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Irish computistics between Isidore of Seville and the Venerable Bede and its reception in Carolingian times

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TO THE MEMORY OF

BRUNO KRUSCH

BARTHOLOMEW MAC CARTHY
EDUARD SCHWARTZ

&

ARNO BORST

CONTENTS

ABBREVIATIONS

ANGERS 477: Angers, Bibliothèque Municipale, 477 (461).
ARG. AQUENS.: 'Der Aachener Vorbehalt von 816', ed. Borst, *Schriften*, 1356–66.
ARN SERM.: 'Die Predigt Arns von Salzburg um 802', ed. Borst, *Schriften*, 833–84.
BC: Bobbio Computus, ed. in *PL* 129, 1275–372 (checked against the sole MS witness, Milan, Biblioteca Ambrosiana, H 150 inf).
CCCM: *Corpus Christianorum Continuatio Mediaevalis*.
CCSL: *Corpus Christianorum Series Latina*.
CE: *Computus Einsidlensis* (Einsiedeln, Stiftsbibliothek, 321 (647), p. 82–125).
CAP. COMP.: 'Das Aachener Verhör von 809', ed. Borst, *Schriften*, 1040–53.
COMP. COL.: 'Das Kölner Lehrbuch von 805', ed. Borst, *Schriften*, 891–950.
COMPUTUS COTTONIANUS: London, British Library, Cotton Caligula A XV, fol. 73r–80r.
CSEL: *Corpus Scriptorum Ecclesiasticorum Latinorum*
DCH: *Disputatio Chori et Praetextati* (cited from the Sirmond MS (Oxford, Bodleian Library, Bodley 309, fol. 101r–105v)).
DDT: *De divisionibus temporum*, ed. *PL* 90, 653–64.
DE ANNO: ed. Mountford, 'De mensium nominibus', 115–6.
DE BISSEXTO I–II: ps-Alcuin, *De bissexto I–II*, ed. *PL* 101, 993–9.
DE HEBDOMADIBUS: ed. Jones, *Bedae opera*, 394–5.
DE SALTU LUNAE I–VIII: ps-Alcuin, *De saltu lunae I–VIII*, ed. *PL* 101, 984–93.
DIAL. BURG.: 'Das burgundische Lehrgespräch von 727', ed. Borst, *Schriften*, 353–74.
DIAL. LANGOB.: 'Das langobardische Zwiegespräch um 750', ed. Borst, *Schriften*, 433–61.
DIAL. NEUSTR.: 'Das neustrische Streitgespräch von 737', ed. Borst, *Schriften*, 381–423.
DNR: Isidore, *De natura rerum*, ed. Fontaine, *Traité*, 163–327.
DRC: *De ratione conputandi*, ed. Ó Cróinín in Walsh & Ó Cróinín, *Cummian's letter*, 113–213.
DRP: Anatolius (?), *De ratione paschali*, ed. Mc Carthy & Breen, *De ratione paschali*, 44–53.
DT: Bede, *De temporibus*, ed. Jones, *Bedae opera*, 295–303 (including only the beginning of the chronicle).
DTR: Bede, *De temporum ratione*, ed. Jones, *Bedae opera*, 175–291 (not including the chronicle).
EPIST. RAT.: 'Der Regensburger Protestbrief von 809', ed. Borst, *Schriften*, 1027–53.
EPISTOLA CUMMIANI: ed. Walsh & Ó Cróinín, *Cummian's letter*, 55–97.

EPIT.: Virgilius Maro Grammaticus, *Epitomae*, ed. Löfstedt, *Virgilius Maro Grammaticus*, 103–245.

ETYM.: Isidore, *Etymologiae*, ed. Lindsay, *Isidori Hispalensis episcopi etymologiarum sive originum libri XX*.

EW: Bede, *Epistola ad Wicthedum*, ed. Jones, *Bedae opera*, 319–25.

HE: Bede, *Historia ecclesiastica gentis Anglorum*, ed. Plummer, *Baedae opera* 1, 1–360.

KAL.: The various recensions of the *Reichskalender* (Borst, *Reichskalender*, 399–1644).

LECT. COMP.: 'Die rheinische Anleitung von 760/792', ed. Borst, *Schriften*, 544–659.

LIB. ANN.: 'Das Veroneser Jahrbüchlein von 793', ed. Borst, *Schriften*, 676–722.

LIB. CALC.: 'Die Salzburger Enzyklopädie von 818', ed. Borst, *Schriften*, 1383–451.

LIB. COMP.: 'Die Aachener Enzyklopädie von 809', ed. Borst, *Schriften*, 1087–334.

LDA: Dicuil, *Liber de astronomia*, ed. Esposito, 'An unpublished astronomical treatise', 378–446.

M: Munich, Bayerische Staatsbibliothek, Clm 14456.

M*: M before correction.

MC: The original Munich Computus (cited from the edition by chapter and line), as well as its author.

MGH: *Monumenta Germaniae Historica*.

AA: *Auctores antiquissimi*.

Epp.: *Epistolae (in Quart)*.

Epp. sel.: *Epistolae selectae*.

DD Mer.: *Diplomata regum Francorum e stirpe Merovingica*.

LL: *Leges (in Folio)*.

Poetae: *Poetae Latini medii aevi*.

SS: *Scriptores (in Folio)*.

SS rer. germ.: *Scriptores rerum Germanicarum in usum scholarum separatim editi*.

PG: *Patrologiae cursus completus, series graeca*.

PL: *Patrologiae cursus completus, series latina*.

PP: *Pauca problesmata* ('The Irish reference Bible'), ed. Mac Ginty, *CCCM* 173.

PROL. AQUIT.: 'Das aquitanische Vorwort zur Ostertafel von 721', ed. Borst, *Schriften*, 337–47.

PV: Pacificus of Verona, *Computus*, ed. Meersseman & Adda, *Manuale di computo*, 53–166.

QUAEST. AUSTR.: 'Die austrasische Abhandlung von 764', ed. Borst, *Schriften*, 466–508.

QUAEST. LANGOB.: 'Die langobardische Abhandlung um 780', ed. Borst, *Schriften*, 514–26.

RM: Rabanus Maurus, *De computo*, ed. Stevens, *CCCM* 44, 199–321.

SAT.: Macrobius, *Saturnalia*, ed. Willis, *Saturnalia*.

SER. NOV.: ‘Die ostfränkische Ahnentafel von 807’, ed. Borst, *Schriften*, 971–1008.

SIRMOND MS: Oxford, Bodleian Library, Bodley 309.

VERS. TUR.: ‘Das Tourer Lehrgedicht um 800’, ed. Borst, *Schriften*, 804–19.

FOREWORD

The present study is a revised and extended version of my Ph.D. thesis, submitted and accepted at the Department of History of NUI, Galway, in September 2007. In the four years of working on this thesis, and the two years since, I was extremely fortunate in meeting many very supportive colleagues, who are not only fine scholars, but who also soon became close friends. This thesis profited greatly from the exchange of ideas with them – on a daily basis with the group of medievalists in Galway, and less frequently with scholars further afield. First and foremost I would like to thank my supervisor, Dáibhí Ó Cróinín, for inviting me to participate in the *Foundations of Irish culture project* that he set up in Galway in 2002 and which I entered a year later. The door of his office was always open for any discussion of computistica (as well as other fields of medieval Irish history), and he kindly allowed me to use his notes and unpublished material not only on the Munich Computus (which included a transcription), but also on other published and unpublished computistical texts; without his initiative, his belief in his student, and his tremendous support even before starting the Ph.D., this book would never have been written. Furthermore, I would like to particularly thank the two post-doctoral researchers of the project, Mark Stansbury and Rick Graff, for patiently discussing many of my questions, providing me with material whenever I was abroad, and assembling a fine microfilm collection that opened my eyes to the absolute necessity of studying the original texts, especially in a field like computistics where more texts remain unpublished than published. Anne Connon first introduced me to early medieval Irish history, and I am very grateful to her for setting me on that path. Great social support came, besides the above named, from the fellow Ph.D. students in the *Moore Institute* (formerly the *Centre for the Study of Human Settlement and Historical Change*), who created a very friendly, collegial atmosphere, from which I profited a great deal, both academically and personally. Among my fellow Ph.D. students I would like to thank Pádraic Moran and Jacopo Bisagni in particular for extremely interesting discussions of matters of shared interest, as well as a very enjoyable life outside of college. Outside of Galway, I especially benefited from many memorable afternoons and evenings discussing computistica (especially its technical dimensions) with Dan Mc Carthy in Dublin. All these people created a wonderfully kind, warm, and friendly atmosphere for a *peregrinus pro studio* in Ireland, and I very much miss them since being back in Germany. Additionally, ever since the memorable *First International Conference on the Science of Computus* in Galway in 2006, I have had the pleasure and privilege of many learned conversations, personal and via e-mail, with Leofranc Holford-Strevens. Closer to home, I would like to thank Kerstin Springsfeld for numerous stimulating discussions, as well as Karl-Heinz Spieß for giving me the chance to pursue an academic career. Menso Folkerts took a keen interest in my studies of early medieval science throughout and kindly accepted my thesis for the *Beihefte* to *Sudhoffs Archiv*, a series that has, at this

stage, established a tradition of publishing studies of science in the so-called 'Dark Ages' (ca. AD 500–1100) and therefore appeared as the most obvious and best choice to print the present book. In the process of preparing my thesis for print, Dirk Schultze helped out in technical matters and Daniel Frisch did a great job when it came to indexing and layout.

It remains to thank certain institutions for their help and support. I gratefully acknowledge the financial support of the *Programme for Research in Third Level Institutions* (2003–6) and the *Arno-Borst-Foundation* (2007), the latter also for covering the publication costs of the present book. I am very grateful to various libraries for allowing me access to their manuscripts *in situ*, namely the Bayerische Staatsbibliothek in Munich, the Dombibliothek in Cologne, the Landesbibliothek in Kassel, the Herzog-August-Bibliothek in Wolfenbüttel, the Zentralbibliothek in Zürich, the Universitätsbibliothek in Basel, the Burgerbibliothek in Bern, and most of all the Stiftsbibliothek in Einsiedeln, especially its librarian, Odo Lang, OSB. Additionally, I want to thank the Staatsbibliothek in Berlin and especially the Staats- und Universitätsbibliothek of my *alma mater* in Göttingen for letting me use their outstanding research facilities. I am also grateful to the Bayerische Staatsbibliothek in Munich, the Staatsbibliothek in Berlin, the Stiftsbibliothek in Einsiedeln, the Dombibliothek in Cologne, and the Biblioteca Apostolica in the Vatican for granting me permission to reproduce in the Appendices photographic material under their copyright.

The thesis itself is dedicated to the four scholars who introduced the text here edited for the first time to modern scholarship and first established its context. First and foremost it is dedicated to Bruno Krusch, who discovered the Munich Computus when researching in Munich in 1878, being a Ph.D. student himself, though some five years younger than myself when I started the project. Bartholomew Mac Carthy and Eduard Schwartz (the latter studying this text when at my *alma mater*, the University of Göttingen, after a short spell in the late 1870s of studying at the university I am working in at present, the University of Greifswald) placed this text into its right geographical and chronological context. Of the scholars this book is dedicated to, its greatest debt is owed to Arno Borst, who first realized the Munich Computus' implications on Carolingian intellectual thought. I had the pleasure of meeting him twice in his home in Konstanz, where we discussed our work, as well as the more general developments in the field. He also very kindly asked me to proof-read his *Schriften zur Komputistik im Frankenreich*, and this work, as well as our correspondence about his texts, was extremely instructive and illuminating. His encouragement never ceased and his support continued after the publication of his monumental work with a kind offer of financial support for my project from his own *Arno-Borst-Foundation*. His death in April of 2007 marks the end of an outstanding career, and is a great loss not only to computistical studies, but to the study of the middle ages in general. It is a great pity that I was not able to discuss the final draft of my thesis with him, which would, no doubt, have very much profited from his comments. My thesis is dedicated to his memory and that of the other three fine scholars.

Greifswald, February 2010

INTRODUCTION

THE MUNICH COMPUTUS IN MODERN TIMES

Ever since Jean Mabillon, the founder of modern palaeography and diplomatics, studied the codex containing the Munich Computus in the monastery of St Emmeram in Regensburg as part of his travels through German and Swiss libraries in 1683,[1] it became well known for its unique transmission of the Regensburg annals (*Annales Ratisponensis*), which he subsequently edited in volume four of his *Veterum analectorum*.[2] Therefore, when this codex was transferred to the Königliche Hof- und Centralbibliothek (now Bayerische Staatsbibliothek) in Munich in 1812 as a result of the secularisation of Bavarian monasteries,[3] it received immediate attention because of these annals, particularly since these annals had been re-edited twice in the Benedictine Colomann Sanftl's handwritten catalogue of St Emmeram codices only three years earlier.[4] In 1819, the precursor to the *Monumenta Germaniae Historica* (*MGH*) was founded, with the primary object of editing all German sources of the medieval

1 For Mabillon's voyage to Switzerland and Germany see especially Mabillion's own account entitled *Iter Germanicum* in the fourth volume of his *Veterum analectorum*, where he gives a detailed description of his stay at St Emmeram in Regensburg from 20 to 25 August 1683 (Mabillon, *Veterum analectorum* 4, 3–92, the stay in Regensburg on p. 51–61; the *Iter Germanicum* was published separately in Germany in 1717, where Mabillon's stay in Regensburg can be found on p. 55–66). Cf. also Jadart, *Mabillon*, 31–3, 206–8 (the latter passage is a summarized itinerary of the voyage); Bergkamp, *Mabillon*, 55–7; Ruinart, *Mabillon*, 64–9; Leclercq, *Mabillon*, 200–30 (a very lively description of Mabillon's stay at St Emmeram on p. 220–1); Barret-Kriegel, *Mabillon*, 64–7 (Mabillon's stay in Regensburg just briefly noted on p. 66).

2 Mabillon, *Veterum analectorum* 4, 476–7 (without indication of the codex). For the codices used by Mabillion during his stay in St Emmeram cf. Bischoff, *Mittelalterliche Bibliothekskataloge* 4,1, 133–4.

3 For the transfer of manuscripts from the Bavarian monasteries to the Königliche Hof- und Centralbibliothek in Munich in the course of the secularisation in the early 19th century cf. especially Hauke, 'Bedeutung', 87–97 (the case of St Emmeram in Regensburg on p. 91). For the transfer of manuscripts from St Emmeram in Regensburg in particular cf. Docen, 'Anzeige', 425; Hemmerle, *Benediktinerklöster* I, 105; idem, *Benediktinerklöster* II, 242; Bezzel, *Bayerische Staatsbibliothek*, 12–3; Bischoff, *Mittelalterliche Bibliothekskataloge* 4,1, 138; Kellner & Spethmann, *Historische Kataloge*, 385.

4 Sanftl, *Catalogus* II, 934–6; IV, 443–4. In the section on mathematics (*mathesis*), Sanftl also mentions the Munich Computus and other computistica from this MS (Sanftl, *Catalogus* III, 1729). For Sanftl's catalogue cf. Kellner & Spethmann, *Historische Kataloge*, 388–9.

period, AD 500 to 1500.[5] On foot of this, Bernhard Joseph Docen, the Munich librarian, was contacted with a request for a list of all texts in the newly acquired Regensburg manuscripts that would be of special interest to the intended corpus of editions. In his list, published in 1820 in the first volume of the *MGH*'s (or rather its precursor's) just-founded journal, Docen mentioned the *Annales Ratisponenses*, but without any reference to the manuscript in which they are contained.[6] This led to a further inquiry from the *MGH* about the manuscript in question, which Docen answered by providing a catalogue description of this codex. In this description, the Munich librarian mentioned a *Computus S. Augustini –, S. Dionysii, S. Quirili Greciae et ceterorum* as the main text of this manuscript. Not finding the time to study and contextualize this computus further, Docen tentatively conjectured that this text might have been composed at the time of or even by Bede himself; but, as he explicitly stressed in the final sentence of his article, it was also possible, if not likely, that this text presents an otherwise unknown, unpublished, and important source for Christian time-reckoning.[7] Yet, whereas the *Annales Ratisponenses* were re-edited by the first president of the *MGH*, Georg Heinrich Pertz, in the *MGH*'s first volume of editions,[8] the computus did not receive any further attention for another fifty years. The reason for this neglect presumably was Docen's tentatively assumed connection between this text and the Anglo-Saxon scholar Bede, which placed it outside of the *MGH*'s interest.

It was only due to Bruno Krusch's non-national, chronological interest that the Munich Computus did not remain in obscurity any longer. As a 21-year old doctoral student he came across the Munich Computus in the Bayerische Staatsbibliothek in 1878, while working on Victorius' paschal cycle and its precursors, the 84-year Easter tables.[9] Krusch was exclusively interested in only

5 For the foundation of the *Gesellschaft für ältere deutsche Geschichtskunde* see Bresslau, 'Geschichte', 34–40 (p. 38: the principal object of editing all German medieval texts constitutes the first paragraph in the foundation statute); Fuhrmann, 'Goethe', 3; idem, *Gelehrtenleben*, 11–3; Schmitz, 'Entstehungsgeschichte', 503–7.

6 Docen, 'Anzeige', 425–9 (the *Annales Ratisponenses* are listed on p. 428). Docen worked directly from Colomann Sanftl's handwritten early 19th-century inventory of Regensburg manuscripts, in which Sanftl had re-edited the *Annales Ratisponenses* and had referred to the Munich Computus (cf. note 4). For Docen's career and his position and occupation in the Munich library at that time see especially Haller, *Bayerische Staatsbibliothek*, 121–2, 132.

7 Docen, 'Notizen', 515–9.

8 The edition in *MGH SS* 1, 91–3. For this first *MGH* volume of editions cf. Bresslau, 'Geschichte', 151–6; Fuhrmann, 'Goethe', 20–1; idem, *Gelehrtenleben*, 33; Wesche, 'Der erste Band', 17–21; Schmitz, 'Entstehungsgeschichte', 518–9.

9 For the date of Krusch's discovery see Krusch, *Studien* II, 58. For his scholarly occupation at that time see Krusch, *Studien* I, v; idem, *Studien* II, 5. For his early career and his chronological studies see Heymann, 'Bruno Krusch', 505–6. Cf. also Ó Cróinín, *Early Irish history*, 1. Krusch may have known the brief reference to the Munich Computus in Halm et al., *Catalogus*, 175, which was published only two years earlier, in AD 1876; it seems likely that this or Docen's earlier reference stimulated Krusch's initial interest in this text; in his first publication on this computus, Krusch (*Studien* I, 10) refers only to Docen.

one feature of this text, namely its frequent references to a *latercus*, which he correctly identified as an 84-year Easter table with 14-year *saltus*, having Easter lunar limits of 14 to 20. Most unfortunately for chronological studies to the present day, however, he connected the *latercus* information of the Munich Computus with the *laterculus* of Augustalis as transmitted in the *Computus Carthaginiensis*, because of the similarity in terminology. This resulted in his wrong reconstruction of the *laterculus* of Augustalis, which Krusch believed covered the years AD 213–312.[10] It was only some 20 to 25 years later that Bartholomew Mac Carthy as well as Eduard Schwartz proved that the Munich *latercus* did not in the least refer to the *laterculus* of Augustalis, and that Krusch's reconstruction was therefore obsolete.[11] Krusch himself accepted this view shortly before his death.[12] However, many historians of chronology to the present day refer to Krusch's theory of the *laterculus* of Augustalis as historically correct,[13] so that it cannot be overemphasized that the basis for Krusch's reconstruction, the Munich *latercus*, has nothing to do with Augustalis' table.[14]

Despite the faultiness of his theory, Krusch certainly deserves all due credit for rescuing the Munich text from obscurity and for highlighting its exceptional chronological value in its unique *latercus* references. Precisely this unique data attracted two of the leading chronologists of their time to the Munich Computus, the Reverend Bartholomew Mac Carthy in 1901 and the classicist Eduard Schwartz in 1905. Mac Carthy was the first to prove that the *latercus* mentioned in the Munich text refers, in fact, to the 84-year Easter cycle followed in some regions of Britain and Ireland until the eighth century. Since no Easter table of that reckoning was known to have survived, the Irish scholar realized the outstanding value of the Munich Computus' information about that reckoning; he

10 Krusch, *Studien* I, 5–19. The *Computus Carthaginiensis* is edited in Krusch, *Studien* I, 279–97.

11 Mac Carthy, *Annals of Ulster* 4, lxvi–vii, and especially Schwartz, 'Ostertafeln', 63–6. Cf. O'Connell, 'Easter cycles', 73–4; Wallis, *Bede*, xlv; Warntjes, '84 (14)-year Easter reckoning', 69–70.

12 Krusch, *Studien* II, 58.

13 Rühl, *Chronologie*, 122–4 (before the publication of Schwartz's correction); Schmid, *Osterfestberechnung in der abendländischen Kirche*, 19–20; Jones, *Bedae opera*, 15–6, 19; Cordoliani, 'Computistes insulaires', 6, 12; David, 'Saint Martin', 285; Strobel, *Ursprung*, 137, 161–2, 228, 273–4, 365, 384–6; Gougaud, *Christianity*, 186; Grumel, 'Problème', 167–8; Pedersen, 'Ecclesiastical calendar', 39–40; Stevens, 'Scientific instruction', 95; idem, 'Cycles of time', 37, 50; Blackburn & Holford-Strevens, *Companion to the year*, 806, 870, 872; Butzer & Butzer, 'Mathematics', 79; Lejbowicz, 'Computus', 160; idem, 'Tables paschales', 21, 44; Dekkers & Gaar, *Clavis patrum latinorum*, 725; Machielsen, *CCSL Clavis Patristica* 3A, 219; von den Brincken, *Chronologie*, 74; Holford-Strevens, *History of time*, 47.

14 The correct theory about this *laterculus* of Augustalis is Schwartz, 'Ostertafeln', 63–6. This is accepted by Gentz, 'Ostern', 1651; O'Connell, 'Easter cycles', 73–4; Wallis, *Bede*, xlv; Warntjes, '84 (14)-year Easter reckoning', 69–70. Ginzel, *Handbuch* 3, 243, only outlines Krusch's and Schwartz's theories, without stating any preference; Mc Carthy & Breen, *De ratione paschali*, 17 have their reservations about the Julian calendar and lunar limits attributed to this table by Krusch. See now also Mosshammer, *Easter Computus*, 224–8.

even attempted to reconstruct such a table from the data provided by the Munich text.[15] Subsequent to Mac Carthy's study, the Munich Computus was primarily analyzed for its references to this obscure and rather legendary Easter reckoning followed by the Irish and British in the early centuries of the middle ages. The most comprehensive analysis of the Munich *latercus* references was published by Schwartz, in his seminal study of the history of Easter tables, only four years after Mac Carthy's book had appeared in print,[16] which he may have known, even though he did not refer to it.[17] Being a very thorough and cautious scholar, Schwartz believed a reconstruction of the 84-year Easter table followed in Ireland and Britain based on the Munich data to be an impossible task.[18] Nevertheless, the Reverend D.J. O'Connell published another attempt at reconstructing such an Easter table on the basis of the Munich Computus in 1940,[19] an attempt that was refined by the Church historian Knut Schäferdiek in 1983.[20] However, only two years later an Easter table of that reckoning was discovered by Dáibhí Ó Cróinín in a Padua manuscript, which was subsequently reconstructed by Dan Mc Carthy.[21] In this reconstruction, the Munich Computus played a major part, since it transmits reliable and crucial information about the sequence of lunations underlying this table; the importance of this technical detail becomes immediately apparent from the fact that the reconstruction failed in the first place, precisely because this sequence of lunations was not consid-

15 Mac Carthy, *Annals of Ulster* 4, lxv–lxxxi.

16 Schwartz, 'Ostertafeln', 89–104.

17 Schwartz does not mention Mac Carthy's work anywhere in his study. Consequently, O'Connell, 'Easter cycles', 67 assumes that Schwartz was not familiar with Mac Carthy's book; likewise, Mc Carthy & Ó Cróinín, 'Easter table', 66. Mc Carthy, 'Easter principles', 223, however, convincingly argues that the parallels between Mac Carthy's and Schwartz's studies in the analysis of the *latercus* are so close that they must have been, in some way, dependent. In his opinion, the two scholars were likely to have collaborated, with Schwartz providing the source for Mac Carthy, since Schwartz's account of the *latercus* is the more detailed of the two, even though the publication dates speak against this hypothesis. I am inclined to think that Schwartz knew Mac Carthy's study and extended and corrected it. Note, however, that the Göttingen library (Schwartz wrote his study of Easter tables in his time at the University of Göttingen) did not acquire a copy of Mac Carthy's volume 4 of the *Annals of Ulster* before 1929 (I would like to thank the Göttingen librarian Helmut Rohlfing for providing me with this information). Therefore, if Schwartz did know Mac Carthy's work, he probably worked from his own copy. Dáibhí Ó Cróinín informed me that he could not find any reference to Mac Carthy in Schwartz's Nachlaß in Munich.

18 Schwartz, 'Ostertafeln', 102.

19 O'Connell, 'Easter cycles', 84–106.

20 Schäferdiek, 'Osterzyklus', 357–78.

21 For the date of the discovery of the Padua table see Ó Cróinín, *Early Irish history*, 4; Mc Carthy & Breen, *De ratione paschali*, 10. It was first analyzed and published in Mc Carthy & Ó Cróinín, 'Easter table', 58–75, but correctly reconstructed only in Mc Carthy, 'Easter principles', 204–24; cf. Mc Carthy & Breen, *De ratione paschali*, 10–1. A translation and concise summary of the technicalities underlying this table can be found in Blackburn & Holford-Strevens, *Companion to the year*, 870–5. A full facsimile is printed in Warntjes, '84 (14)-year Easter reckoning', 80–2.

ered.[22] After the discovery of the Padua table, the Munich Computus obviously lost its importance as the primary witness for this Easter reckoning. Only one further study of the Munich *latercus* followed, a detailed comparison between the Munich data and the Padua table, with the object of identifying the source underlying the information about the *latercus* in the Munich text, as well as analyzing its author's familiarity with this reckoning. Moreover, this study proved that a reform of this 84-year reckoning to prevent it from becoming increasingly inaccurate had never been executed, and neither did this reckoning include mechanisms that would have made it more accurate astronomically while abandoning its cyclic character at the same time.[23]

A different interest in the Munich Computus also existed, beyond the technical details of the 84-year Easter reckoning followed in Ireland and Britain, because of the few Old Irish words contained in this text. Generally, the incorporation of Old Irish words in the main body of a Latin text, as is the case in the Munich Computus, is a very rare phenomenon compared to the regular occurrence of Old Irish in interlinear or marginal glosses to other Latin texts. This phenomenon is yet to be fully explained, and any future study of it will need to rely on the evidence of the Munich text in particular, and of early Irish computistical material in general.[24] Moreover, any new discovery of Old Irish terms complements the comparatively small corpus of Old Irish vocabulary from this early period of the written Irish language. Mac Carthy drew attention to the occurrence in the Munich Computus of the bilingual term *dies cetene*,[25] Ó Cróinín to the Old Irish verb *tomel*.[26] This terminology, together with the additional occurrence of the curious term *noinaic*, and a few Old Irish numerals, have only recently been analyzed linguistically, and thoroughly discussed in the context of code-switching and code-mixing.[27]

22 For the problems occurring in the first attempt of reconstruction due to the application of the alternating sequence of lunations cf. Mc Carthy & Ó Cróinín, 'Easter table', 231–2. The non-alternating *latercus* sequence of lunations was then applied in Mc Carthy's definite reconstruction of the Padua table (Mc Carthy, 'Easter principles', 210–3); its importance for this reconstruction is subsequently stressed in Mc Carthy, 'The origin of the *latercus*', 25–6; Warntjes, '84 (14)-year Easter reckoning', 43.

23 Warntjes, '84 (14)-year Easter reckoning', 31–85.

24 Other computistical texts, in which Old Irish words occur in the main body of the Latin text, are the newly discovered *Computus Einsidlensis* and a lemmatized treatise on the Dionysiac and ps-Dionysiac *argumenta* in Padua, Biblioteca Antoniana, I 27, 77v–78r. For Old Irish in the *Computus Einsidlensis* cf. Warntjes, 'Computus Einsidlensis', 62 (note that one of the page references to the occurrence of Old Irish in this text has been cited wrongly due to a printing problem, which led to all '7' being substituted by '9' throughout the article; in note 7 – itself misprinted as 9 – it should read 97 instead of 99) and especially the full analysis of all Old Irish terms found in this text in Bisagni & Warntjes, 'Early Old Irish material', 77–105. For the occurrence of Old Irish in the Padua MS see Ó Cróinín, 'Dionysius Exiguus', 272.

25 Mac Carthy, *Annals of Ulster* 4, clxxx.

26 Ó Cróinín, 'Old Irish gloss', 131–2. Cf. also Ó Cróinín, 'Earliest Old Irish glosses', 16–7.

27 Bisagni & Warntjes, 'Latin and Old Irish', 1–33. For the Old Irish terms in the Munich Computus cf. also p. LXXV–LXXVI below.

Since the primary interest in the Munich Computus lies in the passages that deal with either these Old Irish words or the details of the *latercus*, the question remains whether these features present all of the text's originality and therefore constitute the only points of interest in this text. If so, would not an edition and detailed analysis of these passages, as now provided by the two most recent studies, suffice? In other words, is an edition of the entire text necessary and of any interest?

Docen's verdict would have been that if the Munich Computus proves to be an independent and unpublished text, as it surely does, then it certainly deserves to be edited in its entirety, as would any other text with these two characteristics.[28] However, the two German scholars who had worked most intensively on this text, Krusch and Schwartz, explicitly denied any value in editing the Munich Computus. In 1905, Schwartz wrote on this matter:[29]

> Sollte jemand auf den Einfall kommen den münchener Computus in ganzem Umfang abdrucken zu lassen, so würde der wesentliche Erfolg der sein, dass Bedas chronologisches Wissen und seine nüchterne, nie sich verwirren lassende Praecision sich von einem dunklen Beispiel occidentalischer Ignoranz mit wirklich Erfurcht gebietender Klarheit abheben.

Previously, in 1878, Krusch had only randomly studied the Munich Computus for his dissertation. After having read Schwartz's account of the Munich *latercus*, however, he returned to the text and transcribed it in full. His final verdict, formulated in 1937, was:[30]

> Ich habe den Computus zuerst entdeckt. Dann hat Schwartz die Hs. sich kommen lassen und ihn abgeschrieben. Um seine Ergebnisse nachzuprüfen, mußte ich sie mir wieder kommen lassen, und jetzt habe ich den Computus ganz abgeschrieben. Aber ich bin mit Schwartz der Ansicht, daß er den Druck nicht verdient. Die Hs. ist sehr fehlerhaft geschrieben. Schwartz hat vieles verbessert, aber noch mehr ist zu tun.

For these two scholars, then, three principal arguments spoke against an edition of this text. It was contemporaneous with Bede, so that in all probability most of the information given in the Munich Computus could be found in a clearer and more precise style in Bede's major computistical work, *De temporum ratione*. Therefore, the extremely time-consuming work of correcting this highly corrupted text would not prove worth the effort. Moreover, in some instances the Latin appears 'barbaric', to a degree that the sense of certain passages may never be fully understood.

Interestingly enough, in the 20th century it was particularly this last aspect, the 'barbaric' Latin, that attracted scholars to this text in its entirety. Schwartz, being one of the leading classicists of his time, showed little or no appreciation for non-classical Latin. Yet, in the last two decades of the 19th century, and especially with the appointment of Ludwig Traube to the newly created chair of

28 Cf. Docen, 'Notizen', 518–9.

29 Schwartz, 'Ostertafeln', 93.

30 Krusch, *Studien* II, 58. Cf. Ó Cróinín, 'A seventh-century Irish computus', 104.

medieval Latin in Munich in 1904, this general attitude changed.[31] Regional differences and characteristic features of medieval Latin became the focus of analysis, with Hiberno-Latin constituting one of these regional categories.[32] Mac Carthy, in a brief and rather uninspired analysis of the Munich Computist's orthography, was the first to hint at the potential of the Munich Computus for the study of Hiberno-Latin.[33] Traube's second successor, Bernhard Bischoff, arguably one of the most prolific scholars of Hiberno-Latin in the 20th century, referred to the Munich Computus only in passing.[34] A few more Hiberno-Latin aspects in this text have more recently been pointed out by Ó Cróinín,[35] but a comprehensive analysis of the Munich Computist's Latin as a whole has not been considered to the present day. It is hoped that the present edition provides the stimulus for such a study, especially since the study of the Latin of early medieval scientific texts (Hiberno-Latin or not) is a more general desideratum.

The true computistical value of the Munich Computus has only most recently been emphasized. Charles W. Jones, the author of the outstanding edition of Bede's computistical works, pointed to Bede's dependency on an Irish collection of computistical tracts, which he identified with a large section of the Sirmond manuscript (Oxford, Bodleian Library, Bodley 309).[36] With the exception of some minor pieces, the tracts themselves are, however, not of Irish ori-

31 Traube was one of three scholars who are regarded as the founding fathers of the study of medieval Latin; the other two are Traube's contemporaries Wilhelm Meyer in Göttingen and Paul von Winterfeld in Berlin. For the creation of the chair of medieval Latin in Munich, Traube's early career, his pioneering work and impact on the study of medieval Latin cf. Boll, 'Traube', XVIII–XXXI, XLI–VII; Silagi's notes to Traube, *Rückblick*, 3–9, 30–1; Lehner & Berschin, 'Nachwort', 243–4.

32 Seminal is Traube's 'Die lateinische Sprache des Mittelalters', which is published in his *Vorlesungen* 2 (the special place of Ireland and Britain in the development of medieval Latin on p. 39–41, 61–2, 91). For the subsequent development of the study of Hiberno-Latin in the 20th century and its results cf. Herren, 'Sprachliche Eigentümlichkeiten', 425–33; Stotz, *Handbuch zur lateinischen Sprache* 1, 85–6, 107–12. An overview of the literature on the subject prior to 1972 is provided by Bieler, 'Hiberno-Latin dictionary', 248–55, without reference to any scientific work. A detailed linguistic analysis of a Hiberno-Latin text, as well as a thorough (though sometimes outdated) discussion of Hiberno-Latin features, is provided in Bengt Löfstedt's dissertation on the Irish grammarian Malsachanus (Löfstedt, *Malsachanus*, 81–156), and also in his discussion of the language of the *Anonymus ad Cuimnanum* (Bischoff & Löfstedt, *Anonymus ad Cuimnanus*, xxiv–xxxviii). It is worth noting here that Traube also had an interest in computistical texts; his study of the *Computus* of Helperic of Auxerre (Traube, 'Computus Helperici') still is the best study of that text to date; cf. Borst, *Kalenderreform*, 140.

33 Mac Carthy, *Annals of Ulster* 4, clxxviii–ix; cf. also his discussion of the Hiberno-Latin term *singularis* in Mac Carthy, *Annals of Ulster* 4, lxix.

34 Bischoff, 'Das griechische Element', 250.

35 Ó Cróinín, 'Hiberno-Latin calcenterus', 56–7; idem, 'A seventh-century Irish computus', 104–7; Walsh & Ó Cróinín, *Cummian's letter*, 62–3, 182, 211.

36 Jones, 'Sirmond manuscript', 208–19; idem, *Bedae opera*, 105–13. For subsequent discussions of this manuscript and Bede's dependency on its material cf. Ó Cróinín, 'Irish provenance', 173–90; idem, 'Bede's Irish computus', 201–12; Wallis, *Bede*, lxxii–ix; Springsfeld, *Alkuins Einfluß*, 68–80; Graff, 'Recension of two Sirmond texts', 112–42.

gin.[37] Jones also mentioned the Munich Computus in this pre-Bedan Irish context, but he never discussed it and its relation to Bede's and other computistical texts in any detail.[38] It was not until the studies of Dáibhí Ó Cróinín in the 1980s that the genuinely Irish contribution in the field of computistics in the period between Isidore and Bede was placed on a solid footing. After having discovered a most original Irish computistical textbook of this period, *De ratione conputandi*, he compared selected passages of this new textbook with the Munich Computus in the article announcing the discovery, as well as in his subsequent edition of *De ratione conputandi*.[39] Unfortunately, in both studies the comparison was not systematic, so that many parallels between the two texts remained unnoticed. Nevertheless, in the company of *De ratione conputandi*, the Munich Computus was rightly considered as an extremely important witness to what may be termed as the Irish phase in the history of computistics, i.e. the period between the reception of Isidore and that of Bede. Yet, in Jones' and Ó Cróinín's studies, the Munich Computus was almost exclusively discussed in an Insular context. It is the merit of Arno Borst to have placed this computus in

37 Jones divided the allegedly pre-Bedan section of the Sirmond manuscript into two books; book one contains items 3 to 9 in his list, while book two consists of items 13–45 (cf. the references in the previous note). In this second book, evidently of Irish origin are sections of item 26 (published in Ó Cróinín, 'Bede's Irish computus', 209–10; the originally Irish bits are numbered VI and VIII–XII in Ó Cróinín's edition) and of items 35–36 (published in Ó Cróinín, 'Bede's Irish computus', 204–7; quite certainly of Irish origin are the unidentified pieces numbered IX and X by Ó Cróinín; note that the source references on p. 207 of Ó Cróinín's article are out of sequence: the Isidorian citation listed under V belongs to IV, and subsequently the source identifications VI to IX refer, in fact, to V to VIII; number IX is, therefore, unidentified); for parallels between these sections of the Sirmond manuscript and the Munich Computus cf. the following passages in the edition of the Munich Computus below (the edition is abbreviated as MC in the following, with references to chapter.lines): 41.107–110, 44.11–12, 50.22–28, 50.47–49, 59.38–69, 62.65–67, 64, and see also the discussion on p. LVII–LVIII and LXXX–LXXXII below; item 13 may also be of Irish origin, since it shows parallels to a heavily corrupted, apparently Irish tract in Padua, Biblioteca Antoniana, I 27, 77v–78r (cf. Ó Cróinín, 'Dionysius Exiguus', 272–4). In the first book, items 4–5, the tracts *De computo dialogus* and *De xiiii divisionibus temporum*, ultimately derive from Irish tracts, but here appear in a Carolingian recension (my reading of the evidence; for the controversy about place and time of these tracts cf. note 55); items 6 to 8, the ps-Alcuin tracts on the bissextile day and the *saltus lunae*, show many parallels to Irish texts (cf. MC 8.38–43, 24.12–14, 36.2–5, 41.7–8, 41.38–49, 41.80–88, 41.92–106, 46.16–20, 48.2–7, 55.6–12, 62.14–63, 62.68–72, 62.87–95, 62.111–117), but they may also have been (and in my opinion are) continental compositions drawing on Irish sources (again, their origin is highly disputed; cf. Jones, *Bedae opera*, 110; Cordoliani, 'Traités', 53; Dekkers & Gaar, *Clavis patrum latinorum*, 736; Borst, 'Alkuin', 59–61; Stevens, 'Rabani', 173–4; idem, 'Present sense', 18–20; Machielsen, *CCSL Clavis Patristica* 3A, 215; Springsfeld, *Alkuins Einfluß*, 77–9; Butzer & Butzer, 'Mathematics', 79).

38 Jones, 'Sirmond manuscript', 209–10, 213–4, and especially idem, *Bedae opera*, 110, where he simply states that Bede does not cite the Munich Computus.

39 Ó Cróinín, 'A seventh-century Irish computus', 104–7, 110–1, 118–9, 124–7; Walsh & Ó Cróinín, *Cummian's letter*, 23–4, 115–6, 134, 143–5, 156, 163, 165, 169, 172, 181, 204–5, 210. For the Munich Computus in the context of the reception of Virgilius Maro Grammaticus in computistical literature see Ó Cróinín, 'Virgilius Maro Grammaticus', 197–200.

a wider, Western European context. In his 2006 monumental corpus of editions of Frankish computistical texts, the Munich Computus plays an important part as a crucial source for Frankish computistica of the eighth century.[40] This demonstrates the influence of this Irish computistical textbook and highlights its role in the shaping of western medieval computistics.

Consequently, the principal value of the Munich Computus lies in the fact that it is a crucial text in the history of the most important science of the early middle ages, computistics, and as such essential to the understanding of the development of science in this period. Its scientific context, and especially its outstanding place in the formative period of medieval computistics, will be accentuated in detail in the following two chapters.

Terminology: Before proceeding to these, however, a note on the titles given to the Munich Computus in the studies outlined above is necessary. In general, the reference to Munich does not appear appropriate for a text that was evidently composed in Ireland and copied in Regensburg, where it was subsequently housed for almost a millenium before being transferred to Munich. Yet, ever since Mac Carthy's study of this text, which was the first such study published in English, this text is exclusively referred to as the 'Munich Computus' in English publications.[41] It appeared inappropriate, therefore, to change this terminology for the *editio princeps* of this computus, which would only lead to confusion about the text in question.

40 The fact that Borst begins the introduction to his corpus of editions with a quote from the Munich Computus illustrates the importance placed by him on this text. Borst, *Studien*, 1. On p. 134–7 he discusses this text in the context of pre-Bedan Irish computistics, there presented as one of the main foundations of Frankish computistics. The Munich Computus is referred to as *Comp. Hib*. throughout Borst's editions.

41 Mac Carthy, *Annals of Ulster* 4, lxvii–lxxv, ccxxviii–xxx; Kenney, *Sources*, 223; O'Connell, 'Easter cycles', 84–90; Lapidge & Sharpe, *Bibliography*, 95; Ó Cróinín, 'A seventh-century Irish computus', 102–27; idem, 'Old Irish gloss', 131–2; idem, 'Irish provenance', 183; idem, 'Virgilius Maro Grammaticus', 197; idem, 'Columbanus', 52; idem, 'Earliest Old Irish glosses', 16; idem, *Early medieval Ireland*, 188; idem, *Irish history*, 4–5; Walsh & Ó Cróinín, *Cummian's letter*, 258; Mc Carthy & Ó Cróinín, 'Easter table', 58–67; Mc Carthy, 'Easter principles', 205–24; idem, 'Origin', 49; Warntjes, '84 (14)-year Easter reckoning', 31–85; idem, 'Earliest occurrence', 96–105; Bisagni & Warntjes, 'Latin and Old Irish', 1–33; idem, 'Early Old Irish material', 77–91. The manuscript reference is preferred by some authors (Jones, 'Sirmond manuscript', 209; idem, *Bedae pseudepigrapha*, 48–9, 125; idem, *Bedae opera*, 110), and on very few occasions the lengthy heading of this text is referred to (Mac Ginty, 'Irish Augustine', 78). Note, however, that Jones, *Bedae pseudepigrapha*, 67, in his imprecise and vague treatment of the Munich MS, describes this text as 'the Irish Computus, composed AD 689'; he gives the heading of the Munich Computus as the incipit, but no explicit or folio number for the end; it appears from Jones, *CCSL* 123B, 351 that he regarded the entire MS from fol. 8r onwards as one recension of the now lost, hypothetical 'Irish computus'; hence, 'the Irish Computus, composed AD 689' was a description rather than a title, and referred to more than just the text from fol. 8r to 46r. For 'Munich Computus' denoting the MS as a whole, rather than the specific text of fol. 8r–46r, see note 54.

Unfortunately, anonymous computistical texts of the early middle ages are often referred to under various titles by modern commentators, depending on their personal preferences. This led to the bizarre situation that some of these texts are referred to by three or more different titles, with only their dates of composition providing definite clues about their identity. The wish to avoide such a scenario for the Munich Computus may serve here as a justification for retaining this rather inappropriate title. Some of the more prominent anonymous eighth-century computistical texts may illustrate the argument: The computistical anthology Milan, Biblioteca Ambrosiana, H 150 inf, is published under the title *Liber de computo* in volume 129 of the *Patrologia Latina*, and referred to by this name in some studies; in others, however, it appears as the Bobbio Computus (because of its provenance), the Milan Computus (because of its present location), or as one (if not the main or only) recension of a computistical compilation called *Computus Graecorum sive Latinorum*.[42] Similarly, evidently Frankish computistical texts in particular have received numerous different titles over the past century: The Frankish computus of AD 727 based on Victorian principles was first called according to the sole manuscript witness 'Berner Computus Nr. 611 von 727' by Krusch, and it was described as 'Komputus im Berner Codex n. 611 aus dem Jahre 727 n. Chr.' by Schmid; in Krusch's following *editio princeps*, however, he published it under the title 'Der merovingische Computus Paschalis vom Jahre 727 n. Chr.', so that it was subsequently referred to as 'Der merowingische Computus von 727', with the English equivalent 'Merovingian computus of 727', the French 'Comput Mérovingian de 727', the Latin *Computus paschalis merowingicus anni 727*; yet, Jones preferred to term it *Computus Victorianus*; in catalogues it is listed as *Computus paschalis a. 727*, or simply *Computus paschalis*, accompanied by additional reference to the manuscript, while it appeared as 'L'Anonyme de 727' in French literature; it has just recently been critically edited by Borst as 'Das burgundische Lehrgespräch von 727', with the Latin title *De ratione conpoti* and the abbreviation *Dial. Burg.*; an earlier publication by Borst makes it apparent

42 *Liber de computo*: *PL* 129, 1275–372; Cordoliani, 'Traités', 64; Jones, *Bedae pseudepigrapha*, 151; idem, 'Sirmond manuscript', 208; idem, *Bedae opera*, 111, 401; idem, *CCSL* 123A, XIII; idem, *CCSL* 123C, 777; Boschen, *Annales Prumiensis*, 246, 252; Rissel, *Rezeption*, 28–9; Walsh & Ó Cróinín, *Cummian's letter*, 115, 257; Dekkers & Gaar, *Clavis patrum latinorum*, 736; Machielsen, *CCSL Clavis Patristica* 3A, 198. Bobbio Computus (which is the title used in the present study, so that it is not confused with Rabanus Maurus' or Helperic's *Liber de computo* or other texts of the same title): Wallis, *Bede*, lxxii–iii, 451; Warntjes, '84 (14)-year Easter reckoning', 41–3. Milan Computus: Ó Cróinín, 'A seventh-century Irish computus', 105, and more often. *Computus Graecorum sive Latinorum*: Borst, 'Alkuin', 57; idem, *Plinius*, 119; idem, *Kalenderreform*, 181–2; idem, *Streit*, 143, 168; idem, *Studien*, XXVII (abbreviated as *Comp. Graec.* throughout Borst's corpus of editions); Kühnel, *End of time*, 102; Dekkers & Gaar, *Clavis patrum latinorum*, 736; Cordoliani, 'Traités', 59, 64; idem, 'Encyclopédie carolingienne', 237; idem, 'Contribution', 174; idem, 'Manuscrit de comput ecclesiastique', 20; Machielsen, *CCSL Clavis Patristica* 3A, 200–3; Lejbowicz, 'Tables paschales', 22; Germann, *De temporum ratione*, 44, and more often. Untitled: Wiesenbach, *Sigebert von Gembloux*, 59.

that the latter abbreviation stands for *Dialogus de computo Burgundiae*.[43] The Frankish computus of AD 737 based on Dionysiac principles was first referred to as *Tractatus de computo ecclesiastico* by Labbe, who was only concerned with the dating clause incorporated in the text; it was not given any title by Valentin Rose, who first described it in some detail in his catalogue of Berlin manuscripts, and there only tentatively characterized it as 'ein Schulbuch über den computus vom Jahre 737'; Krusch called this text more rigorously 'Das älteste fränkische Lehrbuch der dionysischen Zeitrechnung', and it was later referred to as simply 'Fränkisches Lehrbuch von 737', translated into English as 'Merovingian manual of 737'; Cordoliani refers to this text as 'Comput dionysien de 737', and, in accordance with Cordoliani's title, it appears as *Compotus Dionysii a. 737* or *Computus Dionysianus a. 737* in recent catalogues; Borst terms this text in the *editio princeps* 'Das neustrische Streitgespräch von 737', with the Latin title *De paschali racione aliique causis* and the abbreviation *Dial. Neustr*.; again, an earlier publication by Borst reveals that the latter abbreviation stands for *Dialogus de computo Neustriae*.[44] The Frankish computistical formulary of AD 793 has received less variation in its titles over the years; it has mostly been referred to as *Annalis libellus*, which was also the Latin title first preferred by Borst (with the abbreviation *Ann. lib.*), before he opted for changing the order of words to *Libellus annalis* with the corresponding abbreviation *Lib. ann.* in his recent edition; the German title employed there and earlier is 'Das Veroneser Jahrbüchlein von 793'; in a recent catalogue of computistical

43 For Krusch's titles see Krusch, 'Lehrbuch', 241; idem, *Studien* II, 53. 'Komputus im Berner Codex n. 611 aus dem Jahre 727 n. Chr.': Schmid, *Osterfestberechnung in der abendländischen Kirche*, 82. 'Der merowingische Computus von 727': Borst, 'Computus', 15; idem, *Computus*, 42, 152. 'Merovingian computus of 727': Thorndike & Kibre, *Catalogue of incipits*, 82; Walsh & Ó Cróinín, *Cummian's letter*, 118, and more often; Wallis, *Bede*, 13, and more often (it does not appear in the indices of either work). 'Comput mérovingien de 727': Cordoliani, 'Traités', 59 ; idem, 'Table pascal de Périgueux', 60 (with additional MS ascription). *Computus paschalis merowingicus anni 727*: Machielsen, *CCSL Clavis Patristica* 3A, 192. *Computus Victorianus*: Jones, *Bedae opera*, 400 ; idem, *CCSL* 123C, 735. *Computus paschalis a. 727*: Dekkers & Gaar, *Clavis patrum latinorum*, 732. '*Computus paschalis* in der Handschrift Bern 611': Frede, *Kirchenschriftsteller*, 78. 'L'Anonyme de 727': Lejbowicz, 'Computus', 159–61, 181. For Borst's titles see: Borst, *Schriften*, XXIX, 348, 353. *Dialogus de computo Burgundiae*: Borst, *Streit*, 84, 168. Pedersen, 'Ecclesiastical calendar', 55 describes it as 'a Merovingian *Computus Paschalis* from A.D. 727'.

44 *Tractatus de computo ecclesiastico*: Krusch, 'Einführung', 137; Schmid, *Osterfestberechnung in der abendländischen Kirche*, 83. For Rose's description see Rose, *Handschriften-Verzeichnisse*, 285–6; for Krusch's title Krusch, 'Lehrbuch', 232. 'Comput dionysien de 737': Cordoliani, 'Traités', 59; idem, 'Table pascale de Périgueux', 57. *Compotus Dionysii a. 737*: Thorndike & Kibre, *Catalogue of incipits*, 1249. *Computus Dionysianus a. 737*: Frede, *Kirchenschriftsteller*, 84 ; Dekkers & Gaar, *Clavis patrum latinorum*, 732; Machielsen, *CCSL Clavis Patristica* 3A, 282. 'Fränkisches Lehrbuch von 737': Borst, 'Alkuin', 55; idem, *Plinius*, 114–6. 'Merovingian manual of 737': Kühnel, *End of time*, 101. Borst's titles: Borst, *Schriften*, XXIX, 375, 381. *Dialogus de computo Neustriae*: Borst, *Streit*, 24, 169. Untitled: Jones, *Bedae opera*, 66; Rissel, *Rezeption*, 28; Stevens, 'Rabani', 170; Walsh & Ó Cróinín, *Cummian's letter*, 161; Declercq, *Anno Domini*, 162.

texts it has been simply termed *libellus computisticus*.[45] The two enormous Frankish computistical compendia of AD 809 and 818, however, have received a great variation of titles: The earlier one has been called 'astronomisch-komputistisches Lehrbuch', 'astronomisch-komputistisches Werk von 809', 'Seven-book computus' with the German equivalent '7-Bücher-Computus', 'une grande compilation d'astronomie et de comput de l'an 809', 'Aix-la-Chapelle encyclopedia', while it was termed by Borst in his recent edition and earlier as 'Die Aachener Enzyklopädie von 809' (which is translated into English as the 'Aachen encyclopaedia of 809'), with the Latin title *Libri computi* and the corresponding abbreviation *Lib. comp*.[46] The later one was named 'Three-book computus' with the German equivalent '3-Bücher-Computus', whereas Borst in his edition employed the German title 'Die Salzburger Enzyklopädie von 818' (while he earlier preferred 'Salzburger Kompilation') and the Latin *Liber calculationis* with the corresponding abbreviation *Lib. calc*.[47]

45 *Annalis libellus*: Borst, *Plinius*, 138–9, 375, 428; idem, *Kalenderreform*, 317 (but with the abbreviation *Lib. ann.*); Kühnel, *End of time*, 105–6; Springsfeld, *Alkuins Einfluß*, 12, 409. Borst's titles: Borst, *Computus*, 50, 154; idem, 'Alkuin', 61–2; idem, *Plinius*, 138, 144, 375, 428; idem, *Streit*, 41, 173; idem, *Schriften*, XLI, 660, 679. *Libellus computisticus*: Machielsen, *CCSL Clavis Patristica* 3A, 207. Untitled: Krusch, 'Lehrbuch', 233; Thorndike & Kibre, *Catalogue of incipits*, 1311. Rose, in his catalogue of the Phillipps MSS in the Berlin library (Rose, *Handschriften-Verzeichnisse*, 283), describes it as 'Werk kurzer Belehrungen über den Computus (Zeitrechnung), verfasst i. J. 793 (bzw. 776)'. Stevens, 'Present sense', 19 refers to it as *Liber annalis*.

46 'Astronomisch-komputistisches Lehrbuch': Köhler, *Karolingische Miniaturen* 3, 119–27; Mütherich, 'Buchmalerei', 50; idem, 'Erneuerung', 18; idem, 'Leidener Aratus', 150, and more often; Mütherich & Gaehde, *Buchmalerei*, 8, 12, 89. 'Astronomisch-komputistisches Werk von 809': Boschen, *Annales Prumiensis*, 13, 17–8, 24, 242–6. 'Seven-book computus': King, *Excerpts*, 3–27 (cited from Borst, *Plinius*, 171); Eastwood, 'Astronomy in Christian Latin Europe', 251; idem, 'Plinian astronomy', 201; idem, 'Plinian astronomical diagrams', 148, and more often; idem, 'Astronomies of Pliny', 164, and more often; Butzer, 'Scholars', 50 (confusing it with *Lib. calc.*); Butzer & Butzer, 'Mathematics', 80. '7-Bücher-Computus': Springsfeld, *Alkuins Einfluß*, 12, 409. 'Une grande compilation d'astronomie et de comput de l'an 809': Cordoliani, 'Encyclopédie carolingienne', 237; idem, 'Contribution', 174. 'Aix-la-Chapelle encyclopedia': Kühnel, *End of time*, 103, 107–10. 'Aachen encyclopaedia of 809': Wallis, *Bede*, xci–ii (with wrong manuscript ascriptions, since the Munich and Vienna MSS rather contain *Lib. calc.*); Butzer & Butzer, 'Mathematics', 80. Borst's titles: Borst, 'Alkuin', 71; idem, *Plinius*, 156, 382, 389; idem, *Kalenderreform*, 319; idem, *Streit*, 16, 173; idem, *Schriften*, XLI, 1054, 1056, 1087. Wilmart, *Codices*, 160, in his very detailed description of one of the MSS of this work, terms this text *De temporum ratione atque de rerum natura libri septem, seu chronologica et astronomica syllogia*. Untitled: Neuß, 'Kopie', 113–40. For the problem of terminology for this and the following work cf. also Germann, *De temporum ratione*, 30–1, 88–90.

47 'Three-book computus': Eastwood, 'Plinian astronomy', 201; idem, 'Plinian astronomical diagrams', 144, and more often; idem, 'Astronomies of Pliny', 163, and more often; Butzer, 'Scholars', 50 (confusing it with *Lib. comp.*); Butzer & Butzer, 'Mathematics', 80. '3-Bücher-Computus': Springsfeld, *Alkuins Einfluß*, 12, 409. Borst's titles: Borst, 'Alkuin', 73; idem, *Plinius*, 171, 381–2, 421; idem, *Kalenderreform*, 321; idem, *Streit*, 36, 173; idem, *Schriften*, XLI, 1367, 1369–70, 1383; Kühnel, *End of time*, 110. 'Salzburger Kompilation': Borst, *Plinius*, 171, 381–2, 421; Kühnel, *End of time*, 110. Cordoliani, 'Traités', 58; idem, 'Manuscrit de comput ecclesiastique', 26 merges the MSS of this Frankish encyclopaedia

These are only the most prominent examples of the widespread tendency of renaming anonymous computistical texts whenever previous titles appear inappropriate. Such a situation could be avoided for the Munich Computus by adopting the title unanimously given to this text in previous studies in English, though at the cost of a more suggestive and appropriate title. In German literature, however, the titles attributed to this text vary. Docen referred to it by its rather lengthy heading, *Compotus sancti Augustini, sancti Hieronimi, sancti Ysidori, sancti Dyonisii, sancti Quirilli Greciae, et ceterorum*, as do almost all catalogue entries.[48] Krusch did the same when introducing this text in his 1880 analysis, but in the following discussion he used the shorter 'Münchener Computus', which is the origin of the terminology applied in English studies of this text.[49] This terminology was adopted by Schwartz, and then in turn by Schäferdiek, who based his study on Schwartz's results.[50] Yet, in the summary of his article, Schäferdiek calls this text very precisely 'ein durch eine Münchener Handschrift überlieferter irischer Komputus aus dem Jahre 719'.[51] This phrase appears to rely on Krusch's one page note on this computus published shortly before his death, where, after Mac Carthy and Schwartz had demonstrated the Irish origin of this text, Krusch decided to coin it 'Der große irische Computus vom Jahre 719 n. Chr.'.[52] This then led Borst to the Latin title *Computus Hibernicus*, abbreviated as *Comp. Hib*.[53] Even though this terminology is more adequate, it is nevertheless more confusing than 'Munich Computus': In modern literature, only one text has been termed 'Munich Computus', namely the text edited here (Munich, Bayerische Staatsbibliothek, Clm. 14456, fol. 8r–46r), and

of AD 818 with those of the earlier encyclopaedia of AD 809, and terms the text 'Compilation d'astronomie et de comput (809)' (Cordoliani is more correct in other studies; cf. previous note); presumably based on Cordoliani's confused entry, Stevens, 'Present sense', 23–4, calls this text quite mistakenly *Compilatio computistica et astronomica AD DCCCVIIII* (he terms it simply *Compilatio DCCCVIIII* in idem, 'Karolingische Renovatio', 674), apparently inverting the dates and thus the chronological order of *Lib. comp.* and *Lib. calc*. (cf. Borst, *Schriften*, 1086); Stevens's terminology and mistakes were copied in Machielsen, *CCSL Clavis Patristica* 3A, 196–8, which is generally useless, since it appears not to be based on first-hand manuscript research; consequently, relying on secondary literature, it uncritically includes almost all of the numerous mistakes of previous scholars without qualifying them; McCluskey, 'Astronomies in the Latin West', 153 refers to this and the previous text as 'astronomical and computistical anthologies that emerged around the year 809', while in *Astronomies*, 135–9 he inverts the titles (and manuscript witnesses) of these two texts by referring to the earlier one as 'three-book computus', to the later one as 'seven-book computus'. Similar confusion in Butzer & Butzer, 'Mathematics', 50. Untitled: Neuß, 'Kopie', 118–40; Mütherich, 'Buchmalerei', 50; Stevens, 'Rabani', 170.

48 Docen, 'Notizen', 516. For the catalogue entries cf. Halm et al., *Catalogus*, 175; Cordoliani, 'Traités', 59; Thorndike & Kibre, *Catalogue of incipits*, 244; Machielsen, *CCSL Clavis Patristica* 3A, 188–9. Under this title also McGinty, 'Irish Augustine', 78; Stevens, 'Rabani', 170 (wrongly described as a collection of *argumenta*).

49 Krusch, *Studien* I, 10–6.

50 Schwartz, 'Ostertafeln', 89–102, especially 89; Schäferdiek, 'Osterzyklus', 360–77.

51 Schäferdiek, 'Osterzyklus', 378.

52 Krusch, *Studien* II, 58.

53 Cf. especially Borst, *Schriften*, XXVIII, 1.

therefore this title is unambiguous.[54] The same cannot be said about the title *Computus Hibernicus* (*Comp. Hib.*), since this term was already used by Jones in a different context, referring to a hypothetical, now lost 'Irish Computus'.[55]

54 Note, however, that Ó Cróinín, in some of his studies, applies the term 'Munich Computus' to the entire MS rather than specifically to the text on folios 8r–46r, although his argument is exclusively based on that text: Ó Cróinín, 'A seventh-century Irish computus', 102; idem, 'Virgilius Maro Grammaticus', 197; Walsh & Ó Cróinín, *Cummian's letter*, 258. Unfortunately, this transfer of title subsequently led, in some instances, to the transfer of the characteristics of the text on folios 8r to 46r to the entire MS, so that it is argued, quite mistakenly, that the whole MS is a copy of an Irish exemplar of 718: Ó Cróinín, 'Old Irish gloss', 131–2; idem, 'Earliest Old Irish glosses', 16; similarly Ohashi, 'Sexta aetas', 59. In only one of the studies dealing with material of this MS other than the text on folios 8r to 46r is the term 'Munich Computus' explicitly employed for the entire MS: Graff, 'Thirteenth figure', 321, 329. Concerning the extent of the text, only Thorndike & Kibre, *Catalogue of incipits*, 244 disagree with common opinion; they appear to regard the ps-Dionysiac *Argumentum XIV* which immediately follows the Munich Computus in the manuscript as part of that text, since they argue that this computus extends from fol. 8r to 47v rather than 46r; from the MS it is, however, perfectly clear that the ps-Dionysiac *argumentum* constitutes a separate treatise, because the last quarter of fol. 46r is left blank so that this independent text could start at the beginning of the following page.

55 Jones uses the term *Computus Hibernicus* (*Comp. Hib.*) only in his 1980 *CCSL* edition of Bede's computistical works, not in his earlier 1943 edition. In this 1980 *CCSL* edition he does not clearly define this term, neither in the *index auctorum* (Jones, *CCSL* 123C, 735), nor anywhere else in this edition. From the general introduction to this work it is, however, immediately apparent that the Munich Computus is certainly not meant by this term, since Jones mentions it without referring to it as *Computus Hibernicus* (Jones, *CCSL* 123A, XIII). An analysis of all source references to *Comp. Hib.* then shed light on what Jones associated with this title. Six of the eight references listed in the *index auctorum* of the 1980 *CCSL* edition correspond to cross-references to the appendix in the 1943 edition (Jones, *CCSL* 123B, 299–303; *CCSL* 123C, 587 versus Jones, *Bedae opera*, 195–7, 296). In this appendix, Jones published 'excerpts from the Irish computus', namely the preface and table of contents of a now lost computus from the Sirmond MS (Oxford, Bodleian Library, Bodley 309, fol. 62r–v) and a chapter of that computus headed *De Hebdomadibus* from Bern, Burgerbibliothek, 417, fol. 52v–53v. It is therefore clear that Jones denoted a hypothetical pre-Bedan Irish Computus (for which see also Jones, *Bedae opera*, 112) with the term *Computus Hibernicus*, parts of which survive in the Sirmond group of manuscripts. The exact contents of this lost computus obviously cannot be established, but it is apparent from Jones' two further references to *Comp. Hib.* (Jones, *CCSL* 123B, 310, 351) that he regarded an excerpt from the Sirmond MS (Oxford, Bodleian Library, Bodley 309, 73v) and the Anatolian (?) table for calculating the number of days from 1 January to any given Julian calendar date as part of it (his reference here is to Munich, Bayerische Staatsbibliothek, Clm 14456, 65v–67r, but it should only be to fol. 66v; cf. the table of contents of this MS p. CCXIII–CCXXI below; already in *Bedae opera*, 110, Jones argued that this MS contains parts of the Irish computus). For further clarification of Jones' *Comp. Hib.* references see Wallis, *Bede*, 32. Two problems with Jones' Irish computus need to be pointed out here: First, a distinction between the *Comp. Hib.* and *De divisionibus temporum* (which is repeated in Machielsen, *CCSL Clavis Patristica* 3A, 192–5, 236–8) appears not to be justified; a version of *DDT* apparently was, according to the table of contents published by Jones, part of the *Comp. Hib.*, and Jones should have included the *DDT* references among the *Comp. Hib.* ones (cf. Wallis, *Bede*, 34, where she identifies *DDT* as an 'Irish computus tract'). Second, the table of contents published by Jones from the Sirmond MS quite cer-

Accordingly, the term ‘Munich Computus’ is used in the present study for its unambiguity and for the sake of consistency with English literature on the subject, as well as the two authoritative German studies; the author of this text is consequently referred to as the ‘Munich computist’.

tainly refers to a late eighth-century Frankish Computus based on Irish material rather than a pre-Bedan Irish text: If this table of contents is compared to the three pre-Bedan Irish computistical textbooks, it becomes immediately apparent that certain chapters listed in that table of contents were not part of Irish computistical teaching of ca. AD 700, namely the chapters dealing with the incarnation year, the indiction, the *cyclus lunaris*, the calculation of the lunar age and weekday of any given day of a year, the time of the day of the kindling of the moon, the length of moonlight per day, the rogation, as well as the astronomical chapters. In accordance with this, some scholars regard Jones’ *Comp. Hib.* rather as a later Frankish compilation based on Irish material, called *Sententiae s. Augustini et Isidori in laude computi* (short *Sententiae*), which appears to have survived in numerous differing versions. Cf. especially Cordoliani, ‘Encyclopédie carolingienne’, 237–43; idem, ‘Traités’, 66; Borst, *Plinius*, 118–9; idem, *Kalenderreform*, 187–8; the references in the index of Borst, *Schriften*, 1487; and furthermore Frede, *Kirchenschriftsteller*, 91; Stevens, ‘Rabani’, 170–1, 179–80; Dekkers & Gaar, *Clavis patrum latinorum*, 735–6; Machielsen, *CCSL Clavis Patristica* 3A, 192–5; Springsfeld, *Alkuins Einfluß*, 77. It is, however, quite problematic that neither Jones’ *Comp. Hib.*, nor the *Sententiae* are anywhere clearly defined, and in the end do not appear to be identical. The task of future studies will be to precisely define both texts and to identify the Irish kernel, as well as the Frankish additions. Cf. note 115.

THE MUNICH COMPUTUS IN THE HISTORY OF COMPUTISTICS

The period between the collapse of the Western Roman Empire in the fifth century and the arrival of Greek scientific texts through Arabic channels, as well as genuinely Arabic scientific tracts, from the eleventh century onwards is commonly regarded as a 'dark' period in the history of Western science.[56] The reason for this view is that the sciences taken into consideration are almost exclusively astronomy and fields of pure mathematics, especially geometry and number theory. In astronomy, the most important author, the second-century Alexandrian scholar Ptolemy (who had assembled the essentials of antique astronomical knowledge in one outstanding book, the Almagest) was not known in the West before Gerard of Cremona's (and a Sicilian anonymous' earlier) translation of this work in the twelfth century.[57] Western knowledge of astronomy in the early middle ages amounted only to random information from the works of Calcidius, Macrobius, Martianus Capella, Isidore, and Pliny.[58] In ge-

56 Historians of mathematics in particular show little appreciation for Western science in the early middle ages, at least in their overview accounts of the history of mathematics; note that computistics is not considered by these scholars, even though, in the early middle ages, it was primarily a mathematical science. Cantor, *Vorlesungen*, 821–47 is still the best and most balanced account for the early medieval period to date. Wußing et al., *Algebra*, 204 note that no medieval pre-twelfth-century text on algebra is known to have originated in the West; Linn, *Mathematics*, 13–24, heads the chapter on Western mathematics in the early middle ages with the title 'The West's asleep', stating that 'there can be little argument about the general lack of real intellectual and mathematical activity'; particularly harsh is Kline, *Mathematics*, 115: 'A people unacquainted with the rudiments of arithmetic could hardly be expected to advance mathematics. Actually history has no surprise for us in this instance. In no one of the civilisations that have contributed to our modern one did mathematical learning exist on as low a level as it did in medieval Europe. From the years 500 to 1400 there was no mathematician of note in the whole Christian world'. Singer begins his description of scientific development in the period AD 400 to 1000 in the following way (Singer, *History of scientific ideas*, 137): 'We now enter the last and longest phase of the Great Failure'. Cf. also Haskins, *Studies*, 3; Eves, *Mathematics*, 207–8; Burton, *History of mathematics*, 271–3.

57 For Ptolemy's Almagest, its transmission and importance, cf. especially Pedersen, *Survey* (p. 11–25 for the transmission and reception); Kunitzsch, *Almagest* (p. 6–112 for the transmission); and furthermore Stahl, 'Dominant traditions', 95–8, 123–4; idem, *Roman science*, 125–6; North, *History of astronomy*, 106–20; Pedersen, *Early physics*, 76–89; Dreyer, 'Medieval astronomy', 103, 108–20; Haskins, *Studies*, 14–5, 103–10, 157–64, 189–93; Pannekoek, *History of astronomy*, 146–62; McCluskey, *Astronomies*, 20–4, 188–90; Hoskins, *History of astronomy*, 16–24; Burton, *History of mathematics*, 190–2, 274–6.

58 For the history of astronomy in the West in the early middle ages cf. especially Eastwood, 'Astronomy in Christian Latin Europe', 235–53; McCluskey, 'Astronomies in the Latin West', 139–56; and furthermore Meier, 'Sieben freien Künste', 23–4; North, *History of astronomy*, 226–30; Pedersen, *Early physics*, 216–8; Dreyer, 'Medieval astronomy', 103–6; Stahl, 'Dominant traditions', 97–106, 111–9, 121–4; Bergmann, *Innovationen*, 18–9, 21–6; McCluskey, *Astronomies*, 114–49, 157–64; Hamel, *Geschichte der Astronomie*, 85–100; Hoskins & Gingerich, 'Medieval Latin astronomy', 68–72; Hoskins, *History of astronomy*, 29–32; Stevens, 'Karolingische Renovatio', 674–80; Eastwood, 'Plinian astronomy', 197–

ometry (as well as other mathematical disciplines) the West had to rely on a pseudo-Boethian text, a miscellany of excerpts from Boethius (and through Boethius of Euclid, but under omission of all proofs), Cassiodorus, Isidore, the Roman *agrimensores*, and others;[59] in number theory the most prominent text was Boethius' *De arithmetica*;[60] in arithmetic the calculation tables of Victorius of Aquitaine constituted the most widely used tool for mathematical operations.[61] The fundamental studies by Greek scientists, especially Euclid's Ele-

212; idem, 'Plinian astronomical diagrams', 141–3; idem, 'Dungal's letter', 119–21; idem, 'Astronomies of Pliny', 161–77; Eastwood & Graßhoff, *Planetary diagrams*, 1–10, 14–21. For a cultural perspective on astronomy in the early middle ages cf. Englisch, *Artes liberales*, 182–279; for astronomy in the early medieval classroom cf. Rissel, 'Hrabans Liber de computo', 149–51.

59 This text has never been published in full. For its content and transmission in the middle ages cf. especially the fundamental studies by Tannery, 'Notes', 39–50; Folkerts, 'Pseudo Boethian geometria', 189–90, 193–204; idem, 'Altercatio', 85–102; and furthermore Cantor, *Vorlesungen*, 580–9; Manitius, *Geschichte*, 28; Reindel, 'Beginn des Quadriviums', 518–9; Folkerts, *'Boethius' Geometrie II*, XI; idem, 'Geometry II', 1; idem, 'Euklidbearbeitungen', 5–6; Pingree, 'Boethius's geometry', 155–7; Zaitsev, 'Early medieval geometry', 523–35; Machielsen, *CCSL Clavis Patristica* 3A, 168–70; Butzer & Butzer, 'Mathematics', 81–2. For the history of early medieval geometry cf. epecially Folkerts, 'Development of mathematics', 1–6; for geometry in the Carolingian period cf. Stevens, 'Compotistica', 38–43; for a cultural perspective on early medieval geometry cf. Englisch, *Artes liberales*, 149–82.

60 Edited by Oosthout & Schilling, *CCSL* 94A. For this text and its reception in the early middle ages cf. especially Masi, *Boethian number theory*; White, 'Boethius', 163–5, 168–88 (for the reception of this work); and furthermore Cantor, *Vorlesungen*, 579–80; Manitius, *Geschichte*, 26; Stahl, *Roman science*, 198–9; Burton, *History of mathematics*, 238; Jones, 'Sirmond manuscript', 219; Cadwell, 'De institutione arithmetica', 137–9, 142; Stevens, 'Compotistica', 35–8; idem, 'Karolingische Renovatio', 670; Folkerts, 'Development of mathematics', 16–7; Machielsen, *CCSL Clavis Patristica* 3A, 182–3. For a cultural perspective on early medieval number theory cf. Englisch, *Artes liberales*, 91–149.

61 Arithmetic is here understood (according to modern mathematical understanding) as the study and application of elementary mathematical operations; it has to be clearly distinguished from number theory: arithmetic forms the basis of every calculation, so that basic knowledge of it was obviously as essential in everyday life as it was for any science; the theory of numbers, however, was a highly specialized theoretical field studied by only few intellectuals. Victorius' *Calculus* is edited by Peden, *Abbo of Fleury*, 1–62 as the basis of Abbo's commentary on this text; her edition supersedes the 19th-century editions by Christ, 'Argumentum calculandi', 132–6 (partial); Friedlein, 'Victorii calculus', 443–63; idem, 'Calculus des Victorius', 58–79. For this text cf. Christ, 'Argumentum calculandi', 100–32; Friedlein, 'Calculus des Victorius', 42–58; Jones, 'Sirmond manuscript', 218–9; idem, *Bedae pseudepigrapha*, 53; Rissel, 'Hrabans Liber de computo', 143–6 (including facsimiles of some multiplication tables); Bergmann, *Innovationen*, 34–6; Folkerts, 'Development of mathematics', 18; Stevens, 'Compotistica', 36, 38; idem, 'Cycles of time', 28; idem, 'Karolingische Renovatio', 667–70; Peden, *Abbo of Fleury*, xv–vii, xxxvi–xlix. For the execution of arithmetical operations in the early middle ages cf. Meier, 'Sieben freien Künste', 6–7; French Anderson, 'Arithmetical computations', 145–9; Rissel, 'Hrabans Liber de computo', 143–6 (underrating the calculation with fractions); Williams & Williams, 'Finger numbers', 590–3; Wallis, *Bede*, 254–63; Springsfeld, 'Rechnen', 224–31; Pillonel-Wyrsch, *Calcul*, 24–31.

ments, were not available before the late twelfth century,[62] and western scientists hardly improved on the few late antique tracts available to them. Therefore, the period roughly between 500 and 1000 is usually regarded as a time of scientific stagnation, ignorance, and disinterest. This point of view would quite certainly be valid if it was not for one science, computistics, which is too often neglected by scholars of the history of science, who traditionally focus on the quadrivium, and do not necessarily regard computistics as a medieval science in its own right.[63]

When the Christian church decided in the second century that Easter was neither to be celebrated on the same day as the Hebrew pasch, nor on a fixed Julian calendar date, but rather on the Sunday after the first full moon in spring, mathematical and astronomical methods needed to be applied for determining this date. Out of this necessity of calculating the most important feast in Christianity, a science developed with the primary object of calculating Easter, called computistics.[64] In the scientific centres of late antiquity, most notably Alexandria, computistics was, in its scientific relevance, little more than a subfield of applied astronomy and mathematics. However, the spread of Christianity to a less scientifically developed West led to an increase in the importance of computistics relative to the traditional sciences, especially since the bishops of Rome were eager to understand the calculation of Easter, so that they would not be dependent on Alexandria in that fundamental question. Two developments, then, accompaning the collapse of the Western Roman Empire had a profound impact on the study of science in the West in the early middle ages: Contact to the Greek speaking world was limited, so that availability of important scientific texts as well as personal expertise was severely restricted, to say the least. At the same time, Christian rather than secular institutions, most notably the

62 For Euclid's Elements, its transmission and importance, cf. Haskins, *Studies*, 24–5; Kline, *Mathematics*, 59–79; Eves, *Introduction*, 115–25; Burton, *History of mathematics*, 145–84, 273–8; Folkerts, 'Euclid', 1–49; idem, 'Development of mathematics', 6–11. For the parts of Euclid's work that were available in the West before the twelfth century see especially Folkerts, 'Euclid', 1–3, 19–25.

63 Pannekoek, *History of astronomy*, 173 calls computistics 'a thin rivulet of science'. Contrary to Wallis' opinion (*Bede*, xviii), computistics do 'seek to establish universal principles' (namely one universal system for the calculation of Easter) and do boast a scientific theory (a well defined luni-solar system based primarily on mathematical principles). Pedersen, *Early physics*, 216 rightly refers to computistics as 'a particular Medieval science', and similarly Cordoliani, 'Comput', 45 refers to computistics as 'cette science de comput ecclésiastique'.

64 For discussions and definitions of the term computistics and the various meanings of the Latin *computus* (as well as its equivalents in other languages) cf. especially the detailed studies by Borst, 'Computus', 10–51; idem, *Computus*, 9–56; Lejbowicz, 'Computus', 151–87; and furthermore Sickel, 'Lunarbuchstaben', 153; Bach, *Osterfestberechnung*, 3; Henel, *Studien*, 1–4; Jones, *Bedae pseudepigrapha*, 4; idem, *Bedae opera*, 75–6; idem, *CCSL* 123A, XII; Neugebauer, *Ethiopic astronomy*, 3, 68–9; Rissel, 'Hrabans Liber de computo', 138; Ó Cróinín, 'Irish provenance', 173; Stevens, 'Rabani', 167; idem, 'Cycles of time', 28–9; Wiesenbach, *Sigebert von Gembloux*, 31; Englisch, *Artes liberals*, 280–1, 283; Wallis, *Bede*, 425–6; Machielsen, *CCSL Clavis Patristica* 3A, 185; Blackburn & Holford-Strevens, *Companion to the year*, 801, 878.

monasteries, became the centres of science. Accordingly, the sciences were studied from a purely Christian perspective, in an environment suspicious of heathen authors, as well as of a study of science disconnected from religious objectives.[65] It does not surprise, therefore, that the traditional sciences were studied only rudimentarily, primarily as *Hilfswissenschaften* to the only 'truely' Christian science, computistics.[66]

Computistics, on the other hand, flourished to an exceptional degree, as the hundreds of manuscripts dealing with computistical matters surviving from the seventh to the tenth century impressively illustrate. It can hardly be doubted that almost every person educated in a monastic school was taught at least the basics of this science.[67] In this sense computistics was more than merely the applied science of calculating Easter. In the early sixth century, when Dionysius Exiguus made the Alexandrian Easter table available to the West, this science was rather narrowly defined as the means necessary for an understanding of this new table and the system underlying it. From the middle of the seventh century

65 For early medieval Christian attitudes towards science cf. especially Wallis, *Bede*, xxi–viii; McCluskey, *Astronomies*, 29–48; for Bede's case Stahl, *Roman science*, 229; for the case of geometry cf. Zaitsev, 'Early medieval geometry', 528–53. Cf. also note 119.

66 This is the role assigned to astronomy, at least in the pre-Carolingian period, if not thereafter, by Eastwood, 'Dungal's letter', 118; McCluskey, 'Astronomies in the Latin West', 146; to mathematics by Meier, 'Sieben freien Künste', 7; Struik, *History of mathematics*, 84; to arithmetic and astronomy by Rissel, 'Hrabans Liber de computo', 139–40; Bergmann, *Innovationen*, 20, 28, 36; Stevens, 'Cycles of time', 46; implicitly by Stahl, *Roman science*, 225.

67 The central document of the Carolingian educational reform, the *Admonitio generalis* of AD 789, lists c. 79 the *computus* among the subjects to be taught in monastic schools (*MGH LL* 1, 65): *Et ut scolae legentium puerorum fiant. Psalmos, notas, cantus, compotum, grammaticam per singula monasteria vel episcopia, et libros catholicos bene emendatos; quia saepe dum bene aliqui Deum rogare cupiunt, sed per inemendatos libros male rogant*. Likewise, a Frankish capitulary of AD 805 (*Capitulare duplex in Theodonis villa promulgatum*) states explicitly that all ecclesiastics should learn the *computus* (*MGH LL* 1, 132): *De computo, ut veraciter discant omnes.* This opinion is repeated as late as the 13th century by Guillaume Durand in his *Rationale divinorum officiorum* 8.1 (*CCSL* 140B, 131): *Quoniam, sicut ait beatus Augustinus, sacerdotes compotum scire tenentur, alioquin uix in eis sacerdotis nomen constabit, sub uerbo notitiam cursus temporis lunae ac kalendarii intelligimus quoniam compotus est scientia certificandi tempus secundum solis et lune progressum*. The most explicit statement comes from the Irish context, with the tenth-century *Saltair na Rann* ll. 261–268 arguing that every learned churchman should be able to correlate Julian calendar, lunar, and weekday data: (Stokes, *Saltair na Rann*, 4–5; the translation is cited from David Green's notes now in the Dublin Institute for Advanced Studies and available on the world wide web at:
http://www.celt.dias.ie/publications/online/saltair_na_rann/ (see Canto 001–010, p. 31)): *A coic cachlae d'fiss cenbrath / dlegair docachintliuchtach, / docachoen, cengláma gné, / bis fograda ecailse. // Laa mis grene, ésca aes, / rith mara cen immarbáes, / laa sechtmaine, feili noeb n-uag, / iarcertglaine con-imluad*. 'There are five things which a learned man should know about each day, everybody who is connected with the church, without appearance of censure. // The day of the solar month, the age of the moon, the running of the sea – without folly – the day of the week, of pure festivals, according to right clarity, with their variations.'

onwards, however, computistics developed into a synthesis of everything even remotely relevant to time reckoning in its most general form. Therefore, computistics covered every aspect of theoretical as well as applied science, including methods of finger-counting and other simple arithmetic, basic astronomical theory, tracts on the various units and divisions of time, descriptions of the history and workings of the lunar and solar calendar, algorithms for the calculation of chronological data (especially those connected to Easter), theories about and simple tools for the measuring of time, and the like. In short, science was almost synonymous with computistics in the Christian milieu of the early middle ages.[68]

Yet, the first and foremost aspect of computistics still was the calculation of Easter. Accordingly, a classification of the history of computistics into different periods quite naturally has to be based on the methods underlying this calculation. From the resurrection of Christ to the present day, four different phases can specified:[69]

1) The period from the resurrection of Christ to ca. the early second century, which is marked by the celebration of Easter on the fourteenth moon of the Hebrew first month, Nisan. The few sources available for this early period suggest that the earliest Christian communities in Asia Minor commemorated the passion of Christ at the same time as the Hebrew pasch, in accordance with John's Gospel.[70]

2) The period from ca. the early second century to the early ninth century, which is marked by the existence of competing systems, differing in their lunar calendars. At some point in the second century, most Christian communities agreed that Easter should commemorate the resurrection rather than the passion of Christ, and it should therefore be celebrated on a Sunday. The general rule was, as it still is to the present day, to celebrate Easter on the first Sunday after the first full moon (which is the fourteenth moon) in spring. Some communities in Asia Minor, however, rejected this reform, and stuck to the old practice of celebrating Easter on the fourteenth moon, irrespective of the weekday; they were soon condemned as heretics, called quartodecimans (from celebrating Easter on *luna quartodecima*).[71] More difficulties arose when the Hebrews

68 For similar conclusions cf. especially Pedersen, 'Ecclesiastical calendar', 60; Stevens, 'Scientific instruction', 83; and also idem, 'Compotistica', 49.

69 A similar classification of the history of computistics on the basis of competing systems can be found in Bach, *Osterfestberechnung*, 7–20.

70 For this early period cf. especially Hilgenfeld, *Paschastreit*, 160–214; and furthermore Ideler, *Handbuch*, 200–1; Bach, *Osterfestberechnung*, 7–8; Rühl, *Chronologie*, 110; Schwartz, 'Osterbetrachtungen', 2, 6; Ginzel, *Handbuch*, 210–1; Chaîne, *Chronologie*, 19–20; O'Connell, 'Easter cycles', 67–8; Gentz, 'Ostern', 1647–9; Jones, *Bedae opera*, 8–9; Declercq, *Anno Domini*, 50; Vogtherr, *Zeitrechnung*, 60–1; Holford-Strevens, *History of time*, 44–5.

71 For the developments in the second century and the quartodecimans cf. Ideler, *Handbuch*, 202–5; Hilgenfeld, *Paschastreit*, 216–320; Duchesne, 'Question', 6–16; Bach, *Osterfestberechnung*, 8–11; Rühl, *Chronologie*, 110–1; Schwartz, 'Osterbetrachtungen', 13–4; Ginzel, *Handbuch*, 212–6; Chaîne, *Chronologie*, 20–5, 42; O'Connell, 'Easter cycles', 68; Gentz, 'Ostern', 1649; Jones, *Bedae opera*, 9–10; Mohrmann, 'Conflit pascal', 154–71;

started to cyclically calculate their lunar calendar. In this calendar the first month, Nisan, and with it the Hebrew pasch on the fourteenth day of that month, could occur before the beginning of spring according to Christian reckoning;[72] accordingly, the Christian communities of Asia Minor who celebrated Easter on the Sunday after the Hebrew pasch commemorated Christ's resurrection earlier than the rest of Christendom; for that reason they were referred to as protopaschists.[73]

The main paschal conflict of late antiquity, however, developed from the late third century onwards between the church of Alexandria and that of Rome. Since Easter had to fall on the Sunday after the first full moon in spring, the obvious task was to create a working system by combining the solar with the lunar calendar. No difference existed between Alexandria and Rome in the choice of the solar calendar, since the Julian calendar was well-established throughout the Mediterranean world at that time. However, they differed in their lunar calendars: While Alexandrian computists applied a 19-year lunar cycle from the late third century onwards,[74] their Roman counterparts first tried an 8-year lunar cycle, which formed the basis for the Hippolytan 112-year Easter cycle;[75] soon thereafter they developed a more accurate 84-year lunar cycle with 12-year *saltus*. The period of 84-years was chosen because it constitutes a multiple of the 28-year solar cycle, so that, in fact, a luni-solar and there-

Pedersen, 'Ecclesiastical calendar', 24–30; Declercq, *Anno Domini*, 50–1; Blackburn & Holford-Strevens, *Companion to the year*, 791; Vogtherr, *Zeitrechnung*, 61–2. For quartodeciman practice cf. especially the detailed studies of Strobel, *Ursprung*, 17–69; and furthermore Dugmore, 'Quartodecimans', 411–21.

72 Cf. especially Grumel, 'Problème', 166–76.

73 For the protopaschists cf. Ideler, *Handbuch*, 206; Rühl, *Chronologie*, 110–1 (both with a wrong definition); Bach, *Osterfestberechnung*, 12–3; Ginzel, *Handbuch*, 212, 216–8; Declercq, *Anno Domini*, 51.

74 For the Alexandrian reckoning cf. Petavius, *De doctrina temporum* 1, 286–98; van der Hagen, *Dissertationes*, 208–47, 267–328; Rühl, *Chronologie*, 116–9; Mac Carthy, *Annals of Ulster* 4, l–lv; Schwartz, 'Ostertafeln', 8–29; Ginzel, *Handbuch*, 233–5; Chaîne, *Chronologie*, 40–2; Jones, *Bedae opera*, 29–33; Strobel, *Ursprung*, 133–7; Neugebauer, *Ethiopic astronomy*, 7–10, 56–63, 98–101 (through Ethiopic sources); Blackburn & Holford-Strevens, *Companion to the year*, 803–5; Holford-Strevens, *History of time*, 48–9, 132–4.

75 For the Hippolytan Easter table cf. especially Schwartz, 'Ostertafeln', 29–36; Neugebauer, *Ethiopic astronomy*, 85–7; Pedersen, 'Ecclesiastical calendar', 32–9 (with a facsimile of the original table on p. 33); Lejbowicz, 'Tables paschales', 13–7, 44–5, 48; most recently Mosshammer, *Easter Computus*, 116–27; and furthermore Petavius, *De doctrina temporum* 1, 110–1; Bucherius, *De doctrina temporum*, 133–5, 291–312; Ideler, *Handbuch*, 214–25; Hilgenfeld, *Paschastreit*, 331–40; Duchesne, 'Question', 17–9; Rühl, *Chronologie*, 119–22; Mac Carthy, *Annals of Ulster* 4, xxxii–xl, clxii–iii; Schwartz, 'Osterbetrachtungen', 17–8; Ginzel, *Handbuch*, 236–8; Chaîne, *Chronologie*, 43–4; O'Connell, 'Easter cycles', 689; Gentz, 'Ostern', 1650–1; Jones, *Bedae opera*, 11–2; van de Vyver, 'L'évolution', 7; Strobel, *Ursprung*, 122–4; Ferrari d'Occhieppo, 'Osterberechnung', 100–2; Stevens, 'Cycles of time', 35–6; Wallis, *Bede*, xxxvi–vii; Blackburn & Holford-Strevens, *Companion to the year*, 805; Mc Carthy & Breen, *De ratione paschali*, 16–7; Declercq, *Anno Domini*, 69–71. For its history, context, and subsequent development, cf. especially Richard, 'Comput de cent-douze ans', 257–77; idem, 'Comput pascal par octaétéris', 308–39 (arguing for the use of reformed *octaeterides* well into the fourth century).

fore Easter cycle of 84-years was created, called the *Supputatio Romana*.[76] But there were also other fundamental differences between the *Supputatio Romana* and the Alexandrian reckoning. The Romans were in favour of lunar limits 16 to 22 for Easter Sunday, since *luna* 16 occurred on the resurrection according to the Gospel of John. The Alexandrians, for their part, remained closer to Hebrew tradition by advocating lunar limits 15 to 21, which agreed with the Hebrew period of unleaven bread, as well as with the fact that according to the Synoptic Gospels Christ was cruxified on *luna* 15. Additionally, 21 March was strictly observed as the spring equinox (representing the beginning of spring) in the Alexandrian reckoning, so that the Easter full moon had to fall on or after this date. For the Romans, however, it was of paramount importance that the most important feast of Christianity did not coincide with the pagan celebrations commemorating the foundation of their city; therefore, Easter Sunday could not be celebrated later than 21 April, which meant that concessions had to be made to the lower Julian calendar limit in order to establish a working system, so that Easter could fall as early as 18 March in Rome. The conflict between Rome and Alexandria continued throughout the fourth and well into the fifth century.[77]

In the course of time it was realized in the West that the *Supputatio Romana* had become increasingly inaccurate. For this reason, various reforms of the 84-year cycle were implemented in the first half of the fifth century.[78] Only

76 For the *Supputatio Romana* cf. especially Schwartz, 'Ostertafeln', 40–50; most recently Mosshammer, *Easter Computus*, 204–13; and furthermore Bucherius, *De doctrina temporum*, 419–32; Noris, *Dissertationes*, 81–148; van der Hagen, *Observationes in anonymi cyclum LXXXIV annorum*, 247–89; Ideler, *Handbuch*, 239–53; Krusch, *Studien* I, 31–115 (which has to be read with caution, since only the discussion of what Krusch calls the 'younger' *Supputatio Romana* is correct; the same holds true for every subsequent study based on Krusch); Mac Carthy, *Annals of Ulster* 4, lxxxii–iii; Rühl, *Chronologie*, 124–5; Ginzel, *Handbuch*, 238–42; Jones, *Bedae opera*, 27–8; O'Connell, 'Easter cycles', 71–4; Cordoliani, 'Computistes insulaires', 6 (explicitly preferring Krusch's wrong theory to Schwartz's correction); Strobel, *Ursprung*, 225–33; Blackburn & Holford-Strevens, *Companion to the year*, 805–7.

77 For the history of the conflict between the Alexandrian and the Roman church concerning the date of Easter in the fourth and fifth centuries cf. especially Schwartz, 'Ostertafeln', 50–8; Schmid, *Osterfestberechnung in der abendländischen Kirche*, 1–29; and furthermore Ideler, *Handbuch*, 253–8; Hilgenfeld, *Paschastreit*, 369–72; Duchesne, 'Question', 22–42; Bach, *Osterfestberechnung*, 14–5; Chaîne, *Chronologie*, 48–60; van de Vyver, 'L'évolution', 16–8; Stevens, 'Cycles of time', 38–40; Declercq, *Anno Domini*, 72–9; Blackburn & Holford-Strevens, *Companion to the year*, 792–4, 807–8.

78 Besides the *latercus* or 84 (14), which will be discussed presently, four fifth-century modifications of the *Supputatio Romana* are known at present: 1) The *Laterculus* of Augustalis, which some scholars still believe to be an original third century table (cf. notes 13 and 14); only random information about this table is transmitted in the *Computus Carthaginiensis* (ed. Krusch, *Studien* I, 279–97); 2) two further tables described by the Carthaginian computist; cf. Krusch, *Studien* I, 164–88; Schwartz, 'Ostertafeln', 68–9; Schmid, *Osterfestberechnung in der abendländischen Kirche*, 15–7; Ginzel, *Handbuch*, 243–4; O'Connell, 'Easter cycles', 75; Strobel, *Ursprung*, 137, 271–3; Stevens, 'Cycles of time', 38; Declercq, *Anno Domini*, 79–80; Warntjes, '84 (14)-year Easter reckoning', 70–1; 3) the Zeitz table, first critically edited by Mommsen in a separate treatise ('Zeitzer Ostertafel', 541–8) and then in *MGH AA* 9, 507–10; Krusch, 'Bruchstücke', 996 managed to reconstruct an addi-

one of these reforms, however, had an impact on the following centuries, namely the *latercus* or 84 (14)-year Easter reckoning.[79] It appears that Sulpicius Severus created this 84-year Easter cycle with *saltus* in 14-year intervals in ca. AD 410. At the very least it can be regarded as fairly certain that the Easter cycle in question had its origin in the early fifth century.[80] Influenced by Eastern computistics, this cycle shows a number of considerable differences from the *Supputatio Romana*. Its Julian calendar and lunar limits for Easter Sunday were 26 March to 23 April and *luna* 14 to 20 respectively. On a more technical level, it applied a different sequence of lunations and the *saltus* were placed in every fourteenth year instead of every twelfth. If and for how long this cycle was used in Gaul and / or other parts of continental Europe must remain speculative. In the Insular remoteness of Ireland and Britain it became the predominant Easter reckoning at some stage of the fifth century and remained as such until it was gradually abandoned (depending on the area) between the early seventh and the late eighth or early ninth centuries.[81]

tional part at the beginning of the table; further fragments of the Zeitz table have just recently been rediscovered in the Stiftsbibliothek of Zeitz, and a full, though hardly readable facsimile of all fragments is published in the catalogue to the exhibition following the rediscovery (Overgaauw & Steving, *Zeitzer Ostertafel*, 13–24); in this catalogue, an upcoming new edition is announced (Overgaauw & Steving, *Zeitzer Ostertafel*, 30); for this table cf. also Mommsen, ‘Zeitzer Ostertafel’, 539–40, 549–66; idem in *MGH AA* 9, 503–6; Krusch, *Studien* I, 116–23; idem, ‘Bruchstücke’, 982–97; Schwartz, ‘Ostertafeln’, 71–2; Schmid, *Osterfestberechnung in der abendländischen Kirche*, 15–7; Rühl, *Chronologie*, 125; Ginzel, *Handbuch*, 244–5; O’Connell, ‘Easter cycles’, 74–5; Gentz, ‘Ostern’, 1651; Strobel, *Ursprung*, 270–1; Declercq, *Anno Domini*, 79, 84; Overgaauw & Steving, *Zeitzer Ostertafel*, 5–11; Warntjes, ‘84 (14)-year Easter reckoning’, 71.

79 The construction of the 84 (14) has been the subject of debate for centuries. Only due to the discovery of an Easter table of this reckoning by Dáibhí Ó Cróinín in 1985 was it possible to convincingly reconstruct the 84 (14). For the discovery and the construction of the 84 (14) cf. the literature cited in note 21. All previous discussions are therefore outdated; for these cf. p. XVII–XIX above.

80 Aldhelm, *Epistula ad Geruntium* (*MGH AA* 15, 483) attributes this 84-year cycle to Sulpicius Severus. This identification has already been accepted by Ussher, *Antiquitates*, 173, 482, 514, but in the following centuries it was often rejected. Cf. van der Hagen, *Observationes in laterculum paschalem centum annorum*, 342–7 (based on outdated theories about the the 84 (14), but, as everything else from van der Hagen, certainly worth a read); Krusch, ‘Einführung’, 162; Schmid, *Osterfestberechnung auf den britischen Inseln*, 13–8 (a good summary of older opinions on this question, but useless in its technical discussion, as it is based on theories outdated since); Jones, *Bedae opera*, 101. Very recently Mc Carthy, ‘Origin’, 38–44, made a case for Sulpicius’ authorship, which was judged unconvincing by Wallis, *Bede*, lvi, without outlining any argument to the contrary. Schwartz, ‘Ostertafeln’, 102; idem, ‘Osterbetrachtung’, 27 argues from the context of 84-year Easter tables that the 84 (14) was an invention of the fifth or sixth century (probably early fifth and pre-Victorius), a hypothesis that was confirmed by my own study (Warntjes, ‘84 (14)-year Easter reckoning’, 34, 36–7), which has shown on technical grounds that an early fifth century origin, and thus Sulpicius’ authorship, is most plausible.

81 For the abandonment of this reckoning in the various parts of Ireland and Britain cf. p. XXXIX–XL, LXXXIII–LXXXIX, XCIII–XCV, CLVI–CLVIII.

Interestingly enough, the creation of and adherence to this cycle appear to have been totally independent of Rome. The crisis between Alexandria and Rome concerning the correct date of Easter reached its height in the mid-fifth century. Pope Leo the Great, at that time, asked the reknown mathematician Victorius of Aquitaine to solve the differences between the two computistical centres. The Easter table created by Victorius, therefore, was designed to be a compromise between Roman and Alexandrian principles.[82] The basis of this table was a 19-year lunar cycle as used by the Alexandrians, though with slight technical differences, which had far-reaching consequences: The 19-year *saltus* was introduced 13 years before the Alexandrian one; the Julian calendar limits for Easter Sunday were 22 March to 24 April, so that the Alexandrian 25 April was not acceptable in the Victorian reckoning; moreover, the Roman lunar limits of *luna* 16 to 22 were kept, but alternatives were noted for cases in which Easter Sunday fell on the controversial lunar age 22. This Victorian system, problematic as it was in some of its details, nevertheless proved extremely successful, especially in Francia, where it was decreed as the definitive reckoning at the Council of Orleans in AD 541, and where it was only gradually abandoned in a slow process throughout the eighth century.[83] It also enjoyed a short spell of popularity in southern Ireland and Anglo-Saxon England.[84]

However, Victorius' ambiguity in listing double dates for certain years in particular, as well as the inclusion of the controversial lunar age 22, did not solve the disputes. For these reasons the papal curia decided in AD 525 to contact the monk Dionysius Exiguus, a famous canonist and translator from Greek to Latin. It appears that Alexandrian Easter tables and paschal tracts were available in Rome at that time, but only in Greek. Accordingly, Dionysius' principal task was to translate the available material, which he accomplished in style and

82 Victorius' computistical works are edited by Bucherius, *De doctrina temporum*, 2–10, 14–69; Mommsen, 'Victorii Aquitani cursus', 677–735; Krusch, *Studien* II, 17–52. For the Victorian reckoning cf. Bucherius, *De doctrina temporum*, 11–13, 145–81, 205–43; Noris, *Dissertationes*, 133–5; van der Hagen, *Observationes in veterum patrum prologos et epistolas*, 161–87; Ideler, *Handbuch* 2, 275–85; Rühl, *Chronologie*, 126–8; Mommsen, 'Victorii Aquitani cursus', 669–72; Bach, *Osterfestberechnung*, 17–8; Mac Carthy, *Annals of Ulster* 4, lxxxiii–ix; Schwartz, 'Ostertafeln', 72–80; Schmid, *Osterfestberechnung in der abendländischen Kirche*, 30–1; Ginzel, *Handbuch* 3, 245–7; Chaîne, *Chronologie*, 61–2; Krusch, *Studien* II, 4–5, 10–15; O'Connell, 'Easter cycles', 75–6; Jones, 'Victorian and Dionysiac Paschal tables', 409–13; Jones, *Bedae opera*, 61–8; Strobel, *Ursprung*, 138–9; Neugebauer, *Ethiopic astronomy*, 81–3; Pedersen, 'Ecclesiastical calendar', 47–9; Stevens, 'Scientific instruction', 92–3; idem, 'Cycles of time', 40–1; Wallis, *Bede*, l–lii; Declercq, *Anno Domini*, 82–95; idem, 'Dionysius Exiguus', 181–7; Blackburn & Holford-Strevens, *Companion to the year*, 793, 808–9; Holford-Strevens, *History of time*, 48–9; most recently Mosshammer, *Easter Computus*, 239–44.

83 For the decree of the Council of Orleans see *Concilium Aurelianense* 1 (*CCSL* 148A, 132), as well as the discussions in Bucherius, *De doctrina temporum*, 183–4; Noris, *Dissertationes*, 179; Krusch, 'Einführung', 125–6; Schmid, *Osterfestberechnung in der abendländischen Kirche*, 63–4. For the slow adoption of the Dionysiac reckoning cf. p. XXXIX–XLI.

84 Cf. p. XXXIX–XLI, LXXXIII–LXXXIX, CLVI–CLVIII.

therewith made the Alexandrian table, for the first time, readily accessible in the Latin West.[85] However, except for centres with Byzantine contact in the Mediterranean, it took some time for the adoption of this table throughout Western Europe. Rome itself appears to have finally decided to adhere to the Dionysiac reckoning in the 640s or slightly thereafter,[86] Anglo-Saxon England

85 Dionysius' computistical works are edited by Jan, *Historia cycli dionysiani*, 59–115 (repr. in *PL* 67, col. 483–520) and Krusch, *Studien* II, 59–86 (whose edition is in many aspects inferior to Jan's). Given the fact that Dionysius appears to have been a rather limited computist (cf. note 103), it seems that he reiterated or simply translated into Latin what his exemplars outlined in Greek, rather than that he would have executed many calculations himself. He may have tranferred Cyril's 95-year table to the subsequent 95-year period by using the manual he outlined in his prologue (cf. note 104) and his *argumenta*, but it seems more likely that this continuation of the Cyrillian table was already available in Greek. It is also likely that the conversion of the dates from the Alexandrian to the Julian calendar had already been accomplished in Dionysius' exemplar, or that Dionysius used a table synchronizing the dates of the Alexandrian calendar with the Julian one; Cyril's Easter table was the official one used in Alexandria, but it is possible, if not very likely, that Greek Easter tables of the Alexandrian reckoning adapted to the Julian calendar circulated in Dionysius' time. More importantly, Dionysius appears, in my opinion, not to have been capable of changing the era in his *argumenta* from the Diocletian to the Incarnation era (for the mathematical difficulties of that operation cf. Neugebauer, 'Computus paschalis', 293–301), so that the AD era must already have been the basis of the Greek *argumenta* that Dionysius then simply translated, while transferring the examples to his *annus praesens*. For different opinions on Dionysius' computistical and chronological skills and the task accomplished by him in AD 525 cf. especially Neugebauer, *Ethiopic astronomy*, 104–5; Ogg, 'Hippolytus', 2–3, 17; Declercq, *Anno Domini*, 99–147; idem, 'Dionysius Exiguus', 187–246; Holford-Strevens, *History of time*, 49–50; Mc Carthy, 'Emergence of anno domini', 32–8, 51–3; most recently Mosshammer, *Easter Computus*, 59–106; and furthermore Piper, *Kalendarium*, 87–9; Ginzel, *Handbuch* 3, 247–8; Jülicher, 'Dionysius Exiguus', 998–9; Krusch, 'Einführung', 106–8; idem, *Studien* II, 59; Jones, *Bedae opera*, 68–73; Mordek, 'Dionysius Exiguus', 1090–1; Teres, 'Time computations', 177–87; Pedersen, 'Ecclesiastical calendar', 49–54; Stevens, 'Scientific instruction', 90; idem, 'Cycles of time', 41; Wiesenbach, *Sigebert von Gembloux*, 47–8; Borst, *Kalenderreform*, 177; McCluskey, *Astronomies*, 87.

86 In general, a detailed history of the Easter controversy in the early middle ages, substituting the outdated accounts by Krusch, Schmid, Jones, and others, is one of the main desiderata in the field. Some scholars believe that Rome had adopted the Dionysiac reckoning already in the sixth century; cf. Krusch, 'Einführung', 110–4; Schmid, *Osterfestberechnung auf den britischen Inseln*, 50–60; Betten, 'Adoption', 487; O'Connell, 'Easter cycles', 76. The crucial evidence for the time of uncompromising adoption of this reckoning in Rome comes from the British Isles. Cummian, in his letter to the Iona abbot Ségéne and a certain Béccán, relates that the southern Irish clergy had sent an embassy to Rome, which apparently advocated the Victorian reckoning on its return (cf. note 238). Therefore, the Victorian system appears to have still been followed in Rome at this time (this is denied by Krusch, 'Einführung', 152; Schmid, *Osterfestberechnung auf den britischen Inseln*, 27; O'Connell, 'Easter cycles', 80; Jones, 'Paschal tables', 417–8; idem, *Bedae opera*, 90–1, who argue, quite unconvincingly, that the southern Irish converted to the Victorian principles not because of papal authority, but because the embassy had obtained Victorian tables in Gaul on their return to Ireland, or because they made no clear distinction between the Victorian and the Dionysiac systems). The next piece of evidence for Rome's conversion to the Dionysiac system is Bede's description of the papal letter to the northern Irish

followed around 664,[87] while it was unanimously accepted in Pictland in AD 710,[88] throughout the *regiones Scottorum* by the 720s,[89] in at least the greater part of Wales by 768.[90] In Francia, the process of adopting the Dionysiac reck-

clergy of AD 640. In this account, Bede (*Historia ecclesiastica gentis Anglorum* 2.19, ed. by Plummer, *Bedae opera* 1, 122–4; hereafter *HE*) argues that the pope-elect instructed the Irish to celebrate Easter Sunday from *luna* 15 to *luna* 21 (which are the Dionysiac lunar limits), but in the subsequent quote from this letter omits any reference to the lunar limits for Easter Sunday. The question now is whether Bede omitted this reference (if it was, in fact, part of the original letter) because he had already mentioned it, or because the lunar limits advocated by the papal curia were, in fact, still the Victorian. The former interpretation is obviously preferred by scholars arguing for a sixth-century change in Rome; cf. especially Jones, 'Paschal tables', 417–9; and furthermore Krusch, 'Einführung', 150; Schmid, *Osterfestberechnung auf den britischen Inseln*, 44; contradictory Gougaud, *Christianity*, 191, 194. I find the latter more likely, as does Poole, 'Earliest use', 59–60. It appears, then, very probable that Rome officially switched from the Victorian to the Dionysiac reckoning in the 640s or 650s, certainly before the Synod of Whitby of AD 664. Cf. Kenney, *Sources*, 215; Gougaud, *Christianity*, 191; Blackburn & Holford-Strevens, *Companion to the year*, 794; and the following note. Ó Cróinín, 'New heresy', 96 argues for this switch having taken place in the 630s. Jones, 'Legend of St. Pachomius', 205 quite unconvincingly argues that Rome remained uncommitted until the ninth century; similarly Stevens, 'Scientific instruction', 90; idem, 'Cycles of time', 41; idem, 'Karolingische Renovatio', 671; idem, 'Present sense', 16.

87 The first disputes in the Anglo-Saxon church concerning the date of Easter originated in the differences between the Victorian reckoning and the 84 (14). The Dionysiac system, for its part, appears to have been first accepted by Benedict Bishop and / or Wilfrid, who had learned the details of this reckoning in Rome in the 650s (where the papal curia must then have just recently adopted it; cf. previous note) and then fervently advocated it on their return to England. The crucial decision in favour of the Dionysiac reckoning was then taken at the Synod of Whitby in AD 664. Cf. *HE* 3.25, 5.19; Stephen of Ripon, *Vita sancti Wilfrithi* 5, 7, 10, 47 (Colgrave, *Life of bishop Wilfrid*, 12, 14–6, 20–2, 98); and the various differing opinions of Krusch, 'Einführung', 153–8; Schmid, *Osterfestberechnung auf den britischen Inseln*, 49–61; Poole, 'Earliest use', 60–1; Gougaud, *Christianity*, 194–7; Betten, 'Adoption', 489–90; O'Connell, 'Easter cycles', 84; Jones, 'Paschal tables', 413, 419; idem, *Bedae opera*, 103–4 (Jones's opinion is that the Dionysiac system was known and taught since the beginning of the Canterbury mission, and that no real distinction was made between the Victorian and the Dionysiac reckoning, both tables being used side-by-side, until the synod of Whitby); Grosjean, 'Recherches', 231–2 (following Jones' point of view with a stronger emphasis on the Dionysiac reckoning); Stevens, 'Scientific instruction', 97–8; Harrison, 'Easter cycles', 1–2; Evans, 'Celtic church', 222–3; Mc Carthy, 'Lunar and Paschal tables', 175–6; Smyth, *Understanding the universe*, 147; Wallis, *Bede*, lxi–iii; Declercq, *Anno Domini*, 155; Ohashi, 'Sexta aetas', 60; Blackburn & Holford-Strevens, *Companion to the year*, 795; Holford-Strevens, *History of time*, 52–4; idem, 'Marital discord'.

88 The source for the conversion of the Picts is Ceolfrith's letter to the Pictish king Nechtan, and Bede's additional information, in *HE* 5.21. For the conversion of the Picts cf. Ussher, *Antiquitates*, 366–7, 541; Krusch, 'Einführung', 163–5; Schmid, *Osterfestberechnung auf den britischen Inseln*, 65–8; Gougaud, *Christianity*, 199–200; Betten, 'Adoption', 493–4; Jones, *Bedae opera*, 104; Declercq, *Anno Domini*, 156.

89 For the developments in Ireland cf. p. LXXXIII–LXXXIX, XCIII–XCV, CLVI–CLVIII.

90 *Annales Cambriae s.a.* 768 (Morris, *Nennius*, 88): *Pasca commutatur apud Brittones †super dominicam diem† emendante Elbodugo homine Dei*. Cf. Krusch, 'Einführung', 166;

oning (as the Latin translation of the Alexandrian system is forthwith called) stretched over decades, if not centuries. That region must have made contact with this reckoning through Italian and Spanish channels in the seventh century, and the Franks were then more immediately confronted with it by Irish and Anglo-Saxon missionaries in the late seventh and throughout the eighth century; the numerous Irishmen remain anonymous, while the most prominent Anglo-Saxons are represented by Willibrord, Boniface, and Alcuin. By the early ninth century, every region in Francia seems to have converted to the Dionysiac reckoning.[91]

3) The period from the early ninth century to 1582, which is marked by the unanimous acceptance of the Alexandrian / Dionysiac reckoning throughout Christendom. Whereas the Easter controversy had been an integral part of society in the early middles ages with three fundamentally different systems (the 84 (14), the Victorian, and the Dionysiac reckoning) competing with each other, no such conflict existed from the early ninth century to the end of the middle ages, from the adoption of the Dionysiac reckoning in the last region of Western Europe to the Gregorian calendar reform.[92]

4) The period from 1582 to the present day, which is again marked by the existence of competing systems, differing in their solar and / or lunar calendars. Differences between competing systems and controversies about the correct calculation of Easter resumed with the introduction of the Gregorian calendar among Catholic churches in 1582. The inaccuracy of the Julian calendar had been discovered by the fact that the astronomical vernal equinox, the day of equal length of day and night, did not happened to fall on 21 March, which is regarded as the vernal equinox in the Dionysiac reckoning, but ten days earlier by the time of pope Gregory XIII.[93] This inaccuracy of ten days had accumu-

Schmid, *Osterfestberechnung auf den britischen Inseln*, 87–8; Gougaud, *Christianity*, 200–1; Betten, 'Adoption', 497–8; Hughes, 'Annales Cambriae', 235; Evans, 'Celtic church', 223–4; Declercq, *Anno Domini*, 156; Blackburn & Holford-Strevens, *Companion to the year*, 796.

91 For the conversion from the Victorian to the Dionysiac reckoning in Francia see the unsatisfactory accounts by Krusch, 'Einführung', 129–31, 136–41; Schmid, *Osterfestberechnung in der abendländischen Kirche*, 83–4; O'Connell, 'Easter cycles', 77; Declercq, *Anno Domini*, 160–4; and furthermore Ohashi, 'Sexta aetas', 61.

92 To be sure, certain chronological elements of the Victorian reckoning, like the *annus passionis*, can still be found in later chronicles; cf. Krusch, 'Einführung', 166. Note, however, that a fundamental difference exists between the observance of an Easter table and the use of its chronological elements: If these elements proved useful and suggestive for the compilation of chronicles, for the composition of an unambiguous linear timeline, then they could outlast by decades (if not centuries) the Easter tables in which they occurred. Accordingly, the fact that such chronological tools are found in chronicles does not allow for conclusions about the Easter reckoning followed at that time.

93 Critique of the Julian calendar and the need for reform was repeatedly articulated by various scholars since the twelfth century. Cf. especially the seminal study of Kaltenbrunner, 'Vorgeschichte', 293–411; and furthermore Wislicenus, *Kalender*, 18–9; Ginzel, *Handbuch*, 252–7; Ferrari d'Occhieppo, 'Osterberechnung', 105–6; McCluskey, *Astronomies*, 198–202; von den Brincken, *Chronologie*, 30–1; Blackburn & Holford-Strevens, *Companion to the year*, 682–3; Holford-Strevens, *History of time*, 33–5. For the discussions and

lated over centuries because a tropical solar year was shorter (the mean tropical year consists of ca. 365.24219, the vernal equinox year of ca. 365.2424 days) than the 365.25 days fixed by Julius Caesar; the Gregorian reformers, more accurately than Caesar, took the tropical solar year to consist of 365.2425 days, which amounted to a difference of 0.0075 days per year, or one day in 133 ⅓ years, if compared to the length of the Julian calendar year. For this reason, two reforms were implemented which turned the Julian into the Gregorian calendar:[94] Ten days were eliminated between 4 October and 15 October 1582, so that 4 October was followed by 15 October in that year. Moreover, the calendar was rendered more accurate by subduing three bissextile days in 400 years, namely the ones in centennial years not being divisible by four (i.e. no bissextile day was to be implemented in 1700, 1800, and 1900, but it was in 1600 and 2000). For the correct calculation of Easter, the same mechanism had to be applied to the lunar calendar, since every solar bissextile day corresponded to a lunar bissextile day; accordingly, whenever a bissextile day was subdued in the solar calendar, it had also to be subdued in the lunar calendar. Finally, the 19-year lunar cycle developed by the Alexandrians from Greek or Babylonian precursors was not absolutely accurate, either. After 310 years, the calculated moon lagged one lunar day behind the astronomical moon. For this reason, the calendar reformers decided to add three lunar days at once, and that in the future eight lunar days should be added in the course of 2500 year in 300-year intervals except for the last interval, which was extended to 400 years; the first such addition was to be implemented in 1800.

At the present day, the difference between the calculation of Easter in the Orthodox Church on the one hand, and Catholic and Protestant churches on the other, is that Orthodox Christians still apply the medieval practice, i.e. the Dionysiac reckoning with its Julian calendar and Alexandrian 19-year lunar cycle, while Catholics and Protestants follow the rules outlined in the Gregorian calendar reform. Yet, this modern unity between Catholics and Protestants in this question is a fairly recent consensus, achieved in 1867, following centuries of disputes about the correct method. Protestant regions were slow in adopting (and at the beginning vigorously opposed to) the Gregorian calendar introduced by the pope in 1582. In 1700, however, most Protestant countries accepted the Gregorian calendar, though not the Gregorian method of reckoning Easter.[95]

disputes immediately preceding the reform cf. Schmid, 'Zur Gregorianischen Kalenderreform', 389–407.

94 For the technicalities of the Gregorian calendar reform cf. especially Wislicenus, *Kalender*, 19–20, 46–51; Bach, *Osterfestberechnung*, 29–32; Ginzel, *Handbuch*, 257–64; Blackburn & Holford-Strevens, *Companion to the year*, 683, 817–9; Holford-Strevens, *History of time*, 35–6, 57–8; and furthermore von den Brincken, *Chronologie*, 31–2.

95 For the introduction of the Gregorian calendar in certain regions between 1582 and 1700 cf. Wislicenus, *Kalender*, 20–1; Ginzel, *Handbuch*, 266–71; Bach, *Osterfestberechnung*, 19–20 (a concise list of all places and dates of change); von den Brincken, *Chronologie*, 32–4; Blackburn & Holford-Strevens, *Companion to the year*, 683–5. For the adoption of the Gregorian calendar in most Protestant countries in AD 1700 and the difference in the calculation of Easter cf. Wislicenus, *Kalender*, 21–2; Goldscheider, 'Einführung', 4–7; Lind-

Incited by the recent astronomical successes of Tycho Brahe and Johannes Kepler, and eager to make a clear statement of independence from papal authority, they preferred to determine the Easter full moon, i.e. the first full moon after the spring equinox, on the basis of astronomical observations rather than cyclic calculations. It was only due to the intervention of Frederick the Great in 1775 that most Protestant countries accepted the Gregorian mathematical method.[96] Fourteen years earlier, England had given way to the Gregorian calendar (though in a different format) as well as the Gregorian mathematical calculation of Easter.[97]

The most turbulent history of adopting a suitable method for the calculation of Easter is that of Sweden.[98] There, the attempt was made to introduce the Gregorian reform gradually over a period of forty years from 1700 to 1740 by subduing the eleven bissextile days of this period. Accordingly, the Julian bissextile day of 1700 was subdued, the two subsequent ones, however, in 1704 and 1708, were not. This led to the bizarre situation that, since 1700, Easter Sunday was recorded a calendar and lunar day later compared to the Julian calendar date and lunar age calculated on Dionysiac principles. In years in which the increase of the lunar age by one led to a transgression of the lunar limit of *luna* 21 (i.e. in Sweden this became *luna* 22), Easter Sunday fell a week (or, more precisely, six days) earlier than in the Dionysiac reckoning. But this situation did not continue for long, since in 1712 the Julian calendar was restored by intercalating two days in February, namely the bissextile day of that year and the bissextile day that was subdued in 1700. Twenty-eight years later, in 1740, the next and equally unique reform was implemented in Sweden, when it was decided that the astronomically calculated Easter full moons should be observed in the Julian calendar, which resulted in Easter Sunday occurring as early as 14 March (25 March in the Gregorian calendar) in 1742. The Gregorian calendar was not introduced until 1753. From that year to 1823 the Swedes reckoned Easter by means of the Gregorian calendar and astronomically calculated full moons. In 1823, then, the Swedish king decreed that the Gregorian Easter was to be followed in the subsequent two years (1824 and 1828) in which the astronomical Easter would differ from the Gregorian one; the official change to the Gregorian mathematically calculated full moons was finally introduced in 1844, and with this act conformity with the Catholics and almost all Protestants was

hagen, 'Der schwedische Kalender', 1–2; Ginzel, *Handbuch*, 272–2; Bach, *Osterfestberechnung*, 20; von den Brincken, *Chronologie*, 34; Blackburn & Holford-Strevens, *Companion to the year*, 685, 798; Holford-Strevens, *History of time*, 60–1.

96 Cf. Wislicenus, *Kalender*, 22; Goldscheider, 'Einführung', 7; Ginzel, *Handbuch*, 273–4; Bach, *Osterfestberechnung*, 20; Blackburn & Holford-Strevens, *Companion to the year*, 798–9; Holford-Strevens, *History of time*, 61.

97 For the case of England and its colonies cf. Ginzel, *Handbuch*, 275; Blackburn & Holford-Strevens, *Companion to the year*, 685–7; Holford-Strevens, *History of time*, 62.

98 For the case of Sweden cf. especially Goldscheider, 'Einführung', 10–37 (34–7 for the post-1700 period); Lindhagen, 'Der schwedische Kalender', 2–4; and furthermore Ginzel, *Handbuch*, 275–6; Blackburn & Holford-Strevens, *Companion to the year*, 687, 798–9; Holford-Strevens, *History of time*, 61–2.

ensured. Only Finland, conquered from Sweden by Russia in 1809, observed the astronomically calculated Easter full moons until as late as 1867.[99]

Yet, the existence of rivalling systems can only be a rough guide for the classification of different periods in the history of computistics. On a more specific level, scientific knowledge and competence has quite naturally also to be taken into consideration, as these constitute the fundamental criteria in the assessment of the history of any science. In terms of computistics, the mere use of an Easter table has a profoundly different quality to the understanding of the technical system underlying such a table;[100] furthermore, the ability to construct a new system obviously lies far beyond the understanding of an existing system. This is especially important for the second phase in the history of computistics outlined above, from the early second to the early ninth century. By the mid-fifth century, the composition of Easter tables had stopped.[101] It may not be a coincidence that this end to the creation of Easter tables coincided with the general decline of scientific knowledge in the West due to the political upheavals of that time. In the decades, and even centuries, after the collapse of the Western Roman Empire, the scientific expertise necessary for the creation of a working luni-solar system appears to have been lacking. In fact, even the understanding of the existing systems seems to have been regressive. Two of the three reckonings followed in the West from the sixth to the early ninth century, the Victorian one and the 84 (14), were transmitted only in tables: On the one hand, no additional technical information that would explain the system underlying his table is given by Victorius in the prologue to his Easter table; on the other hand, the 84 (14) was not, to our present knowledge, accompanied by any explanatory text. Without such guidelines at hand, a full understanding of these reckonings must have been difficult.[102] The situation was slightly better concerning the

99 For the Finnish case cf. Blackburn & Holford-Strevens, *Companion to the year*, 799; Holford-Strevens, *History of time*, 61.

100 Cf. Wallis, *Bede*, lxii.

101 Note that Dionysius, in the early sixth century, did not construct an Easter reckoning, but merely translated an existing one, the Alexandrian reckoning, for western usage. For his computistical skills cf. notes 85 and 103.

102 Concerning the 84 (14), the only known Easter table of that reckoning is not accompanied by any explanatory text in the manuscript (Padua, Biblioteca Antoniana, I 27, fol. 76r–77v; this table is preceded by Anatolius (?)'s *De ratione paschali*, and followed by a lemmatized explanation of certain features of the Dionysiac and ps-Dionysiac *argumenta*). The only text that supplies a reasonable amount of technical details about the 84 (14) is the Munich Computus itself (for the passages cf. note 253). Victorius' computistical work consists of the prologue to his Easter table and the Easter table proper (Krusch, *Studien* II, 17–52); the prologue itself does not explain any constructional detail of this reckoning. Later textbooks describing the Victorian reckoning are extremely rare. Only three texts from the seventh and eighth centuries deal with this reckoning exclusively, namely *Dial. Burg.*, *Quaest. Austr.*, while the earliest and most interesting still remains unpublished in Bern, Burgerbibliothek, 645, fol. 41r–71v. But technical information about this reckoning can also be found in the few texts that compare the Victorian with the Dionysiac reckoning (cf. notes 184–5, 239, 252).

third reckoning, the Alexandrian, termed the Dionysiac in its Latin adaptation. Despite being a rather untalented computist himself,[103] Dionysius provided numerous interesting technical details about this reckoning when translating and applying the Greek material available to him. In his prologue, he gives detailed instructions for converting an expiring 95-year Easter table into one that covers the subsequent 95-year period.[104] Additionally, he attached a number of computistical algorithms to his Easter table, designed to calculate and check the data listed in that table.[105] Finally, the only object of Dionysius' letter to the papal

103 It appears that Dionysius' Greek sources rather than his own computistical ability must have been outstanding; cf. note 85 above. His computistical incompetence is revealed by his treatment of the cyclic character of the 19-year cycle: Being unable to prove this cyclic character himself, he looked for sources that would provide him with the essential proof. Yet, he could only find a proof of the cyclic character of the eight-year lunar cycle underlying the Hippolytan table in Quintus Julius Hilarianus' writings. Since the 19-year cycle is divided into *ogdoas* and *hendecas*, i.e. into periods of eight and eleven years, he used Hilarianus' proof to show that the *ogdoas* is truly cyclic. This left him with the impossible task of proving that the *hendecas* was truly cyclic as well. It appears that he never realized the simple mathematical fact that eight and eleven years each could only be truly cyclic if one year was truly cyclic, since the only common divisor of eight and eleven is one; however, a lunar year, as Dionysius himself very well knew, had eleven days less than a Julian calendar year, so that one year could not constitute a lunar cycle. Since no attention has been drawn to Dionysius' problematic discussion of the 19-year cycle since the 18th century (cf. Noris, *Dissertationes*, 225; van der Hagen, *Observationes in veterum patrum prologos et epistolas*, 216), and since these early modern scholars were bewildered by Dionysius' misconception rather than able to provide an explanation (being unaware of Dionysius' source), it may be appropriate to cite here at length the relevant passage of Dionysius' letter to Boniface and Bonus, as well as his source. *Epistola Dionysii* (Krusch, *Studien* II, 83): *In ogduade diximus V annos esse communes, tres embolismos. Quinquies ergo trecenteni quinquageni quaterni fiunt ĪDCCLXX et ter trecenteni octuageni quaterni, ĪCLII, ac per hoc simul fiunt ĪĪDCCCCXXII. Similiter octo anni solares, si in summam redigantur, id est, octies trecenteni sexageni quini et quadrantes, faciunt simul ĪĪDCCCCXXII. Simili modo et endicadis annos, qui sunt communes VII et quattuor embolismi, si in summam ea, qua diximus, supputatione congesseris, tantundem paene repperies, quantum XI solares anni conficiunt hoc est ĪĪĪĪXIIII. Haec est igitur embolismorum, sicut praediximus, ratio, ut incrementis suis communium annorum detrimenta compensent*. Quintus Julius Hilarianus, *Expositum de die paschae et mensis* 13 (*PL* 13, 1113B; the corrections are mine): *Inde per annos singulos hac diversitate dies annorum lunae cum diebus solis, qui in trecentis sexaginta quinque et quadran<te> conficit annum, non sibi concordare videntur. Proinde etiam hoc ostendimus, ut appareat omnibus aequales eos invicem dies habere, et ab initio cursus eorum isto ordine cucurrisse, et damna communium annorum eadem luna in annis embolysmis compensasse. Octo annorum rationem, quae perfecta fore videtur, in medium proferamus. In octo scilicet annos luna quinque annos habet communes et tres embolysmos. Ergo quinquies CCCLIV faciunt <M>DCCLXX, et ter CCCLXXXIV faciunt MCLII; fiunt simul dies duo millia DCCCCXXII. Sic deinde et solis octo annorum summam in unum colligamus octies CCCLXV quadran. duo millia DCCCCXXII. Ita igitur congregavit solis ac lunae cursus cum diebus suprascriptis*.

104 Krusch, *Studien* II, 64. For this manual and its application cf. especially van der Hagen, *Observationes in veterum patrum prologos et epistolas*, 68–71, 194–6; Declercq, *Anno Domini*, 101, 105–6; idem, 'Dionysius Exiguus', 192, 198–9.

105 For the Dionysiac *argumenta* see especially Warntjes, 'Argumenta' and now also Mosshammer, *Easter Computus*, 97–106.

magistrates Boniface and Bonus was to explain the 19-year cycle. Yet, his technical explanations are not always correct, and numerous crucial technicalities remained unconsidered in his works.[106] It cannot be doubted that better computists than Dionysius existed in the western Mediterranean in the sixth century, especially in centres with Byzantine connections,[107] but the further these tables and texts travelled in time and space, the less likely it was that computists knew more about these reckonings than what they found in these tables and tracts.

In the seventh century, Insular computists, like almost all computists of Western Europe, were therefore faced with the situation that the material available to them did not provide for a full understanding of the computistical systems. When confronted with the Dionysiac reckoning, they were basically left with the challenging task of reconstructing the system underlying it. This task was successfully accomplished by Insular computists by the early eighth century, so that computists of regions subsequently converting to the Dionysiac reckoning, most notably Francia, could study all important details of this reckoning in Insular texts. Then, after the Dionysiac system had become the undisputed reckoning throughout almost all of Western Europe in the late eighth and early ninth centuries, the basic preoccupation of computists was the invention of new or better methods of calculating calendrical data within this system. The system itself was not questioned for another two hundred years, for various reasons: Its century-long tradition, going back to the legendary Alexandrian computists, as well as being connected to the decrees of the council of Nicaea of 325, gave it the utmost authority. The workings of this system were now completely understood and appreciated, with its errors being only marginal. And, most importantly, for the first time in the history of Christianity, unity was achieved in the observance of Easter, the most important Christian feast, due to the unanimous acceptance of this reckoning. This situation only changed with the improvement of scientific knowledge due to contacts with the Arabic world from the very late tenth century onwards. The introduction of fundamental

106 For the most obvious of Dionysius' mistakes cf. note 103 above. Crucial information about the construction of the 19-year cycle are not mentioned by Dionysius, most importantly the exact placements of the *saltus* and of the embolisms within the Julian calendar; moreover, he apparently was not aware of the existence of lunar bissextile days. This led to confusion and differing customs among seventh- and eighth-century computists. Cf. note 111.

107 The anonymous authors of the additions to Dionysius' *argumenta* were able computists (cf. Warntjes, 'Argumenta'). Slightly later, in AD 640/1 (for the date cf. van der Hagen, *Observationes in Maximi monachi computum paschalem*, 2–4), Maximus Confessor's *Computus ecclesiasticus* demonstrates that there must have been a tradition of good computists among the Greek-speaking population in the Western Mediterranean in the sixth century; it must be presumed that Dionysius himself relied on their studies. Unfortunately, Maximus Confessor's computus has not received much attention among modern scholars (as so often, the most detailed discussion of this work still is van der Hagen's 18th-century *Observationes in Maximi monachi computum paschalem*; it is also discussed in Schwartz's excellent study, 'Ostertafeln', 81–8) and this most interesting work still awaits a critical modern edition (the latest edition appeared in *PG* 19, 1217–80, a reprint of Dionysius Petavius's early 17th-century edition and Latin translation). For other Greek paschal texts from the fourth and early seventh century cf. Schissel & Ellend, 'Berechnung', 150–1.

Greek and Arabic texts, as well as astronomical instruments, led to a rapid improvement of scientific expertise, especially in astronomical observations. Even though the Dionysiac reckoning was not abandoned anywhere for another five hundred years, its faults became increasingly apparent, the critique of this system increasingly louder, until it finally culminated in the Gregorian calendar reform.[108]

This tour de force through the history of computistics provides the context for an understanding of the particular importance of the Munich Computus. The seventh and early eighth century transpired as an exceptionally significant period in the history of computistics, since it saw the final and possibly most vigorous controversy about the correct method of calculating Easter before the Gregorian reform, a controversy that continued in Wales and Francia right into the early ninth century. Moreover, the reconstruction of the Alexandrian / Dionysiac system in this formative period set this influential and long-lasting (in the Orthodox Church to the present day) reckoning for the first time on a solid footing in Western Europe. In modern literature on computistics, one man alone is usually credited with this exceptional achievement, the Anglo-Saxon scholar Bede, so that the formation of medieval computistics became synonymous with Bedan computistics.[109] Hardly ever is his work discussed in context, and it has

108 Cf. the references in note 93.

109 The only serious attempt to place Bedan computistics into context was undertaken by Jones in his first edition of *De temporum ratione* (*DTR*) (Jones, *Bedae opera*; this is the edition used in the present study), in which he frequently referred to texts like the Bobbio Computus, the pseudo-Alcuin tracts on the *bissextus* and *saltus*, *De divisionibus temporum*, *Dial. Burg*., and some minor treatises. However, unpublished comprehensive textbooks that had already been identified some decades before Jones's publication, like the Munich Computus and *Dial. Neustr.*, were not consulted. Since Jones' day, studies of Bede's computistics were not based on more than Jones' evidence, even though new texts had come to light; in fact, most scholars of Bedan computistics did not even consider the same material as Jones did. The fact that most of these new texts remained unpublished appears to have been the reason for their neglect, which led to a totally unbalanced view of Bede's computistical achievement. But even those texts which received a critical modern edition, like *De ratione conputandi* (*DRC*), were never compared in detail to Bedan thought by Bedan scholars. The tendency of present scholarship is to analyze and explain Bedan computistics in isolation rather than against the background of the compustical literature immediately preceding and following Bede; this tendency is impressively illustrated by the latest commentary on *DTR* (Pillonel-Wyrsch, *Calcul*), in which no computistical text between Isidore and Rabanus Maurus is seriously considered. If scholars want to do Bede and his contemporaries justice, they will need to place Bedan computistics in the context of immediately preceding Irish and immediately following Frankish computistics; this means that, additional to the texts referred to by Jones, at least the three known Irish computistical textbooks (cf. p. LIV–LV; for the other two Irish computistical textbooks besides the Munich Computus, see especially p. CXXXIII–CLII for the *Computus Einsidlensis*, p. CXCI–CCI for *De ratione conputandi*) and the 20 Frankish texts just published by Borst, *Studien*, *always* need to be included in the analysis. For the common overrating of Bede's computistical achievement cf. Schwartz, 'Ostertafeln', 93 (comparing Bede's with the Munich computist's achievement); Krusch, *Studien* II, 58 (a statement approved of by Jones, *Bedae opera*, 138); Cordoliani, 'Comput', 46; Rissel, *Rezeption*, 26–7; idem, 'Hrabans Liber de

almost always been overlooked that Bede stands at the end of a tradition of intense scholarly research in computistical questions undertaken in Britain and Ireland, most prominently in the *regiones Scottorum*, in the seventh century. More importantly, Bede's works certainly did not solve every computistical question of his day, or of the centuries to come.[110] Certain fundamental issues, like the beginning of the Lenten fast, were not even touched upon in his texts, and for others he only recorded his own, regional customs, sometimes not even very clearly.[111] Accordingly, computistics of the centuries after Bede cannot

computo', 138–9; Pedersen, 'Ecclesiastical calendar', 56–9; Stevens, 'Bede's scientific achievements', 18–9; Bergmann, *Innovationen*, 16–20; Borst, 'Computus', 16; Englisch, *Artes liberales*, 281, 475; Wiesenbach, *Sigebert von Gembloux*, 52–3; von den Brincken, *Chronologie*, 10, 49, 74; Germann, *De temporum ratione*, 32; and also the following note.

110 The belief that Bede's work solved every computistical problem of its time is still common. Cf. Manitius, *Geschichte*, 78–9; Englisch, *Artes liberales*, 281; Germann, *De temporum ratione*, 34, 78; see also the previous note.

111 Walsh & Ó Cróinín, *Cummian's letter*, 102–3, have quite rightly observed that Carolingian computists writing after the reception of Bede's works clearly felt that the Northumbrian scholar had not solved every computistical problem of their day, and modern scholars should take this feeling seriously. E.g., Bede does not discuss the *initium quadragesimae* anywhere in his computistical works, even though it needs the same technical explanations as Easter Sunday, on which it totally depends. (Note that a thorough discussion of the *initium* given by Rabanus Maurus (*De computo* 83), who is often accused of not providing any information beyond Bede, constitutes one of the main differences between his and Bede's work; yet, Rabanus Maurus is only the redactor, not the original author of this chapter, which is largely based on chapter 28 of a still unpublished and originally unfinished Fulda computus of AD 789 (Basel, Universitätsbibliothek, F III 15k, fol. 36r–49r: fol. 43v–44r); this unfinished, but still extremely interesting text presumably has to be connected to the *Admonitio generalis* of the same year, and still awaits a thorough sudy and especially a critical edition). The placements of the embolisms listed by Bede (*DTR* 45.35–38) reflect only his own regional custom; since Dionysius had never defined these placements (cf. note 106), every computistical centre had its own theory about them; from the ninth century onwards Bede's placements became standard in most regions, but before AD 800 countless different opinions on them exist; these have never been studied in detail (only Sickel, 'Lunarbuchstaben', 174–80 notes that different customs existed, but ascribes the main variations to the late rather than the early middle ages; cf. now Holford-Strevens, 'Lunar calendars', 201), but it may suffice here to say that hardly ever do two texts written before the reception of Bede agree on the placements of the embolism (especially the tables listing the lunar age of the calends of every month for all 19 years vary considerably, reflecting different placements of the embolisms and the *saltus*); cf. p. CLXV. Bede (*DTR* 41) places special emphasis on the lunar bissextile day, and rightly so, since the application of lunar bissextile days was crucial to an understanding of the 19-year cycle; in this chapter, Bede argues that the lunar bissextile day should be placed at the end of the February lunation; he does not mention that a different (presumably Irish) custom exists, according to which the lunar bissextile day accompanies the extra Julian calendar day (this custom is deducible from the *Computus Einsidlensis* (*CE*) (Einsiedeln, Stiftsbibliothek, 321 (647), p. 82–125) p. 119–122; the Munich Computus (MC) c. 58; *De ratione conputandi* (*DRC*) c. 100–102). Concerning another feature not specified by Dionysius, the exact placement of the *saltus* in the Julian calendar, Bede mentions three options, namely the end of the July, November, or March lunation (*DTR* 42.55–63); as it is obvious from his calculations, he preferred and applied the November placement (cf. especially *DTR* 20.41–45); yet, he never explicitly states this preference, which confused modern commentators more than

entirely be explained or understood by reference to his works alone, since many aspects simply lie outside of Bedan tradition. This is even more so the case for the decades and even centuries preceding Bede. Even though the Easter controversy plays an immensely important part in his *Historia ecclesiastica gentis Anglorum*, he is remarkably silent in his computistical works about the technical details of the reckonings in question other than the Dionysiac one. Being an ardent supporter of the Dionysiac system, he wanted to draw his readers away from the older methods that he despised. Consequently, only very few details about the 84 (14) and the Victorian reckoning can be found in Bede's texts,[112] and he is equally silent about the technical arguments discussed in the Easter controversy (the theological ones are outlined in his *Historia ecclesiastica gentis Anglorum*). A study of the technical details of the 84 (14) and the Victorian reckoning in general, and of the technical issues of the Easter controversy in particular, in order to fully grasp und understand pre-Bedan computistics and especially the intellectual foundation of the Easter controversy, cannot be based on Bede, who deliberately obscures rather than illuminates the reckonings he condemned.[113]

The most important key to an understanding of computistical issues neglected or differently interpreted by Bede but prominent in seventh- and eighth-century and later discourse, as well as of the context of Bede's own work, is supplied by Irish computistics of the period between the reception of the writings of Isidore of Seville and those of Bede.[114] Only three Irish texts of this pe-

medieval computists; it is a widely accepted (and absolutely wrong) modern assumption that Bede favoured the March placement, an assumption based on Bede's phrasing in *DTR* 42 rather than his more significant calculations (cf. Noris, *Dissertationes*, 237; Wallis, *Bede*, 327–8; Borst, *Streit*, 48; idem, *Schriften*, 408; already van der Hagen, *Observationes in veterum patrum prologos et epistolas*, 287–8 criticizes this opinion, and then (p. 352–3) gives the proof that Bede followed the November placement; also correct is Springsfeld, *Alkuins Einfluß*, 138–42). For the *saltus* see p. CLXVI–CLXVII; for Irish computistical features of the late seventh, early eighth centuries see p. LXIX–LXXIII, CIII, CXXXIII–CLII, CLIX–CLXVIII, CXCV–CC below.

112 The only details about the Victorian reckoning mentioned by Bede are the placement of the *saltus* in the sixth year of the *ogdoas*, leading to an epactal change from 4 to 16 on 1 January (*DTR* 43.32–34), as well as the lunar limits for Easter Sunday of *luna* 16 to 22, which he does not explicitly attribute to Victorius (*DTR* 59.26–28); likewise, in *DTR* 62.12–38 Bede discusses the one year in the Victorian 19-year cycle in which the Easter full moon occurred before the equinox of 21 March, without any reference to Victorius; on the other hand, in *DTR* 51 he condemns the Julian calendar limits for the Easter new and full moon ascribed to the Latins in Victorius' prologue without specifying that Victorius, in fact, did not follow these limits in his Easter table; thereby, he gives medieval computists, as well as modern commentators, the totally misleading idea that these limits were Victorius' own, whereas Victorius only referred to them as the limits of the *Supputatio Romana*. Concerning the 84 (14), Bede only mentions the lunar limits for Easter Sunday, *luna* 14 to 20 (*DTR* 51.36–44).

113 Besides the three Irish computistical textbooks discussed below, the fundamental texts dealing with these two reckonings are listed in note 102.

114 For previous assessments of Irish computistics of this period cf. Ó Cróinín, 'A seventh-century Irish computus', 99–127; Borst, *Schriften*, 73, 134–8.

riod are known,[115] of which only one, *De ratione conputandi* (*DRC*), has been edited before the publication of the present book.[116] With the edition of the other two, the Munich Computus and the newly discovered *Computus Einsidlensis* (*CE*), this formative period in the history of computistics and its implications will be more readily understood.[117] Among these three Irish texts, the Munich Computus holds a special position, since it is the only one that is securely datable. It therefore must constitute the basis for the contextualisation of the other two texts.[118] Standing at the end of the Easter controversy in the *re-*

115 A note is necessary here on two texts that are often included in the corpus of Irish texts from this period, namely the Bobbio Computus (for its other names cf. p. XXIV above) and the work called the 'Irish computus', *De ratione temporum uel de compoto annali*, or *Sententiae in laude compoti*. The first of these is a computistical anthology compiled in Bobbio in the first quarter of the ninth century; it certainly contains numerous original Irish tracts, but likewise Anglo-Saxon and especially Frankish material, some of which were composed as late as AD 827; therefore, the Bobbio Computus in its entirety cannot be regarded as representative of Irish computistics, nor of Irish computistical knowledge in the seventh and early eighth centuries; it has to be carefully analyzed with the object of disentangling the various strata; for this task, the three computistical Irish textbooks will certainly be of special importance. The second text presents a very similar case; the extent of this text has never been clearly defined, but it is quite obvious that it is a Frankish text based, but not exclusively, on Irish material (cf. note 55); again, first the text, and then the various strata need to be carefully specified. More fruitful would be the reconstruction of the archetype of the text *De divisionibus temporum*, of which a later recension is published in *PL* 90, 653–64; it appears that the archetype of this text dealt exclusively with the fourteen divisions of time; since the first half of the Munich Computus is based on such a text, it is quite obvious that the archetype originated in seventh-century Ireland (for the numerous unedited versions of this text cf. especially Jones, *Bedae pseudepigrapha*, 48–51 and see also note 332). Besides these rather problematic texts, note should be taken of the 'Langobardische Zwiegespräch' (*Dial. Langob.*) just recently published by Borst, *Schriften*, 433–61; Borst, *Schriften*, 424–4 argues that this text was written by an Irishman in Bobbio at around AD 750; the detailed discussion of the indiction in the final chapter of this work (*Dial. Langob.* 26) certainly points to a continental origin of this text; on the other hand, there are numerous parallels between this text and the Munich Computus in otherwise rarely-attested computistical features; moreover, except for the chapter on the indiction, this text appears to reflect nothing but Irish computistical thought of the early eighth century; for these reasons I find it as likely that *Dial. Langob.* was composed in the *regiones Scottorum* early in the eighth century (cf. the more detailed discussion of this text on p. CLXXIV–CLXXIX below). Finally, the present study has unearthed another Irish treatise, to be termed *De comparatione epactarum Dionysii et Victorii* and to be dated to AD 689; it is discussed and edited below p. CLII–CLVIII and Appendix 2 respectively. An Irish computus based on Victorian principles, now lost, was also compiled in this year; cf. p. CXXIV–CXXVI below.

116 Walsh & Ó Cróinín, *Cummian's letter*, 113–213.

117 For the *Computus Einsidlensis* (Einsiedeln, Stiftsbibliothek, 321 (647), p. 82–125) cf. Warntjes, 'Computus Einsidlensis', 61–4; Bisagni & Warntjes, 'Early Old Irish material', 77–105; and p. CXXXIII–CLII below.

118 For an analysis of the chronological order of these three texts, with the securely datable Munich Computus at its heart, see the discussions of the *Computus Einsidlensis* (p. CXXXIII–CLII) and *De ratione conputandi* (p. CXCI–CCI) below; for the date of the Munich Computus itself see p. LVII–LXI below.

giones Scottorum, and having a scholarly rational and rather unbiased focus,[119] these texts, and especially the Munich Computus, provide a unique insight into the older reckonings[120] and the technical questions posed and arguments discussed in the debates of the seventh century.[121] On the other hand, documenting an earlier phase in the reception of the Dionysiac reckoning than Bede, they show a clearer picture of the difficulties faced at the earliest attempts of first analyzing and then reconstructing this new system. In this process, specifically regional customs, to be vaguely connoted as Irish, developed prior to and contemporaneous with Bede's writings. The computistics particularly of the eighth to the tenth centuries depended as much on these Irish customs as on Bedan theories.

119 Scholars of medieval mentalité have quite recently started to analyze scientific attitudes and rationality in computistics as the foremost science of this period. In these studies, the focus in the early middle ages lies exclusively on Bede. This narrow focus leads to the conclusion that early medieval science is dominated by Christian beliefs; a strictly scientific attitude did not exist, but science was rather steeped in theological explanations and justifications; computistics was a means of understanding God's creation, a *doctrina christiana*; cf. Englisch, *Artes liberales*, 301–6, 393, 475–6; Wallis, *Bede*, xxi–viii (conceding p. lxxxviii–xcvi that this attitude changed in Carolingian times); Pillonel-Wyrsch, *Calcul*, 4; Germann, *De temporum ratione*, 41–4. It should be noted, however, that Bede stands at the beginning of (or isolated in?) this attitude towards computistics. Computistics turned into a *doctrina christiana* only at a time when one system for the calculation of Easter was unanimously accepted. Admittedly, the arguments prevailing in the Easter controversy of the seventh century certainly were primarily of a theological and dogmatic nature. On the other hand, this controversy also shaped a scientific mentality that would even meet modern standards, in which differing systems and customs were compared in detail and explained on a purely technical, non-theological level. An outstanding example of this early medieval scientific attitude is the *Computus Einsidlensis*, which certainly deserves a detailed study in this respect, comparing its strictly scientific methodology with Bede's more theological and dogmatic approach.

120 Cf. the passages listed in notes 251–3.

121 In this respect, chapter 52 of the Munich Computus is particularly noteworthy. It shows that followers of the Victorian reckoning must have vehemently criticized the Dionysiac reckoning for not recording accurate data for the *annus passionis* (the year of Christ's passion); in the year regarded as the *annus passionis* by Victorius and his followers, AD 28, the lunar age of Easter Sunday was 15 in the Dionysiac reckoning rather than *luna* 17, which would have been the lunar age suggested by certain authoritative texts and the Synoptic Gospels. Adherents of the Dionysiac reckoning tried to counter this accusation by a technical trick, namely by correlating the epacts of the Dionysiac *ogdoas* with those of the Victorian *hendecas*; this led to the desired data occurring in the second year of this comparison, which is the equivalent to the Victorian *annus passionis*. Only two other texts deal with the same question, namely the rather obscure *Comp. Col.* 5.4–6, and a more detailed and comprehensible, but to the present day unedited and even unnoticed tract in Cologne, Dombibliothek, 83², fol. 176v–178r, here termed *De comparatione epactarum Dionysii et Victorii*, discussed and edited for the first time below on p. CLII–CLVIII and Appendix 2 respectively.

THE MUNICH COMPUTUS IN THE HISTORY OF COMPUTISTICAL TEXTBOOKS

This formative period in the history of medieval computistics, roughly AD 650 to 750, also witnessed the origin of a new literary genre, the computistical textbook. In late antiquity, western Latin computistical writings, as far as can be judged from the surviving texts, consisted almost exclusively of only one type of text (neglecting Easter tables and their prologues here), namely computistical letters discussing the Easter dates of certain years, or more generally the theological arguments for and against certain solar and lunar dates connected to this feast.[122] This situation changed with the computistical works of Dionysius Exiguus, who appended a body of *argumenta*, of mathematical algorithms for the calculation of calendrical data, to his Easter table. Such a strictly defined body of algorithms, often incorporating mathematical tools (like multiplication tables) and additional texts designed for an understanding of these algorithms, can be characterized as a computistical formulary. The origin of the computistical formulary written in Latin, therefore, lies in Dionysius' writings.[123] In the ca. 150 years after its initial composition, this body was only marginally extended. Yet, from the last quarter of the seventh century, this genre started to flourish, primarily due to the acceptance of the Dionysiac reckoning in certain regions. By the eighth century, computistical formularies were well-established, constantly growing in size with markedly differing structures.[124] Parallel to this development was the creation of computistical anthologies, large collections of computistical material of all sorts. It appears that the first such collections were established in seventh-century Spain (though no Spanish anthology of the seventh century has survived), but soon they became the primary means of transmission of computistical texts, formularies included, throughout the Latin West.[125] The computistical textbook, for its part, had a similar, but more specific and structured purpose. It was designed to supply its reader with a comprehensive and well-structured introduction and guide to all aspects deemed necessary for a thorough understanding of this subject.

The first author to assemble in a structured way a great variety of basic but essential information on the reckoning of time in general, and the calculation of

122 Cf. Wallis, *Bede*, xvii. There are two noteworthy exceptions, namely the paschal tract of Anatolius (?) (ed. Mc Carthy & Breen, *De ratione paschali*, 44–53; *DRP* hereafter) and the Carthaginian Computist (ed. Krusch, *Studien* I, 279–97).

123 Dionysius explicitly states that he worked from 'Egyptian' sources when compiling the *argumenta* (Krusch, *Studien* II, 67), so that it can be deduced that computistical formularies written in Greek had a longer tradition. Cf. especially Piper, *Kalendarium*, 144–5; Declercq, 'Dionysius Exiguus', 200–2; and also notes 85, 107. See also Neugebauer's (*Ethiopic astronomy*, 70–6) discussion of a Coptic formulary.

124 For this development cf. especially Warntjes, 'Argumenta'; and furthermore Piper, *Kalendarium*, 145–8.

125 For computistical anthologies cf. Jones, *Bedae opera*, 75–7; Rissel, *Rezeption*, 22–4; Borst, *Schriften*, 146–51; Germann, *De temporum ratione*, 14–5.

Easter in particular, was the Spanish bishop Isidore of Seville († AD 636). Yet, this information was scattered in three sections throughout his great encyclopaedia, the *Etymologiae*. In book three, chapters 24 to 71, he discusses astronomical theory; in book five, chapters 28 to 39, the various divisions of time are outlined; book 6 chapter 17, then, specifically deals with the calculation of Easter. Seventh-century computists were generally not too concerned with astronomical theory. To them, computistics was a mathematical rather than an astronomical science. Basic lunar and solar theory for explaining the structure of the solar and lunar calendar was all they were concerned with in astronomical terms. Astronomy was granted a more important place in computistics only from Bedan times.[126] Accordingly, when computists in the seventh century thought about the creation of a concise computistical textbook, detailed astronomical theory was not part of their consideration. In my opinion, the first computistical textbook consisted merely of a combination of book 5, chapter 28 to 39, and book 6, chapter 17 of Isidore's *Etymologiae*.[127] This combination must, however, soon have been regarded as too basic and not comprehensive enough, so that it was reshaped with additional information from Macrobius, Dionysius Exiguus, Victorius of Aquitaine, Isidore's *De natura rerum*, and other texts.

The exact date of the first of these comprehensive computistical textbooks cannot be determined. The earliest securely datable computistical textbook is Bede's *De temporibus* of AD 703 (*DT*), which was, however, far from comprehensive.[128] Precisely because the scope of this work was felt to be too narrow

126 Astronomical theory like the course of the sun and the moon through the zodiac is not discussed in any of the Irish computistical textbooks of the late seventh and early eighth centuries; Bede introduced this theory into his *De temporum ratione* (c. 16–19), and ever since it held a prominent place in the study of computistical theory (the Bedan chapters, e.g., are cited in *Lib. ann.* 69; *Lib. calc.* 36–38; RM 39–42; PV §§320–336; note that there is no sign of such discussion in Frankish computistics before the second half of the eighth century). Cf. also Eastwood, 'Dungal's letter', 118; McCluskey, 'Astronomies in the Latin West', 144 (arguing that 'geometrical astronomy' (dealing with the course of the sun and the moon through the zodiac and other theories) became an integral part of computistics only from Bedan times onwards).

127 Similarly, Jones, *Bedae opera*, 130–1 argues that Northumbrian schools before the compostion of Bede's *DT* in AD 703 relied predominantly on books 5 and 6 of Isidore's *Etym.* (as well as the texts transmitted in the Sirmond MS) for computistical theory. Problematic for the interpretation outlined above, however, is the fact that *Etym.* 5.28–39 and 6.17 are not transmitted as a separate tract in any MS to my knowledge. Note, however, that Isidore's chapters on the various divisions of time, his chronicle, his chapters on astronomy and on cosmology constitute an independent text in Paris, Bibliothèque Nationale, Lat. 5239, fol. 145r–162r; Paris, Bibliothèque Nationale, Lat. 5543, fol. 148–157v. Moreover, in the Bobbio Computus (*BC*) c. 140, Isidore's discussion of the calculation of Easter (*Etym.* 6.17.10–32, i.e. *Etym.* 6.17 without the history of paschal cycles and the Easter table) is transmitted as a separate text, denoted as a letter of Cyril; strangely enough, neither Jones nor Borst realized its true content: Jones, *Bedae opera*, 97 regards this text as 'a late corruption, probably Irish'; Borst, *Schriften*, 939 as a genuine Cyrillian letter.

128 In the present study, Jones' first edition of Bede's *De temporibusm* is used (Jones, *Bedae opera*, 293–303); this edition is preferable to Jones's second edition in *CCSL* 123C, since

by the brethren of Bede's monastery, he compiled a more comprehensive text, *De temporum ratione* (*DTR*),[129] which was to become the standard work in computistics for centuries. Bede composed this work in AD 725,[130] but six years earlier, in AD 719, an equally comprehensive textbook originated, the Munich Computus. Consequently, the Munich Computus is, contrary to modern belief, the *earliest securely datable comprehensive* computistical textbook known at present, and as such deserves all due attention.[131] The only comprehensive computistical textbooks known at present that may be earlier, but which do not incorporate dating clauses, are the other two Irish texts of that genre, *De ratione conputandi* and the *Computus Einsidlensis*. Both texts can be safely placed in the period between the reception in Ireland of Isidore on the one hand, and that of Bede on the other, that is to say roughly between AD 650 and 750.[132] Moreover, both texts advocate the Dionysiac reckoning, so that it must be presumed that they were not compiled before the unanimous acceptance of that reckoning at leastin certain parts of the *regiones Scottorum*. Consequently, it seems unlikely to me that they were compiled pre-ca. AD 670.[133] Whether or not they were composed at any stage prior to the Munich Computus can only be determined by a detailed comparison of these texts, which is provided further below, the results of which may be briefly summarized here: When the textual details of the *Computus Einsidlensis* and *De ratione conputandi* are compared

it has better readings and provides valuable commentary; but note that only the *CCSL* edition includes the chronicle and glosses. In this work, Bede explicitly refers to AD 703 as his *annus praesens* in the computistical algorithms of chapter 14.

129 In the present study, Jones' first edition of Bede's *De temporum ratione* is used (Jones, *Bedae opera*, 173–291; this edition is preferable to Jones' second edition in *CCSL* 123B, since it has better readings and provides valuable commentary; but note that only the *CCSL* edition includes the chronicle and glosses). Bede outlines the reasons for compiling *De temporum ratione* in the preface to this work. For commentaries on this passage and Bede's reasons for writing this textbook cf. Wallis, *Bede*, 253–4; Pillonel-Wyrsch, *Calcul*, 6–13.

130 Bede mentions AD 725 twice as the *annus praesens* in his work: *DTR* 49.4, 52.3; the date is given once without reference to the *annus praesens*: *DTR* 54.

131 For the false belief that Bede's *De temporum ratione* is the first comprehensive treatment of computistics cf. Cantor, *Vorlesungen*, 828; Rissel, *Rezeption*, 26–7; Englisch, *Artes liberales*, 475; Wallis, *Bede*, xvi–vii; Germann, *De temporum ratione*, 45, 78.

132 The reception of Isidore in Ireland is heavily disputed: AD 650 constitutes the earliest possible date, and therefore this is chosen here; cf. Anspach, 'Fortleben', 327–9, 337–8 (dating the first citation of Isidore's work in Irish texts to the first half of the seventh century); Bischoff, 'Europäische Verbreitung', 180–3 (certainly late seventh century); Löfstedt, *Malsachanus*, 50–1 (mid-seventh century); Smyth, 'Isidore of Seville', 69–102 (late seventh century); Herren, 'Earliest Irish acquaintance', 243–50 (mid-seventh century); Ó Cróinín, *Early medieval Ireland*, 213–4; idem, 'Hiberno-Latin literature', 390 (mid-seventh century). In the end, the Isidorian reception in Ireland depends very much on the dating of the Irish computistical texts here discussed. The reception of Bede's computistical works is equally difficult to establish; AD 750, 25 years after his composition of *DTR*, only serves as a rough guide here.

133 For the acceptance of the Dionysiac reckoning in Ireland cf. p. XXXIX–XL, LXXXIII–LXXXIX, XCIII–XCV, CLVI–CLVIII.

to those of the Munich Computus, it transpires that the *Computus Einsidlensis* must have been written before the Munich text, i.e. pre-AD 719, while *De ratione conputandi* shows dependencies on both of these two texts and therefore appears to have been compiled post-AD 719. Further analysis of these two texts then suggests that the *Computus Einsidlensis* was composed ca. AD 689–719, *De ratione conputandi* ca. AD 719–727.[134] Accordingly, my reading of the evidence is that these three Irish computistical textbooks originated roughly in the period AD 689–727, the chronological order being: *Computus Einsidlensis*, Munich Computus, *De ratione conputandi*.

The concept of a computistical textbook, which originated in this Insular context of the late seventh century, certainly shaped the study of that science in the early middle ages, and even thereafter. The earliest Frankish computistical texts, written before 750, appeared in this or related formats, though the structure may have been different and at times it is debatable whether these texts should be considered as comprehensive texbooks or rather treatises dealing with specific chronological issues.[135] In the ninth century, Pacificus of Verona, Rabanus Maurus, and, most influentially, Helperic of Auxerre at the end of that century, decided to arrange computistical knowledge in textbooks.[136] The tenth

134 See the detailed analyses p. CXXXIII–CLII and CXCI–CCI below. For the dating of the *Computus Einsidlensis* see now also Bisagni & Warntjes, 'Early Old Irish material', 81–91 (an earlier view, superseded by the just mentioned article, is presented in Warntjes, 'Computus Einsidlensis', 62–3). Prior to the present study, Ó Cróinín dated *De ratione conputandi* to ca. AD 650 (Ó Cróinín, 'A seventh century Irish computus', 121), and this dating is generally accepted (not, however, by Smyth, 'Isidore of Seville', 94, 100; eadem, *Understanding the universe*, 156). The main argument for this dating is that three sources used by this computist, namely Jerome's *Commentarium in Aggaeum*, Ambrosiaster's *Liber Quaestionum*, and an obscure tract attributed to Origen, are only cited in one other text, Cummian's letter (Ó Cróinín, 'A seventh century Irish computus', 111–3); the inference is that place and time of *De ratione conputandi* and Cummian's letter must have been reasonably close; this, however, does not exclude the possibility that *De ratione conputandi* was indeed written in the same monastic school as Cummian's letter by a person taught in the same tradition as Cummian and using the same library, but some decades after Cummian's death. It should be noted here that the citation from ps-Origen also occurs in Bede, *In Marci evangelium* 4.14 (*CCSL* 120, 604–5; cited by Sedulius Scottus, *In Matthaeum* (Löfstedt, *Sedulius Scottus*, 560)); *In Lucae evangelium* 6.22 (*CCSL* 120, 373); *Homiliae subdititiae*, *Homilia 53* (*PL* 94, 389C); ps-Bede, *De officiis* (*PL* 94, 536D); Smaragdus, *Collectiones* (*PL* 102, 174D–175A); Haymo of Halberstadt, *Homiliae de tempore*, *Homilia 66* (*PL* 118, 393A).

135 'Das burgundische Lehrgespräch von 727' (*Dial. Burg.*) (Borst, *Schriften*, 353–74); 'Das neustrische Streitgespräch von 737' (*Dial. Neustr.*) (Borst, *Schriften*, 381–423); 'Das langobardische Zwiegespräch um 750' (*Dial. Langob.*) (Borst, *Schriften*, 433–61); for the possibility that the last-mentioned text was composed in Ireland before AD 750 cf. note 115 and especially p. CLXXIV–CLXXIX below; for its structure and character see p. CXI below.

136 Pacificus' *Computus* is edited in Meersseman & Adda, *Manuale di computo*, 82–137; Rabanus' *De computo* by Stevens in *CCCM* 44, 199–321; Helperic's *De computo* in *PL* 137, 17–48, which simply is a reprint of Pez's early 18th-century edition from a single, rather late MS witness (of more than 80 known today); a critical modern edition of this most influential computistical text is desperately needed. For the role of these three text-

century was dominated by Helperic's work,[137] while new computistical studies of that century, by Notker Labeo and others, were of a more specific, treatise-like character dealing with some specific computistical aspects rather than constituting comprehensive textbooks. When the genre of the textbook became more popular again in the eleventh century, the character of these was fundamentally different compared to early medieval textbooks, because of the more general change in science due to contacts with the Arabic world. Any study of comprehensive computistical textbooks in the early medieval period, i.e. from the origin of this type of text in the late seventh century to the reception of Helperic's work in the tenth, must, quite naturally, start with its earliest dateable witness, the Munich Computus.

books in the computistical discourse of the ninth century cf. also Wiesenbach, *Sigebert von Gembloux*, 55–7, as well as p. CX–CXII below.

137 For this text and its various later recensions cf. especially Traube, 'Computus Helperici', 128–52; for a classification of the English manuscripts McGurk, 'Computus Helperici', 1–5.

THE HISTORY OF THE MUNICH COMPUTUS

THE DATE

The Munich Computus was first dated by Bruno Krusch to AD 689 on the basis of two passages mentioning the year of the consuls *Bero et Barbua*; in one of these instances this year is explicitly referred to as *annus praesens*.[138] Krusch correctly identified this year as the 130th year of the Victorian Easter table, under which the consuls Verus II and Bradua are listed.[139] Victorius designed his

138 MC 41.107–110 (*annus praesens*), 62.65–67. Krusch, *Studien* I, 10; Krusch, 'Einführung', 162–3 repeats AD 689 as the date of composition, as does Mommsen in *MGH AA* 9, 34, 696–7. For discussions of this dating clause see also Mac Carthy, *Annals of Ulster* 4, lxx–i; Schwartz, 'Ostertafeln', 89–91, who then correctly argue that AD 689 should not be regarded as the date of composition of the Munich Comutus, but of an older layer in this text. Note that Krusch later, in 1938 (*Studien* II, 58), accepted Schwartz's dating of this text to AD 719. Nevertheless, Jones (*Bedae opera*, 110) repeats Krusch's original dating of AD 689, even though he had earlier ('Sirmond manuscript', 209) accepted Mac Carthy's date of AD 718, and was even more accurate in *Bedae pseudepigrapha*, 125, giving AD 718 as the date of composition of this computus, AD 689 as the date of one of its exemplars (but in *Bedae pseudepigrapha*, 48 he argues that the *manuscript* derives from an exemplar of AD 718, while some part of it was written in AD 689; on p. 67 he also only mentions the AD 689 date; note that Jones indicated that he had not consulted the MS himself); even less understandable is the reference to AD 689 as the date of composition of the Munich Computus in Thorndike & Kibre, *Catalogue of incipits*, 244 (here, that date is followed by the date of the MS, AD 817–24) as well as in the 2003 publication Machielsen, *CCSL Clavis Patristica* 3A, 188, 287. In all other studies subsequent to Mac Carthy and Schwartz, the AD 689 date is only mentioned (and rightly so) as the date of an older layer within the Munich Computus; cf. Kenney, *Sources*, 223; O'Connell, 'Easter cycles', 84; Gentz, 'Ostern', 1652 (wrongly associating this layer with the *latercus*); Schäferdiek, 'Osterzyklus', 361, 377; Lapidge & Sharpe, *Bibliography*, 95; Ó Cróinín, 'A seventh-century Irish computus', 102; idem, 'Old Irish gloss', 131; idem, 'Virgilius Maro Grammaticus', 197; idem, 'Columbanus', 52; idem, 'Earliest Old Irish glosses', 16; Mc Carthy & Ó Cróinín, 'Irish 84-year Easter table', 66; Ohashi, 'Sexta aetas', 59; Warntjes, '84 (14)-year Easter reckoning', 61, 74, 77; Borst, *Schriften*, 1.

139 Among the Victorian Easter tables known at present, only three contain the full consul list (cf. Mommsen in *MGH AA* 9, 672–4; Krusch, *Studien* II, 6–8): Gotha, Forschungsbibliothek, 75, fol. 77v–106r; Leiden, Universiteitsbibliotheek, Scaliger 28, fol. 3r–21r; and the Sirmond manuscript, which was identified with Oxford, Bodleian Library, Bodley 309 (the Victorian Easter table on fol. 113r–120r) by Jones ('Sirmond manuscript') at the same time as Krusch published his edition of Victorius' computistica, and was therefore unknown to the German scholar. The Victorian Easter table in the Bobbio Computus (Milan, Biblioteca Ambrosiana, H 150 inf, fol. 130r–132r) also includes the consul list, but only lists the years AP 1–120, 144–154 (these final eleven years being denoted as AP 121–131) and therefore does not transmit the year in question here. The consuls of the year in question are spelled *Vero II et Bradua* in both the Gotha MS, fol. 84v, and the Leiden MS, fol. 6r (cf. *MGH AA* 9, 696; Krusch, *Studien* II, 33), but *Ivro et Bardua* in the Sirmond MS, fol.

532-year Easter table in such a way that it began with the year of the passion of Christ (*annus passionis*=AP) rather than with the year of the incarnation (AD), which was introduced into western Easter tables by Dionysius Exiguus only some seventy years after Victorius' composition of AD 457. The construction is such that AP 1=AD 28.[140] Therefore, the year in question is the 532-year cyclic equivalent to AD 157, i.e. AD 157, 689, 1221, and so on. Since the Victorian Easter table did not exist in AD 157 and the manuscript incorporating the Munich Computus was written in the early ninth century, there cannot be any doubt that AD 689 was meant by the reference to *Bero et Barbua*. Both passages give more chronological details concerning this year, but these details are to be reconstructed from the established fact that AD 689 is the year in question, rather than that they would provide independent evidence.

It was, however, pointed out by Mac Carthy and four years later by Schwartz that the Munich Computus is a compilation with two datable layers. The first of these is the one established by Krusch, to be dated, as we have seen, to AD 689. It is worth noting here that the dating clause itself reveals a Victorian bias of this layer, so that the later author of the Munich Computus obviously incorporated excerpts from a Victorian computus of AD 689 into his textbook.[141] The second dating clause, then, refers to a later date, which undoubtedly reflects the date of composition of this text. Since Mac Carthy and Schwartz slightly differ in their interpretations of the passage in question (the Irish scholar identifying AD 718 as the year of composition, the German AD 719),[142] it is worth discussing it in detail here.

115r. Because of the correspondence between MC and the Sirmond MS in the spelling of the second name, it seems that the author of the Munich computist's exemplar of AD 689 worked from a Victorian Easter table similar to the one that survives in the Sirmond MS, possibly its exemplar (in which the corruption of the first name to *Ivro* had not yet occurred). Note that Bucherius, in his edition of the Victorian Easter table (*De doctrina temporum*, 27), which was based on the Sirmond MS (cf. Mommsen in *MGH AA* 9, 673, 676; Krusch, *Studien* I, 210; idem, *Studien* II, 8), gives the same reading as the Gotha and Leiden MSS; therefore, Mommsen and Krusch, taking Bucherius' edition as witness for the Sirmond MS, did not note any variant for the Sirmond MS in their editions; Mommsen (*MGH AA* 9, 696–7), however, with his characteristic thoroughness, listed the variants from MC.

140 For the construction of the Victorian Easter table cf. the literature cited in note 82.

141 For the Victorian layer of AD 689 underlying parts of the Munich Computus cf. Schwartz, 'Ostertafeln', 102; Kenney, *Sources*, 223; Warntjes, '84 (14)-year Easter reckoning', 61, 74. See also p. LXXX–LXXXII and especially CXXIV–CXXVI.

142 Mac Carthy, *Annals of Ulster* 4, lxx; Schwartz, 'Ostertafeln', 91. Mac Carthy's dating is accepted by Kenney, *Sources*, 223; O'Connell, 'Easter cycles', 84 (arguing that Schwartz advocates the same date); Jones, 'Sirmond manuscript', 209; idem, *Bedae pseudepigrapha*, 125; Bischoff, 'Das griechische Element', 250 (through Kenney); Harrison, 'Luni-solar cycles', 73; Lapidge & Sharpe, *Bibliography*, 95; Ó Cróinín, 'A seventh-century Irish computus', 102–3, 126 (attributing this date to Schwartz); idem, 'Old Irish gloss', 131; idem, 'Virgilius Maro Grammaticus', 197; idem, *Early medieval Ireland*, 188; idem, 'Earliest Old Irish glosses', 16; idem, 'Columbanus', 52; Mc Carthy & Ó Cróinín, 'Easter table', 60, 66 (arguing that Schwartz advocates the same date); Mc Carthy, 'Easter principles', 221; Borst, *Kalenderreform*, 187; Ohashi, 'Sexta aetas', 59; Lejbowicz, 'Tables pas-

Chapter 56 outlines a method for determining the Julian calendar date and the lunar age of Easter Sunday:[143] The preconditions are the Julian calendar date of the Easter full moon (which is listed for every year of the 19-year cycle in the passage immediately preceding this calculation and then calculated from the lunar age of 1 January in the immediately following passage[144]) and the weekday of 1 January; with this information the weekday of the Easter full moon is calculated; the Julian calendar date and lunar age of Easter Sunday is, then, determined by simply counting forward from the weekday of the Easter full moon to the following Sunday. This calculation is illustrated by three examples, which contain the following chronological data:

example	**bissextile or not**	**weekday of 1 January**	**Julian calendar date of Easter full moon**	**Julian calendar date of Easter Sunday**	**lunar age of Easter Sunday**
1st year	non-bissextile	*dominicum* (Sunday)	*v Idus Aprilis* (9 April)	*xvi Kalendas Maii* (16 April)	21
2nd year	bissextile	*ii feria* (Monday)	*iiii Kalendas* Aprilis (29 March)	*ii Kalendas Aprilis* (31 March)	16
3rd year	non-bissextile	*iiii feria* (Wednesday)	*xv Kalendas Maii* (17 April)	*xii Kalendas Maii* (20 April)	17

This information is, of course, more than enough to date this sequence of years: The second and third columns alone identify these years as the 28th, 1st and 2nd year of the solar cycle, the fourth column as the 17th, 18th, and 19th year of the Dionysiac 19-year cycle respectively.[145] Such a combination is obviously

chales', 21. Schwartz is followed by Gentz, 'Ostern', 1652; Cordoliani, 'Traités', 59; Warntjes, '84 (14)-year Easter reckoning', 33; idem, 'Computus Einsidlensis', 63 (the date is incorrectly given as AD 919 instead of 719 due to printing problems); Borst, *Schriften*, 1, 261, 1022. Note especially that Krusch himself (*Studien* II, 58) later accepted Schwartz's dating. Characteristically careful and accurate is Schäferdiek, 'Osterzyklus', 360–1, stating that the text was arguably written 718 / early 719, though on p. 378 he only refers to AD 719.

143 MC 56.15–43.

144 MC 55.61–68, 56.44–57.

145 The solar cycle is designed in a way that its first year, corresponding to 9 BC and recurring in 28-year intervals, is bissextile with 1 January falling on a Monday. Since the second example has these criteria, it agrees with the first year of the solar cycle. For the solar cycle cf. Ideler, *Handbuch* 2, 185–9; Rühl, *Chronologie*, 63–72; Wislicenus, *Kalender*, 34–6; Ginzel, *Chronologie*, 124–34; von den Brincken, *Chronologie*, 57–8. In all these accounts of medieval chronology, the years of the solar cycle are characterized by dominical letters. Yet, these letters do not become standard before the early eleventh century, so that the calculation with them is quite anachronistic for the period in question here. In the early middle ages, the solar characteristic for a year was the weekday of 24 March (*concurrentes*) or

unique in a 532 (28×19)-year luni-solar cycle (since 28 and 19 do not have a common divisor other than one), so that these three examples undoubtedly refer to AD 719, 720 and 721.[146] The first of these examples, i.e. AD 719, is denoted in this passage as *annus inminens*, literally the imminent year.[147] It seems, then, that Mac Carthy thought in terms of calendar years beginning with 1 January, so that in his opinion the *annus inminens* started on 1 January 719, the author consequently writing in AD 718; Schwartz, however, when arguing that the Munich Computus was composed immediately before Easter of AD 719, appears to have rather thought in terms of Dionysiac lunar years extending from *luna* 15 of the paschal month to the Easter full moon of the following calendar year.[148] The fact that the computist's reference to the imminent year follows immediately after the description of the method for calculating the data of Easter Sunday certainly suggests that it was the Easter Sunday in question (i.e. of AD 719) that was imminent rather than the year itself. Therefore, I am inclined to follow Schwartz's argument; with certainty, however, it can only be argued that the Munich Computus was composed after Easter Sunday of AD 718 and before that of AD 719.

The exact same dating clause recurs slightly later in the text, in a passage that outlines a method for the calculation of the Julian calendar date and the

1 January, and it is therefore helpful that not only the dominical letter, but also the *concurrentes* is given for each year of the solar cycle in Rühl, *Chronologie*, 142, 144–5; Ginzel, *Chronologie*, 144; Blackburn & Holford-Strevens, *Companion to the year*, 821. The translation of the weekday of 1 January to the *concurrentes* is achieved by subtracting two in common, one in bissextile years; if the result is 0 or negative, seven has to be added. Note that in pre-Bedan Irish computistics the solar characteristic of a year always was the weekday of 1 January, and all calculations were executed from that datum. In fact, in the three Irish computistical textbooks, the *concurrentes* are discussed only once (MC 67), but without using the technical term (cf. note 188). As for the Dionysiac 19-year cycle (*cyclus decemnovennalis*), a list of the 19 full moons of that cycle is given in the Easter table composed by Dionysius himself (cf. Krusch, *Studien* II, 69–74), and they are also separately listed in MC 55.61–68, as in many other computistical texts (for such a list in modern literature on chronology cf. Ideler, *Handbuch* 2, 199; Rühl, *Chronologie*, 153; Blackburn & Holford-Strevens, *Companion to the year*, 821). The Easter full moons mentioned in the three examples occur in 17th to 19th place there. Generally, the first year of the Dionysiac 19-year cycle corresponds to 1 BC and recurs in 19-year intervals. For this cycle cf. Ideler, *Handbuch* 2, 197–9; Rühl, *Chronologie*, 133–42; Wislicenus, *Kalender*, 45–6; Ginzel, *Chronologie*, 134–43 (note again that these accounts are based on later medieval practice).

146 In the incarnation era, the first correspondence of the 17th year of the Dionysiac 19-year cycle with the 28th year of the solar cycle is AD 187, and it then recurs every 532 years. Since AD 187 is obviously too early for the composition of this text, and since the MS was written in the early ninth century, the only possible date for the *annus inminens* is AD 719.

147 MC 56.19.

148 Note that both interpretations can be supported by the evidence of MC: On the one hand, a year is generally characterized by the weekday and lunar age of 1 January throughout this text, and all calculations are based on that data (cf. MC 29.2–12, 36.2 (and cross-references there); 49.14–32, 50, 52, 56.15–55, 58.33–74, 61.11–27); on the other hand a lunar year is defined as extending from the Easter month of one Julian calendar year to the Easter month of the following one (cf. MC 36.3–5, 53.5–11; and the cross-references in these two passages).

lunar age of the *initium quadragesimae*, i.e. the beginning of the Lenten period.[149] Because of the proximity within the text of this passage to the just discussed calculation of Easter Sunday, as well as the similarity in the methods applied, the computist used the same three years as examples here, though this time without any reference to an *annus praesens* or *annus inminens*. In consequence, the chronological data supplied in this second passage does not differ from the first passage.

All other technical examples outlined in this computus are evidently chosen for reasons other than being the *annus praesens* of the Munich computist or any of his sources, and therefore they do not provide any additional evidence for possible dating-clauses.[150]

149 MC 58.33–80. Cf. Schwartz, 'Ostertafeln', 91.

150 In chapter 50, the years chosen are the first two years of the Dionysiac 19-year cycle, the Victorian and alleged *latercus* equivalents to that first year, as well as exceptions to the rule outlined in that chapter (cf. Warntjes, '84 (14)-year Easter reckoning', 46–51); in chapters 51 and 59, the three groups of three examples each refer to the first three years of the Dionysiac 19-year cycle; the first years of a certain cycle were generally chosen as fitting theoretical examples rather than references to the time of composition.

THE AUTHOR

As is the case with most early medieval computistical texts, the author of the Munich Computus remains anonymous. Nevertheless, the text itself provides enough indications for identifying at least the nationality of its author. In fact, the evidence for an Irish authorship of this text is so overwhelming that it has never been questioned since Bruno Krusch introduced this computus into modern scholarship. Krusch himself had discovered an explicit reference to the *Scotti* in the text, which led him to the assumption that it was composed in Britain;[151] in the imperial usage of his time, the term Britain quite naturally referred to the British Isles. This identification was further specified by Mac Carthy, who left no room for doubt that the author himself was a *Scottus*, an Irishman. His analysis, the most thorough investigation of the authorship of this text to date, focused on two criteria, language and sources. Concerning the language of the author, Mac Carthy pointed to the use of two extraordinary terms: 1) *singularis*, which he regarded as the Hiberno-Latin equivalent to Old Irish *uathad* (oneness or singularity), in context to be translated as 'single digit' (i.e. denoting numbers from one to nine);[152] 2) *dies cetene*, which he identified as a bilingual term consisting of Latin *dies* and the Old Irish genitive singular *cétaíne*; it appears in the text with the meaning of Wednesday, being the equivalent to Latin *dies Mercurii* (literally 'the day of Mercury') and to Old Irish *día cétaíne* (literally 'the day of the first fast').[153] Additionally, Mac Carthy listed orthographic features that he believed to have originated from Irish phonetics.[154] Concerning sources, Mac Carthy drew attention to the fact that three texts which had been identified as Irish forgeries were cited by the Munich computist, namely the so-called Acts of the Council of Ceasarea, the paschal tract of Anatolius (?) (*De ratione paschali*), and the letter of ps-Cyril (*Epistola Cyrilli*), as well as one other evidently Irish text, *De mirabilibus sacrae scripturae*.[155] All subsequent studies of the Munich Computus, from Schwartz to O'Connell to Schäferdiek, provided no additional evidence on this matter.[156] In fact, since Mac Carthy's analysis no need for further investigation of this question was felt. Nevertheless, in the 1980s, Dáibhí Ó Cróinín discovered two more elements that highlight the Irish authorship of this text, one in each of the two categories outlined by Mac Carthy. Concerning the language of the author, Ó Cróinín pointed out that the Munich computist used the Old Irish verb *to·mel* (Classical

151 Krusch, *Studien* I, 13; idem, 'Einführung', 162–3. This was accepted by Mommsen in *MGH AA* 9, 34.

152 Mac Carthy, *Annals of Ulster* 4, lxix.

153 Mac Carthy, *Annals of Ulster* 4, clxxx. Cf. p. XIX and especially the discussion on p. LXXV–LXXVI.

154 Mac Carthy, *Annals of Ulster* 4, clxxviii–ix.

155 Mac Carthy, *Annals of Ulster* 4, lxxix–lxxx. For the 'Irish forgeries' cf. note 162. For *De mirabilibus* cf. p. LXXVIII–LXXX.

156 Cf. Schwartz, 'Ostertafeln', 92, 100–1; Krusch, *Studien* II, 58; O'Connell, 'Easter cycles', 84; Schäferdiek, 'Osterzyklus', 361.