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A COMPUTER AID FOR
TEXTUAL CRITICISM

JAMES D. PRICE

Several basic principles of NT textual criticism have been employed in designing a computer program that groups manuscripts into probable genealogical relationships, constructs a resulting genealogical tree diagram, and identifies the statistically most likely reading of a text. The program has been initially applied to the books of Philippians, 1 Timothy, and Jude using the variants listed in UBSGNT[2]. The results indicate that the program has potential as an aid to NT textual criticism.

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INTRODUCTION

T HE use of computers in biblical studies is viewed by many with considerable skepticism. Computer studies in literary criticism have led some scholars to reject Pauline authorship of certain epistles,[1] and others to reject the traditional authorship of portions of some OT books.[2] These studies are based on debatable presuppositions and methodology, the criticism of which is beyond the scope of this work. Such use of computers to provide mathematical proof or disproof of authorship led Bonifatius Fischer to question whether this was "charlatanry or scholarship."[3]

However, after discussing many limitations of the use of computers in biblical studies, Fischer wrote favorably of their use in the field of textual criticism:

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[1]A. Q. Morton and J. McLeman, *Christianity and the Computer* (London: Hodder and Stoughton, 1964); and *Paul, the Man and the Myth* (New York: Harper and Row, 1966); for further examples see J. R. Moore, "Computer Analysis and the Pauline Corpus," *BSac* 130 (1973) 41–49.

[2]Y. T. Radday and D. Wickmann, "Unity of Zechariah Examined in the Light of Statistical Linguistics," *ZAW* 87 (1975) 30–55.

[3]B. Fischer, "The Use of Computers in New Testament Studies, with Special Reference to Textual Criticism," *JTS* 21 (1970) 297–308.

After so much pessimism we come at last to a field where the computer is of great importance to the student of the New Testament, indeed where it opens up a new dimension and makes possible what hitherto the scholar had not even dared to dream of: that is, in textual criticism.[4]

PROPER THEORY AND METHODOLOGY

Fischer further discussed the importance of proper theory and methodology in creating a computer program as an aid for textual criticism, and the vanity of expecting a computer to reconstruct the exact history of a text and its manuscript copies. However, he concluded that the manuscript relationships that could be discovered through the use of a computer would be of great value to the textual critic in reconstructing the transmissional history of a text. He visualized two stages in the process—a mathematical stage and an evaluative stage:

> Two stages must be distinguished. In the first the relations between the manuscripts and the texts are defined on the basis of all their readings, irrespective of whether these readings are true or false: this stage is a purely mathematical process which can be done by a computer—indeed in so complicated a case as the New Testament it should be done by a computer. Then follows the second stage, the proper task of the textual critic, the judgment of the truth or falsity of the readings, the recension of the original text and perhaps also of its more important subsequent forms, and the reconstruction of the history of its transmission. This is a task that only a man can perform: it is beyond the capacities of a computer. But it rests on the firm basis that the computer supplies.[5]

COMPUTERS AND THEORIES OF TEXTUAL CRITICISM

Several studies have been made of various theories that might be suitable for computer application to NT textual criticism. G. P. Zarri studied the *stemmata codicum* theories of Don H. Quentin.[6] After expressing skepticism about expecting quick solutions, he concluded that Quentin's theories may help to clear up some difficult problems.

John G. Griffith experimented with the method of R. R. Sokal, known as numerical taxonomy,[7] which Sokal used in arranging biological classes into family trees. Griffith adapted the methodology to

[4]Ibid., 304.

[5]Ibid., 306.

[6]G. P. Zarri, "Algorithms, *Stemmata Codicum* and the Theories of Don H. Quentin," in *The Computer and Literary Studies* (Edinburgh: Edinburgh University, 1973) 225–37.

[7]J. G. Griffith, "Numerical Taxonomy and Some Primary Manuscripts of the Gospels," *JTS* 20 (1969) 389–406.

textual criticism and experienced some success in classifying a number of the biblical manuscripts into near-neighbor clusters that approximate family tree relations. He concluded that this method achieved "a sorting of material which proves refractory to the conventional logic of the stemma. It can be tested quantitatively in a way that the stemma cannot, and does not beg any questions about the merits of the material being handled."[8]

W. Ott experimented with a matrix containing percentages of agreement among the manuscripts.[9] The percentage of agreement was a test of close relationship—the closer the agreement, the closer the relationship. The method succeeded in revealing some group relationships among manuscripts.

Extensive research has been conducted at the Claremont Graduate School to develop a method for classifying Greek manuscripts into genealogical groups. This method, known as the Claremont Profile Method, makes use of a selected set of readings that define a unique profile for each of several manuscript groups. Each manuscript is then classified into one of these groups by means of its level of agreement with the profile of the group. This sampling method is being used to prepare a new comprehensive apparatus for the NT. Most of the work has been done manually, but recently W. L. Richards used a computer to assist the classification of manuscripts for the Johannine epistles.[10]

Kurt Aland and his associates at the Münster Institute have developed the Münster Fragment Identification Program which employs a computer to piece together papyrus fragments, to collate the readings of many manuscripts,[11] and to define manuscript groups and large manuscript complexes.[12]

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[8]Ibid., 405.

[9]W. Ott, "Computer Applications in Textual Criticism," in *The Computer and Literary Studies* (Edinburgh: Edinburgh University, 1973), 199–223.

[10]W. L. Richards, *The Classification of the Greek Manuscripts of the Johannine Epistles* (SBLDS 35; Missoula, MT: Scholars Press, 1977); E. J. Epp, "The Claremont Profile-Method for Grouping New Testament Minuscule Manuscripts," in *Studies in the History and Text of the New Testament*, eds. B. L. Daniels and M. J. Suggs, vol. 29 of Studies and Documents (Salt Lake City: University of Utah, 1967) 27–38; E. C. Colwell et al., "The International Greek New Testament Project: A Status Report," *JBL* 87 (1968) 187–97; P. McReynolds, "The Value and Limitations of the Claremont Profile Method," in *Society of Biblical Literature, Book of Seminar Papers* (Sept. 1972) 1.1–7; F. Wisse, *The Profile Method for the Classification and Evaluation of Manuscript Evidence, as Applied to the Continuous Greek Text of the Gospel of Luke* (Grand Rapids: Eerdmans, 1982); W. L. Richards, "A Critique of a New Testament Text-Critical Methodology—The Claremont Profile Method," *JBL* 96 (1977) 555–56.

[11]E. J. Epp, "A Continuing Interlude in New Testament Textual Criticism," *HTR* 73 (1980) 133–34.

[12]Ibid., 142.

Although these methods have mapped general genealogical relationships among manuscripts, none has succeeded in producing specific genealogical tree diagrams of manuscript history. It is widely held that the task is too complex, the manuscripts are of mixed parentage, and the genealogical history of biblical texts is beyond recovery.

A NEW COMPUTER METHOD

For several years I have experimented with computer techniques for reconstructing the genealogical history of a NT text by using the variant readings and dates of the extant manuscripts. The research has resulted in a computer program that groups manuscripts into probable genealogical relationships, constructs a resulting genealogical tree diagram of an approximate textual history, and identifies the most likely readings of the original text based upon this reconstruction. For numerous test problems, the program has yielded results similar to those that have been obtained through conventional means. The problems approximate the complexity and difficulty of the biblical text. The program provides good solutions when the textual evidence is statistically adequate; it provides a good approximation when the evidence is sparse. If the manuscript shows signs of mixed parentage, it indicates so; if they appear to have no genealogical relationships, it indicates so; and if they exhibit the relationships defined by Zane Hodges's textual model,[13] it indicates so.

The program is designed as a research aid for the textual scholar. At key points in the computing process, the program displays the results of its decisions, the statistical validity of the decisions, the source of the data, and the specific rules employed to reach the decision. In case the decision is statistically weak, or otherwise questionable, the scholar may interact with the program to improve its performance by human insight. Experience has revealed that this interaction is needed, but not often. As Fischer predicted, the results of the computer analysis must be evaluated, edited, and optimized; but the final result is indeed a probable reconstruction of the genealogical history of the text.

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[13]Hodges's textual model is understood to view all manuscripts as primary witnesses to the text of the original autograph, and to view them as exhibiting essentially no genealogical relationships among themselves. That is, at any place in the text where a variant reading occurs, the majority of manuscripts contain the reading of the autograph, and the non-original readings are genealogically random (see Z. C. Hodges, "Modern Textual Criticism and the Majority Text: A Response," *JETS* 21 [1978] 143–56). However, in his later work Hodges acknowledges the existence and importance of genealogical relationships and advocates the necessity of studying the genealogical history of every book in the NT (see Z. C. Hodges and A. L. Farstad, *The Greek New Testament According to the Majority Text* [Nashville: Thomas Nelson, 1982]).

BASIC PRINCIPLES

As a result of my experimental research, several basic principles have been developed for reconstructing the genealogical history of a text. Most of the principles are self-evident upon examination.

Each Book Is Independent

Because the early history of each biblical book was different, each book should be studied independently. Failure to do this could result in unnecessary confusion.

Each Manuscript Is a Copy or a Recension

Each manuscript is a copy of its exemplar (usually containing all of the variants of the exemplar) or a recension. Recensions are determined by evidence of two or more parents. Therefore, a manuscript bears witness to a *set* of variants, not simply to individual variants. Viewing the data of the manuscripts as sets of variants reduces confusion. The manuscripts are regarded as having a type of genetic profile that bears witness to its genealogical descent. This agrees in principle with the Claremont view, and disagrees with Aland who seems to regard each variant as having an independent genealogical history.

Fathers and Versions Used

The quotations of a church father are evidence for the Greek text used by him. Where the evidence is sufficiently complete, the set of variants supported by a church father may be treated as a Greek manuscript.[14] The same is true for the ancient versions. It may be assumed that each version was translated from a single Greek manuscript containing the variants supported by the version. The scholar must take this into account when interacting with the decisions of the program, recognizing the uncertainties associated with patristic quotations and translations.

Primary Witness Takes Priority

A manuscript bears primary witness to the readings of its immediate parent exemplar, and secondary witness to more remote ancestors and relatives. The computing procedure should make use of primary witnesses throughout, and should use the primary witness of each manuscript to define its place in the genealogical tree.

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[14]It is recognized that some church fathers quoted from more than one ancient text. Although the procedure is complicated, the program usually can differentiate multiple ancient texts of this kind.

Similarity Defines Siblings

A small group of manuscripts more like one another than those outside the group may be assumed to be immediate sibling descendants of a common parent exemplar. Such a group exhibits a high percentage of agreement and has one or more readings unique to itself. Siblings bear primary witness to the readings of their parent exemplar and may be used to identify the parent. A large set of manuscripts that are genealogical descendants of a common original text may be expected to have numerous small groups of siblings (or near siblings) of this type. When a set of manuscripts fails to exhibit this condition, the manuscripts are of hopelessly mixed parentage or not genealogically related.

How Exemplars Are Identified

Sibling descendants bear primary witness to the readings of their immediate parent exemplar. Within a sibling group, majority vote usually identifies the parent readings. When majority vote fails for a given variant, then near relatives—such as uncles or cousins[15]— usually share the parent reading and may resolve the uncertainty. When this fails, any unique reading may be eliminated; it will lack confirmation by any witness outside the group. When all these fail to determine the most likely reading, the scholar may resolve the uncertainty by internal evidence. In any case, the scholar may overrule the computer's decision on the basis of evidence not available to the computer.

Exemplars More Authoritative

Once a parent exemplar is identified it replaces the witness of its descendants, being the authority that accounts for their existence. If an exemplar so identified is extant, it is allowed to bear further witness to its own immediate parent. If the exemplar so identified is not extant, the program creates the exemplar and allows it to bear witness in place of its descendants; its existence is justified by the witness of its descendants, although some uncertainty may be introduced for readings with weak support.

Iteration Required

An ordered iteration of these principles produces a tree diagram of the genealogical relationships among the manuscripts traced back

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[15] A near relative is a manuscript outside the sibling group, but more like the group than any other manuscript in the data base.

to one common ancestor. The resultant tree diagram represents an approximation of the genealogical history of the text. The tree diagram must be studied, optimized, and interpreted by textual scholars. The final result is a reconstruction of the history of the text and a list of the most likely readings of the autograph, together with the statistical probability for each reading.

INITIAL RESULTS

To date, the program has been applied to three small books of the NT,[16] making use of the textual data available in the *UBSGNT*[2].[17] Figures 1, 2, and 3 are slightly simplified diagrams of the preliminary reconstruction of the textual history of the books.[18] The results have been what would be expected, indicating the validity of the program's logic.

Simple Descent Confirmed

Most manuscripts were found to exhibit simple descent from only one parent exemplar. A few were found to descend from two parents, a still smaller number from three or more; few if any were of hopelessly mixed parentage. Table 1 summarizes the manuscript parentage for the three books. Genealogical descent was found to be consistent with historic chronology—late manuscripts exhibited descent from earlier ones (occasionally a late manuscript exhibited descent from a very early one);[19] early manuscripts fit into the early branches of the tree diagram, and late manuscripts fit into late branches. Although the computer program makes use of the date of the manuscripts, it has no logical mechanism that predetermines chronological consistency in the genealogical tree diagram. This chronological consistency would not be expected if the genealogical groupings found by the computer had no correspondence with the

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[16] Philippians, 1 Timothy, and Jude.

[17] The UBS text was selected because it lists more manuscripts in its apparatus than others. This advantage was offset somewhat by the smaller number of variants. Better results are expected from a more complete set of data.

[18] A complete textual commentary on these books based on the computer analysis of the data in the *UBSGNT* will be produced at a later date.

[19] For example in Philippians, MSS 81 and 1241 appear to descend from an early form of the Alexandrian text; group 330, 451, 1962, 2127, and 2492 appears to descend from another early form of the Alexandrian text; group D^c, 326, and 1877 appears to descend from an early form of the Antiochan text; and MS Ψ appears to descend from an early form of the Western text. In 1 Timothy, group 81, 1739, and 1881 appears to descend from an early form of the Alexandrian text; and group Ψ, 104, 330, 451, 1877, and 2492 appears to descend from an early form of the Antiochan text. In Jude, group A, 81, and 1739 appears to descend from a very early form of the Alexandrian text.
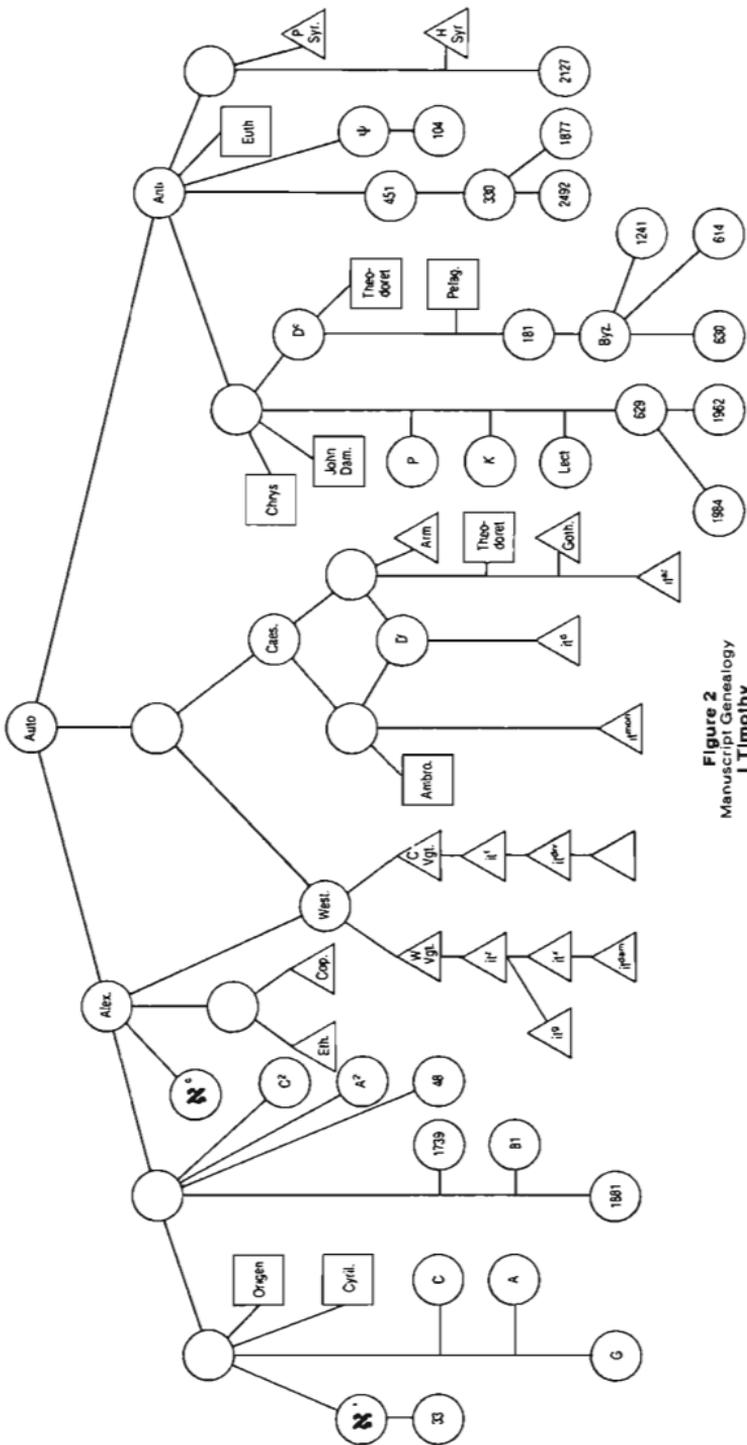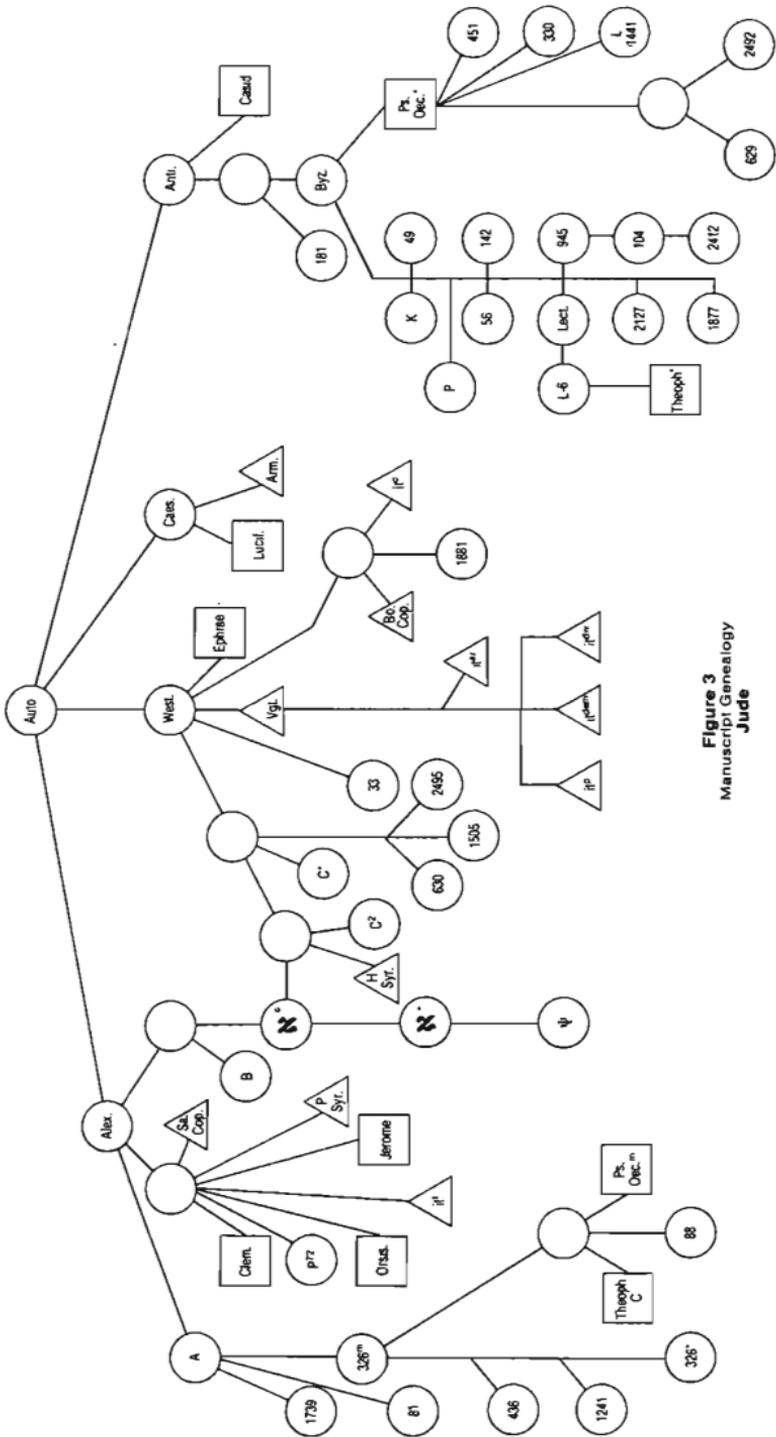
Figure 1
Manuscript Genealogy
Philippians

Figure 2
Manuscript Genealogy
I Timothy

Figure 3
Manuscript Genealogy
Jude

TABLE 1

*Summary of Parentage**

Book	1 Parent	2 Parents	3 or More	Total
Philippians	51 MSS	12 MSS	7 MSS	70 MSS
1 Timothy	61 MSS	4 MSS	1 MSS	66 MSS
Jude	34 MSS	15 MSS	0 MSS	49 MSS
Total	146 MSS	31 MSS	8 MSS	185 MSS
% of total	78.9%	16.7%	4.4%	100.0%

*Data include only extant MSS, not created exemplars.

TABLE 2

*Summary of Text Degradation**

| Book | Number of variants introduced by a MS | | | | | Total |
	0	1	2	3	More	
Philippians	25	34	18	12	8	97
1 Timothy	42	34	11	1	1	89
Jude	38	30	6	2	0	76
Total	105	98	35	15	9	262
% of total	40.1%	37.4%	13.3%	5.7%	3.5%	100.0%

*Data include extant MSS and created exemplars.

history of the text. If the genealogical groupings were unrelated to history, one would expect the distribution of the manuscripts in the genealogical tree to be chronologically random rather than ordered. Therefore, the existence of chronological consistency in the genealogical tree diagrams produced by the computer suggests the validity of the program's logic.

Simple Degradation Confirmed

Most variants were found to be introduced simply, that is, only once, and only one or two at a time. When a variant appeared again in another branch it was generally due to multiple parentage. When several variants arose in the same manuscript, it was usually due to a recension, an infrequent occurrence. Table 2 summarizes the text degradation as indicated by the number of variants introduced by the manuscripts. (A variant is understood here to mean a reading differing from that of the immediate parent exemplar.)

Text-types Confirmed

The reconstructed genealogical history confirmed four basic ancient text-types more like one another than like their own remote descendants: the Alexandrian,[20] the Western,[21] the Antiochan,[22] and a fourth that may correspond with the Caesarean.[23] Nothing in the logic of the program could have predetermined this reconstruction. Each text-type exhibits an early form with several subsequent branches.[24] The Antiochan text exhibits an early form that is related to the Syriac (though not in Jude) with several subsequent branches. The Byzantine text is located in one of the later branches. Nothing in the logic of the program could have predetermined this late secondary descent of the Byzantine text.

Ancient Versions

The ancient versions exhibit genealogical descent from Greek texts usually current in the locality of the version. The Vulgate was consistently from an early form of the Western text. There were several independent Old Latin versions, usually made from early forms of the Western text. A few Old Latin versions were non-Western; it^d was consistently Caesarean; it^{ar} was Caesarean in 1 Timothy; and it^t was Alexandrian in Jude. The Armenian version was consistently Caesarean. The Coptic and Ethiopic versions were consistently Alexandrian, except that the Boharic Coptic version was Western in Jude. On the other hand, the Syriac version appears to be Caesarean in Philippians, Antiochan in 1 Timothy, and Alexandrian in Jude. The Gothic version is Caesarean in 1 Timothy and Western in Philippians.

The Church Fathers

Not many church fathers offered sufficient evidence to identify their underlying Greek texts. Of those whose texts could be identified,

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[20]The Alexandrian text-type consistently included ℵ*, ℵ^c, A, B, (C*), C^2, 81, Origen, Clement, Coptic (Sa), and Ethiopic. Ms ℵ^c was usually close to the earliest form.

[21]The Western text-type consistently included the Vg, it^c, it^{dem}, it^{div}, it^f, it^g, it^x, and it^z. A few Greek mss were classified in Western branches, but not consistently. The Vg was usually close to the earliest form.

[22]The Antiochan text-type consistently included D^c, K, 181, 629, 1877, 1984, 1985, Byz, Lect, Theodoret, and John of Damascus. D^c and 181 were usually close to the early form of the Byzantine branch, whereas witnesses to the earliest form varied from book to book.

[23]The Caesarean text-type consistently included the Armenian, it^d, and it^c; other witnesses varied from book to book.

[24]The Western text appears to have mixed parentage for 1 Timothy.

TABLE 3

Number of Statistically Probable Readings

	Philippians	1 Timothy	Jude	Total
No. of variants	16	11	6	33
Alexandrian	14 (87.5%)	10 (90.9%)	6 (100.0%)	30 (90.9%)
Western	12 (75.0%)	9 (81.8%)	5 (83.3%)	26 (78.8%)
Caesarean	12 (75.0%)	9 (81.8%)	5 (83.3%)	26 (78.8%)
Antiochan	13 (81.2%)	10 (90.9%)	4 (66.6%)	27 (81.8%)

several consistently agreed with a local text, and some differed from book to book. Origen and Clement were consistently Alexandrian; Theodoret and John of Damascus were consistently Antiochan. Several had sufficient data to be used for only one of the three books studied. But it appears that the church fathers usually made use of a form of the text current in their locality.

Evidence of Recensions

If it is assumed that the earliest form of each ancient text-type was the result of a local recension, then this study suggests that the recensions were fairly successful in standardizing the text in each area. For the books covered in this study, the Alexandrian text-type is the most consistent, with statistically probable readings for 100% of the variants in Jude, 90.9% in 1 Timothy, and 87.5% in Philippians (for an overall average of 90.9%). The Antiochan text-type for the three books yielded statistically probable readings for 81.8% of the variants, whereas the percentage for the Western and Caesarean text-types was 78.8% (see table 3).

In addition, the study suggests that a few subsequent recensions were made, some of more consequence than others. One interesting occurrence of recensions appears to be associated with the rise of the versions. There seems to have been a recension made in preparation for the translation of some of the versions. For example, in Philippians and 1 Timothy, the Ethiopic and Coptic versions appear to have been made from recent recensions.[25] In Philippians, the Gothic

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[25]In 1 Timothy, the Coptic and Ethiopic were made from a mild recension of the earliest form of the Alexandrian text of which ℵᶜ was a direct descendant. In Philippians, the Ethiopic and Boharic Coptic were made from texts close to the one used by Eusebius, of which MS 33 is a late copy. In fact, MS B³ appears to be a major recension of the same text, with six variants introduced by mixed parentage; B³ evidently was the recension made for translating the Sahidic Coptic, with B* as a copy of B³, differing in only one reading. This does not seem to be the case in other of the Pauline epistles.

version appears to have been made from a recension known to Chrysostom.[26]

In Philippians and 1 Timothy, the Old Latin version it^g appears to be translated from a recension; MS G^c is near the text of this recension in Philippians[27] and related to it in a more complex way in 1 Timothy. A similar recensional background must account for the Old Latin it^d and it^e, its copy.[28]

In all three books, the Armenian version, although clearly a descendant of the Caesarean text, exhibits evidence of being translated from a recension. Something similar must be true for the text behind the Syriac versions. In Philippians, the text is derived from the Caesarean; in 1 Timothy it is derived from the early Antiochan; and in Jude it is derived from the Alexandrian.

Recovering the Original Text

If it can be assumed that the earliest form of each ancient text-type was an independent witness to the original text, then their mutual agreement would provide convincing identification of original readings.[29] For each of the three books studied, the procedure reconstructed four ancient text-types more like one another than like their own remote descendants. For the thirty-three readings identified by the program to be most probably original in the three books studied, sixteen readings (48.5%) had the full support of all four ancient text-types; seven readings (21.2%) had the support of three against one; six readings (18.2%) had the support of two ancient text-types against one each supporting different readings; only four (12.1%) had the support of two ancient text-types against two supporting another. That is, 87.9% of the readings had good statistical support; only 12.1% had uncertainties that statistical analysis could not resolve.

The readings of the reconstructed original text frequently were those selected by the editors of *UBSGNT*[2]; but a number of them

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[26]The exemplar for the Gothic version was a descendant of an early form of the Western text, but it was of mixed parentage and introduced five variants. The text of Chrysostom differed from this recension in only two readings.

[27]Ms G^c is a descendant of an early form of the Western text; but it was of mixed parentage and introduced seven variants; the text of it^g differs from G^c in only three readings. MS G* is a copy of G^c.

[28]In 1 Timothy MS D appears to be a recension bringing together two early forms of the Caesarean text; D seems to be the Greek text from which it^d was translated. However, D does not appear to be the text of it^d in Philippians, but rather the early form of the Caesarean text itself was the text of it^d.

[29]This conclusion is limited by the uncertainties associated with reconstructing the text-types. Although the logic of the program employs primary witnesses and chooses readings with the greatest statistical probability, some degree of uncertainty accumulates in the reconstruction process. More needs to be known about how uncertainties accumulate.

were different.[30] More study and experience with the program are needed before its use may produce decisions more reliable than theirs.[31]

CONCLUSIONS

This computer program has provided some thought-provoking observations. Contrary to current opinion, it appears that the manuscripts of the Greek NT may really have simple genealogical relationships, and that the text may have experienced simple degradation. It appears that some reconstruction may be made of an approximate transmissional history of the text, using the computer program as a research tool in the hands of a textual scholar.

The present study was made using a limited number of manuscripts[32] and a limited number of variants.[33] However, the manuscripts generally are regarded as the best representatives of the larger corpus.[34] With such a good representative sample to work with, it is reasonable to expect that the larger corpus of data will exhibit similar characteristics without much greater complexity. A recent computer study of the text of Romans with Richard Young has been completed. The data consists of 64 manuscripts and 91 variants. The larger number of variants made the solution a little more complex, but the results and conclusions were essentially the same.[35] This provides confidence that the results are not accounted for merely on the basis of overly simple problems. The computer is capable of handling much larger problems. It is expected that further study and research with the computer program will provide valuable insight into the history and text of the Greek NT.

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[30]For Jude, five out of six readings were in agreement with the critical editors; for Philippians it was eight out of sixteen; and for I Timothy, six out of eleven.

[31]See my forthcoming article, "A Textual Commentary on the Book of Philippians."

[32]Philippians, seventy MSS; I Timothy, sixty-six MSS; Jude, forty-nine MSS.

[33]Philippians, sixteen variants; I Timothy, eleven variants; Jude, six variants.

[34]Some scholars doubt that the manuscripts in the *UBSGNT*[2] represent a good sample of the textual history. Our own study supports that conclusion for the book of Revelation.

[35]A textual commentary on Romans based on this study will be produced at a later date.