016) compared the hypotheses of several computer-assisted methods with the results of traditional textual criticism on open and closed real-life textual traditions. Despite their clear preference for traditional methods and some problems in interpreting the results of the algorithms, their conclusion was that the computerised methods yield better and more useful results on contaminated textual traditions.

4.4.8 Status quo and future prospects

One of the traditional weaknesses of textual criticism, be it traditional or computerised, is the unnecessary division of labour. Scholars of biblical exegesis, ancient texts, and mediaeval literature, for instance, work in surprising isolation from each other, even though they share many of the same scholarly challenges. Here, it is worth mentioning one example of a novel approach to reconstructing textual traditions including contamination, the Coherence-Based Genealogical Method, or CBGM (egora.uni-muenster.de/intf/service/downloads_en.shtml; see also 4.2.3.6, 7.1.2.2).

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.