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Mapping the Discipline of Ancient Mediterranean Religion through Primary Text Co-citation Analysis

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Mapping fields using co-citation information is a common endeavour in many disciplines but has rarely been performed in the humanities. In this article, I use data from 417 back-of-book source indices to map the field of ancient Mediterranean religion on three levels: sub-discipline, ancient work, and references in ancient works. The method innovatively makes use of primary text references, rather than research articles, to construct the co-citation network. After mapping the overall relationships between sub-disciplines, I show how the data can be used to identify two types of ancient works that bridge these sub-disciplines: works which are central for the whole network, and works which are not central overall but cited more often with specific sub-disciplines. The article provides an understanding of the structure of the field of ancient Mediterranean religions, and more generally of the challenges and advantages of methods to map scholarship in historical disciplines.

La cartographie des domaines à l'aide d'informations de co-citation est une entreprise courante dans de nombreuses disciplines, mais elle a rarement été réalisée dans les sciences humaines. Dans cet article, j'utilise les données de 417 index de sources de livres pour cartographier le domaine de la religion méditerranéenne ancienne à trois niveaux : la sous-discipline, l'ouvrage ancien et les références dans les ouvrages anciens. La méthode utilise de manière innovante des références de textes primaires, plutôt que des articles de recherche, pour construire le réseau de co-citation. Après avoir cartographié les relations globales entre les sous-disciplines, je montre comment les données peuvent être utilisées pour identifier deux types d'œuvres anciennes qui font le lien entre ces sous-disciplines : les œuvres qui sont centrales pour l'ensemble du réseau, et les œuvres qui ne sont pas centrales dans l'ensemble mais qui sont citées plus souvent avec des sous-disciplines spécifiques. L'article permet de comprendre la structure du domaine des religions méditerranéennes anciennes et, plus généralement, les défis et les avantages des méthodes de cartographie de l'érudition dans les disciplines historiques.

1. Introduction

The field of ancient Mediterranean religion spans several sub-disciplines: religious studies, classics, theology, archaeology, art history, and Judaic studies, working with different methodologies, different aims, and frequently with different primary sources. The objective of this article is to map the discipline and its various communities through the analysis of co-citation of primary sources in secondary literature.

Science mapping—charting out a scientific knowledge domain, its sub-disciplines, interfaces, and dynamics—is a common endeavour in many areas of the sciences (Small 1999). Science mapping can be performed through various methods, of which co-citation analysis is a major one. In this method, a relevant corpus is mined for citations of research publications. These citations are then used to build networks that represent the frequency of co-citation of the different publications so that works commonly cited together are placed close together and vice versa. The modelling of co-citations as a network allows many further forms of analysis, including locating the most important and influential publications, determining the sub-disciplines of the discipline and the relationship between them, charting changes over time in the discipline, and more (Chen 2013; Chen 2017; Petrovich 2021).

Science mapping has only rarely been performed in the humanities, for various reasons, including idiosyncratic citation practices, lack of databases of publications, the centrality of monographs and edited volumes rather than journal articles, and, perhaps, an animosity towards quantitative methods (Franssen and Wouters 2019; Hellqvist 2009; Leydesdorff, Hammarfelt and Salah 2011; Petrovich and Tolusso 2019). This is true for ancient history as well, and I do not know of any publication that attempted to systematically map the field of ancient historical scholarship using co-citation networks (or, indeed, any other bibliometric method).

As opposed to the exact and social sciences, the historical humanities typically cite two types of sources: primary and secondary (Romanello 2016; Colavizza, Romanello, and Kaplan 2018). Thus, co-citation analysis can be performed either on primary source citation, or on secondary source citations, or on both at once; each results in different types of information. Examining co-citation of secondary sources (research articles and monographs) cited in secondary sources provides a map of the discipline from the perspective of the scholars involved and their citation of each other. It can thus show the structure and interaction of sub-disciplines, the relative centrality of different scholars, and shifts in the focus of the field. However, it provides only indirect information on the object of study itself. Primary source co-citation analysis, on the other hand, provides

information on how scholars actually use the primary sources they study, the main research tool in ancient history (Blidstein and Zhitomirsky-Geffet 2022).

In this article, I will use hybrid primary-secondary source co-citation analysis, in which the network is formed by mining citations of primary sources (hereafter: "works") in secondary literature (hereafter: "books") and analyzing their co-occurrence. This type of analysis provides a map of the field based on how scholars are using their sources. In brief, primary sources that are commonly cited on the same page in a book will be considered strongly connected, and vice versa. This will allow us to understand several issues:

1. Which groups of works are commonly studied together, and how these relate to common conceptions of sub-disciplines.
2. Characterize sub-disciplines and define their degree of insularity.
3. Characterize the citation practices of specific works, namely, their significance and centrality and how they are cited across sub-disciplines. Specifically, I will investigate which works cross sub-disciplinary borders (i.e., are frequently cited together with works outside of their sub-discipline).

In short, co-citation analysis of the works' references can be a valuable tool for a bird's-eye view on practices of textual citation in the historical disciplines (Buchanan and Hérubel 1997; Colavizza 2017; Colavizza 2018). This paper has three different audiences in mind. First, it is aimed at historians of ancient Mediterranean religion, who will be interested in understanding their own discipline, and checking their assumptions about the structure of the field against the data presented here. Second, it is aimed at historians in general, looking for insights into how a historical humanities discipline can be mapped using these types of tools, including the significance of source indices and how they can be used for this end. Third, it is aimed more broadly at researchers interested in techniques in science mapping and their differing deployment in varied types of disciplines.

2. Methodology

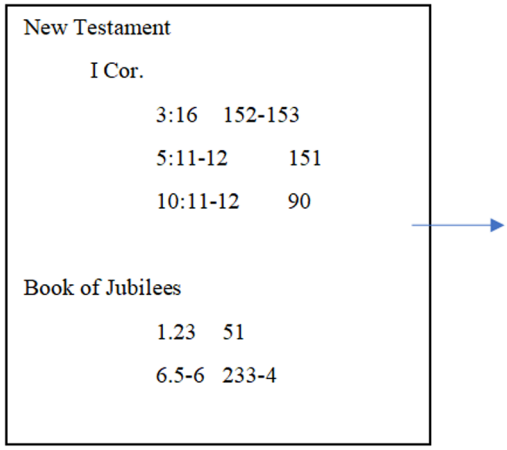
2.1 Corpus construction

To locate the co-citation of primary works in a corpus of secondary books, primary work indices were extracted from scholarly books in English on ancient Mediterranean religion and culture. This included 417 scholarly books in the disciplines of ancient history, classics, ancient philosophy, ancient law, New Testament and patristic

studies, Biblical studies, Jewish Second Temple literature, and Rabbinics; the majority of the books could be found on the presses' lists by these subjects. (The full list of books is online at Tiresias: The Ancient Mediterranean Religions Source Database [Blidstein and Raban 2023]. Note the online list includes additional books added since the writing of this article.) Rather than limit the corpus arbitrarily, it was decided to use technical criteria: all books in several leading university and commercial presses (Oxford University Press, Cambridge University Press, Brill, De Gruyter), which included a primary work index, fully accessible online and listing more than 100 references to works written in the Mediterranean area between the ninth century BCE and the seventh century CE. Some books from additional presses (e.g., Princeton University Press, Mohr Siebeck, University of California Press, Routledge), which were available and on topic, were added as well in order to diversify the corpus.

A primary work index typically includes a list of work authors, work title, references to a specific part of the work (e.g., chapter and verse references), and the page numbers of the book discussing these references (see **Figure 1**). The indices were downloaded from online repositories via the University of Haifa Library and parsed using Python code written by the author for cleaning and unification of the data. Then, a database of ancient titles, authors, and reference styles was applied in order to identify the works' authors and titles. The database was based on recognized resources on the field, such as the TLG Canon of Greek Authors and Works, abbreviation tables from various Greek and Latin dictionaries, and the Classical Works Knowledge Base, but included many more items and expanded also to titles of Coptic, Hebrew, Syriac, and other ancient works. However, even with this database, some work authors and titles (about 10%) could not be automatically identified, and this may have produced some bias regarding lesser known and cited works, which cluster in certain sub-disciplines. Also, ranges of references and page numbers were expanded. Canonical references (e.g., line number, chapter and verse, etc.) were entered into the database according to how they appeared in the index. Since variable canonical reference system exist for some works, these works may be referenced in different ways in different indices, wrongly influencing the resulting network structure. Again, this is especially true for lesser-studied works, including fragmentary texts, papyri, and epigraphy.

The result of this process was a total of 1,482,825 rows, each including an identifying number of the work, a precise reference (such as "12.7" to denote chapter 12, verse 7), the book from which it came, and the page number in the book where the reference appeared; 3642 unique ancient works were referenced in these files.



Secondary work number	Ancient work number	Reference	Page number
1	8056	3.16	152
1	8056	3.16	153
1	8056	5.11	151
1	8056	5.12	151
1	8056	10.11	90
1	8056	10.12	90
1	2309	1.23	51
1	2309	6.5	233
1	2309	6.5	234
1	2309	6.6	233
1	2309	6.6	234

Figure 1: Primary work index encoding example.

2.2 Corpus characteristics

Most of the books included were published after the year 2000, as only a few books published before this date were digitized to date (see **Figure 2**). Because of this relatively short time span and the small number of books included from the decade 2000–2010, the corpus will not be used for longitudinal or diachronic analysis, such as charting changes in the field over time.

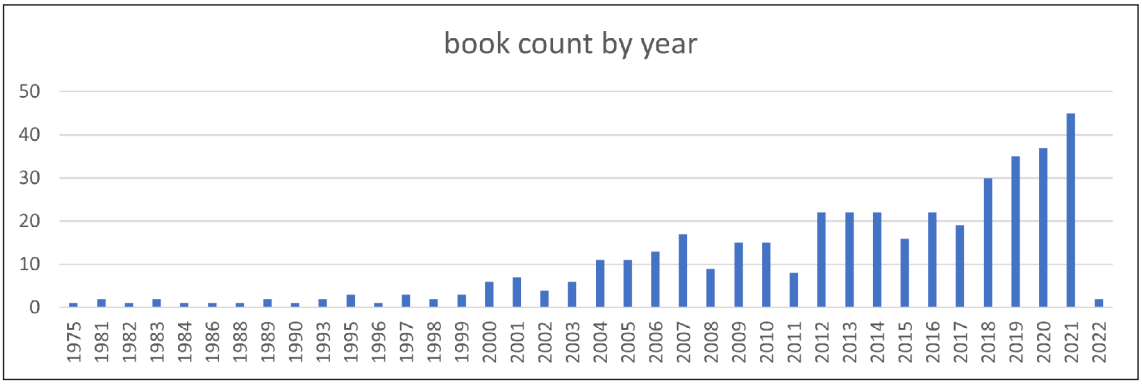


Figure 2: Book distribution by publication year.

To give a general sense of the subject area of the corpus, I tagged the books with the scholarly field I considered most salient (though an attempt was made to use classifications of the Dewey decimal system or the Library of Congress, they were

problematic and at times nonsensical, with a wide distribution of subjects). Some books were labelled with two labels: "Judaism and Christianity" and "Greek and Latin"; in these cases, the books explicitly discuss both areas. "Cross subject" refers to books that focus on more than two fields (e.g., on antiquity in general), or when it was difficult to provide a more precise designation. As can be seen in **Figure 3**, a wide variety of fields are represented in the corpus. Notable exceptions are art history and archaeology since the corpus is textual-based and includes only a few references to artifacts.

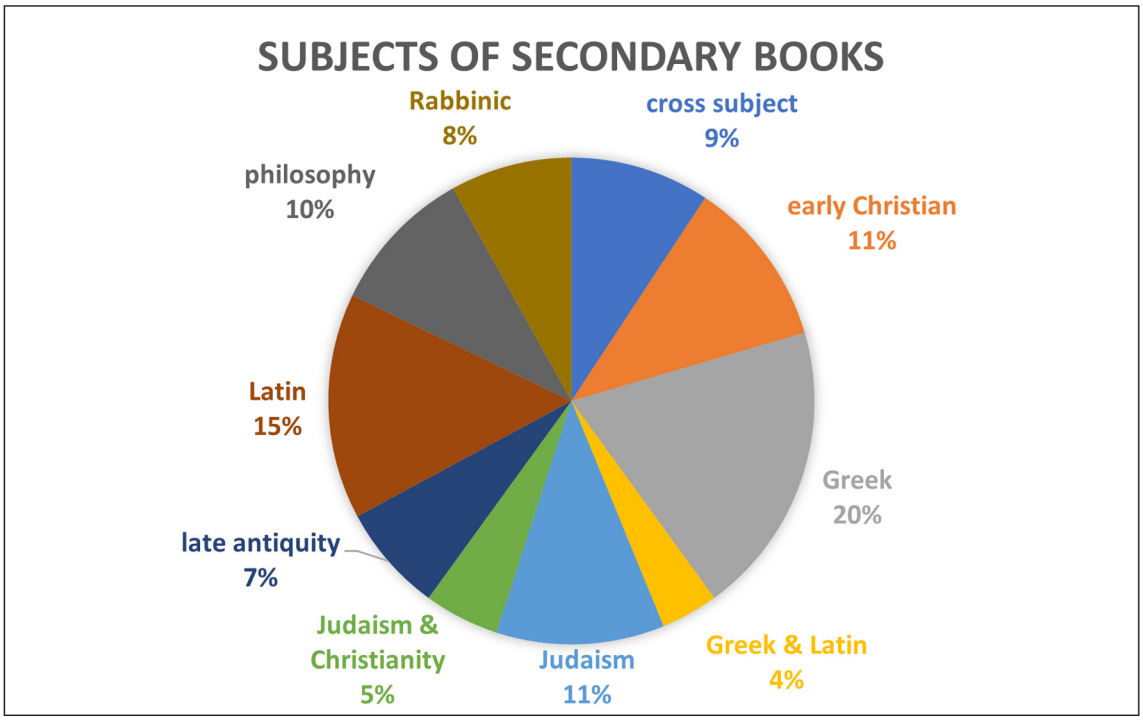


Figure 3: Subjects of secondary books used to build database.

3. Network and communities

3.1 Network creation and analysis

The index files were used to create network files, using the Python NetworkX package for analysis and Gephi for graphing. Different types of networks can be constructed using the indices—networks which explicitly show both the books and the works as nodes; networks representing not only the different works but also the exact references in each work ("12.7" in the example above); or networks which show ancient works only, with edges connecting nodes appearing on the same page of the book. The different networks and their relative advantages and disadvantages in describing a historical humanities corpus were discussed in another article (Blidstein and Zhitomirsky-Geffet

2022). For this analysis, I opted for a network showing ancient works only in order to focus on the structure of the discipline through its communities of practice as regards citation of ancient works.

The network consists of 3642 nodes and 275,327 edges; each node represents an ancient work, and each edge connecting the nodes represents a co-occurrence of the works on the same page. Edge weight was determined by summing the number of pages a pair of ancient works were both cited on. Using weighted edges for network construction allows differentiation between works that are cited together rarely and those that are cited together frequently. However, there is no differentiation between works cited together many times but only in a few books, compared to those cited together less often but in many books. Thus, theoretically, a book or two that focus on a specific ancient work may skew the results somewhat, especially when looking at less-often cited works or at specific references. However, the large size of the corpus is expected to balance out such cases.

The network was plotted on Gephi software using the AtlasForce2 layout (see **Figure 4**), so that nodes that are cited together most often would be graphed closest to each other, with the degree of nodes (i.e., the sum weight of edges connected to that node) represented by their size.

In order to further investigate these groups and their structure, the nodes (works) had to be divided into clear groups. Two methods were possible: division into communities by an algorithm, which analyzes the network and locates the groups of nodes most strongly connected to each other; or manually, and somewhat subjectively, determining the category of each ancient text. Both methods were attempted. Many algorithms exist to divide networks into groups or communities; dozens are available for Python through the CDLIB library (Rossetti, Milli, and Cazabet 2019). However, different results can be obtained by using varying algorithms or by choosing different values. For example, in the popular Louvain algorithm (Blondel et al. 2008), it is possible to loosely determine the number of communities by using different resolutions. Thus, the number and membership of the groups in the networks are in fact determined by the user, though not directly. Therefore, rather than arbitrarily selecting an algorithm and its determining values and achieving a result that only loosely corresponds to the actual sub-disciplines of the field, it was decided to manually categorize the texts and closely examine the relationships between the resulting groups. Though some of these categories may be controversial, and the texts can be divided into any number of groups in many ways, the proposed division seemed to be a reasonable starting point. **Table 1** displays the categories and their main characteristics in the network. Of course, more groups would have allowed more precise designations, but this would also have made

the ensuing analysis more difficult. Furthermore, if not based on a clear date cutoff, they would have entailed difficult decisions (e.g., is Plutarch in "Greek literature" or in "philosophy"?). The proposed categories are thus a starting point for analysis and will be examined in this paper through an examination of works bridging the disciplines.

	Sub-disciplinary Group	Details
1	Hebrew Bible	The books of the canonical Hebrew Bible
2	Jewish Second Temple	Jewish literature produced between the third century BCE and the end of the first century CE
3	Early Christian	Christian literature, including the New Testament, produced until 330 CE
4	Rabbinic	Jewish literature produced between the second and the eighth century
5	Latin literature (up to fourth century)	Latin literature until 330 CE
6	Early (pre-Roman) Greek literature	Greek literature until the second century BCE
7	Late (Roman up to fourth century) Greek literature	Greek literature after the second century BCE
8	Late Antiquity (post fourth century)	Latin and Greek literature after 330 CE
9	Papyri and Epigraphy	Editions of Latin, Greek, Hebrew and Aramaic papyri and epigraphy

Table 1: Sub-disciplinary groups.

To give an idea of the specific composition of these groups, **Table 2** shows the five nodes with the highest degrees in each group, ranging between 500–1700 degrees. This provides insight into the most cited works, or, more precisely, into the works cited most often together with other works in the network. All of the works in **Table 2** are major works, and it is not surprising to find them in the top ranks. Furthermore, the majority of them are large works, and some are encyclopedic in range, and therefore cited more frequently. Nevertheless, it would have been difficult to predict that specifically these works would have been chosen, or in this order. For example, the Book of Acts appearing as most cited in the early Christian group is by no means obvious. Some works missing from the first five list are also surprising (e.g., Vergil's *Aeneid*).

The papyri and epigraphy group requires additional discussion. The network visualization in **Figure 4** shows that this group is hardly coherent. Indeed, the works in these groups are substantially different from the other works in the corpus: they are not actually ancient works, but titles of modern collections of ancient documents,

	Group	5 Largest Nodes (unweighted)	
1	Hebrew Bible	Hebrew Bible, Genesis	1488
		Hebrew Bible, Deuteronomy	1256
		Hebrew Bible, Exodus	1250
		Hebrew Bible, Isaiah	1245
		Hebrew Bible, Psalms	1189
2	Second Temple literature	Josephus, *Jewish Antiquities*	1597
		Josephus, *Jewish War*	1038
		Josephus, *Against Apion*	825
		Philo of Alexandria, *On the Special Laws*	752
		2 Maccabees	748
3	Early Christian	New Testament, Acts	1757
		New Testament, Matthew	1714
		New Testament, Luke	1640
		Clement of Alexandria, *Miscellanies*	1367
		New Testament, Mark	1323
4	Rabbinic	*Genesis Rabba*	733
		Babylonian Talmud, *Sanhedrin*	615
		Sifre Deuteronomy	581
		Mishnah, *Avot*	568
		Babylonian Talmud, *Berachot*	546
5	Latin literature	Pliny the Elder, *Natural History*	1344
		Seneca the Younger, *Letters*	931
		Livy, *History*	896
		Ovid, *Metamorphoses*	789
		Cicero, *On the Nature of the Gods*	768
6	Early Greek	Herodotus, *Histories*	1635
		Homer, *Iliad*	1387
		Homer, *Odyssey*	1158
		Plato, *Republic*	1059
		Plato, *Laws*	927

(Contd.)

	Group	5 Largest Nodes (unweighted)	
7	Late Greek	Diogenes Laertius, *Lives of the Philosophers*	1541
		Pausanias, *Description of Greece*	1429
		Diodorus Siculus, *Historical Library*	1387
		Strabo, *Geography*	1375
		Cassius Dio, *Roman History*	932
8	Late Antiquity	Jerome, *Letters*	797
		Augustine, *The City of God*	700
		Lactantius, *Divine Institutes*	547
		Justinian, *Digest*	540
		Epiphanius, *Panarion*	530
9	Papyri and Epigraphy	Epigraphy, *SEG*	1148
		Papyri, *P. Oxy.*	766
		Epigraphy, *IG*	690
		Epigraphy, *CIL*	677
		Papyri, *Papyri Graecae Magicae*	622

Table 2: Top five nodes by degree for each sub-discipline.

grouped together mostly according to their language, the geographic location in which they were found, and, especially, the date in which they were found. They are typically not differentiated by ancient period or by religion, with the exception of some special collections such as collections of Jewish papyri (e.g., JIGRE). It is therefore difficult to cancel the group by distributing it among other groups (for example by language). Despite its relative incoherence, information can be gained from including it. For example, it can be seen that the group is closer to Greek and Latin literature, that is, that Christian and Jewish studies make relatively little use of these works.

The relationships between the groups can be seen in **Figure 4**. From this visualization, it is clear that the most sub-disciplinary groups occupy distinct areas of the network, and, moreover, that some groups are closer to each other than others. Rabbinic is very distinct, while the Hebrew Bible is close to the Rabbinic, Early Christian, and Second Temple literature groups. Early and Late Greek literature, as well as Latin (frequently studied in classics departments and publications), are clearly differentiated from Jewish and early Christian literature (frequently studied in theology and Jewish studies departments and publications). Late Antiquity, however, is connected to both sides of this divide. Inside the classics group, Early Greek and Latin literature are both relatively

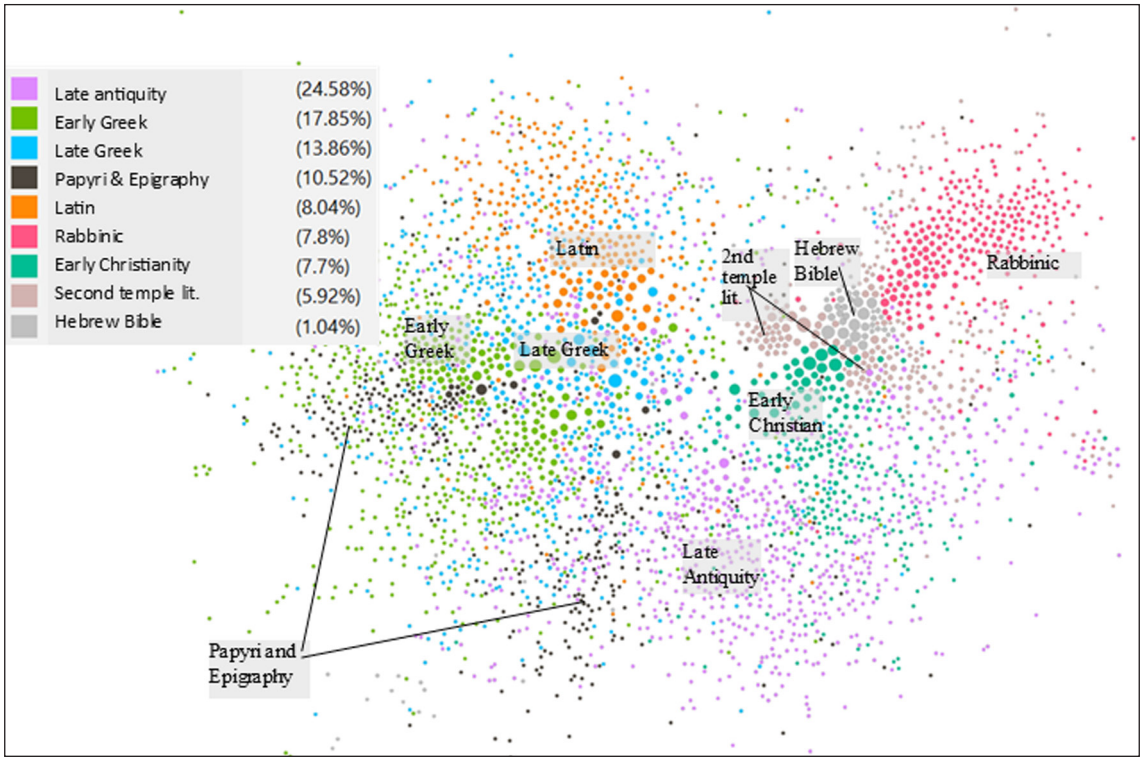


Figure 4: Overall network with colour-coded sub-disciplinary groups, visualized with Gephi. Nodes are sized by degree. The network is filtered by node degree>5 for visibility. Percentages in the legend relate to node count.

well defined, while Late Greek is somewhat distinct but also interspersed with both of the former. Epigraphy and Papyri, which do not form a chronological or thematic group, are interspersed within Greek and late ancient groups, and to a lesser extent with Latin. The centre of the network, between the early Christian and the Late Greek group, is sparsely occupied by a diverse set of works.

Groups are diverse in sizes, though this diversity is more marked in the number of nodes in each group than the weight of edges connecting them, as can be seen in **Table 3** and **Figure 5**. Thus, the Hebrew Bible includes only 40 distinct works, 1.1% of the nodes in the network, but they are cited very often, and thus edges in which these nodes participate comprise 7.8% of the edge weights. The opposite is the case for Early Greek literature, with 20.5% of the nodes and 11.3% of the edge weights. There is also a diversity in average degree (i.e., the combined weights connecting each node); the Hebrew Bible has a largest number of edges for each node, while Late Antiquity has the smallest number. Although there is a loose reverse correlation between the number of nodes in a group and the average degree, it is by no means uniform: for example, the Early Greek and Latin groups have a similar average degree despite being very different in size. The differences in average degrees thus cannot be explained only by the number of nodes in the group, but must also

reflect differing levels of citation together with other works, whether together with other works in the same group or with works from other groups. The standard deviation of the average degree also has meaning. A high SD (as in Early Christian, Early and Late Greek literature, and Late Antiquity) means that some works in the group are "stars," cited much more often than others, while a low SD (in the Jewish and Latin works) indicates a more uniform distribution. This is also a result of the smaller size of these groups, which makes it more likely most of them will be cited more often.

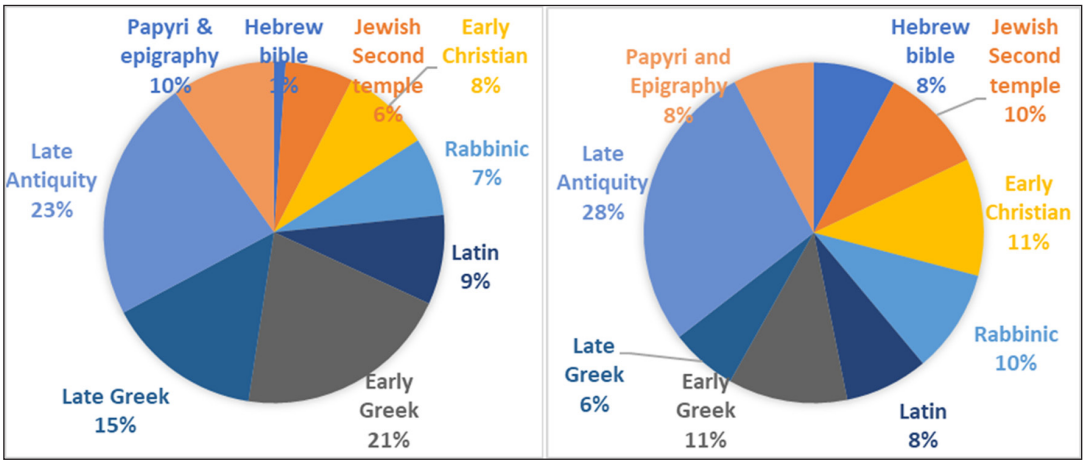


Figure 5: Node count (left) and edge weights (right) for sub-disciplinary groups.

		Nodes		Edge Weights		Average Degree
		Count	Percent of Total	Count (in + out)	Percent of Total	
1	Hebrew Bible	40	1.1%	141,016	7.8%	557.5 (SD: ±362, 65%)
2	Jewish Second Temple	235	6.4%	181,206	10.0%	265.79 (SD: ±221, 83%)
3	Early Christian	307	8.4%	200,055	11.1%	211.66 (SD: ±266, 126%)
4	Rabbinic	270	7.4%	176,474	9.8%	204.88 (SD: ±117, 57%)
5	Latin literature	309	8.5%	42,522	7.9%	217.61 (SD: ±210, 96%)
6	Early Greek	749	20.5%	203,819	11.3%	185.71 (SD: ±210, 113%)
7	Late Greek	540	14.8%	114,133	6.4%	152.99 (SD: ±226, 148%)
8	Late Antiquity	838	23.1%	498,770	27.9%	81.51 (SD: ±102, 125%)
9	Papyri and Epigraphy	357	9.8%	138,420	7.7%	113.36 (SD: ±177, 156%)
	Total	3642	100%	1,796,415	100%	

Table 3: Node count, edge weights, and average degrees for sub-disciplinary groups in network.

3.2 Sub-disciplinary group interactions, bridging works and references

3.2.1 Sub-disciplinary group interactions

In science mapping, co-citation information is commonly used to gain a better understanding of the interconnections and relationships between sub-disciplinary groups, including identification of insular and interconnected groups, clusters of groups, and specific items inside each group that are most connected to the others (Kreuzman 2001; McLevey et al. 2018; Tolusso 2021). I examined at first the pattern of inter-group citation at the group level: how often works from one group are cited together with works from another. The results are shown in **Table 4** as a triangular heatmap.

Rabbinic	38224								
Latin	39774	314							
Greek, late	9901	728	11114						
Late Antiquity	20948	962	6323	4764					
Papyri & Epig.	6526	213	1929	2496	1183				
Second Temple	36275	7277	2342	3901	3390	778			
Early Christ.	48367	4630	4153	4831	10171	921	20908		
Hebrew Bible	29849	15840	880	1143	2368	281	29304	15605	
Greek, early	55565	339	6469	17983	4389	4711	3579	2984	1991
	self	**Rabbinic**	**Latin**	**Greek, late**	**Late Antiquity**	**Papyri & Epigraphy**	**Second Temple**	**Early Christ.**	**Hebrew Bible**

Table 4: Co-citations between works of sub-disciplines, colour coded from red (highest) to blue (lowest).

In **Table 4**, reds are the most cited together. Unsurprisingly, works from the same group usually cite each other most often. This shows that the groups constructed are not arbitrary but in fact correspond to actual sub-disciplines. However, there are two exceptions: Late Greek works are cited together more with Early Greek and with Latin works than with other Late Greek works; and works of the Hebrew Bible are cited together with Second Temple works nearly equally to works within their own group. These patterns reflect the way canonical works are interpreted and developed by later works. More generally, it is clear that early Christian texts, Second Temple Jewish texts, and the Hebrew Bible are often cited together, as are Early Greek, Late Greek, and Latin texts; this general bifurcation of the field into two large groups can be seen also in the general network image, with Rabbinic texts furthest away from all the others. Early Christian texts are, however, also connected quite strongly to the late Greek, Latin and Late Antiquity groups. Groups that rarely cite each other are marked with blue. **Figure 6** visualizes the heatmap as a network, using the layout of the more detailed network image (showing only the links between groups).

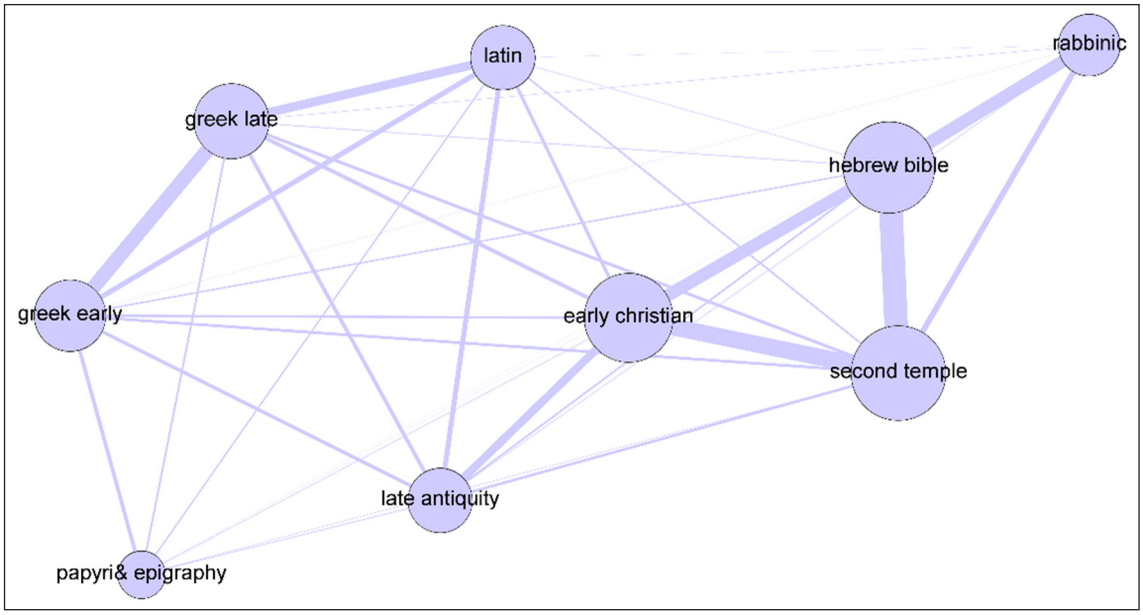


Figure 6: Schematic network of sub-disciplines.

Inter-group citation patterns on the macro level provide an overview of the field, but for information on how individual works are cited, data is needed on which works in the whole network are cited only within their group, and which are cited together with works from other groups. To answer this question, **Table 5** provides a list of the works with the highest edge weights outside their own groups.

Work	Weights Outside Group
Josephus Flavius, *Jewish Antiquities*	5466
Hebrew Bible, Psalms	5419
Hebrew Bible, Exodus	4643
Hebrew Bible, Deuteronomy	4323
Hebrew Bible, Genesis	4168
New Testament, Luke	3542
New Testament, Matthew	3320
Hebrew Bible, Isaiah	3067
New Testament, Mark	2749
Herodotus, *Histories*	2738

Table 5: Top ten works by edge weights connecting outside their group.

The preponderance of biblical material in **Table 5** reflects its common citation by later Jewish and Christian works and studies. Furthermore, this list obviously includes only the most cited works overall, with works with lesser overall impact pushed down the list. To see also works with lesser impact, I divided the edge weights to other groups by overall edge weights to produce a metric of the relative importance of external connections. The highest items on this list are shown in **Table 6**.

	Edge Weights Out	Total Edge Weights	Ratio
Stobaeus, *Eclogues*	179	181	0.98895
Athanasius, *De Synodis*	165	167	0.988024
Justinian, *Edictum Rectae Fidei*	256	262	0.977099
Servius, *In Vergilii Bucolicon Librum*	70	72	0.972222
Menander of Laodicea, *Rhet*.	63	65	0.969231
Derveni Papyrus	154	159	0.968553
Hippolytus, *On the Antichrist*	59	61	0.967213
Celsus, *On Medicine*	55	57	0.964912
Derech Eretz Zutta	53	55	0.963636
The Apocalypse of Ezra	178	185	0.962162
Aeschines, *On the False Embassy*	46	48	0.958333

Table 6: Top ten works by ratio of edge weights connecting outside their groups to total edge weights.

The works on this list are not as well-known, and this is reasonable: less cited works are more influenced by citation in a small number of books, so that, for example, a work that happens to be cited by two books together with works outside its group could appear in this list, while for a work that is overall more frequently cited, this noise would be balanced out. **Table 6** is predominantly composed of late ancient works, some Christian and some not. Some of the works are collections of earlier works or commentaries (Servius, Stobaeus), which would explain their being cited frequently with earlier groups. The *Derveni Papyrus* is cited frequently with Greek literary and religious texts, rather than with other papyri, and, presumably, Celsus's *On Medicine* is cited frequently together with earlier medical texts. *Derech Eretz Zutta*, a Rabbinic work on sexuality, is apparently studied comparatively much more than other Rabbinic works, while Hippolytus, a Christian writer of the third century, is frequently studied

together with later Christian texts. These works are thus on the borders of the sub-discipline. However, considering the low weights of many of the edges, they are not very significant in the discipline.

To look at more frequently cited texts, **Table 7** shows works with the highest external to internal edges ratio but filtered to outer edge weight > 500.

	Edge Weights Out	Total Edge Weights	Ratio
Scholia on Argonautica	1020	1129	0.903454
Papyri Graecae Magicae	583	649	0.898305
Cassius Dio, *Roman History*	612	692	0.884393
Justinian, *Digest*	890	1014	0.877712
Polybius, *Histories*	685	818	0.837408
Orphic hymns., *Fragments*	713	854	0.834895
Eusebius of Caesarea, *Preparation for the Gospel*	1070	1346	0.794948
Septuagint, Judith	924	1168	0.791096
Epiphanius, *Panarion*	610	800	0.7625
Apollodorus, *Bibliotheca*	643	844	0.761848

Table 7: Top ten works by the ratio of edge weights connecting outside their groups to total edge weights, total edge weights > 500.

Again, many of these are works that are collections of earlier works (Eusebius, Justinian, Scholia Argonautica) or works that are used to provide information on earlier issues (Apollodorus, Epiphanius, the Orphic hymns). Cassius Dio and Polybius, though in Greek, are cited very often together with Latin works on Roman history. It is informative to look also at the opposite side of the spectrum (i.e., at works that are seldom cited outside their sub-discipline): a list of these is provided in **Table 8**.

Table 8 includes only Rabbinic, Early Christian and Early Greek works, while Latin, Late Ancient, and Late Greek works do not appear in it at all. Rabbinic citations are rarely cited together with other groups, as seen also in the heatmap. Some Early Christian and Early Greek works certainly are, such as the gospels or Plato, but as this list shows, others, though cited very frequently in their area, are apparently seen as of relatively little interest to other sub-disciplines.

	Edge Weights Out	Total Edge Weights	Ratio
Origen, *Commentary on Romans*	39	2826	0.0138
Xenophanes, *Fragments*	117	3099	0.037754
Aeschylus, *Fragments*	54	1344	0.040179
Menander, *Fragments*	295	5425	0.054378
Sappho, *Fragments*	51	936	0.054487
Cyprian, *Letters*	388	6504	0.059656
Alcaeus, *Fragments*	48	680	0.070588
Babylonian Talmud, *Pesahim*	41	509	0.08055
Babylonian Talmud, *Ketuvot*	73	731	0.099863
Palestinian Talmud, *Berachot*	77	729	0.105624

Table 8: Bottom ten works by the ratio of edge weights connecting outside their groups to total edge weights, total edge weights > 500.

3.2.2 Intersections between specific sub-disciplinary groups

The above analyses identified the works most connected to other sub-disciplines across the network. However, they do not provide insight on interactions between specific sub-disciplines. For this, the list of edge weights of the whole network was divided according to their groups, producing lists of the weights of the edges connecting each work with the works in all the groups, including its own group. **Table 9** (including only the first five works with the highest edge weights in each case and filtered for edge weights > 10) was produced from these lists. It shows, for example, which works from the Early Greek group are cited most often together with works from the Early Christian group, and thus indicates what works in one group are considered by scholars as most relevant for the other.

Table 9 shows that some works are indeed cited alongside works from certain sub-disciplines more than others. For example, in the Early Christianity row, Clement of Alexandria's works are cited together with Greek and Latin works and not together with Jewish or later Christian works. This can be explained by the many fragments of earlier Greek works found in his oeuvre. Or, Vergil's *Aeneid* is in the top five only when cited together with Early Greek materials. At the same time, there are many works that are commonly found in almost all the cases. For example, Josephus's

	Early Christianity	Late Antiquity	Early Greek	Late Greek	Hebrew Bible	Latin	Papyri & Epigraphy	Rabbinic	Second Temple
Early Christianity	Cyp. Ep.; NT Lk; Orig. Comm. Ad Rom; NT 1 Cor; NT Mt	NT Mt; NT Lk; NT Acts; Cyp. Ep.; NT Mk	Clem Strom.; Eus. Pe; NT Lk; Clem Prot.; NT Acts	Eus. Pe; Clem Strom.; NT Lk; NT Mk; NT Acts	NT Lk; NT Mt; NT Mk; NT Acts; NT 1 Cor	NT Lk; NT Acts; Clem. Strom.; NT Mt; NT Mk	NT Lk; NT 2 Tim; NT Acts; Tert Scap.; Clem Prot.	NT Mk; NT Mt; NT Lk; NT Acts; NT Rev	NT Lk; NT Mt; NT Mk; NT Acts; NT Rev
Late Antiquity	Hier. Ep.; Epiph. Pan.; Aug C.D.; Ps.Clement Rec.; Basil Ep.	Hier. Ep.; Basil Ep.; Macr. Sat.; Aug Civ. D.; Ambros Ep.	Proc. In Ti.; Menander Fragments; Macr. Sat.; Serv. Aen.; Aug C.D.	Macr. Sat.; Hier. Ep.; Proc. In Ti.; Lact Inst.; Aug C.D.	Hier. Ep.; Tyconius Book of Rules; Arsenius; Just. Edicta; History of the Monks in Egypt	Macr. Sat.; Hier. Ep.; Just. Dig.; Serv. Aen.; Aug C.D.	Just. Dig.; Cod. Theod; Macr. Sat.; Sidonius Ep.; Proc. In Ti.	Arsenius; Just. Edicta; Athanasios De Synodis; Ephrem Comm. in Gen.; Epiph. Pan.	Just. Edicta; Apocalypse of Ezra; Apocalypsis Sedrach; Athanasios De Synodis; Barsanuphius Ep.
Early Greek	Hdt. Hist.; Plb. Hist.; Arist. Nic. Eth.; Pl. Tim.; Scholia in Aeschin.	Men. Fr.; Hdt. Hist.; Pl. R.; Pl. Phdr.; Pl. Phd.	Men. Fr.; Xenoph. Fr.; Hdt. Hist.; A. Tgf; Hom Il.	Hdt. Hist.; Th. Th.; Ar. Ra.; Arist. EN; Plb. Hist.	Hdt. Hist.; Th. Th.; Hom Il.; Plb. Hist.; X. Mem.	Hdt. Hist.; Arist. EN; Plb. Hist.; Hom Il.; Pl. Ti.	Hdt. Hist.; Lys. Fr.; Arist. Ath.; Aeschin. Ep.; Th. Th.	Hdt. Hist.; Th. Th.; Theopomp. Fr.; Pl. Lg.	Hdt. Hist.; Plb. Hist.; Th. Th.; Pl. Phdr.; Pl. R
Late Greek	Scholia Argon.; Dio Or.; Str. Geog.; Maximus Or.; Orphic fr.	Str. Geog.; Gal. Mixt.; Paus. Descr.; Plot. Enn.; Orphic fr.	Paus. Descr.; Str. Geog.; Apollod. Bib.; Orphic Fr.; Scholia Argon.	Str. Geog.; Paus. Descr.; Numen. Fr.; Iamb. Vp; Dio Or.	Scholia Argon.; Str. Geog.; Paus. Descr.; Diod. S. History; Porph. Abst	Str. Geog.; Dio Hist.; Paus. Descr.; App. Bc; D.H. Ant.	Paus. Descr.; Str. Geog.; Achilles Leuc.; Porph. Abst; D.S. History	Scholia Argon.; Plu. Isis; Muson. Fr.; D.H. Ant.; Paus. Descr.	Scholia Argon.; Str. Geog.; Porph. Abst; Plu. Alex.; Philostr. VA

(Contd.)

	Early Christianity	Late Antiquity	Early Greek	Late Greek	Hebrew Bible	Latin	Papyri & Epigraphy	Rabbinic	Second Temple
Hebrew Bible	Ps; Ex; Is.; Gen; De.	Ps; Gen; De.; Is.; Ex	Gen; Ps; De.; Ex; 2Kg	Gen; Ex; De.; Ps; Je	Ps; De.; Ex; Is.; Gen	Ex; Gen; De.; Ps; Is.	Gen; Is.; De.	Ps; De.; Ex; Gen; Lev	Ps; Gen; Ex; De.; Is.
Latin	Pliny Ep.; Cic Ep.; Sen Ep.; Liv. Hist.; Mart. Epig.	Liv. Hist.; Sen Ep.; Julianus V. Cont.; Cic Ep.; Pliny Nh	Ov. Met.; Liv. Hist.; Virg. A.; Cic Ep.; Sen Ep.	Cic Ep.; Liv. Hist.; Sen Ep.; Pliny Nh; Cic Tus	Sen Ep.; Cic Ep.; Liv. Hist.; Pliny Nh; Cic Fam.	Cic Ep.; Mart. Epig.; Liv. Hist.; Pliny Ep.; Sen Ep.	Pliny Ep.; Liv. Hist.; Ennius Thy.; Mart. Epig.; Cic Ep.	Diocletian Edictum De Maleficiis; Sen Ep.; Quint. Inst.	Sen Ep.; Pliny Nh; Liv. Hist.; Cic Ep.; Juv. Sat.
Papyri & Epi-graphy	PGM; CIL; P.Oxy; P.Cair. Masp; I.Mont	SEG; CIL; I.Mont; P. Oxy; PGM	SEG; IG II2; PGM; IG I; Lscg	SEG; PGM; LSCG; CIL; IG	PGM	CIL; SEG; ILS; PDM; PGM	SEG; LSCG; IG II3; P. Oxy; IG I	P.Yad.	PGM; CPJ; SEG; JIGRE; P. Oxy
Rabbinic	Gen Rab.; m. Halla; m. Berakot; Lam. Rab.; Num Rab.	Yalqut Shimoni; Gen. Rab.; Lam. Rab.; Pesikta Rabbati	Mekhilta Rashbi; t. Shek.	t. Shek.; m. Abot	Sifr. Deut.; Gen Rab.; Lev Rab.; m. San.; m. Berakot	Mekhilta Rashbi; t. Shek.	Mekhilta Rashbi; b. Nida	Sifr. Deut.; Lev Rab.; Gen Rab.; b. Sanh.	Pesikta Rabbati; Gen. Rab.; b. Nida; Lam. Rab.
Second Temple	J. AJ; LXX Tob.; 4 Baruch; LXX Si.; J. BJ	J. AJ; 4 Baruch; J. BJ; Jub.;	J. AJ; LXX Si.; J. BJ; J. Ap.; Philo Op.	J. AJ; J. Ap.; J. BJ; LXX Si.; 2 Macc.	J. AJ; LXX Tob.; LXX Si.; Jub.; LXX Ju.	J. AJ; J. BJ; J. Ap.; LXX Si.; J. Vita	J. AJ; J. BJ; J. Ap.; 2 Macc.; 1 Macc.	J. AJ; J. BJ; Philo Agr.; Philo Cont.; Jub.	J. AJ; LXX Tob.; J. BJ; Philo Abr.; Qumran CD

Table 9: Most co-cited works of each sub-discipline with works of each of the other sub-disciplines. Abbreviations are used for the sake of visibility.

works are at the top in almost all the columns in the Second Temple row, as are the synoptic gospels in the Early Christian row. Thus, the works from sub-discipline *x* most cited by other sub-disciplines *y* and *z* are frequently those which are cited most within the sub-discipline *x* itself, though there may be significant changes in the order to works.

To draw out especially the differences between the various sub-disciplines, I compared the ranking of nodes' degrees in the whole network with the ranking when taking only the edges connecting the node to a specific sub-discipline, and then filtered out works where the difference between these rankings was small, less than 5. **Table 10** includes the top nodes (by degree) for each interaction. This technique thus captures the works that are central (as they have the highest degree in each category), but also have a much more (or much less) significant connection to the specific sub-discipline than they have to the whole network. This method provides much more information that that used in **Table 7** and **Table 8**, since it shows not only which works connect the sub-disciplines, but also their role in this interaction relative to their typical role in the network.

A comparison of the methods of **Table 9** and **Table 10** demonstrates that while, in **Table 9**, most of the works on the same row were identical regardless of their column (i.e., these are central works that are cited with most or all sub-disciplines), **Table 10**, by omitting the most central works, succeeded in capturing different works for each sub-disciplinary intersection. All this information cannot be interpreted here, but I will comment on the Early Christian row as an example. While in **Table 9** the gospels dominated this row as the most central and cited works, here they are totally missing. In the intersection with Late Antiquity, we find some relatively late works (third and early fourth century) and works that are studied in the context of late ancient *paideia* (2 Timothy, Clement of Alexandria's *Paedagogus*). Early and Late Greek works are cited especially together with Early Christian works that contain many fragments of earlier works. Non-Christian Latin works are cited together with Christian Latin literature: Tertullian's apologetic work, which is relatively relevant to non-Christians, and Cyprian's Epistles, as well as with 2 Timothy, 2 Corinthians, and Clement's *Protrepticus*, again an apologetic work. Jewish works—Rabbinic and Second Temple—are cited together with New Testament books, especially Revelation and Hebrews, rather than with later Early Christian works, probably reflecting the greater Jewish identity and involvement of the Christian community in the earlier period.

	Early Christianity	Late Antiquity	Early Greek	Late Greek	Hebrew Bible	Latin	Papyri & Epigraphy	Rabbinic	Second Temple
Early Christianity	Orig. Princ.; NT 1 Joh; Trad. Ap.; NT Heb; Ignatius Phld.	Orig. Princ.; Eus. VC; Clem Paed.; NT 2 Tim; Hippol. Antichristo	Clem Strom.; Eus. PE; Clem Prot.; NT 1 Tim; NT Mk	Eus. PE; Clem Strom.; Clem Prot.; Hippol. Ref.; NT Rom	NT Heb; 1 Cor.; Ps. Sal.; Jos. Asen.; 4 Ez.	Tert Apol.; Cyp. Ep.; Clem Prot.; NT 2 Tim; NT 2 Cor	NT 2 Tim; Clem Prot.; Tert Scap.; NT 1 Thess; Tert Apol.	NT Rev; NT Jn; Jos. Asen.; NT Heb; 4 Ez.	NT Rev; 1 Cor.; NT Rom; NT Jn; NT Heb
Late Antiquity	Ps.Clement Rec.; Tyconius Reg.; Arator Histor. Apost.; Hier. Vir. Ill.; Lact Mort.	Ambros Ep.; Ambros Off.; Just. Nov.; Epiph. Pan.; Lact Inst.	Menander Fr.; Serv. Aen.; Non. Dion.; Olymp. in Phd.; Suda	Stob. Ecl.; Stob. Anth.; Arnob. Nat.; Non. Dion.; Suda	Tyconius Reg.; Arsenius; Just. Edicta Iustiniani; History of the Monks in Egypt; Apocalypse of Ezra	Serv. Aen.; Sidonius Ep.; Serv. Ecl.; Stobaios Eclogae; Aug Conf.	Cod. Theod; Sidonius Ep.; Ephrem Eccl.; Non. Dion.; Just. Inst.	Arsenius; Just. Edicta Iustiniani; Athanasios De Synodis; Ephrem Comm. in Gen.; Andrew of Cesarea Comm. Apoc.	Just. Edicta; Apocalypse of Ezra; Athanasios De Synodis; Barsanuphius Ep.
Early Greek	Plb. Hist.; Pl. Ti.; Scholia in Aeschinem (Uetera); Ion Fgh 392; Clitarch. Sent.	Pl. Phd.; Pl. Ti.; Arist Met.; Archil. Fr.; Parm. Fr.	Alc. Fr.; Hom Od.; E. Supp.; Pl. Ap.; Bacc.	Ar. Ra.; Plb. Hist.; Numen. Fr.; X. An.; Antisth. Fr.	X. Cyr.; X. Mem.; Plb. Hist.; Q.S. Posthomerica	Arist. EN; Plb. Hist.; Pl. Ti.; Arist Rh.; Theoc. Id.	Lys. Fr.; Arist. Ath.; Aeschin. Ep.; Hom Od.; E. El.	Theopomp. Fr.; Pl. Lg.	Plb. Hist.; Hom Od.; Pl. Ti.; Scholia in Aeschinem; X. An.
Late Greek	Maximus Or.; Dion. Hal. Ant.; Alcin. Intr.; Luc Peregr.; Muson. Fr.	Gal. Mixt.; Plot. Enn.; Aristid. Her.; Diog. L. Lives; Apollod. Bib.	Opp. Hal.; Anth. Pal.; Porph. Abst; Dio Or.; Hymni	Numen. Fr.; Achilles Leuc.; Arr. An.; Plu. Fr.; of	Diod. Sic. History; Plu. Ant.; Maximus Or.; Achilles Leuc.	Dio Hist.; App. BC; Dion. Hal. Ant.; Gal. PHP; Plu. Isis	Achilles Leuc.; D.S. History; Ath. Deip.; Plu. Isis; Anth. Pal.	Plu. Isis; Muson. Fr.; D.H. Ant.	Plu. Alex.; D.H. Ant.; Maximus Or.; Plu. Isis; Paus. Descr.

(Contd.)

	Early Christianity	Late Antiquity	Early Greek	Late Greek	Hebrew Bible	Latin	Papyri & Epigraphy	Rabbinic	Second Temple
Hebrew Bible	Pr.; Ma.; Ze.; Mic.; Song	Pr.	Ecc.; Es.; Hos.; Lev.	Pr.	Lam.	Jb.		Song; Ecc.; Lam.	Es.; 1Kg; 1 Chr.; Song
Latin	Quint. Inst.; Cic. Fam.; Hor. S.; Pl. Cur.; Mela Chorografia	Juv. Sat.; Apul. Platone; Cic. Sen.; Mart. Epig.; Hor. S.	Ov. Met.; Virg. A.; Lucr. Rn; Verg. G.; Hyg. Fab.	Cic. Tus; Cic. Fin.; Cic. Div.; Suet. Aug.; Pliny Ep.	Cic Fam.	Pliny NH; Ov. Met.; Cic. Tus; Ov. Pont.; Cic. Fin.	Ennius Thy.; Paulus Dig.; Suet Aug.; Prop. Eleg.; Sen Ep.	Diocletian Edictum De Maleficiis; Quint. Inst.	Juv. Sat.; Sen. Dial; Suet. Aug.; Mela Chorografia; Varr. Antiq.
Papyri & Epigraphy	P.Cair.Masp; I.Mont; Upz; Plond	I.Mont; P.Yad.; Rdge; P.Stras.	IG II2; Derveni Papyrus; Fasti Gabini; Id; SP	RICIS; Derveni Papyrus; IG II3; Ml; IG VII		ILS; PDM; P.Flor.; Fasti Gabini; Ae	ILS; PGM; P.Giss.; P.Col.; Stratonikeia	P.Yad.	CPJ; JIGRE
Rabbinic	Lam. Rab.; Num Rab.; M. Abot; T. Meg.	Yalqut Shimon; Lam. Rab.; Pesikta Rabbati	Mekhilta Rashbi; T. Shek.	T. Shek.; M. Abot	Cant. Rab.; Sifre; Midrash Psalms; M. Tamid; B. Sanh.	Mekhilta Rashbi; T. Shek.	Mekhilta Rashbi; B. Nida	M. Pesahim; M. Gitin; M. Eduyot; T. Avoda Zara; M. Bekorot	Pesikta Rabbati; B. Nida; Lam. Rab.; Num Rab.; M. Abot
Second Temple	4 Baruch; LXX Isa; LXX Gen.; Qumran Aramaic Levi; LXX 1 King.	4 Baruch; LXX 2 Macc.; LXX Tob.; Aramaic Levi	Philo Op.; Philo Prob.; Ep. Arist.; Philo QG; Philo Deus	J. Ap.; 2 Macc.; Philo Prob.; Ep. Arist.; Philo Op.	LXX Ju.; Qumran CD; 4 Baruch; Qumran 1QM; LXX 1 Es.	J. Vita; Ep. Arist.; LXX Isa; Philo Prob.; Philo Op.	2 Macc.; 3 Macc.; Philo Agr.; Ep. Arist.; Qumran 4Q460	Philo Agr.; Philo Cont.; LXX Tob.; Qumran CD; J. Vita	Philo Abr.; Philo Her.; Philo Laws; Philo QG; Philo Cher.

Table 10: Most co-cited works of each sub-discipline with works of each of the other sub-disciplines, with difference in rank. Abbreviations are used for visibility.

3.2.3 Intersections between specific sub-disciplinary groups at the reference level

Despite its advantages, the information in **Table 10** still does not quite capture how scholars actually use these primary texts because scholars cite specific references (e.g., Genesis chapter 1, verse 3) rather than whole books. It is possible to look into the network at higher resolution and examine what references are cited at greater frequency by certain groups. However, this would produce a very large amount of data: the network produced with separate nodes for each reference, based on the same indices used above, contains 500,000 nodes and 70 million edges. Thus, rather than produce an overall table, I will focus on two (double) intersections—Rabbinics and early Christian literature, and Late Greek and Early Christian literature. Another problem with this network is that when it is used to find nodes (primary work references) with the highest degree (i.e., most edges connecting to other nodes) it produces a strong bias towards nodes that appear on a page together with many other references, even if they appear only in one book and are not otherwise popular or significant in the literature. This bias can be corrected by using not the secondary book page as the unit of co-citation, but the whole book. The network produced is denser (since any two references in one book are connected), and this balances out such cases. I thus used this type of network for this case.

The first intersection has produced much discussion in the research regarding the historical interactions between Early Christianity and Rabbinic Judaism, as well as methodological questions concerning different aims and genres of these texts, and how they should best be read together (Horbury 2009; Yuval 2010; Rosen-Zvi 2017). Concerns have also been raised that scholars of one area do not know the other area well enough. The second intersection is also a major concern in scholarship, with many discussions concerning the applicability of one group of texts to the other (Robertson and Marguerat 2019). **Table 11** shows the resolution possible in this analysis, of small textual units comprising between about a dozen to a few hundred words. The verses most co-cited with Rabbinic works are all from Mark and Matthew, almost all of which come from pericopes where Jesus rejects certain aspects of Jewish law or polemicizes against the Pharisees. The Rabbinic texts most cited with early Christian works are more diverse, but all discuss issues central to early Christian issues such as resurrection, the Old and New Covenants, or the election of Israel.

Another interesting intersection is that of the Early Christian group and the Late Greek group (shown in **Table 12**). Again, the relationship between early Christianity and contemporary Greco-Roman society and culture attracts much scholarship (Walsh 2021; Porter and Pitts 2012; Brakke 2002; Clark 2015). The Early Christian references relate mostly to texts that discuss Greek philosophers, or that contain fragments from them. On the other side of the table, most are philosophical texts which relate to figures

seen as close to the Christian movement (items 1, 2, 10) or to Platonic concepts which can be seen as close to Christian theology (Numenius of Apamea, Alcinous).

Rabbinic References Most Cited with Early Christian Works	Early Christian References Most Cited with Rabbinic Works
1. Mishnah, Avot 1.1	1. New Testament, Matthew 5.34
2. Sifre Deuteronomy 306	2. New Testament, Mark 7.1
3. Sifre Deuteronomy 41	3. New Testament, Mark 7.10
4. Babylonian Talmud, Berachot 28B	4. New Testament, Matthew 23.2
5. Babylonian Talmud, Berachot 32B	5. New Testament, Mark 7.22
6. Mishnah, Peah 1.1	6. New Testament, Matthew 15.4
7. Mishnah, Berachot 9.5	7. New Testament, Mark 7.9
8. Mishnah, Sanhedrin 10.1	8. New Testament, Mark 7.6
9. Babylonian Talmud, Pesahim 57A	9. New Testament, Matthew 15.2
10. Mishnah, Avot 1.12	10. New Testament, Matthew 23.6

Table 11: The early Christian/Rabbinic intersection.

Early Christian References Most Connected to Late Greek Works	Late Greek References Most Connected to Early Christian Works
1. Clement of Alexandria, *Miscellanies* 2.119	1. Lucian, *The Passing of Peregrinus* 18
2. Eusebius of Caesarea, *Preparation for the Gospel* 14.6.9	2. Epictetus, *Discourses* 3.22.73
3. Clement of Alexandria, *Miscellanies* 2.131.1	3. Numenius of Apamea, *Fragments* 20
4. Clement of Alexandria, *Miscellanies* 5.9.59	4. Epictetus, *Discourses* 1.29.3
5. Origen, *Against Celsus* 3.27	5. Strabo, *Geography* 8.6.20
6. Origen, *Against Celsus* 3.26	6. Epictetus, *Discourses* 1.14.6
7. Origen, *Against Celsus* 3.1	7. Numenius of Apamea, *Fragments* 12
8. Eusebius of Caesarea, *Preparation for the Gospel* 11.2.4	8. Alcinous, *Handbook of Platonism* 10.3
9. Eusebius of Caesarea, *Preparation for the Gospel* 14.5.11	9. Numenius of Apamea, *Fragments* 16.8
10. Hippolytus, *Refutation of All Heresies* 5.8.40	10. Diogenes Laertius, *Lives of the Philosophers* 3.6

Table 12: The early Christian/Late Greek intersection.

4. Discussion and conclusions

In this article, I attempted to show how detailed information on primary source co-citation behaviour in a historical discipline can be used to map the discipline at three levels: sub-disciplinary group, primary source, and primary source reference,

including interactions within and between these levels. The major innovation of the method used here is the use of primary text rather than secondary literature (or article) citations. I showed that this method can be used effectively in a field where citations of primary texts are central; primary text citations can be used to produce a network that can be analyzed through traditional science mapping techniques. However, they are different from article co-citations in that they reflect the materials being studied, rather than the researchers studying them. This approach has potential for other fields where citation of primary research material is important, whether texts or other objects.

I also indicated some of the challenges inherent in this attempt: first, the definition of the groups, which overlap in different settings and are therefore somewhat arbitrary; second, the interpretation of the meaning of the emerging patterns beyond the general location of groupings. The identification of co-cited works from different sub-disciplines shows that there are two types of such works: the first is works that are cited outside of their sub-discipline because of their overall importance: these can be seen as the core literature of the discipline. The second type consists of works that are not especially central in the overall network, but which are cited relatively frequently outside of their sub-discipline, as measured either by the ratio of out-group to in-group edges or by difference in rank between each sub-discipline and the whole network. I showed these two types in the network as a whole and concerning each sub-discipline in its relationship to each other sub-discipline. The second type is more interesting since it shows which works are at the borders between sub-disciplines.

Concerning the domain itself, the analysis has shown that the discipline of ancient Mediterranean religion is composed of several sub-disciplines of varying degrees of insularity and interrelatedness. Two major groups are Greek/Latin texts on the one hand and Jewish/Christian texts on the other, with texts from Late Antiquity bridging the two. The texts located as bridging sub-disciplines, that is, as co-cited most frequently with texts of other sub-disciplines despite not being very central, typically contain fragments of material from the other sub-discipline or are of subjects that are of direct thematic interest to the other sub-discipline.

In the future, if more data could be gathered for books from the decades of 1990–2010, similar methodologies could be used to implement a diachronic analysis. This will lead to better understanding of the changes in the field and the interactions between sub-disciplines over time. Another development could be tools that allow researchers to follow the network of references in order to locate additional primary source references of interest to them, similar to suggestions currently provided by search tools of research articles.

Competing interests

The author has no competing interests to declare.

Contributions

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