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Tabular Thinking in Late Ancient Palestine: Instrumentality, Work, and the Construction of Knowledge

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Abstract: In late antiquity, a revolution in information technology transformed the practices and possibilities of knowledge. At the cutting edge of this development, several third- and fourth-century figures in Roman Palestine deployed the emerging technology of the column-and-row table as a novel tool of historical and literary scholarship. The Christian scholars Origen and Eusebius and the rabbinic sages of the Palestinian Talmud adapted this specialist technology from grammar and astronomy, and put it to work to structure complex textual corpora. As a "textual machine," the table generated new possibilities of knowledge. Bringing together literary and material evidence, this study analyses the "how" (working methods) and the "who" (human actors) involved in these innovative late ancient projects. I interrogate the pragmatics and the ethics of late ancient tabular thinking in order to locate these projects within broader histories of knowledge construction, in late antiquity and beyond.

1 Introduction

In his 2011 monograph, *Paper Machines: About Cards & Catalogs, 1548–1929*, Markus Krajewski narrates the development of card catalogues and similar in-

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dex systems, tracing a history of use and innovation that extends from the early modern period to the twentieth century.[1] The invention of the card catalogue enabled new practices of knowledge. Cataloguing systems facilitated the large-scale categorization of information about people and things, with ramifications far beyond the scholar's study or the university library. One might think of widespread systems for managing census and population data that emerged in the later nineteenth century, of the emergence of income tax schemes (first organized with card catalogues), or of the millions of individual cards used to collect words and definitions for the *Oxford English Dictionary* or the *Thesaurus Linguae Latinae*. Card catalogues provided an architecture to assemble information from many sources and to coordinate the efforts of many people. These "paper machines" offered new possibilities of organizing information and, thereby, new ways of knowing the world.

The modern card catalogue was not the first such innovation in information technology. The systematizing impulse of Krajewski's "paper machines" has a rich variety of ancient and medieval antecedents. Over the past decade, scholars have analyzed diverse strategies for organizing a world that is "too much to know"[2] and have mapped complex patterns of distributed cognition in Mediterranean antiquity.[3] Building on these developments, I examine the late ancient emergence of the column-and-row table as a technology for constructing historical and literary knowledge. As part of a larger transformation of knowing in late antiquity, the innovative deployment of the table afforded new spatial approaches to organizing information and producing knowledge.[4]

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1 Krajewski 2011. For other recent histories of textual technologies, see Robertson 2019; Lynch/Robertson 2021; Robertson 2021.

2 "Too much to know": Blair 2010. Blair focuses on early modern reference books and the navigational devices that helped people use them. (Eusebius of Caesarea's fourth-century Gospel apparatus, discussed below, is an earlier example of such a navigational device.) As Blair demonstrates, these tools facilitated new projects of knowledge. In recent years, scholarly interest in the history of organizing information has exploded. See Franklin-Brown 2012; Kennedy 2016; Riggsby 2019; Dershowitz 2021; Reader 2021; Wellmon 2021.

3 The foundational work on distributed cognition is Hutchins 1995; Hutchins focuses on two case studies of nautical navigation. On distributed cognition in the ancient Mediterranean, see Anderson *et al*. 2019, as well as the ongoing work of Serafina Cuomo. Applying such cognitive models to writing in the ancient Mediterranean (thinking about the "extended mind" of a single human actor), see Yuen-Collingridge 2018.

4 On a "late ancient revolution" in information technology, see Riggsby 2019, 216–222. Significant studies of late ancient transformations in textuality and knowledge include Grafton/Williams 2006; Chin 2008; Chin/Vidas 2015b; Vidas 2017; Stefaniw 2019. On "affordances," see

Across fields from informatics to the history of science to literary studies, scholars often distinguish between "information" and "knowledge."[5] On these terms, *information* consists of (more or less) raw material, data that can be collected, organized, analyzed, and so forth.[6] *Knowledge* is what people make out of this information through a variety of practices, institutions, and technologies. The distinction is not between "unmediated" or "objective" data and "constructed" or "subjective" knowledge. Both information and knowledge are contingent. Collections of data are often flawed and inevitably partial. Knowledge is inescapably situated, deploying concepts or models to make sense out of limited information for particular ends.[7] Given the contingency involved in every aspect of cognition, a rigid division between information and knowledge will not hold up to scrutiny. Instead, we might imagine a continuum, by which the experienced data of the world are organized into increasingly complex and embedded forms of knowledge. What is vital for the present project are the technologies and the human knowers involved in structuring information into new configurations and, thereby, in constructing knowledge. Knowledge takes the shape that it does, in part, because of how people put it together.

Levine 2015, 6–7. This language derives from environmental psychologist James Gibson (Gibson 1966, developed in Gibson 1979, 127–137).

5 See, e.g., The Postclassicisms Collective 2020, 113–127 ("Knowing"); Wellmon 2021. The most influential account is Kuhn 2012 [1962], building on Polanyi 1958. On knowing in late antiquity, see Chin/Vidas 2015b. As Chin and Vidas write, recent scholarship has often understood "the activity of knowing as thoroughly conditioned, indeed created, by larger patterns of discourse and embedded in systems of social and cultural power" (2015a, 2). Leading the way in a major development in the history of late antiquity, the essays in Chin and Vidas 2015b combine this wider perspective with attention to specific, local, and embodied practices of knowing.

6 Debates continue about how to define and distinguish data, information, and knowledge. Blair articulates a contrast between "discrete and small-sized items that have been removed from their original contexts" — that is, information — and knowledge, which requires "an independent knower" to make sense of that information (Blair 2010, 2). As discussed by Amsler in the introduction to this volume, some draw a sharper distinction between (unsorted) "data" and (minimally organized) "information."

7 As Wellmon writes, knowledge deploys "concepts, methods, or theories" (often submerged or unrecognized) in making sense of available information (2021, 134). For the language of "situated knowledges," see the foundational essay of Haraway 1988. As Haraway writes, "[h]istories of science may be powerfully told as histories of the technologies. These technologies are ways of life, social orders, practices of visualization" (Haraway 1988, 587). Thinking with Haraway, we might describe late ancient tabular thinking as a "situated knowledge" emerging out of particular conditions and enabling particular possibilities because of its reliance on particular configurations of human labor. "Practices of visualization" are particularly relevant to the modes of knowing afforded by the table.

In this study, I examine the role of tables in late ancient scholarship, investigating both the "how" (the technologies and working methods) and the "who" (the human actors) involved in several innovative late ancient projects of knowledge construction.[8] Attending to both the technologies and the human actors involved in the construction of knowledge is crucial for understanding the late ancient social and intellectual contexts in which people developed and deployed this tabular mode of knowing.

The pragmatics and the ethics of knowledge cannot be separated. Technologies and practices for constructing knowledge are often collaborative, involving the labor, expertise, and agency of numerous individuals. This work is distributed across time, space, agents, and artifacts. As Chad Wellmon writes, knowledge is "bound up not just in minds but also in media, technologies, practices, and institutions."[9] Yet ancient and modern projects of knowledge often obscure the people, technologies, and processes involved in complex cognitive work. The present study examines two different kinds of instrumentality: the table as a late ancient tool of knowledge and the human knowers who made this textual machine work. Scholars often overlook both as "merely" instrumental. Both occlusions, moreover, reflect an aversion (ancient and modern) to the embodiment of knowledge. Yet their ethical significance is not the same. To obscure a technology (like the abacus, the drawing compass, or the column-and-row table) differs dramatically from exploiting and erasing human agency and labor. We must actively resist the dehumanizing fiction that Brendon Reay calls "masterly extensibility," which treats subordinated (often enslaved) individuals simply as tools, as extensions of the bodies and wills of others.[10] The

8 Despite their enormous impact, late ancient tables have received scant attention and their technological features remain under-analyzed; see, however, Grafton/Williams 2006, 86–232 (Origen and Eusebius); Crawford 2019, esp. 56–95 (Origen and Eusebius); Riggsby 2023 (Origen); Mansfeld/Runia 1997–2010, 1:111–116 (Ptolemy, Origen, and Eusebius); Coogan 2022 (grammar, Ptolemy, Origen, and Eusebius).

9 Wellmon 2021, 135. For an account of the interlocking structures of philology in nineteenth-century Europe, involving "practices, instruments, and cooperation," see Kurtz 2021, 751. Kurtz's account of varied *instrumenta* in the cooperative enterprise of philology offers a comparandum for late ancient knowing. Modern studies of distributed cognition illuminate how teams of people collaborate with each other and with varied technologies to form complex units for processing information and making decisions; these systems are not reducible to the contributions of any single individual (Hutchins 1995).

10 While enslavement in the ancient Mediterranean differed in various ways from enslavement in other contexts, we cannot overlook its exploitative nature. On "masterly extensibility," see Reay 2005. As described by Joseph Howley, the "despotic discourse" of the Roman Mediterranean regarded human workers as cogs in a machine (Howley forthcoming). See, for example,

erasure of technologies and bodies in favor of an idealized solitary thinker is older than the Cartesian ideal of the European Enlightenment. It is grounded not only in the buffered self of modernity, but in what Joseph Howley has described as the "epistemic firewall" of ancient "despotic discourse," which separates the elite knower from the embodied labor of others.[11] By attending to the often-overlooked technologies involved in late ancient projects of knowledge construction, I intend also to redirect attention to people whom we might otherwise overlook.

In what follows, I define the table and describe its limited uses in Mediterranean antiquity before the third century CE. Then I turn to a revolution in knowledge that centers on figures working in third- and fourth-century Palestine: Origen (ca. 185–ca. 255 CE) in the third century, Eusebius (ca. 260–339/40 CE) in the early fourth century, and the rabbinic sages associated with the Palestinian Talmud (redacted late fourth century). These are among the first known figures to organize texts using tables, but the tabularity of their projects has often been neglected. After analyzing how these projects organize textual knowledge, I conclude by discussing the social and intellectual implications of late ancient tabular thinking.

2 Tables in the Roman Mediterranean

Modern readers encounter tables in manifold mundane contexts. We use them as bus timetables and budgets, gradebooks and coffee shop menus. We might find many everyday tasks inconvenient without this ubiquitous technology. But familiarity may lead us to overlook how tables organize information. What is it that makes the table such a powerful technology? Building on the work of An-

Aristotle, *Nicomachean Ethics* 1161a30–b6, which equates humans and physical tools. See further Candida Moss on the textual interchangeability of enslaved catapult operators and the catapults themselves in P. Berol. 11632 (Moss 2021b) and Sarah Blake on "prosthesis" as a model for the exploitation of enslaved bodies in antiquity (Blake 2012). On ancient tendencies to obscure and modern tendencies to ignore enslaved individuals in the Roman Mediterranean, see Fitzgerald 2021. On how present-day scholars might acknowledge those whom sources actively efface, see Dan-el Padilla Peralta's description of "epistemicide" (Padilla Peralta 2020) and the work of Moss (2021b), drawing on Saidiya Hartman's "critical fabulation" (Hartman 2008).

11 Howley forthcoming. This is not only an ancient prejudice; compare Geoghegan 2020 on the erasure of human cognitive work in modern information technologies. As Geoghegan argues, this erasure is often racialized, gendered, and connected to other bodily difference.

drew Riggsby, I define a table as a regular arrangement of columns and rows that structures information in two directions.[12] The crucial feature is the table's bidirectional significance: one can read both vertically and horizontally to obtain meaningful information. In these terms, the table differs from the list, which structures material in only one direction.[13] Because the table generates new meaningful juxtapositions, one can think with a table.

Although tables are familiar today, they were rare in the Roman Mediterranean.[14] People used tables in a handful of specialized contexts; in each case, tables were part of practical modes of knowing, embedded in particular communities of practice. Tables are first attested in the Mediterranean world around the turn of the era as a specialist technology for organizing scientific information. Astronomical tables on papyrus are extant from the first century BCE.[15] As Courtney Roby observes, the table was a mechanism for the collaborative production and maintenance of knowledge. Because the requisite observational time spans, especially without the precision of modern instruments, transcend the lifetime of any human astronomer, astronomical tables require astronomers to collaborate in collecting data and demand an information structure robust enough to enable different contributors over time to integrate observational

12 Riggsby 2019, 44–45; cf. Coogan 2022, 40.

13 Note the subversive possibilities of the nonlinear reading afforded by the index or the table of contents, e.g., Roy Gibson's discussion of subversive reading engendered by the index in manuscripts of Pliny (Gibson 2014). On nonlinear reading and late ancient tables of contents, see Coogan 2021a; 2021b.

14 Riggsby argues that tables were "vanishingly rare" until the third century CE (Riggsby 2019, 43). He focuses on Latin sources (2019, 42–82). Greek evidence in the first and second centuries CE is more widespread, but Greek tables were still confined to handful of technical contexts.

15 The *Handy Tables* of the second-century CE astronomer Ptolemy are a well-attested and successful example; see, *inter alia*, the papyrus fragments published in Jones 1999. Although I focus on tables that organize literary and historical information, late ancient Christian figures also used column-and-row tables for astronomical purposes. Paschal calculations offer some of the earliest evidence for Christians using tables. Through Eusebius' *Ecclesiastical History*, we discover third-century figures who employed mathematical astronomy to produce paschal canons. Hippolytus of Rome prepared "a canon (κανόνα) for a sixteen-year cycle" (Eusebius, *Hist. eccl.* 6.22.1) and Anatolius of Laodicea devised a nineteen-year cycle, published in a work known as Κανόνες περὶ τοῦ πάσχα (partially preserved in Eusebius, *Hist. eccl.* 7.32.14–19; cf. Jerome, *Vir. ill.* 73), created ca. 264 CE. In addition to a Greek excerpt preserved by Eusebius, a version of Anatolius' work is preserved in the Hiberno-Latin treatise *De ratione paschali* (PG 10, 209–222). As reflected by this Latin version, Anatolius' work contained a short treatise and two tables: the first provided a lunar calendar; the second provided the dates of Easter for the repeating cycle.

data.[16] While astronomical tables are attested first, we also find numerical tables in geography, arithmetic, and other disciplines (τέχναι).[17]

As part of the τέχνη of grammar, tables also appeared in the schoolroom. The table was part of the toolbox of the grammarian, used for declension tables and glossaries.[18] As Eleanor Dickey has demonstrated, arranging parallel texts in adjacent columns was an innovation that emerged out of ancient language learning, especially as a way of organizing bilingual information.[19] Prior to the third century CE, however, we do not find the table as a technology for coordinating multiple texts.

As we consider late ancient tables, there are two things to observe. First, there are actual tables — composed of columns and rows, populated with information. Second, numerous late ancient texts reflect tabular dynamics of vertical sequence and horizontal comparison even when no formal column-and-row tables are preserved. Both kinds of evidence impel us to attend to the technological practices and the social structures involved in the construction of knowledge.

3 Origen's *Hexapla*

In the third and fourth centuries CE, multiple scholars based in Caesarea Maritima in Roman Palestine experimented with tables. Origen of Alexandria and — as I argue — a number of collaborators aligned multiple versions of Hebrew and Greek scriptures in a massive tabular project known as the *Hexapla* ("sixfold").[20] The *Hexapla* correlated divergent but roughly parallel texts: Hebrew scriptures and several Greek translations. Following initial Greek translations of Hebrew

16 Roby 2019, 43–44. Ptolemy similarly describes tabular arrangement as a way of inviting subsequent correction (διόρθωσις) and refinement of geographical data. In *Geogr.* 2.1.3, he invites subsequent users of his tables to correct the positional data and describes how his table can facilitate this revision.

17 See, e.g., Cribiore 1993; Roby 2018; Azzarello 2019. We find a handful of related uses: military duty rosters, surveying grids, and so forth; see Riggsby 2019, 50, 52.

18 Dickey *et al.* 2013; Dickey 2015; 2019. Classroom tables are not discussed in Morgan 1998 or Cribiore 2001.

19 Dickey 2015; cf. Brock 1970.

20 On Origen and the table, see Riggsby 2023; Mansfeld/Runia 1997–2010, 1:111–116; Grafton/Williams 2006; Crawford 2015, revised and expanded in Crawford 2019, 57–74; Coogan 2022, 42–47. Other important discussions of Origen's textual scholarship (e.g., Neuschäfer 1987; Martens 2012) do not engage the table as a technology.

scriptures beginning in the third century BCE, subsequent revisions had been made using various Hebrew texts. Different translation techniques and several distinct projects of revision led to a situation of textual diversity in Greek. While multiple texts were conceptually parallel, they often differed in detail and sequence. Origen responded to this complex situation with a table, using parallel columns to juxtapose multiple Greek versions with a Hebrew text.

The format of the *Hexapla* is unfortunately attested only by muddled literary descriptions and by two partial and palimpsested manuscripts,[21] one from the Cairo Genizah and the other in the Ambrosian Library in Milan.[22] They date from the seventh and ninth centuries CE, respectively. Both contain parts of the Psalms. Although the manuscripts are fragmentary, they enable us to reconstruct how Origen's project appeared on the manuscript page. Across every two-page opening, the *Hexapla* included six columns: a Hebrew text, a transliteration of the vocalized text into Greek characters, and four Greek translations.[23]

Although the *Hexapla* was an ambitious project of textual scholarship, it is unlikely that it was ever intended for distribution. Neither a handy *vade mecum* like ancient astronomical tables nor an ephemeral classroom genre like the grammatical table, the *Hexapla* was enormous. Anthony Grafton and Megan Williams estimate that a *Hexapla* containing the whole Hebrew Bible would

21 Ancient references to the *Hexapla* and *Tetrapla* are assembled in Field 1964 [1875], 1.xii. They include Origen, *Comm. Matt.* 15.14; *Ep. Afr.* 1–5; Eusebius, *Hist. eccl.* 6.16.1–4; Epiphanius, *Mens.* 7 [Greek ed. Moutsoulas 1973, 164–165; Syriac ed. Dean 1935, 21–22 (50c–d)]; *Pan.* 64.3.5–7; Jerome, *Comm. Tit.* 3.9; *Ep.* 102; *Vir. ill.* 54. On these sources and the history of scholarship, see Grafton/Williams 2006, 86–133.

22 The first manuscript (Rahlfs 2005) is Cambridge University Library Taylor-Schechter 12.182 (LDAB 3490; *editio princeps*: Taylor 1900, 1–50). The second manuscript (Rahlfs 1098) is Milan, MS Ambrosianus O. 39 sup. (*editio princeps*: Mercati 1958). Three other manuscripts preserve very limited evidence for the *Hexapla*'s columnar format: Rome, Vat. Barb. gr. 549 (Rahlfs 86), esp. fol. 94v; Milan, MS Ambrosianus B. 106. sup. (Rahlfs 113), fol. 7v; and Rome, Vat. gr. 1747 (Rahlfs 271), p. III. (I am grateful to Benjamin Kantor for discussing these three manuscripts with me.) Other manuscripts attest the *Hexapla* indirectly or include readings from multiple Greek versions, but do not reflect the tabular format of Origen's project. An important example is the fourth-century P. Amh. Gr. I.3c (Rahlfs 912; LDAB 3475), which preserves Gen 1:1–5 in Old Greek and Aquila.

23 For some biblical books (especially the Psalms and Minor Prophets), further Greek translations were included as additional columns. See Eusebius, *Hist. eccl.* 6.16.2–3; Epiphanius, *Mens.* 7 [Greek ed. Moutsoulas 1973, 164–165; Syriac ed. Dean 1935, 21–22 (50c–d)]; *Pan.* 64.3.6; Jerome, *Comm. Tit.* 3.9. These additional columns are not preserved in the extant *Hexapla* manuscripts.

require forty codex volumes of 400 pages each.[24] Although the *Hexapla* might have been copied, late ancient authors describe consulting it in Caesarea rather than using manuscripts elsewhere.[25]

As a table for organizing multi-lingual information, the *Hexapla* resembled earlier tabular glossaries and bilingual texts.[26] Origen might have known such tabular layouts from language pedagogy during his own education or during his career as a teacher.[27] Some scholars have proposed that Origen devised his *Hexapla* as a tool for learning to read the Hebrew scriptures.[28] This is unlikely. Including four or more Greek columns would have been superfluous if the *Hexapla* was primarily a crib; a single translation would suffice. Origen's decision to employ a framework primarily used for language learning does not require that the *Hexapla* was a tool for learning Hebrew. Others have more plausibly proposed that — regardless of Origen's own purposes for his project — his *Hexapla* was inspired by, or even built upon, existing bilingual tables designed to help readers access the Hebrew text. Nonetheless, the expansive project cannot be reduced to a tool for language pedagogy.

The *Hexapla* was an innovative matrix that coordinated textual data in two dimensions. A user could read horizontally across any row to compare the wording of a unit and could also consult each text vertically in its own column. This novel tabular arrangement afforded systematic comparison while preserving the possibility of linear reading.[29] The massive table made existing information

24 This estimate is based on the forty-line, complete-opening format of the Cairo palimpsest, in comparison with similar features in the Milan palimpsest; see Grafton/Williams 2006, 88. This extensive project would have been beyond the financial means of most. Questions of what exactly constituted the "Hebrew Bible" at this stage (and for whom) do not substantially change the massive size of the project.

25 The ambitious project may never have been completed. Pamphilus and Eusebius were working on it more than fifty years after Origen's death. See the colophons discussed in Grafton/Williams 2006, 324 n. 42 and, more extensively, in Marsh 2023.

26 Sebastian Brock perceptively suggested more than fifty years ago that the *Hexapla* was analogous to Latin-Greek parallel texts of Vergil (Brock 1970).

27 According to a farewell panegyric offered by one of his students, Origen's teaching included astronomy and geometry ([Pseudo-]Gregory, *Orat. paneg.* 8); both disciplines employed tables. Note Origen's emphasis on the value of astronomy and geometry in *Ep. Greg.* 1. Compare later reports of Origen's pedagogical breadth in Eusebius, *Hist. eccl.* 6.18.2–4 and Jerome, *Vir. ill.* 54. On the scope of Origen's own education, see Epiphanius, *Pan.* 64.1.1–2.

28 See the summary of positions in Martin 2004; Grafton/Williams 2006.

29 As James VanderKam observes, reading linearly down the page at forty words per opening would be inconvenient when done for any length of time. While the possibility of vertical reading puts each horizontal row in meaningful context and enables the painstaking labor of producing an edition, the *Hexapla* is not designed to be read *in extenso*. Cf. Martens 2012, 46.

available for new uses. The *Hexapla* was a purpose-built textual machine for a specific project, designed to facilitate comparison of parallel texts. As Francesca Schironi and Peter Gentry have both argued, the *Hexapla* juxtaposed Greek and Hebrew versions as a massive preparatory stage for the production of the *Tetrapla*, a non-columnar edited text (ἔκδοσις) of the Greek Bible supplied with critical signs and marginal annotations of variant readings.[30] This instrumental role may explain why ancient descriptions of Origen's project devote so little attention to its tabular features. The *Hexapla* was not the finished product. Instead, it was a ground-breaking textual machine that deployed the technology of the table to afford the efficient, systematic comparison of parallel texts.

The technology of the table was crucial in another way, as well. The *Hexapla*'s tabular format enabled collaboration. As a grid for textual data, it allowed multiple individuals to fill in the matrix.[31] As Andrew Riggsby observes, "[I]t is possible to come up with a table by introspection, but it is easier with a pen and pencil, and easier still in an environment in which different people are adding information to a given document at different times."[32] The simultaneous involvement of multiple individuals facilitated Origen's ambitious project.[33] Debates about the purpose and production of the *Hexapla* often center on Origen's own knowledge of Hebrew. But in light of tabular collaboration, this is unnecessary. Origen's linguistic competence is less important than the availability of one or more unacknowledged collaborators who *did* have the requisite skills.

30 Schironi 2012; 2015; Gentry 2016. The clearest evidence for the text-critical purpose of Origen's project and for the intermediate function of the *Hexapla* derives from the presence (and absence) of critical signs. So-called Aristarchean signs appear in Origen's discussion of his project, in other late ancient literary evidence referring to the *Hexapla*, and in a number of manuscripts of the Greek scriptures. They do not appear in the manuscript evidence for a columnar *Hexapla*. Nor should we expect them to. Aristarchean signs marked additions, omissions, or transpositions, but indicating these phenomena with critical signs was redundant in a table where the reader could visually compare the running texts. The table enables users to visualize textual similarity, difference, and correspondence. The signs belong instead in Origen's critical edition, where a single text is annotated with alternate readings, additions, and omissions — all marked with sigla. Such an arrangement is visible in P. Grenf. 1.5, which dates from the later third or early fourth century CE (Schironi 2015). The critical signs are the result of using the *Hexapla* to create a new text.

31 In his model of distributed cognition, Hutchins identifies the cognitive process as occurring both in the mind and outside the body of the participants, mediated through varied external devices or representations (Hutchins 1995, 292). That is precisely what we see here.

32 Riggsby 2023.

33 Compare the exploitation of enslaved workers which enabled the prodigious intellectual output of Pliny the Elder. Pliny "did all this work — reading, searching, comparing, excerpting, compiling — with the assistance of an enslaved staff" (Howley 2020, 23).

Origen's technological approach relates directly to the collaborative context of textual production. In terms of distributed cognition, the table's unifying information structure coordinates multiple forms of expertise. Table technology enables the *Hexapla* to be what Hutchins describes as an "open tool," subject to use and verification by more than one individual.[34] The *Hexapla* reflects a mode of textual scholarship, a practice of constructing knowledge, that involves the labor of multiple individuals.

Modern scholars tend to imagine collaborative projects in antiquity as the results of school circles, and this may sometimes be the case.[35] But a collaborative process need not imply willing students. Might we imagine other configurations of labor and agency? According to Eusebius, Epiphanius, and Jerome, Origen exploited the work of at least fourteen enslaved individuals as scribes and copyists.[36] We should not ignore this fact in scholarship on the massive editorial project that produced the *Hexapla* and *Tetrapla*. The table provided a way to coordinate a complex working process involving many hands and eyes.[37] It organized the skill and labor of these unacknowledged workers to offer new architectures of knowledge.

34 Hutchins 1995, 170.

35 I diverge from Riggsby (Riggsby 2023), who hypothesizes that the *Hexapla* evokes a classroom environment with the reader in a student position *vis-à-vis* Origen. While this may be the result for the rare individuals to encounter the *Hexapla* later — including figures like Eusebius who imagined themselves as the students of Origen — it does not offer the best model for the initial production of the *Hexapla*. On the idea of a Caesarean "school" under Origen: *Hist. eccl.* 6.32 and 6.36 with Knauber 1968; Crouzel 1970; Neuschäfer 1987; Jacobsen 2012; Martens 2012; Penland 2013; Schott 2013a; 2013b; Rogers 2017; Bäbler 2018; Satran 2018. On Jewish and Christian scholarly circles in Caesarea more broadly: Lapin 2005. Lapin cautions against attributing undue institutional status to the circles around Origen and Pamphilus. As Rogers and Penland both emphasize, much of what we know about Origen's circle reflects Eusebius' retrojection and requires caution.

36 Eusebius, *Hist. eccl.* 6.18.1–2; 6.23.1–2; cf. 6.36.1; Epiphanius, *Pan.* 64.3.4 [Holl 1915–2006, 2.405–406]; Jerome, *Ep.* 43.1; *Vir. ill.* 56; 61.3. Origen often receives exclusive recognition for the work of these specialists, funded by his patron Ambrose. On enslavement and early Christian literary production, see Haines-Eitzen 1998; Moss 2021a.

37 Given Origen's exploitation of enslaved literary workers and the prevalence of elite dictation (on which see, e.g., Arns 1953, 37–62; Herescu 1956; Schlumberger 1976; Horsfall 1995; McDonnell 1996; Cavallo 2000; Dorandi 2000), we might expect that Origen relied on enslaved workers in the production of the *Tetrapla* also.

4 Eusebius' Tables

Another scholar from late ancient Palestine, Eusebius of Caesarea, deployed the table for innovative projects of knowledge construction. Working in the first half of the fourth century, Eusebius devised a number of tabular projects, including his *Chronological Tables*, which synchronized events from world history, and his Gospel canons, a set of cross-reference tables that coordinated the four New Testament Gospels.[38] Both of these projects deployed the emergent technology of the table to configure existing material in innovative ways and to invite new possibilities of historical and textual knowledge.

Eusebius' *Chronological Tables* (Χρονικοὶ κανόνες) organized world history, synchronizing events, eras, and empires in parallel columns. Synthesizing numerous sources, they structured historical data into a framework that coordinates both time and space: the linear movement of time proceeds vertically, while geographical distinctions are represented horizontally.[39] Like Origen's *Hexapla* and earlier linguistic tables, the *Chronological Tables* deployed the technology of the table to organize cross-cultural and cross-linguistic information. Parallel columns often reflect distinct sources. (As we saw with the *Hexapla*, here also the table may coordinate not only varied sources but also the labor of multiple collaborators.) The *Chronological Tables* were distributed as the second half of Eusebius' two-part *Chronography*; the massive table in the second volume structures the various regnal lists and other chronological data that are excerpted, summarized, and annotated in the first volume.[40] The *Chronological Tables*, like the *Hexapla*, are a textual machine. But while the *Hexapla* was preparatory to a conventional edition, Eusebius innovates by publishing his tabular project as the product. This is a form of open data: Eusebius constructed a database to organize his research and made this available to subsequent readers, facilitating ongoing use and adaptation of the *Chronological*

38 In the preface to his *Onomasticon*, Eusebius describes another potentially tabular project, a glossary of Hebrew and Greek place names. Another work attributed to Eusebius, his *Psalms Pinax*, categorizes individual psalms by attributed authorship; this work is a list rather than a table. The text is published in Wallraff 2013. The sole extant copy (titled Πίναξ ἐκτεθεὶς ὑπὸ Εὐσεβείου τοῦ Παμφίλου) is a prefatory paratext to the Psalter in the tenth-century manuscript Oxford, Bodleian Library, Auct. D. 4. 1, fols 24v–25r.

39 On the *Chronological Tables* (sometimes known as the *Chronicon*) and information technology, see Grafton/Williams 2006; Grafton/Rosenberg 2010; Riggsby 2019, 218–222; Coogan 2022, 54–56.

40 On the exploitation of enslaved workers for excerpting and note-taking, see Howley 2020, 23.

Tables and also subsequent production of historiographic texts by others.[41] The *Chronological Tables* organize their disparate sources to offer a particular vision of divinely ordered history, culminating in a single column for a unified *imperium*. The instrumental, tabular medium of the project, inviting ongoing appropriation and reconfiguration, amplified the influence of the Eusebian teleology expressed in the information architecture of the *Chronological Tables*.[42]

Another of Eusebius' projects, his Gospel canons, was massively successful from late antiquity until the modern period.[43] This set of ten tables ("canons") offers a system of cross-references for reading the Gospels according to Matthew, Mark, Luke, and John as a single fourfold whole. Eusebius' Gospel canons are the first system of cross-references ever devised. Eusebius' canons resemble Origen's *Hexapla* in their aim of organizing parallel texts. Yet Eusebius' project differs in crucial ways. Rather than rearranging the Gospels into a single massive table, Eusebius provided a system of marginal numbers that segment the four New Testament Gospels into sections.[44] The ten tables correlate these numbered sections.[45] Each number metonymically represents a section of Gospel text. The tables thus encapsulate the relationships between the four Gospels on just a few pages. In this, Eusebius' succinct system resembles a handy glossary or a set of astronomical tables more than it resembles the expansive datasets of the *Hexapla* or the *Chronological Tables*. The result is an elegant tool for tabular reading. Each linear ("vertical") Gospel text remains intact, expanded by a par-

41 Eusebius provided an information architecture that would be updated and expanded by others, including Jerome of Stridon's translation into Latin, an early translation into Armenian, and various later Greek, Latin, and Syriac chronographies; see Adler 1989; Grafton/Williams 2006.

42 On the theological and political implications of Eusebius' project, see Crawford 2020 (with cited sources).

43 On Eusebius' Gospel canons, see especially Grafton/Williams 2006; Coogan 2017; Crawford 2019; Coogan 2022.

44 The marginal annotations consist of two numbers for each section. The first number enumerates sections in each Gospel sequentially from the beginning of that Gospel. The second number identifies which of the ten reference tables coordinates a section with parallel sections from other Gospels.

45 Each of Eusebius' ten canons organizes a different pattern of relationships. Canon I tabulates material found in all four Gospels. Canons II–IV identify material found in various combinations of three Gospels. Canons V–IX identify material found in various combinations of two Gospels. Canon X consists of four sections, each identifying material found in one Gospel only.

atextual reference system that invites the reader to compare parallels horizontally.[46]

Eusebius' innovative tabular *instrumentum studiorum* enables the reader to identify parallel material and to read in new sequences. Moreover, because the ten canons each map different configurations of parallels, Eusebius' apparatus prompted varied projects of pattern-oriented "distant reading" in late ancient and medieval scholarship on both the Gospels and other texts.[47] Through the widespread transmission of the Eusebian system, tabular reading became part of the Gospel book itself, inviting ongoing engagement by readers in late antiquity and beyond.[48]

Both of these Eusebian projects are complex tabular systems for managing interrelated bodies of information, and perhaps for coordinating the labor of multiple human bodies. We know less about the human and economic conditions of Eusebius' *oeuvre* than we do for Origen's.[49] Yet, in light of the widespread exploitation of enslaved literary workers in the Roman Mediterranean and the use of the table as a tool of collaboration, Eusebius' tabular projects may have similarly depended on the unacknowledged work and expertise of others.[50] The table emerges again as a textual machine that both coordinates

46 As traced in Crawford 2019 and Coogan 2022, numerous readers through late antiquity and the Middle Ages, encountering the Gospels in over a dozen languages, used Eusebius' Gospel canons for tabular reading.

47 By "distant reading" I mean pattern-oriented analysis of large corpora (often in visual or quantitative ways), as opposed to the "close reading" that often characterizes textual scholarship. With the advent of digital humanities, distant reading sometimes studies corpora too large to analyze efficiently without computers, but it need not involve computers *per se* (see Piper 2020). For examples of late ancient and medieval distant reading using the Eusebian apparatus, see Coogan 2022, 33–36.

48 Eusebius' Gospel tables are developed in part from an earlier project devised by Ammonius of Alexandria, who had rearranged the Gospels into parallel layout. See Crawford 2019, 56–95; Coogan 2022, 59–93.

49 A *Life of Eusebius* reportedly penned by his successor Acacius is lost; the work is mentioned by the fifth-century historian Socrates of Constantinople, *Hist. eccl.* 2.4.

50 This is especially true for the *Chronological Tables*, where the tabular structure might have provided a framework to organize the labor of multiple collaborators and multiple written sources. Elsewhere in Eusebius' corpus, we also discern the traces of uncredited workers. See Schott 2013b, 358–359, arguing that Eusebius' *Praep. ev.* reflects the work of multiple individuals. One might propose that these uncredited assistants were students or fellow clergy rather than enslaved or servile literary workers. Yet, given what we know about the role of enslavement in ancient reading and writing, we must resist the tendency to privilege the more palatable alternative in historical reconstructions.

existing information and facilitates new projects of constructing knowledge by a range of different users.

5 Tabular Thinking in the Palestinian Talmud

Origen, Eusebius, and their uncredited collaborators deployed the technology of the table for innovative modes of textual scholarship. But late ancient Palestine offers further examples that reflect tabular thinking, even though physically inscribed tables are not preserved in the extant sources. When we read closely, we find that the rabbinic sages who figure in the Palestinian Talmud were engaged in constructing knowledge with columns and rows.[51] The technology of the table again invites us to examine both modes of knowledge and human knowers.

The Amoraic sages addressed several of the same conceptual and textual problems that Origen and Eusebius did.[52] They were, as Moulie Vidas argues, engaged in "the development of a set of scholarly tools and formulations which address access to or textual problems with rabbinic traditions, a development which resembles in some sense what we find in 'book cultures' of other scholarly traditions."[53] This innovation was interwoven with another one, "the development of a discourse that centered on the way rabbinic knowledge was produced or generated by specific individuals or groups rather than by undifferentiated processes of transmission and production."[54] The scholarly

51 The text dates in something like its current form to the late fourth century. On the date of the Palestinian Talmud and the material that it contains, see Strack *et al*. 1996, 171–176. The traditional periodization of figures and texts locates the Palestinian Talmud in the Amoraic period (ca. 200–500 CE). The material that reflects tabular thinking is overwhelmingly attributed to Amoraic sages rather than to those of the earlier Tannaitic period.

52 Given the importance of tabularity for ancient astronomy, it is striking that we lack evidence for late ancient rabbinic use of astronomical tables. This might reflect both the instrumentality of such tables (such that, once consulted, the tables did not need to be mentioned in rabbinic discussions of astronomical and calendrical questions) and the limited range of genres that characterize the extant early rabbinic corpus. While a lunar phase diagram is mentioned in m. Roš Haš. 2:8 (see Leicht 2014), reference tables do not appear in Tannaitic or Amoraic texts. Medieval rabbinic texts employ tables (Stern and Burnett 2014).

53 Vidas 2017, 28. The analogy is strengthened if we understand the figure of the rabbi to replace the physical book as a locus of textual knowledge (Dohrmann 2020, §§ 32–34). Organizing rabbinic dicta thus becomes equivalent to organizing parallel texts.

54 Vidas 2017, 28.

projects of Origen, Eusebius, and their collaborators — which organized parallel literary texts and historical sources — correspond to both of these transitions that Vidas identifies.

The rabbinic sages of 3rd- and 4th-century Palestine reflect an analogous mode of tabular thinking. This parallel pattern of rabbinic thought does not require direct interaction between early Christian figures like Origen or Eusebius and their respective rabbinic contemporaries.[55] Nor do I argue that the tabular thinking of these third- and fourth-century Palestinian sages depends on the better-attested tabular projects of their Christian contemporaries. It suffices that these figures all participated in the rapid transformations in textuality and knowledge that were taking place in the late ancient Mediterranean world. The *Hexapla*, the *Chronological Tables*, the Eusebian canons, and the Palestinian Talmud each reflect this late ancient shift in knowing.

In light of these broader developments, I develop the implications of an example first identified by Moulie Vidas: the language of שיטה (*shitah*; שיטא in Aramaic).[56] The term has its basic meaning as something like "line." In Jewish Palestinian Aramaic it appears as an inscriptional term, almost always in the plural. It refers to "lines" (שיטין) of writing in bills of divorce or other legal documents (e.g., y. B. Bat. 10:1, 17c; y. Git. 3:2, 44d; y. Git. 9:6, 50c). Instructions for writing a Torah scroll stipulate that four (horizontal) "lines" or "rows" (שיטין) must be left between books of the Pentateuch (e.g., y. Meg. 1:8, 71d). The term שיטה can also refer to a vertical column of text. The most common example is in discussions of bilingual bills of divorce, in which Greek and Hebrew columns are placed side by side (e.g., y. B. Bat. 10:1, 17c). This, we note, approximates the format of the multi-column translations discussed above: tabularity is, again, about organizing linguistically divergent information in a shared space. In short, the שיטה appears both as the horizontal inscriptional line (that is, the row) and as the vertical column of text.

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55 Scholarship over the past half-century (e.g., Baer 1961; de Lange 1976; Kimelman 1980; Horbury 2014) has frequently proposed direct exchange, especially between Origen and his contemporaries. On Origen's exchanges with "sages" (σοφοί), see *Ep. Afr.* 6–7. Note also Niehoff 2019 on R. Abbahu ("most likely active under Diocletian," 297), who is depicted in Amoraic literature as knowing Greek and engaging in the Roman legal-administrative culture of third-century Caesarea; R. Abbahu was Eusebius' contemporary. Some rabbinic circles operated in similar ways to the rhetorical circles of the Second Sophistic or to the philosophical circles around figures like Plotinus, Origen, and Eusebius; see Tropper 2004; Lapin 2005; Hidary 2017.

56 Vidas 2017. I am grateful to Moulie Vidas for discussing his work on שיטה with me in June 2018.

But שיטה also appears in conceptual contexts that do not describe physical writing. Frequently it refers to a "line" of thought. For example, "they answered him by his שיטה: 'by your שיטה [...]'" (y. Shevu. 9:9, 39a). Such usages lead to the gloss "usage, system" that appears in modern lexica of late ancient Hebrew and Aramaic.[57] We see a reflection of this systematizing impulse at various points in the Palestinian Talmud. A school or line of thought can be described as a שיטה (e.g., y. Demai 3:4, 23c; y. Peʾah 7:6, 20b).[58] In some cases, the term describes the logical extension of a "line" of thinking (e.g., y. Or. 1:1, 60d). Often, it is used when a sage steps out of line or breaks his system. We read repeatedly "there he says" (תמן הוא אומ׳) but "here he says" (וכא הוא אומ׳ הכן); to describe such inconsistencies, the Palestinian Talmud tells us that the sage's שיטה has been "changed" or "exchanged" (using מוחלפת or another passive form of the verb הל״ף).[59] This usage does not appear in the Mishnah or in other Tannaitic literature, suggesting that it emerges in Amoraic (that is, late ancient) thought. In reaching two apparently inconsistent halakhic conclusions, a sage is imagined to switch one "line" (שיטה) of thinking for another. A sage who ordinarily rules in one way (corresponding to one column) might diverge from the norm for a given question (a particular row on the table) and offer an opinion that corresponds to the other imagined column. (We might imagine a "strict" column and a "lenient" column for a given halakhic question, although stringency and leniency are not the only possible categories.) This idiom — and its relevance for tabular thinking — becomes clearer in the occasional cases when two sages are imagined exchanging שיטין with one another (e.g., y. Shabb. 12:5, 13d). The mode of thinking reflects not simply a notional column (שיטה), but multiple columns in parallel, a meaningful table that works both down and across. Pattern-oriented halakhic analysis is systematized into a tabular structure of rows and columns.

This rabbinic idiom corresponds with the developments in late ancient tabular thinking that I have traced in the work of Origen, Eusebius, and their collaborators. Yet we lack direct evidence that the sages or their disciples were

57 This is the first entry in Sokoloff's *Dictionary of Jewish Palestinian Aramaic* (Sokoloff 2002, 547a) and the second in the *Comprehensive Aramaic Lexicon* (http:cal.huc.edu; accessed 11 October 2018). This usage appears frequently in Palestinian and Babylonian texts. "System" or "method" also happens to be the normal meaning in modern Hebrew.

58 For discussion of this terminology, but without engaging its tabularity, see Moscovitz 2009, 422–425.

59 For example, in y. Peʾah 7:5, 20b, the redactional voice informs the reader that the שיטה of R. Judah has changed. The passage goes on to attempt to resolve the contradiction; the table is used first to map a perceived inconsistency in the system and then to restore consistency to it.

drawing tables — on wax tablets, parchment notebooks, or any other medium.[60] The spatial mode of constructing knowledge reflected in the language of שיטה may instead have been an ephemeral schoolroom exercise, similar to drawing a grammatical paradigm or a multiplication table. Even so, it is far easier to draw out such ideas — on a chalkboard for us, on a wax tablet or a dusty floor for our ancient predecessors — than to imagine or discuss them in the "pure abstract."[61] This mode of tabular thinking requires visualization to work.

These tables are not, insofar as we can discern, part of the literary output of rabbinic thought.[62] We do not see the rabbinic table deployed as a published *instrumentum*, nor do we discern its systematic use in large-scale ("industrial," as it were) projects of knowledge production. In its non-publication, the table of halakhic opinions is distinct from astronomical tables or the Eusebian Gospel canons. It differs even from the *Hexapla*, which was an intermediate product

60 Several scholars have proposed that sages and their students employed such media in the process of teaching and learning. Taking notes and reviewing lectures using tablets or notebooks were widespread practices around the Roman Mediterranean (e.g., Arrian's *Discourses of Epictetus*; cf. Wollenberg 2017 on rabbinic use of written texts as *aides-mémoires*). These technologies were available to the rabbinic sages. The writing tablet (טבלא) appears frequently in rabbinic texts. The parchment notebook (דפתרא) also appears (e.g., m. Soṭah 2:3). On a couple of occasions, the Palestinian Talmud records halakhic appeal to material recorded in a notebook (פנקס = πίναξ) (y. Ma'as. 2:4, 49d; y. Kil. 1:1, 27a). As Natalie Dohrmann summarizes, "It is clear from the literary remains that [the sages'] teachings reached colleagues and acolytes, were collected, copied into notebooks, memoires, and curricula, excerpted, combined, and reissued in a range of new contexts" (Dohrmann 2020, § 34). We might imagine that such notes included sketched out tables or other diagrams as well. More speculative have been proposals about the relationship between such ephemeral notes and the eventual transmitted rabbinic corpora (e.g., Jaffee 2001, 140–147). As Dohrmann argues, although early rabbinic corpora elide many textual practices to present a dramatically narrowed bibliographic universe, the rabbinic "sense of foreboding in the face of the proliferation of knowledge" and the corresponding "attempt to manage" this complexity reflect the broader landscape of Roman imperial textuality (Dohrmann 2020, § 37). If rabbinic book-phobia participates in the pervasive anxieties of imperial Roman textuality (rather than indicating a complete retreat from textuality itself), then this should not mislead us into imagining that the sages lacked access to varied technologies for taking notes, reviewing material, or analyzing data.

61 Compare Netz 2002 on the physical manipulation of ideas. (Serafina Cuomo's ongoing work also involves discussion of the abacus as a tool of distributed cognition.) As Netz observes, the "abacus" as a technology does not require a specific physical artefact. An imagined division of space or a few lines in the dirt will do. Expert abacus practitioners can perform advanced calculations simply by visualizing an abacus (Netz 2002, 326). The tabular thinking that I propose for the Amoraic sages is similarly flexible regarding physical media.

62 This may reflect both the sages' frequent skepticism about transmitting Oral Torah in writing and the instrumental role of the late ancient table.

neither intended for nor suited to extensive distribution, since Origen's project was durable. Rather than a textual machine for assimilating large amounts of data, the language of שיטה reflects the table as a technology for more localized systematization. It indicates a different social situation, less the textual workshop of Origen or Eusebius, more the classroom of the grammar table, the glossary, and the table of squares. Even so, these rabbinic texts preserve the metaphorical traces of tabular thinking as a late ancient technology for systematizing information and constructing knowledge.[63]

6 Conclusions: Tabularity, Instrumentality, and Agency

The use of the table for textual scholarship was a late ancient innovation. Yet modern scholars have often overlooked how the table transformed textual knowledge. In this essay, I show how late ancient thinkers put the technology of the table to work for creative ends. Origen, Eusebius, and the Amoraic sages each reconfigured existing material to afford new possibilities of knowledge. Their projects of constructing knowledge involved different kinds of information and operated within divergent social contexts, but in each case the table organized sources of information and coordinated human work in projects of constructing knowledge.

The table invites distinctive modes of comparison and visualization. Each of these novel late ancient projects employed the technology of the table in order to afford their users with new — or newly efficient and accessible — patterns, juxtapositions, and comparisons, bringing disparate information into new structuring wholes. Origen's *Hexapla*, Eusebius' *Chronological Tables*, Eusebius' Gospel canons, and the ephemeral tables of the Palestinian Talmud were each instrumental to the production of knowledge. Origen's *Hexapla* provided a tabular grid to organize knowledge in preparation for a consolidated edition of the Greek Bible. Eusebius' tables afforded new practices of comparative reading and reference. Rabbinic tables mapped patterns and anomalies in received dicta. The late ancient table was a technology for configuring and reconfiguring

63 On literary texts preserving instrumental technologies and cognitive processes, see Netz's discussion of the abacus (Netz 2002, 325).

knowledge, making anomalies, patterns, and structures visible. To borrow Krajewski's terminology, these tables were papyrus or parchment "machines."[64]

Attending to the table as a textual machine should compel us to attend to the human agents who made that machine work. The pragmatics and the ethics of late ancient tabular thinking intersect. This essay is thus an exercise in "looking *directly at*" what we usually look "*through*."[65] In drawing attention to a technology that is often overlooked precisely because of its instrumentality, I have also tried to draw our attention to how human workers — often uncredited — interacted with these tables. Our evidence here is limited. We know more about Origen's exploitation of enslaved literary workers than we do about the people involved in Eusebius' literary endeavors. The role of enslaved or subaltern workers in rabbinic knowing is even less clear. Yet, as a machine for constructing knowledge, the table afforded a way of coordinating the efforts and expertise of multiple workers — and modern reconstructions must attend to these histories of work and agency.

Each of the late ancient tabular projects that I survey in this study reconfigured existing material for new ends. Origen organized divergent textual forms of the Jewish scriptures. Eusebius organized historical information about different ἔθνη and narratives about Jesus attributed to particular evangelists. The rabbis of the Palestinian Talmud organized halakhic knowledge attributed to particular sages. These tabular projects constructed knowledge by coordinating material attributed to varied texts and individuals. They reflect not merely a desire to put into order, but a documentary or bibliographic way of thinking that seeks to structure inherited knowledge — and this mode of constructing knowledge works because of the possibilities for visualization that the column-and-row table affords. These modes of knowing are facilitated by the technology of the table, not just as a metaphor, but as a way for people — often multiple people working together — to arrange information in spatial ways that afford reading and knowing in newly shared, systematic, and productive ways. Like Krajewski's "paper machines," the late ancient table is a mechanism that creates knowledge. Attending to comparative dimensions of tabularity reveals parallels between scholarly practices and textual communities in late ancient Palestine and invites attention to how technologies participated in a late ancient transformation in knowledge.

64 Krajewski 2011, 8–9.

65 Here I adapt the words (with emphasis) of Howley 2018, 175.

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