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CONTRASTING AIMS AND APPROACHES IN THE STUDY OF ANCIENT EGYPTIAN MATHEMATICS IN THE 1920s

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Abstract. — The modern academic study of ancient Egyptian mathematics emerged in the mid-nineteenth century as the decipherment of ancient texts revealed the arithmetical and geometrical notions and processes employed by the ancient Egyptians; most of what is now known stemmed from the discovery and study of the Rhind Mathematical Papyrus in the 1860s and 1870s. However, despite the unearthing of a small number of additional sources, the study of ancient Egyptian mathematics remained quite closely focused on the Rhind Papyrus, with many texts simply restating what had already been written about it. In this paper, we discuss how the topic re-emerged in the 1920s in a more fully contextualised form. Particular attention is paid to the contributions of the Egyptologist Thomas Eric Peet (1882–1934) and the historian of mathematics Otto Neugebauer (1899–1990). We argue that by the end of the 1920s, a topic that had hitherto largely been the preserve of Egyptologists had passed into the hands of mathematicians.

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Résumé (L'étude des mathématiques de l'Égypte ancienne dans les années 1920 : des objectifs et des approches contrastés)

L'étude des mathématiques de l'Égypte ancienne s'est constituée en champ académique au milieu du XIXe siècle lorsque le déchiffrement des textes anciens a révélé les notions et les processus arithmétiques et géométriques employés par les anciens Égyptiens; la majorité de nos connaissances actuelles découle de la découverte et de l'étude du papyrus mathématique Rhind dans les années 1860 et 1870. Cependant, malgré la découverte d'un petit nombre de sources supplémentaires, l'étude des mathématiques de l'Égypte ancienne est restée assez étroitement centrée sur le papyrus Rhind, de nombreux textes ne faisant que reprendre ce qui avait déjà été écrit à son sujet. Dans cet article, nous discutons de la façon dont le sujet a réémergé dans les années 1920 sous une forme davantage contextualisée. Une attention particulière est accordée aux contributions de l'égyptologue Thomas Eric Peet (1882–1934) et de l'historien des mathématiques Otto Neugebauer (1899–1990). Nous soutenons qu'à la fin des années 1920, ce sont les mathématiciens qui se sont saisis de ce sujet, qui avait jusque-là été largement l'apanage des égyptologues.

1. INTRODUCTION

In October 1926, the British Egyptologist Thomas Eric Peet (1882–1934), then Brunner Professor of Egyptology at the University of Liverpool, wrote a typically wide-ranging letter to his mentor, the Egyptologist Alan H. Gardiner (1879–1963).[1] The letter covered the content of the new issue of *The Journal of Egyptian Archaeology* (of which Peet was editor), Gardiner's forthcoming *Egyptian grammar* [Gardiner 1927], a recent trip by Peet to the Egyptian collections of Turin, and a critique of the work of an Italian amateur Egyptologist. At the end of the letter, Peet turned to the recent work of the young Otto Neugebauer (1899–1990) in Göttingen. Subsequently a very prominent name in the study of the history of mathematics, Neugebauer had just launched his career as a historian of ancient science by completing a doctoral dissertation [Neugebauer 1926] on the methods of fraction-reckoning found in the Rhind Mathematical Papyrus (hereafter, RMP), the most complete and extensive surviving source on ancient Egyptian mathematics, acquired by the British Museum in 1864 [Budge 1898, p. [1]]. During the completion of his doctoral research, Neugebauer had been in correspondence with Peet about the RMP,[2] owing to the fact that Peet's recent edition of the papyrus [Peet 1923a] had

1 Griffith Institute Archive, Oxford: AHG/42.230.92, Peet to Gardiner, 16th October 1926.

2 See [Hollings & Parkinson 2020].

been Neugebauer's main source. At the time of writing to Gardiner, Peet had recently received a copy of Neugebauer's completed dissertation, and shared his thoughts on it with his mentor: on the whole, Peet agreed with Neugebauer's interpretations of certain arithmetical problems within the RMP, although he had some doubts about the emphasis that Neugebauer placed on particular features. [3] In conclusion, he wrote:

> In any case his is an admirable piece of work and makes me if possible more dissatisfied with my Rhind than I was before. Still it has served to re-open the study of Egyptian maths.

The 'it' referred to in this last sentence was probably Neugebauer's dissertation, which is the main topic of this passage in the letter, although it could just as easily have meant Peet's own edition of the RMP—both have a claim to being the origin of the 're-opening' indicated by Peet, as we shall see. The assertion that such a 're-opening' of ancient Egyptian mathematics had taken place is one that Peet echoed elsewhere, both privately and in print, such as in the following passage at the start of a review of another text [Vogel 1929] on aspects of the mathematics of the RMP:

> The re-publication of the Rhind Mathematical Papyrus in 1923 has led to a renewed interest in the subject of Egyptian mathematics and provoked a series of valuable works on it [...] [Peet 1930a, p. 270] [4]

The nature and consequences of this "renewed interest," and the role of Peet's work within it, are the main theme of the present paper.

In the quotations above, Peet apparently showed a characteristic self-effacing attitude towards the importance of his own works, but positive comments on Peet's edition of the RMP may be found throughout both the Egyptological and the mathematical literatures: Gardiner, for example, later described it as "outstanding" [Gardiner 1934b], whilst the British Egyptologist Battiscombe Gunn (1883–1950), a sometime-collaborator of Peet's, observed that it contains "an excellent survey of Egyptian mathematics as a whole" [Gunn 1926, p. 123]. On the mathematical side, Arnold Buffum Chace (1845–1932), editor of a later edition of the RMP which we will encounter below, welcomed Peet's edition with "keen delight" [Chace 1924, p. 215], and his colleague Raymond Clare Archibald (1875–1955),

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3 For a detailed discussion of these mathematical points, see [Hollings & Parkinson 2020].

4 Among these "valuable works," Peet included Neugebauer's "enlightening if difficult" dissertation.

compiler of a bibliography of ancient Egyptian mathematics, praised the volume in the highest terms:

> The attractive, lucid, and stimulating style of the commentary and the remarkably thorough, judicial and scholarly character of the work as a whole stamp it as a contribution of very high order to our knowledge of Egyptian mathematics. [Archibald 1924, p. 249]

Neugebauer was similarly complimentary, stressing the "fundamental importance" ("grundlegende Bedeutung") of Peet's work for his own, and for any other future investigations, of ancient Egyptian mathematics.[5] Indeed, the historian of science George Sarton (1884–1956) asserted that "[f]rom now on it will be obviously impossible to touch the subject of Egyptian mathematics without a serious study of [Peet's] work" [Sarton 1924, p. 557]. In fact, Peet's edition of the RMP would quickly be superseded, at least for certain audiences, by that of Chace, for reasons that we will explore below.

One of the reasons for the plethora of positive remarks about Peet's edition of the RMP was that by the beginning of the 1920s, its need was badly felt. The RMP was, by this time, a well-known document amongst writers on the history of mathematics, and had already found its position, which it still maintains today, as a text that should always be mentioned at the beginning of any general history of mathematics.[6] Few of these histories, however, had anything new to say about the papyrus, and simply paraphrased the commentary that had been provided by the German Egyptologist August Eisenlohr (1832–1902) at the end of the 1870s [Eisenlohr 1877]. Eisenlohr's edition was completed in collaboration with his mathematically-trained brother Friedrich (1831–1904) and the historian of mathematics Moritz Cantor (1829–1920), and it provided the first glimpse of the processes of ancient Egyptian mathematics, along with a full overview of the content of the RMP. By the end of the nineteenth century, however, developments in the understanding of the Egyptian language, and of the cursive hieratic script in which the RMP is written, meant that a new edition was called for. Writing in 1926, the notoriously meticulous Gunn was particularly critical of Eisenlohr's edition:[7]

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5 Griffith Institute Archive, Oxford: Peet MSS 4.9.2, Neugebauer to Peet, 22nd August 1926.

6 Cf. Robson's comments on the "obligatory Babylonian chapter in every history of mathematics text book" [Robson 2008, p. 271].

7 It was later noted of Gunn that "[h]e demanded the highest standard of accuracy both from himself and from others" [Simpson 2004b].

> Eisenlohr's book, now nearly 50 years old, is both antiquated and unsatisfactory in treatment: not only does it contain a quantity of wrong readings, translations and interpretations, [...] but also the explanations of the exercises are often complicated and abstruse [...] [Gunn 1926, p. 123]

These remarks come from Gunn's review of Peet's edition of the RMP, which Gunn believed "ably supplied" the need for a new version. One of the reasons for the success of Peet's edition was the fact that, like Eisenlohr and his collaborators, he was able to combine his mathematical background (see section 5) with an up-to-date expertise in Egyptology.

As we have already noted, and as we shall see in more detail below, the appearance of Peet's work in 1923 quickly led to an explosion in the number of published works on ancient Egyptian mathematics, mostly by authors approaching the topic from a mathematical background.[8] Indeed, although Peet's edition garnered positive comments from his fellow-Egyptologists, the greater interest seems to have come from mathematicians and from historians of mathematics, a circumstance that Peet all but predicted in a letter to the biologist, mathematician, and classicist D'Arcy Thompson (1860–1948) around the time of the edition's publication: "[t]he interest is almost more mathematical than Egyptological".[9] For most of its readers, Peet's edition provided an up-to-date and accessible entry into source material that would otherwise have been inaccessible to them for reasons of language, script, and cultural context. There was one major exception: Neugebauer, Peet's first and arguably most enthusiastic mathematical follower. Neugebauer was unusual among contemporaneous historians of mathematics for the fact that he made a point of studying the languages in which a range of ancient mathematical texts were written: first Ancient Egyptian, and then Akkadian for the study of Mesopotamian mathematics and astronomy. With the appearance of Peet's edition of the RMP in 1923, the ground was apparently set for

8 The discovery of the tomb of Tutankhamun in 1922 resulted in an increased fascination with ancient Egyptian art and culture ('Tutmania'—see, for example, [Collins & McNamara 2014, pp. 63–87]), but there is no evidence that this was a direct factor in the revival of interest in Egyptian mathematics at this period. The only reference to Tutankhamun known to us among the mathematical sources is a passing mention by Karpinski [1923, p. 529], giving his readers a rough comparative date for the Moscow Mathematical Papyrus.

9 University of St Andrews Library, Department of Special Collections: Papers of D'Arcy Wentworth Thompson, Correspondence to Professor Sir D'Arcy Wentworth Thompson from Thomas Eric Peet, 22 October 1922–27 June 1933: ms23967, Peet to Thompson, 2nd November 1923. The context of this remark is that Peet sought to have his edition reviewed by a Scottish mathematical journal.

a wider and fully contextualised study of ancient Egyptian mathematics. Although a number of publications in this vein did appear,[10] the greater presence of mathematicians than of Egyptologists in this process soon meant that a mathematically-led approach to the subject matter dominated until the later parts of the twentieth century. At this period, Egyptology was seeking to define itself as a professional discipline—Peet's generation had been unable to study Egyptology as an undergraduate degree at Oxford—and often regarded knowledge of Ancient Egyptian language as a distinctive defining characteristic, rather than exploring more cross-cultural approaches, such as those favoured by mathematical writers.[11] This demarcation of the discipline left little room for mathematics, and so in effect, by the end of the 1920s, the study of ancient Egyptian mathematics had passed out of the hands of Egyptologists and into those of mathematicians. In the present paper, we discuss this trajectory, as a contribution to the historiography of ancient Egyptian mathematics, to complement the already quite extensive writings on the recovery of ancient Mesopotamian mathematics during the twentieth century.[12] In what follows, we will see that there had been a similar peak in interest in ancient Egyptian mathematics following the appearance of Eisenlohr's edition of the RMP in 1877. This earlier phase of the recovery of ancient Egyptian mathematics deserves further study elsewhere. What marks out the 1920s as being different and more interesting for our present purposes than the late-1870s and 1880s is the greater presence then of scholars like Neugebauer, who occupied the middle ground between the mathematicians and the Egyptologists: despite being rather mathematical in their outlook, these figures could talk to Egyptologists in ways that mathematicians could not. A focus on the 1920s also allows us to study Peet and his works in detail, and to consider the influence of the very small number of sources on ancient Egyptian mathematics that had become available since the late-1870s in addition to the RMP.

We begin the paper with a sketch of the early development of the understanding of ancient Egyptian mathematical processes (section 2).[13] We

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10 Notably those by Peet himself: [Peet 1923b, 1931a,b], [Gunn & Peet 1929].

11 Clare Lewis, personal communication, 25th April 2022.

12 See, for example, [Robson 2001, 2008], [Høyrup 1996], [Høyrup 2016], [Chaigneau 2019], and several articles in [Jones et al. 2016].

13 This paper does not expect a knowledge of the technical details of ancient Egyptian mathematics from its reader; for this, see [Imhausen 2007] for a general overview of the topic, and [Imhausen 2016] for a detailed and fully contextualised treatment.

then discuss the treatment of the RMP and associated sources in the nineteenth and twentieth centuries, particularly the changes that took place following the publication of Peet's edition (sections 3 and 4). We give some further commentary on Peet's writings on ancient Egyptian mathematics (section 5), and contrast these with the works that followed (section 6). We then attempt to characterise the various actors into different groups as a way of mapping the ways in which mathematical, historical, and philological disciplinary boundaries have influenced the study of ancient Egyptian mathematics (sections 7 and 8). We conclude the paper in section 9 with some remarks on the changing nature of the study of ancient Egyptian mathematics, looking in particular at where it stood in the early 1930s.

2. THE EARLY UNDERSTANDING OF ANCIENT EGYPTIAN MATHEMATICS

With the loss of knowledge of ancient Egyptian scripts and language by the sixth century CE, [14] any direct idea of how the Egyptians had conducted their mathematics was also lost, and it was only in the nineteenth century, with the European decipherment of hieroglyphs, that a renewed understanding of ancient Egyptian mathematics began to emerge. Prior to this, however, a tradition about the general nature of ancient Egyptian mathematics had been handed down from classical authors, usually with the focus on geometry. [15] Thus, for example, Herodotus's *Histories* (fifth century BCE) says of a semi-mythical Egyptian king named Sesostris:

> This king [...] divided the country among all the Egyptians by giving each an equal square parcel of land, and made this his source of revenue, appointing the payment of a yearly tax. And any man who was robbed by the river of a part of his land would come to Sesostris and declare what had befallen him; then the king would send men to look into it and measure the space by which the land was diminished, so that thereafter it should pay in proportion to the tax originally imposed. From this, to my thinking, the Greeks learnt the art of measuring land; the sunclock and the sundial, and the twelve divisions of the day, came to Hellas not from Egypt but from Babylonia. [16]

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14 See, for example, [Parkinson 1999, pp. 178–179].

15 For a survey of ancient comments on Egyptian mathematics, see [Heath 1921, vol. I, ch. I] and the range of extracts presented in [Fauvel & Gray 1987, § 1.D4]. See also [Peet 1923a, pp. 31–32]. On how Egypt was viewed more generally in later antiquity, see [Thompson 2015–2018, vol. 1, ch. 1].

16 II.109. See, for example, [Herodotus 1920]. Herodotus also made a passing nonspecific reference to Egyptian calculation in II.36.

A broadly similar view, perhaps derived from Herodotus, may be found as a passing remark in Strabo's *Geography* (first century BCE), where the earliest geometry is credited to the Egyptians, in parallel with the assertion that it was the Phoenicians who invented arithmetic "because of their commerce".[17] Diodorus Siculus (first century BCE) also repeated this simple statement about ancient Egyptian geometry, along with a rare but nonspecific mention of the "special attention" that was given to arithmetic in Egypt.[18] Proclus's fifth-century commentary on Euclid's *Elements*, which may have incorporated a now-lost History of Geometry by Eudemus, a student of Aristotle, again makes the same claim: that geometry has its origin in Egyptian land-surveying [Taylor 1788–1789, vol. I, p. 98]. All of these authors asserted further that it was Greek travellers returning from Egypt who first brought knowledge of geometry to Greece (most notably Thales of Miletus, perhaps in the late seventh century BCE, or the semi-mythical Pythagoras a few decades later). Thus, starting from Herodotus, we see the two basic 'facts' about ancient Egyptian mathematics that then passed down through the following centuries:

(1) that the Egyptians were forced to invent geometry by the necessities of land measurement,[19] and
(2) that early knowledge of geometry entered Greece from Egypt.

The corollary to the latter, from the point of view of many later writers, was that despite this ancient Egyptian origin, 'true' mathematics—usually meaning pure mathematics and the notion of deductive proof—only began with the Greeks. What Thales and Pythagoras found in Egypt

> was not so much a coordinated system of learning as an accumulated mass of observational material relating to mathematics, engineering, medicine and much else [Lyons 1926, p. 243].

This attitude is visible, for example, in the title of the book [Lasserre 1964]: *The birth of mathematics in the age of Plato.* The latter point above was also the mathematical manifestation of the wider view in Ancient Greece of Egypt as the source of all wisdom (as reflected, for example, in Plato's

17 XVII.3. See, for example, [Strabo 2014, vol. 8].

18 *Bibliotheca historica*, I.69, 81. See, for example, [Diodorus Siculus 2014, vol. 1].

19 Aristotle gave a slightly different explanation of the origin of Egyptian mathematics: "the mathematical sciences originated in the neighbourhood of Egypt, because there the priestly class was allowed leisure" (*Metaphysics*, I.2; see, for example, [Aristotle 1933]). As has been noted, however, the types of problems found in the RMP are practical rather than priestly [Macdonald 1950].

Timaeus).[20] The idea of the ancient Egyptians as practiced surveyors was further reinforced by a reference to the so-called *harpedonaptai* in an account of the Greek philosopher Democritus (fifth century BCE) by the theologian Clement of Alexandria in the first century: the *harpedonaptai* or 'rope-stretchers', who are said to have carried out measurements for building works by using stretched knotted cords, went on to become a staple of general modern accounts of the history of early mathematics and architecture.[21]

By the time of the Arab invasion of Egypt in the seventh century CE, knowledge of ancient Egyptian scripts had been lost, but this did not dampen the interest of the Islamic scholars in Egypt's antiquities during the following centuries.[22] The pyramids, for example, were surveyed, measured, and discussed, and it was acknowledged that their ancient architects must have had some knowledge of geometry, but the precise nature of that knowledge remained unknown; as the twelfth-century writer Saad Allah Abu al Makarim put it: "the modern mind feels itself unable to estimate how much was required in these works of knowledge of geometry" [al Makarim 1895, p. 278]. In an echo of the claims of classical authors, al-Makarim attributed the introduction of geometry to the Biblical Joseph, meeting the needs of land-surveying [al Makarim 1895, p. 203]. The writings of classical authors such as Herodotus were known to the scholars of mediaeval Egypt [El-Daly 2005, pp. 26–27], and this probably represents the extent of their knowledge of, and their major source for, ancient Egyptian mathematics:[23] access to ancient architecture and artefacts was not enough—the ability to read texts was needed, and this would not come for several centuries, despite medieval attempts.[24]

In Europe the renewed interest in classical antiquity that emerged with the Renaissance also brought with it a desire to know more about the earlier Egyptian learning.[25] In particular, one source was the Hermetic tradition, which had also been transmitted in the Islamic world, and

20 See, for example, [Plato 1929]. On this view of Egypt from classical antiquity to the twentieth century, see [Ucko & Champion 2003].

21 See, for example: [Bell 1945, p. 40]; [Schneider 2015, pp. 98–100]. See also the comments in [Rossi 2003, pp. 156–157].

22 See the overview in [Thompson 2015–2018, vol. 1, ch. 2] and the detailed study of [El-Daly 2005].

23 In contrast, Ancient Greek mathematical texts remained available in mediaeval Egypt; see, for example: [El-Daly 2005, pp. 111–112] or [Berggren 2007].

24 See, for example, [Thompson 2015–2018, vol. 1, p. 45].

25 See, for example, [Thompson 2015–2018, vol. 1, ch. 3]; on Renaissance attitudes towards ancient mathematics, see [Goulding 2010, pp. 8–18].

derived from first-century philosophical and mystical texts purporting to record ancient wisdom from Egypt.[26] More generally, Renaissance authors, inspired by the comments of their ancient counterparts, viewed pharaonic Egypt as "a fount of profound knowledge".[27] The specifics of ancient Egyptian mathematics, however, remained unknown. If we look to early modern Europe, when the first partial attempts at written histories of mathematics began to appear, we see the same basic Herodotean story being repeated time and again.[28] A further detail that began to appear was the assertion, apparently stemming from Flavius Josephus (37-*c.*100 CE), that arithmetic had been introduced to Egypt by Abraham.[29] The seventeenth century also saw the incorporation of alleged knowledge of ancient Egyptian geometry into Masonic lore [Lawrence 2015]. Elsewhere, however, more rational studies of ancient Egypt were being carried out, such as in the work of John Greaves (1602–1652) on ancient Egyptian chronology and metrology.[30]

Throughout the eighteenth century, Herodotus remained the "cornerstone for the narrative of Egypt's ancient history" [Merzbach & Boyer 2011, p. 8], both with regard to mathematics and more generally, although doubt was already being cast on the by-now canonical land-measurement story.[31] Nevertheless, Jean-Étienne Montucla's *Histoire des mathématiques*, the first comprehensive treatment of the history of mathematics, simply repeated this [Montucla 1758, p. 51]. References to ancient Egypt, usually more astronomical than mathematical, litter Charles Hutton's *A mathematical and philosophical dictionary* of 1796, again with the same stories [Hutton 1796].[32] The same is true of the French *Encyclopédie*,[33] and even the *Description de l'Égypte*, the published record of Napoleon's expedition to Egypt. The latter features a 300-page account by the engineer Edmé

26 See, for example, [Ucko & Champion 2003].

27 [Thompson 2015–2018, vol. 1, p. 57]. On this view, see in particular chapter 5 in [Ucko & Champion 2003].

28 On attitudes towards ancient mathematics during the early modern period more generally, see [Goulding 2010].

29 *Jewish Antiquities*, 1.viii.2; see, for example, [Josephus 1930].

30 In his *Pyramidographia* [Greaves 1646]; see [Shalev 2002].

31 See, for example, [Gram 1706]. Gram identified Thoth, the Egyptian god traditionally supposed to have introduced mathematics (among other things) to Egypt, with the biblical Abraham; see the comments in [Archibald 1927/1929, p. 127].

32 See, in particular, the entries 'Arithmetic', 'Democritus', and 'Geometry' in volume 1, and 'Mathematics', 'Pythagoras', and 'Thales' in volume 2.

33 See, for example, [d'Alembert 1757].

François Jomard (1777–1862) of ancient Egyptian systems of measure, together with the results of architectural surveys of monuments across Egypt [Jomard 1809]; a short section in the middle of the article begins with the comment that "[t]he state of exact knowledge among the ancients is still a problem today" [34] before proceeding to a comprehensive overview of the remarks made by Herodotus and other ancient authors on the geometry of ancient Egypt.

During the early decades of the nineteenth century, the decipherment of both hieroglyphs and the cursive hieratic script gradually opened up a window onto the Egyptian past, [35] but not immediately onto ancient Egyptian mathematics, simply because of a lack of textual sources dealing directly with the processes of mathematics. The signs for numerals were identified early in the process of decipherment, first the ideograms for 1–9, which were based on strokes, and then the less obvious higher numerals. By 1823, Thomas Young (1773–1829) was able to include a short outline of (integer) Egyptian hieroglyphic numerals in a sign list in his *Discoveries in hieroglyphical literature* [Young 1823, p. 160], [36] and in the mid-1830s, the posthumously published *Grammaire égyptienne* of Jean-François Champollion (1790–1832) featured a comprehensive account of hieroglyphic and hieratic numerals, both integral and fractional [Champollion 1836, ch. IX], but the practicalities of ancient Egyptian arithmetic and geometry remained unknown. Thus, when the first major general 'post-Champollion' account of ancient Egyptian lifeways and culture appeared in print in 1837, it was heavily dependent on classical sources [Thompson 1992, pp. 145–154], and its brief remarks on ancient Egyptian mathematics were again simply those of the ancient authors described above [Wilkinson 1837, pp. 104, 268]. Early nineteenth-century histories of mathematics also continued to follow this pattern. [37] Around this same time, however, we find an explicit acknowledgement of the limited direct knowledge of ancient Egyptian mathematics in the *Penny*

34 "L'état des connoissances exactes chez les anciens est encore aujourd'hui un problème." [Jomard 1809, p. 699]

35 See, for example, [Parkinson 1999].

36 Young claimed to have been the first to have identified Egyptian numerals; see [Bierbrier 2012, p. 595]. He had certainly found some of them at least as early as February 1818: see the letter from Young to William John Bankes MP (1786–1855) that is reproduced in [Parkinson 1999, p. 32]. Another candidate for discoverer of Egyptian numerals is Young's sometime correspondent Edmé François Jomard, whom we cited in the preceding paragraph; see the remarks in [Archibald 1927/1929, p. 128].

37 See, for example, [Chasles 1837, p. 4].

Cyclopaedia, a serialised reference work published in Britain by the Society for the Diffusion of Useful Knowledge. The entry 'Egypt' notes that "[t]he progress of the Egyptians in the exact sciences has been taken for granted without sufficient evidence," before going on to observe: "[t]hat they had some practical knowledge of geometry [...] is generally admitted" [Anonym 1837, p. 310].[38] Similar comments appear in the entry 'Geometry', published the following year; it was written by the mathematician Augustus De Morgan (1806–1871), who was responsible for the mathematical entries in the *Cyclopaedia*,[39] and who had a keen interest in and nuanced understanding of the history of mathematics.[40] In writing about the history of geometry, he began:

> There is a *stock history* of the rise of geometry, supported by the names of Strabo, Diodorus, and Proclus, namely, that the Egyptians, having their landmarks yearly destroyed by the rise of the Nile, were obliged to invent an art of land-surveying in order to preserve the memory of the bounds of property; out of which art geometry arose. This story, combined with another attributing the science directly to the gods, forms the first light which we have on the subject [...] There is no proof whatever that the Egyptians were more geometers than astronomers, and the supposition that the rise of the Nile obliged the builders of the pyramids to make new landmarks once a year, requires at least contemporary evidence to make it history. At the same time, the question of the actual origin of geometry is a very difficult one, and any conclusion can only be of very moderate probability. [[De Morgan] 1838, p. 151, his emphasis]

Later on, he stated quite plainly:

> Of the Babylonian and of the Egyptian geometry we have no remains whatever, though each nation has been often said to have invented the science. In reference to the authorities mentioned above in favour of the Egyptians [...], we may say that no one of the writers who tells the story in question is known as a geometer except Proclus, the latest of them all; and as if to give the assertion the character of an hypothesis, this last writer also adds that the Phenicians [*sic*],

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38 The British Library holds a copy of the *Penny Cyclopaedia* in which the entries have been annotated with the names of contributors (General Reference Collection 733.l). From this, we know that the author of the entry 'Egypt' was a certain A. Vieusseux, about whom, however, we currently know little beyond the brief details that appear against his name in the list of contributors in volume 27 of the *Cyclopaedia*: "author of 'The History of Switzerland' in the Library of Useful Knowledge. [Contributed to the *Cyclopaedia* on topics relating to] *Geography, Topography, Italian History and Biography*, &c."

39 A list of De Morgan's contributions to the *Cyclopaedia* may be found in [De Morgan 1882, pp. 407–414].

40 See [Rice 1996].

on account of the wants of their commerce, became the inventors of arithmetic. [[De Morgan] 1838, p. 152]

The *Cyclopaedia*'s entry on arithmetic [[De Morgan] 1834], on the other hand, has little to say about the history of the subject, directing the reader instead to the corresponding entry by the Cambridge mathematician George Peacock (1791–1858) in a different encyclopaedia, the *Encyclopædia Metropolitana* [Peacock 1845].[41] But in his mathematically detailed account of both practical arithmetic and its history,[42] Peacock barely mentioned Egypt at all, merely noting the form of the (hieroglyphic) numerals with reference to Young.[43] The details of how ancient Egyptian scribes actually performed arithmetical operations were simply not known.[44] As Merzbach and Boyer comment: "Although these early studies of hieroglyphic texts shed some light on Egyptian numeration, they still produced no purely mathematical materials" [Merzbach & Boyer 2011, p. 9].

European understanding of ancient Egyptian mathematics emerged only after the discovery of the RMP in the 1860s (we do not here address Egyptian scholars' study of their country's ancient traditions). One indication of the importance of the RMP in this regard is the fact that

41 Although this volume of the encyclopaedia was published in 1845, internal evidence from Peacock's entry suggests that he had already written much of it in 1826; see [Durand-Richard 2011, p. 282, n. 70]. That De Morgan had seen it by the late 1830s indicates that it had at least a limited circulation prior to formal publication.

42 Of the encyclopaedia entry's 161 pages, 114 are given over to an account of the history of arithmetic. Peacock's interest in the history of the subject stemmed, at least in part, from a desire to present (elsewhere) certain contemporary developments in algebra as being the natural next steps in a centuries-long process of mathematical advancement that began with the origins of numeration; see [Lambert 2013].

43 During the second half of the 1820s, Peacock delivered a series of lectures to the Cambridge Philosophical Society on anthropological themes, with a particular focus on the development of numeration. One of these carried the tantalising title 'On the Discoveries recently made on the subject of the Hieroglyphics', but sadly the title is all that survives [Durand-Richard 2011, p. 282, n. 70]. Peacock later penned a memoir of Young: [Peacock 1855].

44 The mathematical literature of this period contains the occasional reference to something called 'the Egyptian method' (see, for example, [Brickley 1811]), but this does not refer to the mathematics of pharaonic Egypt, but to the solution of indeterminate equations, as found in the third-century *Arithmetica* of Diophantus of Alexandria. By the end of the nineteenth century, however, the term was being used either to indicate the two-column method used in Egyptian arithmetic (as outlined, for example, by Imhausen [2016, § 10.1.1]), or else for the expression of arbitrary fractions as sums of unit fractions, a central feature of ancient Egyptian arithmetic.

Imhausen takes it as the starting point for her brief historiography of ancient Egyptian mathematics [Imhausen 2003, § 1].

3. THE RHIND MATHEMATICAL PAPYRUS

The RMP is a papyrus written by an individual who identified himself as "the scribe Ahmose" [45] in *c.*1537 BCE in Regnal year 33 of King Apepi, although its introductory title states that it is a copy "according to the writings of old made in the time of the Dual [King Nima]are (Amenemhat III)," that is, a copy of a text around 200 years older, placing its composition and contents in the late Twelfth Dynasty. The papyrus is written in a careful and elegant cursive (hieratic) script, and it contains a sequence of more than 80 arithmetical and geometrical problems of the types that would have been encountered during a scribal career, as well as reference tables, apparently to aid in calculations with fractions; the arithmetical problems include the division of loaves of bread among men in both equal and unequal proportions, whilst the geometrical problems consist mostly of the calculation of certain areas and volumes, such as triangles and cylinders. [46] The papyrus is very well preserved, which indicates that it must have been placed in a tomb, perhaps that of its copyist, possibly with other technical manuscripts [Peet 1923a, pp. 1–3; Imhausen 2003, p. 65], as part of a funerary display of the tomb-owner's social and cultural status; this funerary context does not clarify whether the text itself was regarded as a reference manual or a work that was used in scribal training. [47] The precise modern find-spot of the papyrus is unrecorded: [48] all we know is that it was purchased in Thebes (modern Luxor) by the pioneering Scottish excavator Alexander Henry Rhind (1833–1863). [49] The date is usually given as 1858, but research by Margaret Maitland on correspondence between Rhind and Samuel Birch of the British Museum makes it clear that

45 This is also transcribed as 'Ahmes', hence the alternative name by which the RMP is sometimes known by mathematicians: the 'Ahmes Papyrus'.

46 For a detailed breakdown and grouping of the problems, see [Peet 1923a, pp. 4–5].

47 See the comments in [Imhausen 2021a, p. 40].

48 In the Preface to the British Museum's 1898 facsimile of the RMP, it is remarked anecdotally that the papyrus was "said to have been found at Thebes in a chamber in the ruins of one of the small buildings near the Ramesseum" in the necropolis on the west bank of the Nile [Budge 1898, p. [1]].

49 On whom, see [Bierbrier 2012, p. 463], [Gilmour 2015], and [Irving & Maitland 2015].

Rhind purchased it in early 1863.[50] After Rhind's death, it was acquired by the British Museum, where it remains to this day in the two large parts into which it was apparently broken on discovery (as P. BM EA 10057 and P. BM EA 10058). Some small fragments of the roll from the broken area had been separated from the two main parts before Rhind's purchase, and these were subsequently acquired by the New York Historical Society in 1907 [Peet 1923a, pp. 1–2]; they are now held by the Brooklyn Museum (as 37.1784Ea-b).

Although a large part of the content of the RMP is arithmetical in nature, it was the geometrical portions—and, in particular, the accompanying figures—that stood out visually and caught the eye of the first commentators on the papyrus. It was first mentioned in print as a "Traité de Géométrie" in a note presented by the French archaeologist François Lenormant (1837–1883) to the Paris Academy in 1867 [Lenormant 1867]. Its first curator at the British Museum, Samuel Birch (1813–1885), similarly focused only upon the geometrical problems in the papyrus in a brief account published the following year [Birch 1868]. Some of the technical terms in the papyrus, again mainly within the geometrical problems, were identified by the German Egyptologist Heinrich Karl Brugsch (1827–1894) shortly thereafter [Brugsch 1874].[51]

In 1869, the Trustees of the British Museum authorised the production of facsimile plates of the papyrus, but publication of these was delayed until 1898, and the descriptive text that was to have accompanied the facsimile was never completed. In the meantime, Eisenlohr had obtained lithographed copies of the British Museum plates, and published versions of these along with a treatise on the contents of the papyrus [Eisenlohr 1877].[52] Eisenlohr devised the currently accepted numbering of the problems in the papyrus, and he provided the first general overview of its contents: indeed, in spite of the later concerns about its accuracy (noted

50 Margaret Maitland, personal communication, 19th August 2021 (British Museum correspondence 5163–4).

51 On these early commentators on the papyrus, see [Imhausen 2021a, § 3].

52 Eisenlohr's plates are not identical to those of the British Museum facsimile, and were thus apparently traced from these. As well as adding problem and line numbers, the plates also show some previously misplaced fragments rearranged (e.g., [Eisenlohr 1877, vol. II, pl. 24 (no. 86)]). This publication was not without controversy, for, according to some sources [Peet 1923a, p. 1; Archibald 1927/1929, p. 161, n. 1], Eisenlohr did not have permission to publish the plates, a charge that he denied both in print [Eisenlohr 1899] and in a letter to Francis Llewellyn Griffith in April 1899 (Griffith Institute Archive, Oxford: Griffith MSS 21—Correspondence, no. 413, A. Eisenlohr to F. Ll. Griffith, 18th April 1899).

in section 1), this became "the fundamental work for the study of the Papyrus" [Archibald 1927/1929, p. 140]. Moreover, the great majority of works published on the subject of ancient Egyptian mathematics during the last part of the nineteenth century were in one way or another derivative of Eisenlohr's text, since it was the only accessible version of the RMP that was available at that time. [53]

One author who was able to go back to the original papyrus, however, was the Egyptologist Francis Llewellyn Griffith (1862–1934), who published a series of articles on the RMP in 1891 and 1894, while he was working for the British Museum [Griffith 1891–1894]. In these notes, Griffith described the form of the papyrus, and outlined the fundamental principles of ancient Egyptian mathematics, with a particular focus on metrology, a subject on which he also published—from a largely philological, rather than mathematical, point of view—around this time [Griffith 1892–1893]. Griffith corrected some mis-readings that he found in Eisenlohr's treatment of the RMP, [54] and clearly viewed his efforts as being preliminary to a new edition of the papyrus—though there is no specific indication that he intended to produce a full edition himself. Several works on individual problems from the papyrus followed by other scholars, [55] but it was not until 1923 that a new edition of the RMP was published by Peet. Most importantly, Peet, like Griffith, went back to the original papyrus in the British Museum, rather than relying on the published facsimile: many of the revisions of Eisenlohr's treatment were needed not only because of developments in Egyptology, but also, more prosaically, because of the facsimile's errors in the copying of the original hieratic and in the arrangement of the fragments on the plates. [56] As he noted in his preface, Peet had already begun work on the RMP in 1911, and the work had been "well advanced" by the time of the outbreak of war in 1914; the work was paused until 1920, with the edition appearing in print three years after this. However, for reasons that we will describe in

53 For general comments on Eisenlohr's edition of the RMP, see [Imhausen 2021a, § 3].

54 Griffith was sympathetic to Eisenlohr, however: "I must be allowed to state distinctly that time treats Egyptological commentaries *hardly*, and that fourteen years [the time elapsed since Eisenlohr's initial publication of the RMP] is enough to render obsolete most of what is written, above all in connection with a difficult papyrus of the Middle Kingdom, one moreover which introduced an entirely new subject" [Griffith 1891–1894, p. 26, n. †, his emphasis].

55 For example, Borchardt [1897] and Schack-Schackenburg [1899], among many others.

56 See, for example, [Griffith 1899].

section 6, Peet's was not the only edition of the RMP to be released during the 1920s, which also saw the publication of the rather different edition of Chace [1927/1929].[57]

It is impossible in this context to overemphasise the importance of the RMP to the understanding of ancient Egyptian mathematics. Although it needed subsequently to be updated, Eisenlohr's account of the RMP provided a major new understanding of a topic about which only the vaguest of hints had hitherto been available. This may go some way towards explaining the widespread reproduction of Eisenlohr's results, mentioned in passing in section 1, which enabled the communication of ideas about ancient Egyptian mathematics to a range of different readerships, in a number of different languages.[58] Another survey of ancient Egypt, written by the Egyptologist Adolf Erman (1854–1937) for the general reader at the end of the nineteenth century, reveals the change in awareness [Erman 1894]. In contrast to Wilkinson's book of 1837, which simply repeated the general remarks of ancient authors, Erman provided a rather fuller account of ancient Egyptian mathematics (roughly five pages in the English translation), based on Eisenlohr's interpretation, and introduced by the bold claim: "[t]hanks to a papyrus in the British Museum, we are now pretty well informed on this subject" [Erman 1894, p. 364].

4. OTHER SOURCES ON ANCIENT EGYPTIAN MATHEMATICS

Although the RMP was the main known source on ancient Egyptian mathematics at the end of the nineteenth century, it was by no means the only one. In this section, we give a short overview of the other texts that were available, drawing heavily upon the similar outline given by Peet [1923a, pp. 6–7];[59] this list consists only of texts that are relevant for the understanding of the *practice* of mathematics in ancient Egypt, and does

57 We hope to write more fully elsewhere about the editions and editors of the RMP; for a recent comparison, see [Imhausen 2021a].

58 For example: [Favaro 1879], [Rodet 1882], [Bobynin 1882]. In particular, the treatment of Egyptian mathematics found in [Cantor 1880], derived from [Eisenlohr 1877], also opened up the purely mathematical treatment of so-called 'Egyptian fractions' (that is, the expression of arbitrary fractions as sums of unit fractions)—one of the earliest papers on this topic was [Sylvester 1880a;b].

59 Cf. the similar lists that appear in [Neugebauer 1930a, p. 301] and [Ritter 2002b, p. 136].

not include, for example, accounts papyri, which feature lists of numbers without any indication of arithmetic. [60]

(1) The Moscow Mathematical Papyrus (hereafter MMP; also known as the Golenishchev Papyrus). This Twelfth Dynasty text was obtained by the Russian Egyptologist Vladimir Semyonovich Golenishchev (Владимир Семёнович Голенишев, 1856–1947) in Luxor in *c.*1892–1894. This is more fragmentary, shorter, and much less systematic than the RMP, and harder to read, being written in a more cursive hand (described as "appalling" by Peet [1931d, p. 154]). It consists of a range of problems similar to those in the RMP. An early reference to this papyrus appeared on p. 23 of the 1894 second edition of Cantor's *Vorlesungen* [Cantor 1880], but it remained otherwise unstudied until it passed to the Moscow Museum of Fine Arts in 1912 (now E4676). The first publication was a brief paper in English [Touraeff [Turaev] 1917], dealing with a single geometrical problem. This, however, was enough to pique the interest of scholars, and there was much curiosity about the papyrus prior to the eventual publication of a full edition in 1930 [Struve 1930a]. Peet had managed to obtain photographs of the MMP prior to the publication of his edition of the RMP, and these informed his general comments there on ancient Egyptian mathematics. We will discuss the MMP further in section 6, and consider its wider role in the story in section 8.

(2) The Lahun papyri comprise a large body of papyri, discovered in the Middle Kingdom town of el-Lahun in Egypt by Flinders Petrie in 1889, and now held at the Petrie Museum of Egyptian Archaeology, University College London. They include fragments of late Middle Kingdom hieratic papyri showing remnants of tables and problems similar to those in the RMP (P. UCL 32107A, UC 32114B, UC 32118B, UC 32134A + B, and UC 32159–32162). They were first published by Griffith [1898, vol. I, pp. 15–18; vol. II, plate VIII], and more recently by Imhausen and Ritter [2004] as part of a republication of the entire find by Mark Collier and Stephen Quirke.

(3) Papyrus Berlin 6619, dating from the Middle Kingdom, was purchased in Luxor in 1887 (find-spot unknown), now in the Staatliche Museen in Berlin. This papyrus comprises two fragments containing traces of four arithmetical problems, though only three are intact enough to admit any kind of reconstruction. The fragments were published by Schack-Schackenburg [1900a; 1900b].

(4) Two wooden writing boards, possibly written by the same scribe, were said to have been found at Akhmim, and are now in the Egyptian Museum in Cairo (CG 25367–8). [61] They date to the early Middle Kingdom and one mentions Regnal year 38 of a king, probably Senwosret I. The texts comprise scribal exercises, including administrative name-lists and some arithmetical calculations in hieratic. Although they had already been written about in the first decade of

60 For the much broader context of the sources mentioned here, see [Imhausen 2016].

61 Published by [Daressy 1901, pp. 95–96, pl. 62–63].

the twentieth century, these calculations did not receive a full analysis until they were studied by Peet [1923b]. [62]

In addition, Peet also made passing reference to some other sources bearing indirectly on metrology: the administrative records of the Thirteenth Dynasty Theban court preserved in Papyrus Boulaq 18 (as studied by Scharff [1922] [63]) and the Nineteenth Dynasty accounts of Papyrus Rollin (as studied by Spiegelberg [1896]). A further source, about which Peet could not write in 1923, but which became available to scholars later in that decade, was the so-called Mathematical Leather Roll in the British Museum (BM EA 10250.1–2). This was purchased by Rhind in 1863, and may even have been acquired by him from the same source as the RMP, since the palaeography suggests that they are contemporaneous manuscripts. The Leather Roll was also acquired by the British Museum, but was deemed too fragile to be examined until techniques could be developed to soften it and unroll it, whereupon in 1927 it was revealed that this (relatively short) text, whose contents had provoked much speculation, consisted of a further table to aid in calculations with fractions. [64]

This list of the sources for ancient Egyptian mathematics remains substantially the same today as in 1923, as can be seen from Imhausen's recent list of 'Extant hieratic mathematical texts' [Imhausen 2016, § 9.1]. The number of texts available for study in a mathematical context thus remains somewhat limited. What the reader may also glean from the list is that the RMP really is the main source for ancient Egyptian mathematics—the other texts bring additional colour and context by furnishing us with further examples of problems or tables, but (with some possible exceptions from the MMP, which we will explore in section 8) they add little to our understanding of the scope and mechanisms of ancient Egyptian mathematics. This observation serves to reinforce the importance within the literature first of Eisenlohr's treatment of the RMP in 1877, and then of Peet's in 1923.

These hieratic sources all date from the late Middle Kingdom and early New Kingdom (*c.*1800–1550 BCE). This chronological range may be due to the chances of preservation, but cultural factors may also be relevant

62 A more recent detailed treatment may be found in [Vymazalová 2002]; for the name-lists, see [Valbelle 1991].

63 A new edition has recently been produced by [Allam 2019].

64 On the unrolling of the Leather Roll, see [Scott & Hall 1927]; on its contents, see [Glanville 1927].

in part, such as changing practices about what types of texts were suitable to be deposited in tombs as displays of the tomb-owner's cultural status. [65] Such factors seem the most likely explanation for the fact that technical papyri, including mathematical ones, are preserved in tombs from these periods. [66] These hieratic sources have traditionally dominated the study of 'ancient Egyptian mathematics', and we have implicitly followed this focus. Another later body of sources is written in Demotic, which had replaced hieratic as the main cursive script by the middle of the first millennium BCE. Although linguistically Demotic is a development of Later Ancient Egyptian, its distinctive nature has meant that it has traditionally been studied by Egyptologists as a separate language and script, forming a specialised subdiscipline. [67] Indeed, nineteenth-century Egyptologists appear to have made earlier headway with Demotic mathematics than with its hieratic counterpart, as shown by such papers as [Brugsch 1865]. Despite the publication of many Demotic mathematical texts by Parker [1972], these have still received much less detailed attention than the earlier sources, largely because of the way in which the periodisation of ancient Egyptian texts has been institutionalised. This hieratic bias was noted by Peet [1923a, p. 7], in his few comments on Demotic sources, and explained away as an attempt to study a 'purer' form of ancient Egyptian mathematics:

> owing to their late date [that of the Demotic papyri] we must make great allowances for the possibility of contamination from Greek mathematics, and must not use them to prove anything with regard to the state of the science in the earlier periods of Egypt.

Indeed, it was particularly easy for the scholars of the 1920s to make this restriction, since many of the 'earlier' sources had been discovered only recently. As Imhausen has observed, the Mesopotamian influence on Egyptian mathematics during the Greco-Roman period has also been asserted since the beginning of the study of this topic, but "a detailed study of this influence or exchange has as yet to be done" [Imhausen 2016, p. 179, n. 5]. [68]

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65 See [Parkinson 2019] and [Hagen 2019].

66 Imhausen [2018, p. 110] points to administrative reorganisation during the Middle Kingdom as having led to the emergence of mathematical texts of this type in the first place.

67 See, for example, the comments in [Thompson 2015–2018, vol. 3, pp. 367–368], and [Hoffmann 2000, pp. 27–30].

68 See Imhausen [2018] concerning Babylonian influence on Demotic sources.

She stresses that the Demotic sections of her own book are very preliminary, relying on Parker's work, and a fuller reassessment of this corpus is now required, just as Peet had realised the need to reassess Eisenlohr's treatment of the RMP.

5. PEET'S WORKS ON ANCIENT EGYPTIAN MATHEMATICS

As well as his edition of the RMP, published in 1923, Peet also (co-)authored four papers on ancient Egyptian mathematics, along with several book reviews. Nevertheless, it seems to have been the RMP that sparked his interest, in part because of his educational background.[69] He had studied mathematics and classics at The Queen's College, Oxford during the early years of the twentieth century, before engaging in excavation work in Malta, Italy, and then Egypt. It was in Cairo in the autumn of 1909 that Peet first met Gardiner, whereafter his work turned in a philological rather than an archaeological direction. By 1911, he had already developed "a good working knowledge of Middle Egyptian" (the language of the RMP), and around this time he also studied Late Egyptian with Gardiner in Oxford [Gardiner 1934a, p. 68]. Philological work and specifically editing papyri occupied him for the rest of his career, through posts at the Universities of Manchester (1913–1928), Liverpool (1920–1933), and Oxford (1933–1934). Peet's major publications included editions of the Mayer papyri [Peet 1920], and other papyri with accounts of royal tomb-robberies during the Twentieth Dynasty [Peet 1930c].

Peet's interest in the RMP began in the very earliest part of his philological career, and probably in awareness of the need for a new version: in the preface to his 1923 edition, he noted that he had begun work in 1911, and it is tempting to speculate that Gardiner may have directed his attention to it while teaching him. Peet's correspondence during the immediately following years indicates that he was spending "spare moments" working on the RMP: in November 1913, he told the Egyptologist Percy Newberry (1869–1949) that he hoped to produce an edition of the papyrus "in the near future".[70] Indeed, in a letter to Newberry a month earlier, he had provided a glimpse of his motivation in seeking to edit the papyrus:

69 For biographies of Peet, see: [Bierbrier 2012, pp. 420–421]; [Gardiner 1934a]; [Gunn 1949]; [Gunn & Simpson 2004]; [Lewis 2014, 2016]. For a bibliography of Peet's works, see [Uphill 1979]. We plan to deal with Peet's work on, and attitude towards, ancient Egyptian mathematics elsewhere at greater length.

70 Griffith Institute Archive, Oxford, Collection NEWB 2/576—PEET, THOMAS ERIC: 36/37, Peet to Newberry, 30th November 1913.

> It has not been done in full and I have an idea, probably quite a wrong one, that being a mathematician ought to help me. [71]

Peet sometimes referred to himself as a 'mathematician' during these years, presumably in view of his education—it seems to have been a way for him to distinguish himself amongst (more established) Egyptologists. [72] For him, mathematics represented precision and cogency in argument: while working on the RMP he wrote an article criticising the "nebulous" method of archaeological argument by eminent Egyptologists, in which he regretted archaeology's differences from "an exact science [...] its conclusions rarely follow with mathematical certainty from its premises" [Peet 1922, p. 5].

Shortly before the outbreak of war in 1914, Peet was able to report to Newberry that his work on the RMP was "in a fairly advanced state," [73] but it was soon shelved, as Peet enlisted in the army and saw action in the Mediterranean. [74] Following demobilisation in 1919, Peet returned to work on the RMP, and had completed his transcription of it, either from photographs or from the British Museum's published facsimile, by the end of 1921; [75] he would eventually collate his transcription with the original papyrus itself. [76] Over the following two years, his commentary on the papyrus also took shape, with input from Gardiner, Newberry, and perhaps also Griffith, and the edition finally appeared in print in November 1923.

If the strength of Eisenlohr's edition of the RMP lay in its extremely detailed treatment of the mathematics of the papyrus, the first analysis of its kind, then Peet's was notable for situating the papyrus and its mathematics within a broader Egyptological context. [77] Eisenlohr's title emphasises the mathematical contents of the papyrus (*Ein mathematisches Handbuch der alten Aegypter: Papyrus Rhind des British Museum)*, while Peet's is slightly more focussed on the papyrus itself (*The Rhind Mathematical Papyrus: British Museum 10057 and 10058*). Unlike Eisenlohr's publication, but like many

71 Griffith Institute Archive, Oxford, Collection NEWB 2/576—PEET, THOMAS ERIC: 36/36, Peet to Newberry, 2nd October 1913.

72 See the further discussion of this point in [Hollings & Parkinson to appear].

73 Griffith Institute Archive, Oxford, Collection NEWB 2/576—PEET, THOMAS ERIC: 36/39, Peet to Newberry, 30th June 1914.

74 See [Lewis 2014].

75 Griffith Institute Archive, Oxford: AHG/42.230.176, Peet to Gardiner, 7th December 1921.

76 Griffith Institute Archive, Oxford: AHG/42.230.155, Peet to Gardiner, 26th March 1923.

77 For general comments on Peet's edition of the RMP, see [Imhausen 2021a, § 4].

contemporaneous publications and editions of ancient Egyptian papyri, Peet's edition did not provide reproductions of the hieratic original. [78] It was notably contexualising: the title page describes the publication of the papyrus explicitly as 'Introduction, transcription, translation and commentary'. This was partly due to Peet's attitude: his publications of tomb-robbery papyri [Peet 1920, 1930c] are similar in their approach, and his second monograph on these was presented as a "critical study" which included a thorough contextualising "General Introduction" [Peet 1930c, pp. 1–27]. This was praised by one reviewer for dealing "admirably [...] with the historical and cultural implications of the group [of papyri] as a whole" [Allen 1932, p. 66]. Peet's publication on the RMP was perhaps one of the fullest commentaries on a papyrus and its contents by this date, following on from models established by Gardiner with his study, for example, of a literary papyrus in Leiden [Gardiner 1909]. It was conceived in a cross-disciplinary manner:

> Every attempt has been made to render the book intelligible to the mathematician who has no knowledge whatsoever of the Egyptian language. On the other hand, the Egyptologist with little knowledge of mathematics may enter it without fear [...] [Peet 1923a, preface]

Peet began with an overview of the content of the papyrus, and of previous work on it, before enumerating the sources available for the study of ancient Egyptian mathematics, a subject of which he gave a general outline (the details of which owe much to Eisenlohr), including some remarks on its "general character" [Peet 1923a, p. 10]. He provided a section on Egyptian weights and measures, a comparison of Egyptian mathematics with its Babylonian counterpart, and a survey of ancient Greek views on Egyptian arithmetic and geometry (pp. 24–32). The bulk of the book is of course taken up by a problem-by-problem account of the contents of the papyrus, arranged according to the numbering established by Eisenlohr (pp. 33–131); each problem is translated into English (but not transliterated), and is accompanied by an individual detailed mathematical, philological, and more broadly Egyptological commentary. At various points, Peet politely corrected some of the interpretations and translations previously given by Eisenlohr. [79] Twenty-four plates at the end

[78] This will have been at least in part due to expense: see Peet's discussion of a similar absence of reproductions in his publication of the tomb-robbery papyri [Peet 1930c, I, pp. v-vi].

[79] For example, Peet disputed Eisenlohr's imposition of a set of rules on the construction of one of the reference tables [Peet 1923a, pp. 35–36], and elsewhere expressed concern at Eisenlohr's "most unguarded use of algebraical symbols" [Peet

of the book provide a hieroglyphic transcription of the papyrus, collated from the original, rather than the flawed British Museum facsimile. While Peet's own training in mathematics underlay in part his wish to make the work accessible to mathematicians, he was regarded as an exceptionally rounded scholar with a "breadth of interests" [Gardiner 1934a, p. 66] and his work was often conducted across disciplinary divides, such as *A comparative study of the literatures of Egypt, Palestine, and Mesopotamia: Egypt's contribution to the literature of the ancient world* [Peet 1931e].

Around the same time as the publication of his edition of the RMP, Peet also published a short paper on ancient Egyptian arithmetic [Peet 1923b], dealing with the Akhmim writing boards, described in section 4. Peet probably became interested in the writing boards whilst composing the general survey of ancient Egyptian mathematical sources that appears in his RMP—and his disagreement with the conclusions drawn by previous authors concerning the writing boards probably provided the spark for the paper. Prior scholars, namely Georges Daressy (1864–1938), Georg Möller (1876–1921), and Kurt Sethe (1869–1934), [80] had all recognised the mathematical nature of the texts on the writing boards, but had variously disagreed as to the reading and the interpretation of some of the (numerical) signs written there. In Peet's view, none of these authors had offered a satisfactory explanation of the content of the writing boards, and so he sought to provide his own, for he viewed them as an important source: "Rightly understood they form such an admirable commentary on Egyptian mathematical methods that they are well worthy of close study" [Peet 1923b, p. 91]. Peet used the writing boards as the starting point for a general discussion of ancient Egyptian arithmetic, and gave a detailed account of the calculations that appear there. Although we will not go into the details here, we note that it was in discussing some of the general features of Egyptian fractional arithmetic that Peet was able to suggest the source of the errors of the previous authors: they had imposed a uniform method for the solution of all the problems on the tablet that Peet did not believe was valid. The insistence on general and overarching methods went on to become a feature of scholarship on ancient Egyptian mathematics more generally, particularly that written by mathematicians—a point to which we will return in the next section.

1923a, p. 60]. Several of Peet's corrections to Eisenlohr's conclusions hinge upon the readings and interpretations of individual words: see, for example, [Peet 1923a, pp. 77, 83, 93, 97–98, 107, 110, 114, 117].

80 In, respectively, [Daressy 1906], [Möller 1910], and [Sethe 1916, p. 74, n. 2].

Peet's other publications on ancient Egyptian mathematics came later in the 1920s, by which time works by other authors on this topic were beginning to appear. Indeed, two of Peet's later papers, both of them linked to geometrical problems in the MMP, responded directly to the writings of other scholars. As in the case of the paper on the Akhmim writing boards, the goal of Peet's writings was to provide more accurate readings than had been given by previous authors. The first of these papers on the MMP was co-authored with the philologist Gunn [Gunn & Peet 1929], and began with a critical overview of the small number of prior studies of the MMP and the inaccuracies found there;[81] Gunn and Peet sought greater accuracy, in light of "the recent revival of interest in Egyptian mathematics" [Gunn & Peet 1929, p. 167]. Of the four MMP problems considered in this paper,[82] one seeks the side-lengths of a rectangle whose area is given and whose sides are in a certain proportion, two are analogous problems relating to triangles, and the fourth concerns the volume of a truncated pyramid. This last problem, which implies ancient Egyptian knowledge of a formula for the calculation of such a volume, has subsequently seen much study by historians of mathematics, particularly with regard to how the formula was arrived at in the first place.[83] A similarly much-studied problem is the subject of Peet's other paper on the MMP [Peet 1931a], which discusses the relative merits of interpreting the calculation of a particular surface area as being either that of a half-cylinder or of a hemisphere.[84] We will return to these latter two problems in section 8.

Peet's final substantial piece of work on ancient Egyptian mathematics was the text of a lecture [Peet 1931b] that he delivered in the Rylands Library in Manchester in February 1931, which provides us with a succinct summary of his views on the nature of ancient Egyptian mathematics, as well as a comprehensive overview of the state of knowledge of the subject at that time. In line with the comments that we made in section 3, Peet emphasised the importance of Eisenlohr's initial publication of the RMP for

81 Principally [Touraeff [Turaev] 1917] and [Tsinzerling 1925].

82 The papyrus features 25 problems in total.

83 In addition to Peet's paper, and those articles cited above in note 81, see also [Luckey 1930], [Vogel 1930a], [Thomas 1931], [Vetter 1933], [van der Waerden 1954, pp. 34–35], [Gillings 1964], [Gillings 1972, pp. 187–193], [Vilenkin 1985], [Shutler 2009], and [Imhausen 2016, pp. 74–76].

84 Other writings on this problem include [Neugebauer 1930d], [Gillings 1967], [Fletcher 1970], [Gillings 1972, ch. 18], [Couchoud 1987], [Hoffmann 1996], and [Cooper 2010]. See also Peet's further comments on this problem in [Peet 1931b, p. 437].

the study of this topic, and gave an indication of the nature of Eisenlohr's approach:[85]

> The publication of the Rhind Papyrus [...] by Eisenlohr [...] in 1877 gave to science what was practically its first glimpse of pre-Greek mathematics, and the discussion which followed was mainly, though not entirely, concentrated on the external methods of the Egyptian mathematician. [Peet 1931b, p. 409]

Elsewhere, Peet provided a balanced assessment of the necessity of Eisenlohr's methodology:[86]

> Eisenlohr, attempting to interpret the Rhind Papyrus in 1877, when the study of Egyptian grammar was still in its infancy, was justified in using the [...] process [...] of guessing, from the figures, what the problem must be and then trying to force the required meaning out of the Egyptian words. [Peet 1931a, p. 106]

For Peet, Eisenlohr's edition of the RMP belonged to the first of "two successive stages in the history of the study of Egyptian mathematics": one that "consists in examining and describing the actual processes used by the Egyptian mathematician in solving the problems which confronted him" [Peet 1931b, p. 409]. Although he played down his own role in the transition from one stage to the next, it is clear that the new edition of the RMP marked for him the shift to the second stage, which "consists in the attempt to analyse the mental processes which underlie the actual operations":

> When the papyrus was republished [...] in 1923 the history of mathematics had advanced considerably, and the new edition provoked a series of valuable writings not so much on the concrete methods of the Egyptians as on the mental processes which lay behind them. [Peet 1931b]

As we shall discuss in sections 8 and 9, a further aspect of Peet's second stage, "showing how far these [the above-mentioned mental processes] agree with or differ from our own" [Peet 1931b], took on a slightly different character later in the 1920s.

Over the following pages of his lecture, Peet embarked on a systematic survey of ancient Egyptian mathematics, beginning with an overview of the

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85 In this connection, see also Imhausen's discussion of Eisenlohr's translation of a particular problem from the RMP [Imhausen 2021a, p. 44].

86 More recently, Imhausen [2021a, p. 44] has referred to Eisenlohr's edition as a "remarkable achievement" in the early days of Egyptian philology ("Die Erstedition des ersten bekannten mathematischen Papyrus, zudem in der frühen Zeit der ägyptischen Philologie, ist eine beachtliche Leistung.").

available sources (essentially those listed in our section 4), and then proceeding to an account of (hieroglyphic) numerals, the basic mathematical operations, and the important topic of fractional arithmetic, which pervades ancient Egyptian mathematics. Much of the rest of the lecture consists of a series of detailed examples of arithmetical and geometrical problems, largely drawn from the RMP and the MMP, peppered with comments about disagreements amongst various authors about the interpretation of these.

Peet concluded his lecture by giving an impression, as he had done in his edition of the RMP, of the 'general character' of ancient Egyptian mathematics. In doing so, he revisited the remark that he had made eight years earlier, that "[t]he outstanding feature of Egyptian mathematics is its intensely practical character" [Peet 1923a, p. 10]. In 1931, Peet saw no reason to modify this statement, and remarked that the appearance of Struve's edition of the MMP leant further weight to the assertion, but he had come to the view that another of his prior claims, that "everything [in the RMP] is expressed in concrete terms" [Peet 1923a], required some adjustment, in light of the presence within the papyrus of problems phrased solely in terms of 'quantities' (rather than 'number of loaves', for example).[87] Peet also addressed here such points of recent debate as the presence of 'proof' within ancient Egyptian mathematics, and the question of whether it had a 'scientific' character—we discuss these in section 8. Overall, Peet's final publication on ancient Egyptian mathematics was as cautious and considered as his earlier ones, carefully responding to some of the writings that had appeared in the years since the publication of his edition of the RMP. Three years later he was dead.

6. ANCIENT EGYPTIAN MATHEMATICS AFTER PEET

In the earlier parts of this paper, we saw that Peet's publications on ancient Egyptian mathematics were by no means the first such writings, and yet we have stressed their crucial influence (most particularly that of his edition of the RMP) within the study of this topic. By way of building towards this latter assertion, we first survey those works on ancient Egyptian mathematics that appeared in print during the 1920s, following, and in many cases inspired by, Peet's RMP.

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[87] Peet noted that, in contrast to his earlier assertions, the use of the papyrus-roll determinative (classifier-sign) as part of the Egyptian word for 'quantity' indicates that the latter was intended in an abstract sense [Peet 1931b, p. 437, n. 4].

A survey of publications is enabled by Archibald's bibliography of ancient Egyptian mathematics [Archibald 1927/1929], which stretches through to 1930. Prior to the appearance of Peet's RMP in 1923, the vast majority of works listed by Archibald are of a strictly Egyptological—usually philological—nature, although the proportion of books and articles by mathematically-inclined authors increases after the publication of Eisenlohr's version of the RMP. Between 1877 and 1923, the items in Archibald's bibliography fall broadly into two classes: those works, often written by mathematicians, that provided summaries of, or were otherwise derivative of, Eisenlohr's RMP,[88] and more original works, usually by Egyptologists, dealing with the further details of ancient Egyptian mathematics that emerged from the additional sources that became available at the end of the nineteenth century.[89] However, neither of these types of publication represented a systematic approach to the subject of ancient Egyptian mathematics, nor did they add substantially to the overall picture: works in the former class, often written by authors who did not have the language skills to go back to the original sources, strayed little from Eisenlohr's interpretations, whilst the latter were detailed but rather isolated studies. There are of course exceptions to this broad classification: Griffith's writings [Griffith 1891–1894] gave new insights into the RMP, as we have seen, and Sethe [1916] provided a detailed and systematic account of ancient Egyptian numeration. However, the first attempt at a comprehensive overview of the principles and processes of ancient Egyptian mathematics by an author who was intimately familiar with the relevant primary sources was that provided by Peet, notably in his unusually detailed edition and commentary of the RMP.[90] And much of the subsequent work on ancient Egyptian mathematics was conducted within the framework laid down by Peet.

For the first few years following the appearance of Peet's edition of the RMP, Eisenlohr's *Handbuch* quite naturally remained the go-to reference for information on the papyrus. However, by the middle of the decade, Peet's version was beginning to have an impact. One of the most active followers of Peet to emerge at this time, and one whose work is central to the argument of the present paper, was Neugebauer. Having studied

88 For example, those works cited above in note 58.

89 For example, the works cited above in note 80 in connection with the Akhmim writing boards.

90 An earlier detailed account that is worth mentioning here is that by the classical philologist Friedrich Hultsch [1895], but this deals only with Egyptian fractional arithmetic.

mathematics in Göttingen, Neugebauer was, by 1923, already cultivating an interest in ancient Egyptian science under the influence of Göttingen's Professor of Egyptology, Kurt Sethe (1869–1934), but it seems to have been a visit to Copenhagen the following year that brought Neugebauer firmly into contact with Peet's work when the mathematician Harald Bohr (1887–1951) invited Neugebauer to write a review of Peet's edition for the Danish journal *Matematisk tidsskrift* [Neugebauer 1925].[91] The detailed study of the RMP that this must have entailed secured Neugebauer's interest in the papyrus, and resulted in the doctoral dissertation [Neugebauer 1926] with which we began the present paper. Introduction and appendices aside, Neugebauer's dissertation contains just two chapters, each of which explores what he saw as being a major theme of ancient Egyptian arithmetic.[92] In the first chapter, Neugebauer advanced the assertion, backed up by evidence taken from the RMP, that ancient Egyptian mathematics was purely additive ("rein additiv"): that the arithmetical methods were always based upon addition, and that there was no general concept of multiplication—the operations of doubling and decupling, for example, that appear in problems within the RMP should be interpreted as entirely separate processes, rather than specific instances of a general technique. The second of Neugebauer's chapters asserts the central position occupied by fractional arithmetic within ancient Egyptian mathematics, and seeks to unify several of the calculations found in the RMP into an overarching scheme, into which Neugebauer was not averse to interpolating whole new problems that 'should' have been included.[93]

With the appearance of Neugebauer's first work on ancient Egyptian mathematics, we see the beginnings of a trend that would only grow stronger throughout the 1920s and later decades: a movement away from analysis as commentary and into abstraction via the search for overarching principles and general rules within the extant sources on ancient Egyptian mathematics. The 'discovery' of such principles, however, often had more to do with modern ideas about the way in which mathematics ought to be done than with what the sources directly stated. To give one

91 For biographies of Neugebauer, see [Bierbrier 2012, pp. 401–402], [Davis 1994], [Pingree 1990], and [Swerdlow 1993], as well as the volume [Jones et al. 2016]. For (incomplete) bibliographies of Neugebauer's work, see [Anonym 1962] and [Sachs & Toomer 1979]. On Neugebauer's work on ancient Egyptian mathematics and astronomy specifically, see [Ritter 2002b].

92 For an overview of Neugebauer's dissertation, see [Ritter 2002b, pp. 140–147]; see also the remarks in [Imhausen 2021a, pp. 48–49].

93 For a detailed discussion of these ideas from Neugebauer's dissertation, and his communication of them to Peet, see [Hollings & Parkinson 2020].

example, the table of fractions that takes up most of the recto of the RMP received particular attention: this is a table that gives expressions in terms of sums of unit fractions for the quotient $2 \div n$, where n is an odd integer ranging from 3 to 101. Since ancient Egyptian scribes had no notation for most non-unit fractions, the table was a calculational aid for the often-encountered operation of doubling unit fractions. Since the representation of any such $2 \div n$ as a sum of unit fractions is not unique, this has opened up speculation amongst modern (mathematical) scholars as to why the scribes chose the particular representations that they did. Neugebauer was one of the first authors to consider this problem,[94] and in his dissertation and subsequent writings, he sought the purported general principles upon which the whole table had been constructed. However, such principles, variations of which have continued to appear in the literature throughout the ensuing decades,[95] are derived solely from the strictly mathematical content of the sources—there is no other evidence, such as metamathematical discussions, from which we may deduce them—and so the investigation of these principles carries the constant risk of inappropriately attributing modern mathematical ideas and attitudes to ancient Egyptian writers. This is something that Peet, for one, was unwilling to do; in his 1931 lecture, we find the following remarks in connection with the $2 \div n$ table in the RMP:

> The problem involved can be solved in a number of ways, and a modern mathematician would deal with it by some such formula as $\frac{2}{n} = \frac{1}{a} + \frac{1}{na}$, where $a = \frac{n+1}{2}$, which would give a methodical series of results. The Egyptian table, however, shows that no general formula was used, but that the results were purely empirical and obtained by gradual collection. [Peet 1931b, p. 414][96]

Peet was also convinced of the empirical nature of other sets of calculations within the RMP, but such an 'untidy' explanation seems to have been

94 An earlier examination may be found in [Hultsch 1895].

95 See, for example, [Vogel 1929], [Gillings 1972, 1974, 1979], and [Abdulaziz 2008].

96 The fact that a similar table of fractions in the Lahun fragments (taking odd n between 3 and 21) contains precisely the same representations as those in the table in the RMP has added further fuel to the idea that a uniform method was used. However, Imhausen [2021a, p. 39, n. 14] prefers to see this as meaning that a "canonical version" ("eine kanonische Fassung") had emerged via the empirical process described by Peet.

difficult for mathematically-inclined authors like Neugebauer to accept.[97] This is not to imply, however, that Peet and Neugebauer were at loggerheads over the interpretation of aspects of the RMP: Peet seems to have regarded Neugebauer's suggestions as plausible, but, with characteristic caution, he may have harboured concerns about the certainty with which Neugebauer put his ideas across—he certainly thought that Neugebauer had overdone the argument for the 'additive' nature of ancient Egyptian mathematics.[98] Indeed, even other mathematical authors thought the same: for example, the mathematician Heinrich Wieleitner (1874–1931) commented "I do not think this is wrong, but the whole view is pointed and exaggerated,"[99] whilst the historian of mathematics Florian Cajori (1859–1930) held that although Neugebauer had made a convincing argument for the *possibility* of an arithmetic based solely on addition, he had not managed to demonstrate that this was in fact what the ancient Egyptians had [Cajori 1927].[100]

Arguably, what we see in Neugebauer's work is a return to a mathematically-led approach to the RMP and other sources, but one that was a little different from that previously adopted by Eisenlohr. While Eisenlohr had applied mathematical principles at a 'local' level simply to provide a first interpretation of the individual problems at hand, the new approach of Neugebauer and others was, in a sense, carried out at a higher level, with a view to providing a 'global' picture of ancient Egyptian mathematics, removed and abstracted from the specifics of the sources. In this way, it was not unrelated to broader trends within the mathematics of the early twentieth century, that of the Göttingen school in particular. The idea of mathematicians producing 'high-level' investigations of ancient Egyptian mathematics is one to which we will return in section 8.

Following his dissertation, Neugebauer produced a number of further works on ancient Egyptian mathematics, mostly relating to the RMP, but also drawing upon other newly available sources, such as the MMP.[101] Neugebauer stands out amongst the historians of ancient mathematics of the mid-twentieth century in having learnt the languages necessary to

97 Peet and Neugebauer differed in this way in their interpretation of problems 7–20 of the RMP, which Peet dubbed collectively the 'first group of completions': see [Hollings & Parkinson 2020].

98 See the discussion in [Hollings & Parkinson 2020, § 4].

99 "ich halte all das nicht für falsch, aber die ganze Auffassung für zugespitzt und übertrieben" [Wieleitner 1927b, p. 234].

100 See also the discussion of this point in [Hollings & Parkinson 2020, § 4].

101 See, for example, [Neugebauer 1929a, 1930a, 1931].

consult primary materials, rather than relying on other people's translations and commentaries, and we see evidence of this in his publication, alongside his mathematically focused papers, of a short philological note, whose purpose was to back up his assertion that ancient Egyptian scribes had no general concept of multiplication. [102] It is also in Neugebauer's writings that we see the first strong arguments to be made to a mathematical readership in favour of the study of ancient Egyptian and Babylonian mathematics for their own sakes, rather than simply as trivial precursors to ancient Greek mathematics. [103] Overall, the style of Neugebauer's subsequent writings on ancient Egyptian mathematics retained the systematising flavour of his earliest work; as Ritter [2002b, p. 149] has commented, the "main thrust" of Neugebauer's works was "to unveil the organizational principles at work in the Egyptian mathematical texts," an approach that he applied both to arithmetic and to geometry. However, the papers that he published on these topics in 1930 and 1931 were his last original works on ancient Egyptian mathematics; [104] by this time, his attention had been diverted towards Mesopotamian mathematics, which he came to view as being more interesting and challenging than its Egyptian counterpart, although he did retain an active interest in Egyptian astronomy. [105]

Another writer who approached ancient Egyptian mathematics from the mathematical side during the 1920s was Kurt Vogel (1888–1985), whose career trajectory and interests were remarkably similar to those of Neugebauer: Vogel had also studied mathematics and physics before

102 [Neugebauer 1927a]; see the comments in [Ritter 2002b, p. 145]. Neugebauer regularly, and consistently throughout his whole career, stressed the importance of engaging with the primary sources (and therefore, by extension, studying the relevant languages). In his dissertation, for example, he bemoaned the fact that historians of mathematics had not kept up with contemporary philological work [Neugebauer 1926, p. 1], and nearly 40 years later wrote: "Any serious study must be based [...] on the texts themselves, in order to get a proper estimate of the sometimes fluent boundaries between established facts and modern interpretation" [Neugebauer 1962, p. 49]. In this respect, his attitude was close to Peet's: see [Peet 1931e, p. 151], as discussed later. Neugebauer's specialism was in Egyptian and Mesopotamian mathematical and astronomical texts, but it remains an open question as to how comfortable he was with ancient texts of a more general nature.

103 See, for example, [Neugebauer 1929b], and also his plenary lecture at the 1936 Oslo International Congress of Mathematicians [Neugebauer 1937]; [Hollings & Siegmund-Schultze 2020, § 9.9].

104 Neugebauer included accounts of Egyptian mathematics in his later writings, such as [Neugebauer 1962], but these simply repeated the findings of his earlier papers.

105 See, for example, [Neugebauer & Parker 1960–1969], and the comments in [Ritter 2002b, pp. 150–155].

turning to Ancient Egypt, learning the necessary language, and writing a dissertation on aspects of the RMP (in 1929); he too turned eventually to Babylonian mathematics. However, it appears that Neugebauer and Vogel soon established a fierce rivalry, if not outright animosity, towards each other, as evidenced by their negative reviews of each other's works. [106] One of the opening salvos in this decades-long exchange was Neugebauer's politely critical review of Vogel's dissertation on the $2 \div n$ table in the RMP [Neugebauer 1930b]. The dissertation [Vogel 1929] opens with a survey of ancient Egyptian arithmetic, at least insofar as it pertains to the table, and provides a critical examination of some of the earlier writings on the topic: [107] Vogel suggested, for example, that Neugebauer had overstated the additive nature of ancient Egyptian mathematics, and also addressed the question of whether the Egyptians had a general *notion* of non-unit fraction even if they did not have a notation for it (Vogel asserted that they did indeed have the notion). The second part of the dissertation deals directly with the $2 \div n$ table, again surveying earlier writings, and proposing a uniform method (or series of methods) for its construction. Although they were informed by reference to original sources, the focus of Vogel's investigations, here and in other works, was placed firmly upon mathematical procedures. Elsewhere, for example, he was a proponent of an ancient Egyptian notion of algebra (more specifically, the assertion that they had one), a vexed issue within the historiography of ancient Egyptian mathematics, and now regarded as anachronistic. [108]

With two notable exceptions (Struve and Chace, with whom we will deal below), the most detailed works on ancient Egyptian mathematics that were appearing by the early 1930s were those of Peet, Neugebauer, and Vogel, but other mathematically-inclined authors do occur in the literature. One, for example, was Vogel's mentor, Heinrich Wieleitner, whom we have already encountered as a reviewer of Neugebauer's dissertation. Wieleitner's few writings on ancient Egyptian mathematics tie in with our theme of 'high-level' mathematical studies, and we will turn to these briefly in section 8. The Czech historian of mathematics Quido Vetter (1881–1960) also penned a number of (mostly very short) articles on aspects of ancient

106 See the comments in [Ritter 2002b, p. 156]. For biographies of Vogel, see [Mahoney & Schneider 1986] and [Folkerts 1983].

107 For some brief comments on Vogel's dissertation, see [Imhausen 2021a, pp. 49–50].

108 See, for example, [Vogel 1930b]. On so-called 'Egyptian algebra', see [Imhausen 2001], and also Peet's earlier detailed discussion: [Peet 1931b, pp. 420–424].

Egyptian mathematics during the 1920s and 1930s.[109] Unlike Neugebauer and Vogel, however, neither Wieleitner nor Vetter specialised in the history of ancient mathematics, but ranged widely across the centuries. The same comment may also be made of the small number of American mathematical writers who touched, at least briefly, on the subject of ancient Egyptian mathematics during the first decades of the twentieth century: for example, Archibald, L. C. Karpinski (1878–1956), and G. A. Miller (1863–1951).[110] The writings of each of these latter authors were usually produced as summaries of publications of specialist writers (for example, Turaev, Peet, or Struve), and often had an educational slant, to which we will return in section 8.

Turning now to Egyptologists who were writing on mathematical topics at this time, we find that the list is rather thin. Indeed, Peet was the only Egyptologist who was writing extensively on mathematics for its own sake—what we find from other authors are mostly isolated pieces of work, usually prompted by particular considerations. Thus, for example, numeration and metrology are discussed in Gardiner's *Egyptian grammar* [Gardiner 1927, §§ 259–266], compiled with advice from Peet,[111] but the treatment is naturally philological rather than mathematical. The Egyptologist and British Museum curator Stephen Glanville (1900–1956) published an account of the Mathematical Leather Roll in the British Museum after its unrolling [Glanville 1927], but otherwise does not appear to have had any interest in ancient Egyptian mathematics. The only other Egyptologist to have his name attached to more than one piece of writing on a mathematical topic was the philologist Gunn, although these mostly link directly to Peet's work and largely concern linguistic aspects, in line with Gunn's specialism as a linguist and a grammarian, although he had an at least elementary familiarity with mathematics and engineering.[112] Of his three

109 See, for example, [Vetter 1923, 1933]. A further author, about whom we know little at present, is O. Gillain, who published a text on Middle Kingdom arithmetic [Gillain 1927], which Archibald described as "a survey of Egyptian arithmetic from the point of view of the mathematician" [Archibald 1928, p. 395].

110 See, for example, [Archibald 1918, 1930b, 1930c], [Karpinski 1917, 1923, 1925a], and [Miller 1905, 1924, 1931a, 1931b, 1931c]. For biographies of these three figures, see [Adams & Neugebauer 1955], [Jones 1976], and [Brahana 1951, 1957], respectively.

111 This is reflected in their correspondence—see, for example, Griffith Institute Archive, Oxford: AHG/42.230.123, Peet to Gardiner, 30th April 1925.

112 Gunn's major publication was his *Studies in Egyptian syntax* [Gunn 1924]. One biography of Gunn refers in passing to a mooted career as an engineer, "in which his mathematical gifts would have served him well" [Dawson 1950, p. 229].

'mathematical' publications, one was the paper co-authored with Peet,[113] and another was his review of Peet's edition of the RMP; the remaining piece was a review of Sethe's text on numeration [Gunn 1916].[114] Other isolated pieces to mention are the short surveys written by R. W. Sloley, perhaps prompted by the appearance of Turaev's 1917 paper [Sloley 1922], and Warren R. Dawson, seemingly sparked by the publication of Peet's RMP [Dawson 1924]. Sloley's main Egyptological interests lay in astronomy and time-keeping, whilst Dawson's were in medicine.[115]

It seems then that during the 1920s, any interest in ancient Egyptian mathematics amongst Egyptologists was confined largely to the English-speaking part of that community, possibly due in part to the presence of the RMP in the British national collection, and was centred mostly on Peet.[116] However, we ought also to mention the few contributions to the study of ancient Egyptian mathematics that appeared in Soviet Russia around this time, as the MMP finally began to receive detailed study.[117]

113 A third name is attached to this paper: that of the Egyptologist and engineer Reginald Engelbach (1888–1946), who suggested to Gunn and Peet a method for deriving the formula for the volume of a truncated pyramid that seems to be given in the MMP. Gunn and Peet [1929, p. 185] describe this as "a contribution of such magnitude and importance [...] that his name should rightly stand at the head of the article as joint-author" (although it does not).

114 Gunn had a reputation as a fearsome reviewer of textual publications: Dawson [1950, p. 234] commented, for example, on Gunn's "detailed and exhaustive scrutinies [...] of the works of his colleagues. [...] his reviews in every case contributed constructively to the subjects under notice". One place in which this is particularly visible is in his extensive review of Peet's edition of the RMP [Gunn 1926], later described by Peet himself as "invaluable" [Peet 1931b, p. 409].

115 On Sloley, see [Faulkner 1958] and [Bierbrier 2012, p. 514]; Sloley went on to write the chapter on 'Science' for the 1942 edition of the volume *The legacy of Egypt* [Sloley 1942]. On Dawson, see [James 1969] and [Bierbrier 2012, pp. 146–147].

116 In Archibald's bibliography [Archibald 1927/1929], up to 1927 he lists 36 works that relate even tangentially to Egyptian mathematics: 13 are in English, 9 in German, 6 in French, 4 in Czech, and 1 each in Portuguese, Italian (but by a Czech author, Quido Vetter), Russian, and Spanish. Given the initial interest shown in the RMP by Lenormant, and the strength of French Egyptology more generally, it is surprising that there was not a greater French involvement in work on Egyptian mathematics, though this may simply have been because the RMP was in the British national museum. Of the 6 French papers listed by Archibald, one is by Vetter and relates to a Demotic papyrus in Michigan, four are general surveys, and just one is a 'proper' paper by a French author, Raymond Weill (on a unit of measure in the RMP) [Weill 1927].

117 There had been some interest in Egyptian mathematics from Russian authors prior to this, the main name to mention being the historian of mathematics Viktor Viktorovich Bobynin (Виктор Викторович Бобынин, 1849–1919), whose main work was an account of the mathematics of the RMP, based on Eisenlohr's analysis [Bobynin 1882]. Bobynin was also a contributor to the fourth volume of Cantor's *Vorlesungen über Geschichte der Mathematik* (1908).

We have already noted the 1917 paper of Boris Aleksandrovich Turaev (Борис Александрович Тураев, 1868–1920; transliterated as 'Touraeff' in the paper) on the calculation of the volume of a truncated pyramid that appears within a problem in the MMP (subsequently labelled as Problem 14). Turaev would have had easy access to the MMP, thanks to his position as Keeper of Egyptian Antiquities at the Moscow Museum of Fine Arts, a post to which he was appointed around the time that the museum acquired Golenishchev's collection [Bierbrier 2012, p. 546]. Although he published only the short note of 1917 prior to his death, his transcriptions and translations of portions of the MMP were subsequently employed by Turaev's sometime mathematical advisor, the mathematician and statistician D. P. Tsinzerling (Д. П. Цинзерлинг, 1864–1941) in an account of ancient Egyptian geometry [Tsinzerling 1925]. However, Turaev's manuscripts were probably not in a polished state, and the inaccuracies in the transcriptions given by Tsinzerling and attributed to Turaev sparked the paper of Gunn and Peet discussed in section 5. In reference to these transcriptions, the latter authors speculated [Gunn & Peet 1929, p. 167]: "it is probable that their author, had he lived, would never have given them to the world in their present form".[118] Nevertheless, despite their shortcomings, it was the writings of Turaev and Tsinzerling that finally, after more than 20 years of waiting, gave the academic world a substantial glimpse of the contents of the MMP. As we have already noted, Peet was able, with some small difficulties, to obtain photographs of the MMP prior to the publication of his edition of the RMP, and it is clear from the associated correspondence that a Russian edition of the MMP was planned from the early 1920s, since Peet was keen throughout not to intrude on anyone else's priority.[119] However, it was not until 1930 that

118 Struve later felt the need to respond to Gunn and Peet's comments about the inaccuracy and incompleteness of Turaev's transcriptions, as presented by Tsinzerling: "I consider this judgment to be entirely unfair. Of course, Turaev's transcription has its flaws, but what pioneering work has not? The incompleteness of the transcription is due to the great caution of Turaev, who carefully avoided any reconstruction. Even the most meticulous worker can make the worst mistakes in reconstructions. Errare humanum est." ("Ich halte dieses Urteil für durchaus ungerecht. Natürlich hat die Transkription von Turajeff ihre Fehler, aber welche Pionierarbeit hat sie nicht? Die Unvollständigkeit der Transkription ist bedingt durch die große Vorsicht Turajeffs, der jegliche Rekonstruktion sorgfältig vermied. Bei Rekonstruktionen kann auch der sorgfältigste Arbeiter die gröbsten Fehler machen. Errare humanum est." [Struve 1930a, p. VIII])

119 See, for example, Peet's comments to D'Arcy Thompson in a letter dated 1st January 1923 (University of St Andrews Library, Department of Special Collections: Papers of D'Arcy Wentworth Thompson, Correspondence to Professor Sir D'Arcy Wentworth Thompson from Thomas Eric Peet, 22 October 1922–27 June 1933: ms23966).

the Orientalist Vasilii Vasilevich Struve (Василий Васильевич Струве, 1889–1965) [120] published a full edition of the papyrus as the first volume of the 'A' strand ('Quellen') of the Springer series *Quellen und Studien zur Geschichte der Mathematik, Astronomie und Physik*, founded by Neugebauer, Julius Stenzel, and Otto Toeplitz. Struve's edition was based in the first instance on manuscripts that he had found amongst Turaev's papers following the latter's death [Struve 1930a, p. VIII]. He had hoped for a collaboration with Tsinzerling, but when this fell through, [121] Struve undertook to produce the mathematical commentary on the MMP himself, under the encouragement of Neugebauer, with whom Struve was in correspondence from 1927 onwards, [122] and Neugebauer suggested that the edition be published by Springer. The effect of Struve's MMP was not unlike that of Peet's RMP in that it sparked a number of derivative accounts of the papyrus, and some speculation on certain of the problems. The interest from mathematicians was particularly strong, [123] as we shall explore in section 8. As with most other Egyptologists, however, Struve's treatment of the MMP was merely a brief foray into mathematical texts. [124]

The study of ancient Egyptian mathematics during the 1920s also included one other substantial piece of work: the further edition of the RMP

In the preface of the edition of the MMP that was eventually published in 1930, Struve stated clearly that he had not begun work on the papyrus until 1927 [Struve 1930a, p. VIII], although it seems that he had taken on the project, at least officially, in 1922: the decision to publish the MMP had been taken at a congress of Egyptologists that was held in Moscow in August of that year, and Struve was named as the editor at that time (see [Archibald 1924, p. 247]; Archibald also reported this news to Thompson, though without naming Struve, in December 1922: University of St Andrews Library, Department of Special Collections: Papers of D'Arcy Wentworth Thompson, Correspondence between D'Arcy Wentworth Thompson and Raymond Clare Archibald, 11 February 1918–7 March 1946: ms22928, Archibald to Thompson, 10th December 1922).

120 On Struve, see [Bierbrier 2012, pp. 530–531].

121 According to Struve, Tsinzerling did not have the time to participate in such a collaboration [Struve 1930a, p. IX]. Nevertheless, Struve did have a collaborator in the Egyptologist Yurii Yakovlevich Perepelkin (Юрий Яковлевич Перепёлкин, 1903–1982; see [Bierbrier 2012, p. 424] and [Bolshakov 2020, pp. 364–366]), whose "artistic hand" ("künstlerische Hand") produced the hieroglyphic transcriptions that appear in the edition [Struve 1930a, p. IX]. Perepelkin also authored a paper on a single problem from the RMP [Perepelkin 1929] which was heavily criticised by Peet [1929].

122 According to Swerdlow [1993, p. 142], Neugebauer visited Struve in Leningrad in 1928, and aided in the preparation of the edition of the MMP for publication.

123 See, for example, some of the works cited in note 110 above.

124 That being said, it was not unique, although Struve's treatment of mathematical topics was neither systematic nor confined to a single culture or period, as the titles of his relevant papers indicate: [Struve 1929, 1930b, 1954] and [Neugebauer & Struve 1929]. Aligning with wider trends in Soviet academia, Struve turned, from around

that was published by Arnold Buffum Chace (1845–1932), the chancellor of Brown University, in two volumes in 1927 and 1929. It is notable that another version of the RMP should appear in print so soon after Peet's, but it exemplifies the dichotomy between mathematical and Egyptological readers of ancient mathematics.

Chace had studied mathematics at Brown during the 1860s, and subsequently also chemistry at the École de Médecine in Paris, but he had cut short his academic career when it fell to him to take over his family's textile business. [125] Nevertheless, he maintained his interest in mathematics, publishing a paper on quaternions [Chace 1879], and in the 1870s, he became involved in the administration of Brown, eventually being elected to the chancellorship in 1907. Later described as "a bookish man of wide research and information" [Archibald 1933, p. 142], his interest in Egyptology seems to have been sparked by a trip to Egypt in 1910. Chace soon purchased a copy of the British Museum's facsimile of the RMP, and over the following decade, he taught himself to read both hieroglyphs and hieratic, with the goal

> that some day [*sic*] he would complete an edition of the papyrus for depositing in the Brown University Library, the consultation of which would enable one unfamiliar with hieratic to be able to find out what each symbol meant. [Archibald 1933, p. 140]

Chace set about translating the RMP into English, with corresponding copies of the hieratic text and hieroglyphic transcriptions produced by his wife, Eliza Greene Chace (1851–1924); she did not live to see the completed two-volume edition [Chace 1927/1929], and the first volume is dedicated to her. By the beginning of the 1920s, Chace was evidently well enough connected with Egyptological scholarship to be aware of Peet's ongoing work on the RMP, and had in fact made contact with him in 1921 to propose a collaboration, even sending him portions of his incomplete manuscript. However, Peet declined over concerns about the quality of Chace's scholarship: he confided to Gardiner that he found aspects of Chace's work "ill construed," [126] and years later, after the publication of Chace's edition, described it as "elaborate" [Peet 1931b, p. 409, n. 2],

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1930 onwards, towards the Marxist interpretation of ancient sources, for which he increasingly found cuneiform materials "more economically informative" [Bolshakov 2020, p. 361].

125 For biographies of Chace, see [Anonym 1920], [Koopman et al. 1932], [Archibald 1933], and [Bierbrier 2012, p. 113].

126 Griffith Institute Archive, Oxford: AHG/42.230.176, Peet to Gardiner, 7th December 1921.

and remarked: “Quite frankly, I found nothing of any value in Chace’s publication of the Rhind except the photographs of the original”. [127]

Questions of scholarship aside, Chace’s edition of the RMP has considerably more visual appeal than Peet’s: whilst Chace’s first volume contains a free translation and commentary on the papyrus, his second features photogravure reproductions and colour facsimiles of the hieratic text in red and black (the colours used in the original) with parallel hieroglyphic transcription, transliteration, and literal translation. Such line-by-line translation, absent from Peet’s edition, seems to have won the favour of non-Egyptologists, since it enables the reader more easily to find specific figures and phrases within the original papyrus, arguably providing a greater sense of direct and unmediated access to an unfamiliar source. For example, when comparing the editions of Peet and Chace, George Sarton considered that Chace’s “is far more instructive, since it enables one to pass gradually from the original hieroglyphics [*sic*] to the free English version” [Sarton 1952, p. 37]. This feature of Chace’s edition has also made it an occasionally convenient resource for Egyptologists, [128] but in particular, it has become the go-to edition of the RMP for mathematicians, who were perhaps discouraged by the philological detail of Peet’s edition, despite the hopes expressed by Peet in his preface (see section 5). The fact that Chace’s edition was published by the Mathematical Association of America would have given it further credibility and visibility amongst mathematicians and, in particular, mathematics educators. [129] Viewed from the Egyptological side, however, Chace’s edition was too idiosyncratic and featured too many departures from established conventions to become a standard edition. For example, the original hieratic reads from right to left, and Egyptological practice is to transcribe this into hieroglyphs that also run from right to left but then to transliterate and translate from left to right. Chace’s edition includes transcriptions that run right to left, matching the direction of the original hieratic text, but making his version difficult to read, even though his line-by-line translations are often more convenient to use than Peet’s presentation, which has the translations without any running transliteration in the main text

127 Griffith Institute Archive, Oxford: AHG/42.230.39, Peet to Gardiner, 19th May 1930.

128 As the second author of the present work can attest from acting as curator of the British Museum’s papyri.

129 Chace’s version of the RMP was later (1979) reissued by the (American) National Council of Teachers of Mathematics as volume 8 in the series ‘Classics of Mathematics Education’. See also the remarks below in note 186.

and the transcriptions on separate plates at the end. Whereas reviews of Chace's edition by non-Egyptologists (mathematicians especially) were unabashedly positive,[130] those by Egyptologists were fewer and often rather more lukewarm, albeit generally polite.[131] This is true in particular of the review written by Peet, who began with the remark:

> Dr. Chace has no reason to regret the fifteen years of his life which he has devoted to the preparation of this great work, for it is a noble contribution both to Mathematics and to Egyptology [...] [Peet 1930b, p. 266]

before going on to spend much of the review contrasting the views of mathematicians and Egyptologists on ancient mathematics, observing of Chace's edition that it "is intended in the main for mathematicians rather than Egyptologists" [*ibid.*]. The preface to his own publication suggests that he may have considered Chace's edition to be less equally inclusive than his own had tried to be. Although Peet disputed some of Chace's interpretations, he emphasised the value of the edition in enabling mathematicians to engage with the original sources—it is worth noting here that, appearing in *The Mathematical Gazette*, the journal of the UK's Mathematical Association, an organisation for mathematics educators, Peet's review was presumably written for that readership. And, indeed, whether they were critical or positive, one thing that all of the reviewers of Chace's edition seem to have agreed upon was that he had achieved his goal of producing an edition that made the RMP accessible, phrase by phrase, to mathematicians. Although this had previously been said of Peet's version, the additional factors noted above served to make Chace's the 'mathematician's edition' of the RMP. Likewise, Peet's became the 'Egyptologist's edition': writing decades later, the Egyptologist Anthony Spalinger referred in his discussion of the papyrus to Peet's work as "the best discussion [of the RMP] available," echoing Peet with the remark that Chace's edition "is useful only for the photographs and minor comments on the text" [Spalinger 1990, p. 295]. This separation of mathematicians' and Egyptologists' resources is present even more recently in Imhausen's introductory remarks on the RMP:[132]

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130 See, for example, [Cajori 1930], [Sarton 1930], [?], and [Slaught 1931].

131 See, for example, [Sethe 1931]. A review by Vogel [1930c] disagreed with some of Chace's interpretations, leading to a brief back-and-forth in the journal *Archeion* [Chace 1931; Vogel 1931].

132 Imhausen [2021a, p. 51, n. 65] has also recently attempted to provide a quantitative basis for the anecdotal claim that Egyptologists have preferred Peet's edition and mathematicians Chace's, but was unable to do so for lack of data in a usable form.

> The two editions reflect the interests of two academic disciplines in this source, Egyptologists on the one hand (who tend to use the excellent edition of Peet) and historians of mathematics on the other hand, who preferred the edition that was made by people they knew. [Imhausen 2016, p. 66]

We will return to this hint of academic tribalism in the following sections, though we stress here—in fairness to Chace—the sheer convenience of the arrangement of his edition for all readers, and note its success in making the text of the papyrus accessible for non-specialists.

7. PHILOLOGISTS AND MATHEMATICIANS

In the preceding sections, we have drawn a number of distinctions between the various figures who appear in the story of the reconstruction of ancient Egyptian mathematics, characterising writers according to their approaches and target readerships, and readers according to their responses to texts, often in connection with their ability (or lack thereof) to read ancient texts. As we will see, these characterisations are fluid, with different people aligning themselves to different groups in different contexts. Nevertheless, the distinctions made by individuals were often quite hard: Peet, for example, talked about 'the mathematician' and 'the Egyptologist' as two mutually exclusive categories. In this section, we will explore such distinctions and the reasons for making them.

We begin with a categorisation that was embedded at the heart of the Springer series *Quellen und Studien zur Geschichte der Mathematik, Astronomie und Physik*, which as we have noted was founded by Neugebauer, Stenzel, and Toeplitz (but on Neugebauer's initiative) at the end of the 1920s. The series was divided into two strands: Section A ('Quellen'), which would contain transcribed, translated, and philologically annotated versions of ancient mathematical and astronomical texts, and Section B ('Studien'), which would feature studies of these texts of a more technical mathematical nature. In a dichotomy introduced in the foreword to the first volume of Section B, the series aimed to unite the differing interests of 'philologists' on the one hand, and 'mathematicians' on the other:

> Satisfying the legitimate claims of both groups, philologists and mathematicians, for real expertise will only be possible if close cooperation can be established between them. [133]

[133] "Den berechtigten Ansprüchen beider Gruppen, Philologen und Mathematikern, nach wirklicher Sachkenntnis Genüge zu leisten, wird nur möglich sein, wenn

The materials for Section A were naturally to be prepared by those with a specialist knowledge of the original languages (the 'philologists'), but to be presented in such a way as to make them accessible to other scholars who were interested in the details of ancient mathematics but who were unable to read the originals (the 'mathematicians'); the latter scholars might then be able to make valuable contributions to Section B on the basis of the sources that had been made available to them via Section A. In this way, a bridge would be built between different approaches to the historical development of mathematical thought (cf. the remarks in [Peet 1923a, preface]).[134]

In this context, the word 'philologist' is apparently used to refer simply to a scholar with a knowledge of appropriate ancient languages (the focus of the series was Greece and the ancient Near East). For Peet, "archaeology and philology should be yoke-fellows" in the study of an ancient culture [Peet 1931c, p. 151], and a knowledge of Ancient Egyptian was implicitly inherent in his designation of 'Egyptologist', and so he would have viewed 'Egyptologists' very much as 'philologists'. At this period, Egyptology's self-definition was often framed in terms of specialist knowledge, especially of the ancient language; this was especially true after increased restrictions to archaeological work were introduced in the newly (albeit nominally) independent Egypt after 1922.[135] The popular appeal that ancient Egypt gained after the discovery of the tomb of Tutankhamun in 1922 further increased the subject's emphasis on specialist knowledge to differentiate itself from popular culture.[136] In 1931, Peet wrote of the importance of accurate and up-to-date philology in enabling cross-disciplinary collaboration, in a review of a book about a medical papyrus:

> How much nonsense is written even in the best of books which could have been avoided had the authors had access, even in translation, to the papyri; and how often would an untenable hypothesis have been checked at the outset if

es gelingt, eine enge Zusammenarbeit zwischen ihnen herzustellen." [Neugebauer 1929a, p. 1]

134 Swerdlow [1993, p. 142] compares the two approaches outlined in this foreword to what C. P. Snow would later term the 'two cultures'. The mathematician/philologist distinction was also acknowledged and discussed by Solomon Gandz in the context of Babylonian mathematics: "The mathematician and the philologist approach reality from two different angles. The mathematician seeks the eternal, absolute truth. [...] Not so the philologist. [...] His main task is to build up the memory of the human race, to explore the growth and evolution of civilization" [Gandz 1940, p. 406].

135 See, for example, [Stevenson 2015, pp. 27–28].

136 Clare Lewis, personal communication, 25th April 2022.

its author had had by him a correct instead of an incorrect rendering of some passage or other! [Peet 1931c, p. 151]

The choice of the term 'philologist' in *Quellen und Studien* is anchored to questions of language, rather than something potentially implying a broader cultural overview (such as 'orientalist', 'Assyriologist' and 'Egyptologist', say), and this choice also aligns Neugebauer and his co-editors firmly within the tradition of the philological-comparative work on ancient texts that Neugebauer had learnt from Sethe. The goal of assembling faithful editions of source texts within Section A of the series is also consistent with such a background.[137]

The 'mathematician' label, on the other hand, requires more consideration. For Neugebauer, Stenzel, and Toeplitz, who apparently took ability with ancient languages as their sole distinguishing criterion, 'mathematician' implicitly referred to those scholars who could not read the original texts, as it did for Peet elsewhere. Mathematicians were therefore dependent on the editions produced by others. However, a more finely grained categorisation is required for a figure such as Neugebauer himself. According to the philologist/mathematician dichotomy articulated in *Quellen und Studien*, Neugebauer would be aligned with the philologists, and yet there was clearly a difference in the approaches to ancient sources adopted by Neugebauer and other 'philologists' such as Peet.[138] Peet had both mathematical and philological training at university level, but also broad archaeological experience, and so his career crosses many of the boundaries implicit in these various distinctions, signalling the limitation in such categorisation. For clarity in the following discussion, we will use the term 'mathematician' for those professional academic mathematicians or mathematics educators who took an interest in the history of their subject, but who made no claims to pursue historical studies professionally. These are the scholars who produced many of the digested accounts of the findings of Eisenlohr and others to which we referred in passing in

137 This is a mission that Neugebauer would continue throughout his career by assembling sources both mathematical [Neugebauer 1935-1937; Neugebauer & Sachs 1945] and astronomical [Neugebauer & Parker 1960–1969]. Davis [1994, p. 130] has observed that for Neugebauer "[t]he text was the thing". However, Proust [2016, p. 222] has noted that although "Neugebauer was interested essentially in the publication of primary sources [...] he never returned to them once [they] had been published".

138 Robson [2008, p. 272] places Neugebauer within the tradition of "historically minded mathematicians," but this classification does not seem to give him sufficient credit for his linguistic skills (modern concerns about his archaeological and historical credentials notwithstanding).

section 3, and these are the scholars into whose hands the study and custodianship of ancient Egyptian mathematics would pass by the mid-1930s, as we shall describe.

If the designations 'mathematician' and 'Egyptologist' (or, in a broader setting, 'philologist') in their most exclusive senses can be considered as occupying the extreme points of a spectrum of expertise, then the middle range remains to be explored. Figures between the two specialisms can be conveniently termed 'historians of mathematics', to describe scholars, usually with educational backgrounds in mathematics, who pursued the study of the history of mathematics in a professional capacity. All such figures may be characterised by an interest in mathematics, but their direct knowledge of ancient languages will vary from individual to individual, and also from language to language. In what follows, we will employ the term 'mathematician-philologist' as a convenient shorthand to refer to a historian of mathematics who could read ancient (Egyptian) languages, at least to some extent, while 'mathematician-historian' will refer to ones who could not.[139] Neugebauer, Vogel, and Chace can be viewed primarily as mathematician-philologists, for example, while figures such as Archibald and Karpinski are mathematician-historians. We stress, however, the context-dependence of these labels, and their fuzzy boundaries: in the context of the study of ancient Greek mathematics, for instance, Karpinski would be a mathematician-philologist. However, what united the mathematician-philologists and the mathematician-historians in contrast to the philologists was their mathematically-led approach to the subject matter: in the ways that we have described above, ancient mathematics was extrapolated on the basis of a modern mathematical understanding, rather than being considered primarily within its original cultural setting. While we do not neglect the crucial dividing line of language ability (as stressed by Neugebauer, Stenzel, and Toeplitz),[140] we nevertheless place greater emphasis on the division created by the attitude towards the mathematics. Thus, while Peet certainly had mathematics in his background, he nevertheless is primarily a member of the 'Egyptologist' group, as he usually categorised himself (but see the discussion of Peet's self-identification in section 5).

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139 Cf. the similar classification employed by Neumann [2008] within a broader setting, and also the multi-layered classification of Fried [2018].

140 Imhausen [2021b] has recently re-affirmed an author's knowledge of the languages of the source materials as a measure of how seriously we ought to take their writings on ancient mathematics.

During the period of renewed interest in ancient Egyptian mathematics that followed the appearance of Peet's edition of the RMP in 1923, each of the groups of scholars mentioned above took its own particular approach to the subject. As we have seen, the further work by Egyptologists on mathematical topics was minimal, perhaps because of a feeling that Peet, certainly by the time he had delivered his Rylands lecture in 1931, had already said everything that was thought to be worth saying from an Egyptological viewpoint.[141] Indeed, Peet had already gone beyond the conventions of many text editions in Egyptology at this time, which often sought merely to present a full edition of a text without necessarily placing it so comprehensively within its wider cultural setting (see above). In many respects, the specific details of ancient Egyptian mathematical processes were of little direct interest to Egyptologists, and the reconstructions and extrapolations attempted by scholars like Neugebauer were not to an Egyptological taste which often preferred to restrict its focus to those features of ancient texts that were clearly and unequivocally present. To do otherwise would be to allow modern sensibilities to enter in an anachronistic manner.[142] The apparent lack of enthusiasm for mathematical topics amongst Egyptologists might be put down to a general disdain for mathematics amongst humanities scholars, but also to the fact that mathematics represented just one small topic within a much broader area of textual and cultural study: ancient Egyptian mathematics simply was not as important to Egyptologists as it was to historians of mathematics and to mathematicians.[143] For the latter in particular, it played a much more central role, as we shall see. In

141 We might point, for example, to Sloley's brief account of Egyptian science for the 1942 edition of *The legacy of Egypt*, where Peet's lecture was deemed to be a sufficient single reference covering Egyptian mathematics [Sloley 1942, p. 178]. In a brief historiographical sketch of the subject, Imhausen [2003, p. 10] mentions no further contributions by strictly Egyptological authors until a 1958 paper on some problems from the MMP [Nims 1958]. Elsewhere, Imhausen [2021a] highlights the unpublished dissertation of Walter-Friedrich Reineke [1964] as a rare example of an Egyptologist taking an interest in mathematical texts.

142 See, for example, Peet's critique of the notion of 'Egyptian algebra' [Peet 1931b, pp. 422–423].

143 Taking a more recent example of general Egyptological writing, we note that Kemp [1991, pp. 112–128] makes a few comments on Egyptian mathematics within a wider discussion of the nature of scribal duties, but has no need for a general theoretical treatment of the subject. Of published anthologies of Egyptian writings, only one includes any mathematical texts [Parkinson 1991, pp. 77–78; RMP Problem 66]. See also the comments of Imhausen [2021a, p. 35, n. 1] on the attitudes of modern Egyptologists towards mathematics, and Robson's similar remarks on the neglect by Egyptologists of library books on Egyptian mathematics [Robson 2004, p. 73]; cf. Robson's comments on Assyriologists and mathematics [Robson 2008, p. xxi].

light of the small number of surviving source texts, and a possible feeling that ancient Egyptian mathematics was a closed subject, those Egyptologists with a taste for 'exact' subjects may have been drawn to other aspects of ancient Egyptian science, such as astronomy and medicine, for which much more extensive (and complex) sources were available and ripe for analysis. [144] This was certainly Neugebauer's trajectory (towards astronomy) within his Egyptian studies, though perhaps for slightly different reasons (see below). The mathematical interests of R. W. Sloley, whose 1922 survey of ancient Egyptian mathematics we cited in section 6, are noted in a short obituary [Faulkner 1958], but his greater Egyptological claim to fame was his work in astronomy [Bierbrier 2012, p. 514]. Similarly, the author of the other short survey of ancient Egyptian mathematics of the early 1920s, Warren R. Dawson, is better known for his work on Egyptian medicine [Bierbrier 2012, pp. 146–147]. Peet was clearly the person driving interest in mathematics amongst Egyptologists, and so his early and unexpected death in 1934 following an operation is almost certainly one factor in the subsequent neglect of this topic within Egyptology, although that discipline is often regarded as operating "in a hermetic compartment" [Gange 2015, p. 64]. [145] One Egyptological figure who was not obviously influenced by Peet was the Russian Struve, whose study of the MMP represents a separate strand in mathematical research amongst Egyptologists. However, what the appearance of Struve's edition of the MMP in 1930 proved to Egyptologists was that the papyrus contains nothing that adds substantially to the knowledge of ancient Egyptian mathematics that had already been gleaned from the RMP. Indeed, Peet had already reached this conclusion in 1923 upon receiving photographs of the MMP: "It is a highly interesting document, but, as far as I can see [...], adds nothing to our knowledge of Eg[yptian] Maths". [146] Moreover, as we have seen, Struve himself took the subject no further. And yet the question of the interpretation of certain problems within the MMP did attract the interest of mathematicians, as we shall discuss in the next section.

Turning next to the mathematician-philologists, we similarly see few further contributions to the study of Egyptian mathematics after the

144 For surveys of ancient Egyptian astronomy, see [Krauss 2018] and [Quack 2018]; on medicine, see [David 2018] and [Nunn 2018]. Crossing boundaries within Egyptology, mathematical and medical texts, but only a few astronomical ones, may be grouped together as being 'procedural' in nature: see [Imhausen 2002].

145 Compare the situation with Egyptological discussions of ancient economics as analysed by Moreno García [2009, pp. 188–198].

146 Griffith Institute Archive, Oxford: AHG/42.230.154, Peet to Gardiner, 9th May 1923.

mid-1930s, although there was a considerable flurry of activity during the 1920s. The reawakening of interest in ancient Egyptian mathematics following the appearance of Peet's RMP was driven largely by the mathematician-philologists, principally Neugebauer and Vogel, both of whom used Peet's edition as their main source. Their works are characterised by an attempted systematisation of ancient Egyptian mathematics, such as the efforts to identify a uniform method for the construction of the table in the RMP. Likewise, Neugebauer's promotion of the idea of the 'additive' nature of ancient Egyptian mathematics was part of an effort to identity (or impose) an overarching classificatory framework, implicitly informed by modern attitudes regarding mathematical aesthetics. Here we see the influence of the Göttingen mathematical school, and its search for the foundations of mathematics. [147] In a 1927 article entitled simply 'Über Geschichte der Mathematik', Neugebauer explicitly extended the search for fundamental principles to historical work:

> Especially in a period of mathematical research, such as the present one, in which the question of the logical foundations of mathematics occupies a central position, one must not ignore these things carelessly whenever one asks about the historical development of the most important categories of thought. [148]

Neugebauer viewed research into the history of mathematics as taking place alongside contemporary mathematics, and sought to present his historical researches as being relevant to modern mathematics. [149] In particular, he believed that a rigorously studied history of mathematics could "provide a unifying force in a field that had been torn apart by excessive specialization" [Pingree 1990, p. 83]. There was a precision in Neugebauer's approach to history that he set in explicit contrast to the more anecdotal forms of historical writing. [150] At the same time, the study of ancient mathematics was to be no mere accumulation of facts, but was to be accomplished through the detailed (mathematical) analysis of source texts. Neugebauer was to revisit this theme time and again in his written works;

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147 For a more detailed treatment of this point, see [Rowe 2016a], as well as the discussion in [Rashed & Pyenson 2012].

148 "Gerade in einer Periode der mathematischen Forschung, wie der gegenwärtigen, in der die Frage nach den logischen Grundlagen der Mathematik eine zentrale Stelle einnimmt, darf man, sobald man überhaupt nach der geschichtlichen Entwicklung der wichtigisten Denkkategorien frägt, nicht an diesen Dingen achtlos vorübergehen." [Neugebauer 1927b, p. 41]

149 See [Chaigneau 2019, § 2.3.2].

150 Neugebauer alluded here to David Eugene Smith's *History of mathematics* [Smith 1923/1925], without naming it directly. See also the remarks in note 221 below.

for example, writing three decades later, he levelled heavy criticism against that once-standard text, Moritz Cantor's *Vorlesungen über Geschichte der Mathematik*, for "its total lack of mathematical competence as well as its moralizing and anecdotal attitude," which he believed had "seriously discredited the history of mathematics in the eyes of mathematicians, for whom, after all, the history of mathematics has to be written" [Neugebauer 1956].[151]

This last observation is closely linked to Neugebauer's general ethos in studying the history of mathematics: as his biographer Noel Swerdlow later remarked, Neugebauer

> was always a mathematician first and foremost, who selected the subjects of his study and passed judgment on them, sometimes quite strongly, according to their mathematical interest. [Swerdlow 1993, p. 142]

In Swerdlow's view, this was a good thing, certainly in relation to Neugebauer's later work,

> for only a true mathematician would recognize and be willing to expend the effort necessary to reveal the depth of Babylonian mathematics and, more so, mathematical astronomy [...] [Swerdlow 1993]

This last point might seem rather overstated—Assyriologists such as François Thureau-Dangin (1872–1944) made significant contributions to the understanding of Mesopotamian mathematics[152]—but we should also acknowledge that an interest in (or, better yet, an enthusiasm for) mathematics must necessarily be a prerequisite for the study of ancient mathematics. Looking back to the Egyptological context, Peet's mathematical background was arguably more important for signalling his *interest* in mathematics than for the specific knowledge gained during his university-level mathematical education, which would have had little direct bearing on his study of the RMP, since the mathematical content of the latter consists of topics that Peet would have learnt at school (arithmetic and some basic geometry). Nevertheless, it is possible that Peet's experience of undergraduate mathematics may have equipped him to judge ancient Egyptian mathematics from a deeper perspective: his attempt to assign a

151 The context for this attack was George Sarton's criticism of B. L. van der Waerden's *Science awakening* for its failure to cite Cantor. In Neugebauer's view, Cantor's work might only be of value to historians of science for the "many drastic examples" it supplied "of how one should not approach a problem". On the contrast between Cantor's style and that of his contemporary H. G. Zeuthen, see [Lützen & Purkert 1994].

152 See, for example, [Høyrup 2016] and several articles in [Jones et al. 2016]. For a comparative study of the works of Thureau-Dangin and Neugebauer, see [Chaigneau 2019].

"general character" [Peet 1923a, p. 10] to the subject, for example, may be evidence of this. From the technical point of view, however, Peet was not that significantly better equipped to study ancient Egyptian mathematics than many of his fellow-Egyptologists; what distinguished him, and caused him frequently to self-identify as a 'mathematician', [153] was probably his interest in the subject, and his willingness to look systematically and in detail at the relevant sources. Nevertheless, it is clear that he regarded these aspects of his expertise as distinct contraries: in his Rylands lecture, Peet observed of the calculations in the RMP that they "are very simple, and their importance is rather for the archaeologist than for the mathematician" [Peet 1931b, p. 427].

That Neugebauer saw mathematicians as the target readership for writings on the history of mathematics is consistent with his general attitude towards the subject as a puzzle-solving activity, [154] made possible by what he regarded as the "immutable character of mathematical knowledge," which, in contrast to other aspects of the investigation of the past, left "no room for historical contingency" [Rowe 2016a, pp. 124–125]. As Rowe has observed,

> [t]he methodological implications Neugebauer drew from this were simple and clear: once an investigator had cracked the linguistic or hieroglyphic codes that serve to express a culture's scientific knowledge he or she then suddenly held the keys to deciphering ancient sources. And since the content of these sources pertained to mathematical matters, one could, in principle, argue inductively in order to reconstruct what they originally contained, namely a fixed and determinable pattern of scientific results. [Rowe 2016a, p. 125]

This is not to say that Neugebauer was unaware of cultural factors—indeed, he acknowledged them explicitly in the essay cited above [Neugebauer 1927b, p. 38], and Swerdlow [1993, p. 141] has written more generally of the "notable tension" present in all of Neugebauer's works "between the analysis of culturally specific documents [...] and the continuity and evolution of mathematical methods regardless of ages and cultures"—it was simply that he gave greater weight to the latter, even allowing mathematical considerations to form the basis of assertions (such as the Babylonian influence on Greek mathematics) for which no documentary evidence exists. [155] Moreover, as far as Neugebauer was concerned, the fact that we know almost nothing of the individual 'mathematicians' of the

153 See the remarks above in section 5, as well as [Hollings & Parkinson to appear].

154 This is an attitude that has been criticised in particular by Robson [2001].

155 See [Robson 2008, §§ 9.3–9.5] and [Rowe 2016a, p. 133].

ancient world renders any discussion of the 'human factor' redundant.[156] Indeed, in reference to the scribe of the RMP, Neugebauer pointed to the advantage in "the disappearance of the individual in Egyptian cultural history,"[157] with the implication that scholarly speculation as to the true status of the scribe Ahmose within ancient Egyptian society had served only as a pointless distraction from the study of ancient mathematics. Neugebauer's goal was

> to trace the eternal truth of "exact thinking" throughout human history while consistently downplaying the role of personality and purely human motives in the history of science. [Siegmund-Schultze 2016, p. 103]

To say that Neugebauer's approach to the history of mathematics is at odds with modern methodologies would be something of an understatement. Twenty-first-century writings on the history of ancient mathematics refer, for example, to the "obsolete style of historiography" associated with Neugebauer and others [Imhausen 2009, p. 781], and condemn that style for being outmoded:

> Questions of authorship, context, and function were systematically overlooked; textuality and materiality played no part in the academic discourse [concerning Mesopotamian mathematics] of the mid-twentieth century. [Robson 2007, p. 60][158]

Famously, the most scathing attack on the mathematically-led approach to ancient mathematics had come much earlier, from the historian of science Sabetai Unguru [1975], who focused in particular on the tendency of many historians of mathematics to convert ancient (initially, Greek) mathematics exclusively into modern terms, in which connection Neugebauer was far from being the guiltiest culprit.[159] Here we simply note that this

156 See the discussion of this point in [Siegmund-Schultze 2016, p. 100].

157 "Das Verschwinden der Einzelpersönlichkeit in der ägyptischen Kulturgeschichte ist nicht immer als ein Vorzug angesehen worden." [Neugebauer 1927b, p. 40]

158 Elsewhere, Robson [2008, p. 4] notes, in fairness to Neugebauer, that "[b]y necessity, scholarly work was at the time confined to interpreting the mathematical techniques found in the tablets, for there was very little cultural and historical context into which to place them. For the most part the tablets themselves had no archaeological context at all, or at best could be attributed to a named city and a time-span of few [*sic*] centuries in the early second millennium BCE."

159 One of Unguru's principle targets was van der Waerden and his *Science awakening* (1954), as well as his wider approach to the history of ancient science, which was an extreme version of the mathematically-led methodology that we have described in the present paper: liberal use of modern algebraic notation, and 'reconstruction' of ancient mathematical ideas on the basis of present-day knowledge. Van der Waerden's

issue of conversion into modern notation is relevant to our following remarks about mathematicians.[160]

The mathematically-led nature of Neugebauer's approach to ancient mathematics, and the fact that he chose research topics "according to their mathematical interest" is particularly relevant for understanding the direction in which his work was moving by the end of the 1920s. His investigation of ancient Egyptian mathematics was all but complete by around 1930, and he then turned his attention to topics in Mesopotamian mathematics and astronomy, as well as Egyptian astronomy. His reason for doing so seems quite simply to have been that he developed a greater interest in Mesopotamian mathematics: he had found ancient Egyptian mathematics to be a very simple 'primitive' affair,[161] and had said all that he wanted to say on the subject. Ritter [2002b, p. 150] has identified the marshalling of all the evidence on a given topic as one of the hallmarks

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interest in the history of mathematics had been inspired by his attendance of Neugebauer's lectures in Göttingen, and his first publication on ancient mathematics was a paper on Egyptian fraction-reckoning in *Quellen und Studien* [van der Waerden 1938]. Nevertheless, Neugebauer later expressed some misgivings about the "sometimes unfounded speculations" that appeared in van der Waerden's historical writings, fearing that they might mislead those readers who couldn't read the primary sources [de Jong 2016, p. 295]. This last point of criticism is one that was later levelled at van der Waerden's *Geometry and algebra in ancient civilizations* [van der Waerden 1983], which similarly contains much that is at odds with modern approaches to ancient science. One of the book's reviewers, W. R. Knorr, expressed concern that van der Waerden's stature as a mathematician would bring his (entirely speculative) views on the prehistoric origins of mathematics greater attention than they deserved. Knorr was particularly worried about the effect on non-specialist readers, "who may not know to distinguish between the general enterprise of scientific research and the reckless notions of some scientists" [Knorr 1985, p. 212]. A later biography of van der Waerden by mathematicians provides a rather startling insight into the attitudes of the latter in this connection: "His background as a creative mathematician enabled him to approach the problems of mathematical or astronomical history from first principles by analyzing their particular mathematical content. This enabled van der Waerden to uncover several mysteries whose solutions had eluded the more philologically oriented mathematical historians and the orientalists; naturally this occasionally exposed him to rather inexpert criticism" [Frei et al. 1994, p. 143]. See also the comments on van der Waerden in [Imhausen 2009].

160 An extensive literature has grown up around Unguru's original writings: see, in particular, [Christianidis 2004], [Rowe 1996, 2016a], and [Schneider 2016].

161 He would later refer, for example, to "the utterly primitive framework of Egyptian mathematics" [Neugebauer 1962, p. 49], and compare the Egyptian system of arithmetic unfavourably with that of Mesopotamia [Neugebauer 1962, p. 21]. It should be noted, however, that an emphasis on the 'primitive' nature of Egyptian mathematics, and the condemnation of a 'cumbersome' system of fractional arithmetic were common features of the writings on this subject by all groups at this time; see, among many examples, [Sloley 1922]. We see assessments of this type appearing from a very early date: see [Poole 1881, p. 362].

of Neugebauer's historical research, and by around 1930, Neugebauer had done just that in his systematisation of ancient Egyptian mathematics: as far as he was concerned, there was nothing else to say. In contrast, the available sources dealing with cuneiform mathematics were not only more extensive, but also promised to be more challenging on a mathematical level, as well as presenting a genuine puzzle in decipherment.[162] Neugebauer had been studying Assyriology and its associated languages since the mid-1920s, and had already written his *Habilitationsschrift* on the origins of the Babylonian sexagesimal number system [Neugebauer 1927c], so this was a natural direction in which to turn. He would go on to dominate the study of Mesopotamian mathematics and astronomy to the extent that other scholars were deflected from the field in the belief that Neugebauer had left nothing more to be done, at least until the being of the reinterpretation of the sources in light of new methodologies during the 1990s.[163]

After the early 1930s, there was apparently nothing more for Neugebauer to say about ancient Egyptian mathematics, and the same was true of the very few other scholars who can be considered mathematician-philologists in this setting: Neugebauer had always been the most active of their number, and he was probably perceived as having brought the study of ancient Egyptian mathematics to completion. It is difficult to provide direct evidence of this last suggestion, other than to observe that other mathematician-philologists also began to turn their attention elsewhere: for instance, after Neugebauer, the next most active such scholar was Vogel, and he redirected his research efforts towards Greek and Babylonian materials. Thus, the mathematician-philologists began the 1930s in much the same position as the Egyptologists: the limited number of extant sources on ancient Egyptian mathematics had been exhausted and everything that could be said had been said—though in permitting themselves more room for speculation, they had been able to say rather more than the Egyptologists. Another difference between the two groups was that whereas the Egyptologists saw Peet as having brought the subject to completion, historians of mathematics in general (as well as mathematicians, as we shall see) awarded this accolade to Neugebauer. It is interesting to note in this context that although Neugebauer published extensively in Egyptological journals, and was therefore visible to Egyptologists, he was

162 See, for example, the comments in [Robson 2008, p. 4].

163 See, for example, the remarks in [Robson 2008, pp. 4, 7] and [Høyrup 2016, p. 53].

only rarely cited in the general Egyptological literature for mathematics: his style of work, and the types of questions that he addressed, seem not to have been of interest to Egyptologists, as opposed to his later work on astronomical texts; Neugebauer's work with Richard Parker on ancient Egyptian astronomy has been of great interest to Egyptologists, perhaps partly because of its relevance to questions of chronology.[164] The only Egyptologist who routinely cited Neugebauer, if only in a limited—though generally positive—manner, was Peet (but these citations do not go beyond the early 1930s, for obvious reasons). In contrast to the position he would later occupy in Assyriology, Neugebauer was something of an outsider as far as Egyptology was concerned, and was referred to, for example, by the Egyptologist Alexander Scharff (1892–1950), though not unkindly, as 'the mathematician' ('der Mathematiker').[165] Moreover, Ritter [2002b, p. 159] notes the unfortunate perception amongst the period's Egyptologists—and subsequently among later historians of mathematics—that Neugebauer was "yet another anachronistic modernizer" in light of his limited use of modern notation to aid in the understanding of ancient mathematics. As we have noted, Neugebauer was far from being the worst offender, and often sounded caution at the practice.[166] In fact, he used modern notation only slightly more than did Peet, and so we might view the criticism of him on this count as an indication of the respective tribes to which he and Peet were deemed to belong.[167]

Scharff's reference to Neugebauer as 'the mathematician' brings us back to the rather slippery use of the term by the various people involved in this story, and reminds us that the categories into which individuals

164 Ritter [2002b, p. 158] observes that Neugebauer was only listened to "when he offered something that was already on the agenda of the Egyptologists," such as when he addressed the possibly overlong Egyptian chronology that had been proposed by the historian Eduard Meyer (1855–1930) [Neugebauer 1939], but not when he questioned the widely accepted view that the hieroglyphic signs for the dimidiated fractions $\frac{1}{2}, \frac{1}{4}, \ldots, \frac{1}{64}$ may be assembled as the component parts of the Eye of Horus [Neugebauer 1930c]. Indeed, Peet's expressed scepticism over the latter was similarly disregarded [Peet 1923a, pp. 25–26]; see [Ritter 2002a].

165 See [Ritter 2002b, pp. 155, 159].

166 For example, in an early section of his doctoral dissertation [Neugebauer 1926, p. 14]. In the dissertation, Neugebauer introduced two now-standard modern notational conventions for representing hieratic mathematics: boldface for those parts that appear in red ink in the original, and '$\bar{n}$' for the unit fraction $\frac{1}{n}$. The latter notation has the virtue of being a reasonably faithful reflection of the original hieratic, which simply adds a dot to the sign for the corresponding integer.

167 Peet was certainly aware of the pitfalls of using modern notation: see note 79 above.

placed themselves did not necessarily reflect how they were viewed by others. In the quite sharp distinction introduced in the foreword to that first volume of *Quellen und Studien*, Neugebauer almost certainly positioned himself with the 'philologists' rather than the 'mathematicians', since language ability was the deciding factor. On the other hand, Peet could refer to himself as a 'mathematician', in light of his almost unique status amongst Egyptologists as someone with a background and interest in mathematics. Elsewhere, however, Peet's use of the word 'mathematician' took on a rather different character.[168] Shortly after the appearance of his joint paper with Gunn on geometrical problems from the MMP, Peet complained to his mentor Gardiner:

> [the article] has brought me in a crop of correspondence with the mathematicians which I could really well spare. Vogel, Neugebauer, Struve and Chace all flood me with letters and articles, which get more abstruse each time.[169]

In this instance, judging by the list of names given, Peet seems to have been using the word 'mathematician' to refer to scholars who could access ancient texts (somewhat equivalent to our 'mathematician-philologist'), but with emphasis placed on these authors' approach to ancient mathematics in particular; the reference to 'abstruse' material is certainly suggestive of work of a mathematically-led nature. Although we do not have the correspondence to which Peet referred, it seems reasonable to speculate that its content would have been of a similar technical style to that of his exchanges with Neugebauer earlier in the decade.[170] The problem concerning the volume of a truncated pyramid (dealt with in Gunn and Peet's paper), and that of the surface area of a hemisphere or half-cylinder (according to interpretation) would almost certainly have featured, since these are the problems that were exciting interest in both mathematicians and mathematician-historians at this time. The quotation above also reminds us of the caution needed in employing the various categorisations discussed in this section: Peet places Struve among "the mathematicians," and yet, if language ability were to be a deciding factor, then he would be placed in the 'philologist' camp. Peet was almost certainly focusing on Struve's published works on ancient Egyptian mathematics, some of which are more mathematically speculative than those produced by other Egyptologists, and therefore more closely aligned

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168 See the discussion of this point in [Hollings & Parkinson to appear].

169 Griffith Institute Archive, Oxford: AHG/42.230.39, Peet to Gardiner, 19th May 1930.

170 See [Hollings & Parkinson 2020].

with the works of the mathematician-philologists. The study of ancient mathematics ultimately resists simple disciplinary classification.

8. THE ATTITUDES OF MATHEMATICIANS

We now turn to the mathematics educators and research mathematicians who took an interest in the history of their subject. As we have already observed, ability with ancient language(s) is a crucial factor here, and so the comments that follow will deal with both of the groups that we have termed mathematicians and of mathematician-historians. These two groups are united by the fact that their access to ancient texts was reliant upon, and mediated by, the writings of Egyptologists (and other philologists) and mathematician-philologists.

As we saw earlier, the writings of European mathematicians over several centuries made vague allusions to the origins of mathematics (geometry in particular) in ancient Egypt, and as we move into the early modern period, Egypt stood in the background for those humanist scholars who sought to root the study of mathematics (and other subjects) in ancient sources. The antiquity of mathematics as a discipline was often stressed,[171] with the mathematics of ancient Greece being cited as a concrete example—the only one then available. The beginning of the recovery of ancient Egyptian languages in the mid-nineteenth century initially created few waves amongst mathematicians, because the forms of the numerals were the only mathematically relevant aspects of this reconstruction to which they could point, as for example in Peacock's article for the *Encyclopædia Metropolitana* [Peacock 1845]. However, the publication of Eisenlohr's edition of the RMP in 1877 suddenly made the processes of ancient Egyptian mathematics accessible, and provided a glimpse of the wider mathematical concepts that had been available in Egypt [Eisenlohr 1877]. Primed by the traditions stemming from Herodotus, mathematicians were ready and eager to learn more about ancient Egyptian mathematics. Eisenlohr's *editio princeps*, though strongly guided by the mathematical content of the RMP, was nevertheless a text aimed primarily, if not exclusively, at Egyptologists, containing linguistic commentary. Mathematicians probably had little use for this aspect of the work, and so a process of digesting

171 For example, Henry Billingsley asserted in the preface to his 1570 English translation of Euclid's *Elements* that a full understanding of geometry "requireth diligent studie and reading of olde auncient authors" [Billingsley 1570, translator's preface, p. [2]].

Eisenlohr's findings began, in order to re-present them in a form that was tailored more specifically to the interests of a strictly mathematical readership.[172] Here, the details of the mathematical methods of the papyrus were brought more clearly to the fore and were now presented as the primary interest, in subtle contrast to their treatment at Eisenlohr's hands, where the mathematical details had certainly been prominent, but as a means of understanding the papyrus as a 'Handbuch'. In the digested versions for mathematicians, little comment was made on the difficulties of translation and interpretation, and ancient Egyptian mathematics, presented in modern terms and symbols, took on the appearance of an easily comprehended discipline. Indeed, put into a modern form, mathematicians saw that Egyptian mathematics was a very elementary subject indeed, though one that could spark modern mathematical investigations: Sylvester [1880a; 1880b], for example, was inspired by "the singular method in use among the ancient Egyptians for working with fractions" [p. 334] to investigate the representation of arbitrary fractions as sums of unit fractions—not as an effort to explain the constructions within the RMP, but simply as a problem in modern number theory. Sylvester's introduction to ancient Egyptian arithmetic was the section on this topic in Cantor's *Vorlesungen*, which became a standard reference for those authors who did not go back to Eisenlohr.[173] From these two sources, material on ancient Egyptian mathematics began to find its way into other more general histories of mathematics—the 'standard' chapters to which we alluded earlier began to appear.[174] In the process, however, particularly in the hands of authors with no knowledge of or engagement with the original sources, the topic of ancient Egyptian mathematics became separated from its original context. As an example of this, we may take Ludwig Matthiessen's 1878 *Grundzüge der antiken und modernen Algebra der litteralen Gleichungen*, which includes the purported original hieroglyphic form of a linear equation in the RMP;[175] Matthiessen was evidently insufficiently familiar with Egyptological conventions to realise that the hieroglyphic representation given by Eisenlohr was in fact a modern transcription of

172 These digests appeared in some cases as full book-length treatments (for example, [Bobynin 1882]), sections in books [Cantor 1880], or short articles/lectures [Weyr 1884].

173 On Cantor's treatment of Egyptian mathematics, see [Imhausen 2021a, p. 45].

174 See, for example, [Vashchenko-Zakharchenko 1883], [Cajori 1894], or [Tropfke 1902/1903].

175 See [Matthiessen 1878, p. 269]. The 'equation' is also reproduced in [Cajori 1896, p. 23].

the cursive hieratic script in which the papyrus was actually written. The frequent references by mathematicians to the papyrus as a 'book', or even a 'textbook', suggest a growing distance from the material object and its context, and its assimilation and reshaping into something more familiar. [176]

During the first years of the twentieth century, mathematicians' writings on ancient Egyptian mathematics tended to focus on its elementary nature, and often viewed it through the lens of modern mathematical education, with little attention given to the wider knowledge of ancient Egyptian culture available at that time. Taking the RMP as a 'textbook', Ahmose's readers were often, correspondingly, seen as ancient Egyptian schoolboys: [177] a slightly later article, written to mark the publication of Chace's edition of the RMP, conjures up images of a modern (American) classroom [Davis 1931]. [178] The less complimentary and more judgemental writers tended to view ancient Egyptian scribes in general as being like under-achieving modern school pupils: the ancient Egyptian system of fractional arithmetic was "cumbersome" (even "useless") and provided "definite evidence of the immaturity of the Egyptian intellect" [Miller 1905, p. 569]. [179] This was part of a general approach to ancient Egyptian culture by European scholars: for example, Griffith remarked in a survey of world literature that "the educated Egyptian had no more subtlety than a modern boy of fifteen, or an intelligent English rustic of a century ago" [Griffith & Griffith 1897, p. 5225].

176 See, for example, [Rouse Ball 1912, p. 5] or [Karpinski 1917, p. 259]. These authors were perhaps influenced by Eisenlohr's choice of the term 'Handbuch', which might better be translated here as 'manual'. Indeed, Eisenlohr deliberately selected the word 'Handbuch' over the alternative 'Lehrbuch' ('textbook'): although he saw a progression of ideas in the RMP which might therefore justify the label 'manual', he did not think that it was self-contained enough to be a 'textbook' [Eisenlohr 1877, vol. 1, pp. 2–3]. As Imhausen notes, Eisenlohr's choice was implicitly informed by the structure of Euclid's *Elements* [Imhausen 2021a, p. 43, n. 34].

177 The male bias here is at least one aspect of ancient Egyptian culture that modern mathematical writers reflected accurately, albeit inadvertently.

178 This image of the ancient schoolboy even appears in the historically more reputable work of Aaboe [1964, p. 1], as discussed recently by Guicciardini [2021, p. 9] within the context of anachronism in the history of mathematics. On a similar theme, see Robson's comments on the spurious identification of a room in an Old Babylonian palace at Mari (in present-day Syria) as an ancient schoolroom [Robson 2008, pp. 130–131].

179 Lumpkin (1978) discusses this early-twentieth-century dismissal of Egyptian mathematics within the context of the persistence amongst European and North American scholars of a colonialist mindset. Her call for a 'new historiography' of mathematics that embraces non-European contributions chimes well with present-day efforts in this direction.

In an early foreshadowing of Neugebauer's later and better-informed attitude, ancient Egyptian mathematics was sometimes presented as a subject to be skipped over briefly in order to reach more challenging topics, such as the mathematics of ancient Greece. [180] As knowledge of Mesopotamian mathematics grew during the first decades of the twentieth century, much attention was also diverted in this direction: [181] for example, to the modern mathematical mind, the use of place-value in the Babylonian number system automatically marked it out as being more sophisticated than its ancient Egyptian counterpart, and therefore more interesting. Similarly, the assertion that linear equations may be found in ancient Egyptian texts was trumped by the identification of quadratic equations in Mesopotamian sources. [182]

It is possible that the educational angle of much of the mathematical writing connected with Egypt stemmed not only from the elementary nature of the mathematics concerned, but also from the long tradition of using Euclid's *Elements* as the basis for a mathematical education. [183] If Greek geometry did indeed have an ancient Egyptian origin, then it stood to reason that Egyptian mathematics should be inserted into its 'rightful' place within an elementary mathematical education. Ancient Egyptian precursors of concepts from modern school mathematics were emphasised by mathematical writers—in particular, any discernible traces of algebraic thinking, however anachronistic such notions may have been. [184] The method of false position, for instance, was recognised, quite plausibly, within the RMP, along with other, rather more doubtful, identifications, such as linear equations. [185] In pedagogical writings, where

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180 For example, Cajori [1894] included just five pages on Egyptian topics, and nearly 50 on the Greeks; Rouse Ball [1912] gave one short chapter (around 10 pages) to Egyptian and Phoenician mathematics (plus some brief dismissive remarks on Chinese mathematics), followed by four chapters (totalling roughly 100 pages) on Greek mathematics. This disparity is of course also a reflection of the quantity of available material.

181 The first popular account of Mesopotamian mathematics was apparently that given by Smith [1923/1925].

182 See the comments in [Imhausen 2021a, p. 60].

183 See, for example, [Wardhaugh 2020]. See also the comments above in note 176.

184 See, for example, [Karpinski 1917].

185 By Matthiessen [1878], for instance; on the Egyptian origin of the method of false position, see also [Lumpkin 1996]. Rather than interpreting problems in Egyptian mathematics in terms of algebraic equations, Imhausen and Ritter have argued that an algorithmic structure is more appropriate: see, for example, [Imhausen 2003].

questions of historical accuracy are secondary, the possibility was raised of using problems from the RMP in an educational setting. [186]

The insertion of ancient Egypt into the sequence of mathematical development was of interest not only to mathematics educators, but increasingly also to research mathematicians, as further evidence of the pedigree of their subject. The seventeenth-century view that the antiquity of mathematics confers prestige upon the discipline persisted into the early twentieth century, and endures to this day. Moreover, it was not just a matter of antiquity, but also continuity. [187] An oft-quoted passage written by the German mathematician Hermann Hankel (1839–1873) gives expression to mathematicians' proud view of the history of their subject, although the reality is of course rather more complicated:

> In most of the sciences, one generation tears down what another has built, and what one has established another destroys. In mathematics alone, each generation puts a new floor on the old substructure. [188]

The inclusion of ancient Egyptian mathematics promised to push the (detailed) history of the subject back several centuries further, and in order to maintain the all-important continuity, it was necessary to be able to anchor later Greek mathematics into an ancient Egyptian ancestry. [189] The clear difference in nature between ancient Greek and ancient Egyptian mathematics was not seen as a problem: surviving Demotic sources

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186 See, for example, the remarks of Slaught [1931] on the possible use of Chace's edition of the RMP by high school students. Elsewhere, Archibald [1918] had recommended the RMP as a suitable object of study for an undergraduate mathematics club. Suggestions as to the inclusion of examples from ancient Egyptian mathematics in modern mathematical education have also been made in more recent pedagogical texts, particularly with regard to promoting multiculturalism: see, for instance, [Fauvel & van Maanen 2002, §§ 1.3.2, 2.3.2].

187 With regard to continuity, we note in passing Imhausen's comments on the appropriateness of even applying the word 'mathematics' to the content of the RMP, when perhaps 'arithmetic' might be more suitable as a translation of *ḥsb*, 'counting, reckoning' ([Erman & Grapow 1926–1963, III, 166.11–167.15] = TLA lemma no. 109870), which is the closest possibility for an ancient Egyptian word for 'mathematics' and occurs in the title of the RMP [Imhausen 2021a, p. 38]. The use of the term 'mathematics' automatically brings with it modern connotations, and emphasises the link between the ideas used by Egyptian scribes and the modern discipline.

188 "In den meisten Wissenschaften pflegt eine Generation das niederzureissen, was die andere gebaut, und was jene gesetzt, hebt diese auf. In der Mathematik allein setzt jede Generation ein neues Stockwerk auf den alten Unterbau." [Hankel 1869, p. 34]

189 Gandz [1928] went further still by suggesting that later developments in algebra in the mediaeval Islamic world owed something to methods found in the RMP.

appeared to provide a possible connection, [190] and in any case, mathematicians could always appeal once again to Herodotus and others in order to establish the link. [191] While Neugebauer had sought foundations within the history of mathematics, ancient Egyptian mathematics had taken on a historically foundational role within the story of mathematics. At the same time, mathematicians engaged in a form of double-think, on the one hand dismissing ancient Egyptian mathematics as primitive and trivial, but on the other asserting it as the basis for their discipline: the overall position of ancient Egyptian mathematics within the story mattered more than its specific details. Nevertheless, mathematicians continued to trawl the digested materials on ancient Egyptian mathematics in search of evidence of familiar concepts, however anachronistic. We have already mentioned the method of false position, and the ever-contentious issue of ancient Egyptian algebra; one of the most extreme examples of this pastime is Miller's astonishing assertion that ancient writers possessed an implicit knowledge of the modern mathematical notion of a group [Miller 1931b]. Such efforts probably contributed to some of the recurring modern myths about ancient Egyptian mathematics: for example, the supposed recovery of an 'Egyptian value of π' (3.16), which does not stand up to scrutiny. [192] In summary, we might say that whereas Egyptologists had sought something new in the mathematical texts that they encountered, mathematicians were interested in the familiar. [193] However, the identification by mathematicians of familiar ideas in ancient Egyptian mathematics was often achieved via a distortion of that part of Peet's 'second stage' of study in

190 Although, as we noted above at the end of section 4, further study of these is still required.

191 In his history of Greek mathematics, Gow [1884, p. 132], for example, reached for Strabo. Elsewhere, glimmers of mathematical ideas were deemed sufficient evidence of the connection: for instance, Karpinski [1923, p. 529] asserted that one of the geometrical problems in the MMP "indicates clearly the Egyptian inspiration of a whole series of problems found in Euclid's Data". See also the comments made more recently by Høyrup [2018, p. 159].

192 This value of π appears, for example, to even greater supposed accuracy as 3.1605, in [Smith 1923/1925, vol. 2, p. 270]. Based on evidence from the RMP, the standard Egyptian method for calculating the area of a circle was to take $\frac{8}{9}$ of the diameter (or, in more authentically Egyptian terms: to take away a ninth part of the diameter) and to square this, hence $\frac{256}{81}$ (≈ 3.16) as the 'Egyptian π'. However, there is no surviving evidence in Egyptian sources of explicit calculation with the ratio of a circle's circumference to its diameter. See [Imhausen 2009].

193 Robson [2008, p. 272] has observed that in Mesopotamian studies, this search for the familiar has caused an imbalance in the types of cuneiform tablets that have been published.

this area that sought to "attempt to analyse the mental processes which underlie the actual operations and [show] how far these agree with or differ from our own" [Peet 1931b, p. 409]: the mathematicians' approach was often simply to attribute modern mental processes to ancient Egyptian scribes.

This search for recognisable notions may well underlie the interest that some mathematicians showed in two particular problems from the MMP during the 1920s and 1930s. The first (eventually to be labelled by Struve as MMP Problem 14) concerns the calculation of the volume of a truncated pyramid. This had first been published by Turaev in 1917, with the comment, bound to attract the attention of mathematicians, that "we have here a new and interesting fact, i.e., the presence in Egyptian mathematics of a problem that is not to be found in Euclid" [Touraeff [Turaev] 1917, p. 102]. During the early 1920s, knowledge of this problem began to spread through the interested sections of the mathematical community—we see brief notes about it in a number of settings [194]—but it was not until 1929 that it received a more detailed and up-to-date discussion from Gunn and Peet in their joint paper that sought to correct the inaccuracies of the writings of Turaev and Tsinzerling. Gunn and Peet observed that the procedure outlined in the papyrus in the form of a numerical example appears to correspond to an application of the modern formula $V = \frac{(a^2+ab+b^2)h}{3}$ (where h denotes the vertical height of the truncated pyramid, and a and b are the upper and lower side-lengths), and they argued that the scribe probably arrived at this idea via the experimental dissection of solid shapes, possibly lumps of clay. As in the case of the $2 \div n$ table in the RMP, however, such a trial-and-error explanation did not sit well with Gunn and Peet's more mathematically-inclined readers—hence, one assumes, the 'abstruse' correspondence mentioned above in section 7, that Peet "could really well spare". The several articles that were written in direct response to Gunn and Peet during the early 1930s all rely, as Imhausen [2016, p. 75] puts it, on "clever modification of algebraic formulas—which were not used in Egyptian mathematics". Moreover, the subsequent literature on this particular problem, from the 1930s up to the present day, exemplifies the lack of Egyptological interest in mathematical detail, as it has been written almost entirely by mathematicians and historians of mathematics. [195] For mathematicians, the search for even

194 See, for example, [Vetter 1922], [Karpinski 1923], and [Smith 1923/1925, vol. 2, p. 293].

195 See the references given above in note 83.

the slightest hint of a general method for finding the volume of a truncated pyramid may have served to elevate ancient Egyptian mathematics above the pedestrian arithmetic and trial-and-error to which the sources appeared to point. We might also view the systematic approaches to the $2 \div n$ table in the RMP in much the same light.

The other part of the MMP that was briefly a source of interest to mathematicians was Problem 10 (in Struve's numbering). This problem was not treated by either Turaev or Tsinzerling, perhaps because of the damage to this portion of the papyrus, and so knowledge of it emerged only slowly during the 1920s, with the first published hints coming via the 1929 supplement to Archibald's bibliography of ancient Egyptian mathematics, thanks to his ongoing correspondence with Struve. [196] Archibald observed that Problem 14 demonstrated ancient Egyptian knowledge of a formula for the volume of a truncated pyramid, and noted:

> No. 10 seems with like certainty to indicate that the Egyptian of 2000 B.C. knew the formula for the area of a hemisphere, a result supposed till recently to have originated with Archimedes. [Archibald 1927/1929, supplement, p. [13]]

The first person to respond directly to this bold claim was Peet in his 1931 paper 'A problem in Egyptian geometry', where he began by noting his surprise at having read the sentence above in Archibald's bibliography:

> for the Moscow Papyrus had been known to me from photographs for some years, and one thing that I had decided about No. 10, a singularly difficult problem, was that it did not deal with the area of the curved surface of a hemisphere. [Peet 1931a, p. 100] [197]

Having patiently waited for the final appearance of Struve's edition of the MMP, Peet found himself "entirely unconvinced by Struve's translation and treatment of No. 10" [*ibid.*], which involved not only the interpretation but also the attempted reconstruction of a damaged portion of the text; [198] although he held that "it would be very flattering to the Egyptians, and very important for the history of mathematics, if we could place this brilliant

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196 Brown University Library, Providence, RI: Raymond Clare Archibald Papers, Series 1, Folders 5 and 9.

197 More privately than in his published bibliography, Archibald had already remarked in a letter to D'Arcy Thompson on the apparent discrepancy between Struve's fresh findings and Peet's earlier assessment of the MMP: "Touraev and Peet must have been careless in their reading" (University of St Andrews Library, Department of Special Collections: Papers of D'Arcy Wentworth Thompson, Correspondence between D'Arcy Wentworth Thompson and Raymond Clare Archibald, 11 February 1918–7 March 1946: ms22935, Archibald to Thompson, 27th July 1928).

198 For Struve's full explanation of the problem, see [Struve 1930a, pp. 157–169].

piece of work to their credit," he believed that there were "very grave" objections [Peet 1931a, p. 101].[199] In Peet's view, the area in question was that of the curved surface of a half-cylinder. At the heart of the issue was the mathematical interpretation of the Ancient Egyptian noun *nbt*, which is attested elsewhere as meaning 'basket' [Erman & Grapow 1926–1963, vol. 2, p. 227.1 = TLA lemma no. 81730]. Working systematically through the grammar of the problem, Peet argued strongly against Struve's interpretation. Whilst acknowledging, with characteristic caution, that there were still gaps in the general understanding of Middle Egyptian grammar, syntax, and palaeography, Peet remarked:

> I do not know how many *mathematicians* I shall convince that this problem deals not with a hemisphere but with a [...] semi-cylinder. I am, however, persuaded that no *philologist* will doubt my restoration of the data of the problem [...] [Peet 1931a, p. 106, our emphasis]

Although it was to prove pessimistic, as we shall see below, this last comment from Peet may have stemmed from an appreciation of just why the hemisphere hypothesis would have been attractive to mathematicians. Earlier in the paper, he had acknowledged that "[t]o conceive such an area [that of a hemisphere] as area at all is not an elementary process of thought" [Peet 1931a, p. 101], since, unlike a (half-)cylinder, a hemisphere cannot be rolled out flat; to accept that Problem 10 concerns the surface area of a hemisphere would be "to put Egyptian mathematics on a very much higher level than previously seemed necessary" [Peet 1931a, p. 100], but it was not a step that Peet felt able to take. Although a small literature has grown up around this problem in the decades since Peet's paper,[200] the only further contribution that he would have been able to read was that of Neugebauer, to whom he had sent a copy of his own work prior to its publication.[201] In a further twist, Neugebauer argued for a slightly different interpretation of the problem: as the surface area of an elongated dome [Neugebauer 1930d, pp. 427–428]. Although Neugebauer's suggestion was closer to Struve's than to Peet's, he was surprisingly quiet on the issue of the status that his interpretation would lend to ancient Egyptian mathematics, perhaps because he was not confident of it; he expressed agreement with Peet that the available information was insufficient for any interpretation ever to be certain [Neugebauer

199 Similar sentiments, along with a detailed critique, appear in Peet's review of Struve's edition [Peet 1931d].

200 See the references in note 84 above, as well as [Imhausen 2016, pp. 120–121].

201 See the acknowledgement in [Neugebauer 1930d, p. 425].

1930d, p. 428], and moreover admitted some years later that the "much more primitive interpretation" (presumably that of a half-cylinder) is preferable.[202] Indeed, insofar as it is possible to tell from the very few references in the Egyptological literature, the consensus that seems to have emerged in that community was, unsurprisingly, the point of view advocated by Peet. All other available evidence of ancient Egyptian mathematics pointed to a quite elementary level of knowledge with which the calculation of the surface area of a hemisphere would be inconsistent.[203] This attitude also carried over into the mathematical community, where the 'primitive' nature of ancient Egyptian mathematics had already become ingrained. Although initially advocating Struve's interpretation,[204] Archibald, for one, came eventually to side with Peet.[205] The problem has remained mildly controversial among writers of all types: in his *Science awakening*, van der Waerden [1954, p. 33] sided with Peet's interpretation, but apparently changed his mind subsequently.[206] The hemisphere interpretation was strongly advocated by Richard J. Gillings as "the outstanding Egyptian achievement in the field of mathematics" [Gillings 1972, p. 247], with the suggestion that the knowledge must have been gleaned from the practicalities of basket-weaving [Gillings 1972, ch. 18]. Most recently, Høyrup [2018, pp. 153–154] has presented both interpretations without coming down on one side or the other, while Imhausen [2016, p. 121] has dismissed any further speculation as "futile," in light of the uncertainty surrounding the problem. Indeed, the uncertainty has made this a much less revealing problem in attempts by mathematicians to assess the nature of ancient Egyptian mathematics than the problem on the volume of a

202 [Neugebauer 1962, p. 78]. Alternatively, the "much more primitive interpretation" could have been the further suggestion made by Peet that this is not a three-dimensional curved area at all, but simply the area of a semicircle. We have left this possibility aside, since it was not Peet's preferred interpretation: it arose from linguistic considerations, but the calculation seemed to him to be too complicated to be connected with a semicircle.

203 See, for example, the remarks in [Sloley 1942].

204 In [Archibald 1930b, 1931].

205 [Archibald 1949, p. 16]. Another mathematical author who sided with Peet was G. A. Miller [1931b; 1931d]. However, whereas Archibald appears to have been swayed by Peet's detailed analysis of the papyrus, Miller agreed with Peet by default, since Miller's overriding and questionable obsession in the history of mathematics was the issue of exactness: in his view, the ancient Egyptians could not have had a means of calculating the surface area of a hemisphere because the proposed method would not result in an answer that is precise by modern standards (of Miller's historical writings, Brahana [1951, p. 380] has commented that "he gave attention to too many things of questionable importance").

206 See [Gillings 1972, p. 194].

truncated pyramid—and perhaps also because, as Peet observed: "the reasons which might incline us to the one solution or to the other are psychological rather than rational" [Peet 1931a, p. 106].

As well as considering individual detailed problems from ancient Egyptian mathematical sources, mathematicians—more so than Egyptologists—were also asking higher-level questions, concerning the general character of ancient Egyptian mathematics, and whether it could be considered 'scientific'. Such questions were often bound up with the related, but not identical, issue of whether ancient Egyptian mathematics really was purely 'practical' in its orientation, an assertion that had been repeated, but rarely examined, since the end of the nineteenth century. For example, the Egyptologist Adolf Erman had insisted that

> [m]athematics served merely a practical purpose for the ancient Egyptians, they only solved the problems of everyday life, they never formulated and worked out problems for their own sake. [Erman 1894, p. 364]

As we have seen, Peet was also broadly of this view, although by 1931, he had slightly modified his opinion in order to admit an element of abstraction into ancient Egyptian mathematics. Nevertheless, the word 'practical' remained prominent in general surveys of the subject: Dawson [1924, p. 51] followed Peet in asserting that mathematics had the same practical character as any other area of study in ancient Egypt, and as far as Sloley [1942, p. 173] was concerned, ancient Egyptian mathematics was "essentially practical". Mathematical writers, however, began to have doubts, as we see most clearly in the title of Wieleitner's article 'War die Wissenschaft der alten Aegypter wirklich nur praktisch?' [Wieleitner 1927a]. Taking 'science' to mean "the systematic, thoughtful consideration of facts and occurrences,"[207] Wieleitner argued that the answer to the question was 'no', explicitly setting himself in opposition to what he regarded as the majority view in Egyptology. Indeed, as an interesting counterpoint to various statements made previously about language ability among mathematicians, we quote Wieleitner's comments on the state of the study of ancient science:

> The judges of the early stages of science are now primarily philologists: Egyptologists, Assyriologists, Sanskritists, Arabists, classical philologists. How could it be otherwise? No historian of science is able to read all the documents himself in the original language. The work of philologists of all kinds is highly valued by

[207] "Wir wollen unter Wissenschaft nur die systematische, überlegende Betrachtung von Tatsachen oder Vorkommnissen verstehen." [Wieleitner 1927a, p. 11]

those in the know. The philologists have their old tradition, each has mastered the philological and historical-critical method. [208]

In Wieleitner's view, however, philologists were "often lacking two things when it comes to assessing ancient science," [209] namely a familiarity with the underlying scientific or mathematical ideas (leading to a bias towards literature and art in the study of the ancient world), and a training in the history of science—a "deficiency" that was "more easily understood and forgivable," [210] owing to the dearth of provision for such training at that time, the (historically rigorous) history of science still being a young discipline. Wieleitner made a passing reference to the volume of a truncated pyramid and declared this to be "real mathematics," [211] a turn of phrase suggestive of a mathematician's mindset. Elsewhere, Wieleitner supported his assertion of a theoretical aspect to ancient Egyptian mathematics by citing problems from the RMP that are phrased in the 'practical' language of distribution of rations, but whose numerical content appears rather contrived, and unlikely ever to arise in real life: for example, RMP Problem 40, which asks for 100 loaves of bread to be shared among five men in such a way that the rations are in arithmetical progression, and the sum of the two smallest shares equals one seventh that of the greatest three. Whereas Wieleitner perceptively remarked on the strangeness of these salary arrangements, and their hint of mathematical playfulness, Peet's commentary had been focussed on the strictly arithmetical and philological. [212] Although, as we have noted, Peet's edition of the RMP goes beyond the usual scope of such text editions in dealing with wider context, he may nevertheless have felt

208 "Die Beurteiler der frühen Wissenschaftsstufen sind nun in der Regel in erster Linie Philologen: Aegyptologen, Assyriologen, Sanskritisten, Arabisten, klassische Philologen. Wie sollte es auch anders sein? Kein Wissenschaftshistoriker ist ja imstande, alle die Dokumente selbst in der Ursprache zu lesen. Die Arbeit der Pilologen [*sic*] aller Art schatzt der Kenner aufs höchste. Die Philologen haben ihre alte Tradition, jeder beherrscht die philologisch- und historisch-kritische Methode." [Wieleitner 1927a, p. 12]

209 "Zu einer Beurteilung alter Wissenschaft fehlt ihnen aber doch häufig zweierlei." [Wieleitner 1927a]

210 "Dieser Mangel ist noch leichter verstandlich und verzeihlich." [Wieleitner 1927a]

211 "Das ist nun schon wirkliche Mathematik." [Wieleitner 1927a, p. 27]

212 See [Peet 1923a, pp. 78–79]. See also the discussion of this point in [Barrow-Green et al. 2019, pp. 18–20]. Imhausen [2018, p. 112] sees such elaborate problems as being deliberately so for scribal training purposes.

constrained by the commentary format, and therefore did not offer any additional remarks on the general issue of 'practical' ancient Egyptian mathematics. Given the broader tendency of Egyptologists simply to assert the practical character of ancient Egyptian mathematics, we tentatively suggest that it took a reader who was approaching the subject from an exclusively mathematical direction to recognise the numerical quirkiness of some of the problems in the RMP. [213]

The idea of the practical orientation of ancient Egyptian mathematics was part of early-twentieth-century orientalism, and is a topic that warrants a more detailed study elsewhere. This dismissive attitude was clearly articulated in the American Egyptologist John Wilson's later interpretation of Ancient Egyptian culture:

> Those people were neither mystics nor modern scientific rationalists. They were basically practical, eager to accept what worked in practice [...] Their reasoning never sought to penetrate the essence of phenomena, and their easy-going pragmatism did not attempt to find the one single way; rather, different and disparate ways were acceptable if they gave some indication of practical effectiveness. Unlike their Asiatic neighbours, Babylonians and Hebrews, the Egyptians made little attempt to systematize a coherent scheme, with separate categories for distinct phenomena. [Wilson 1951, p. 46]

This was part of the influential European tradition of an unchanging Egypt, "the lifeless ground from which civilizational progress—a uniquely Greek invention—rose" [Colla 2007, p. 48]. If we turn once again to Peet's comments in his 1931 Rylands lecture, we find here some slightly more nuanced remarks on the practical nature of ancient Egyptian mathematics. Although they were "mainly occupied with practical problems," Peet conceded that

> the Egyptians occasionally allowed themselves to observe and even to record a result or a method which had no obvious and direct application to the concrete

213 This issue needs further investigation, for in fact a range of arguments were given by mathematical authors against a purely practical assessment of Egyptian mathematics: for example, Karpinski [1917] refuted the 'practical' point of view by citing the appearance of what he regarded as equations of different types in Egyptian sources, whilst Miller [1931a] similarly pointed to supposed traces of modern ideas. Archibald [1949], on the other hand, took the presence of a notion of 'proof' (presumably in its modern Western sense) as a marker of 'scientific mathematics', and therefore denied Egyptian mathematics that label, though he was prepared to go some way towards granting it to Babylonian developments. For brief comments on historical speculation as to the presence of mathematical 'proof' in ancient Egypt, see [Charette 2012, pp. 285–286]; see also [Gillings 1972, Appendix 1].

> facts of life. But there is no sign that such things were regarded as more than idle curiosities. [Peet 1931b, p. 438]

The simple arithmetical relationships recorded independently of any problem in the so-called 'first group of completions' within the RMP arguably fall into this category.[214] Away from the constraints of a commentary publication, Peet here also acknowledged those RMP problems cited by Wieleitner that "contain figures so fantastic or envisage cases so improbable that they could never arise in ordinary practical life" [Peet 1931b]. However, cautious as ever, Peet was careful not to conflate a practical nature with an unscientific character, an error that he believed has been made by several prior writers on this issue. Much as in his writings on the Akhmim writing boards and various problems from the MMP, Peet carefully outlined the views of these previous commentators before setting out—politely and systematically—to dismiss them.[215] For example, in response to Vogel's suggestion that the organisation of the RMP—in particular, the grouping of similar problems—was evidence of scientific thought, Peet highlighted aspects of the arrangement of the papyrus that were "logically far from perfect," and also cited the "disgraceful chaos" of the MMP [Peet 1931b, p. 439, n. 1]. Peet was similarly unconvinced by the conclusions that Vogel drew from his not unreasonable premise that ancient Egyptian scribes possessed an abstract notion of number:

> That the conception of abstract number existed is merely equivalent to saying that the Egyptians had passed beyond a certain primitive stage of thought where practically no mathematics is possible except such elementary operations as that of counting 8 sheep and 5 sheep and observing that together they count 13 sheep; to possess the concept of abstract number is an *a priori* condition of a mathematical system, not a proof of its scientific nature. [Peet 1931b, p. 439]

Peet was prepared to credit ancient Egyptian scribes with a "non-practical speculative interest in mathematics [...] but nothing more" [Peet 1931b]; the lack of any (explicit) discussion of general rules and laws in surviving sources spoke against the 'scientific' character of ancient Egyptian mathematics. However, for Vogel, a student of Wieleitner, ancient Egyptian mathematics marked the beginning of 'scientific mathematics', an accolade that had traditionally been reserved for the ancient Greeks.[216]

214 See [Hollings & Parkinson 2020].

215 The works cited by Peet were: [Vogel 1929], [Wieleitner 1927a], [Rey 1930], and [Gillain 1927].

216 On Vogel's view, see [Imhausen 2021a, pp. 49–50].

Peet's reasons for denying the label 'scientific' to ancient Egyptian mathematics stemmed not from a desire to denigrate, but from concern over the validity of the question, and the tendency to define ancient mathematics in terms of what it is not:

> Are we then to damn Egyptian mathematics once and for all by attaching to it the epithet "unscientific" because it does not conform to our modern conception of scientific method? Not for a moment. The word unscientific conveys a reproach, and those who have studied what Egypt did for mathematics before 2000 B.C. are moved to admiration rather than criticism. [Peet 1931b, pp. 440–441]

In support of this empathetic view, rarely espoused by mathematicians, Peet quoted (in English translation) some comments made by Neugebauer in his review of Vogel's dissertation [Neugebauer 1930b], regarding the legitimacy of applying modern intellectual categories such as 'scientific' to early civilisations: "[t]he possibility that the intellectual structure of these civilisations was of a fundamentally different order is not taken into consideration".[217] As Peet noted, modern categories (such as perspective) had already been recognised as meaningless in the study of ancient Egyptian art, so why not bring the same anti-presentist attitude to the study of mathematics? As we have seen in the writings of mathematicians, the similarity of the underlying subject-matter of ancient and modern mathematics brought with it the temptation to ascribe the notions of the modern to the ancient, but, Peet warned, just

> [b]ecause the Egyptian achieved results which are still acceptable to us we must not assume that he did so, or ought to have done so, by a mental attitude or by methods identical with ours. [Peet 1931b, p. 441]

But such an emphasis on cultural difference and contextualisation was of no interest to mathematicians. The fleeting glimpses of modern ideas that modern mathematicians had seized upon in ancient Egyptian mathematics, in possible formulae for the volume of a truncated pyramid or for

217 [Peet 1931b, p. 441] translating from [Neugebauer 1930b, p. 94]. Despite concerns about the validity of terms such as 'scientific', this seems to have been an easy phrasing to fall into: both here and in his dissertation several years earlier [Neugebauer 1926, p. 17], Neugebauer's benchmark for a truly 'scientific' mathematics was, as for other authors (see note 213 above), a (modern Western) notion of proof, absent from ancient Egypt. In later years, he wrote: "Ancient science was the product of a very few men; and these few happened not to be Egyptians" [Neugebauer 1962, p. 91]. On this contradiction in Neugebauer's writings, see [Imhausen 2021a, pp. 48–49].

the surface area of a hemisphere, and the accompanying hints of the all-important abstraction, once again served to elevate ancient Egyptian mathematics to the level of a worthy predecessor of its modern counterpart, as part of an essentially evolutionary view of progress, where the 'primitive' nature of Egyptian mathematics also had a role to play.

In this context, we can return briefly to Chace's edition of the RMP as an example of the competing approaches of these different groups. This was explicitly produced for mathematical readers, and was rather better received by them than by Egyptologists.[218] Chace explained why he had published a new edition of the RMP just a few years after the appearance of Peet's, making his target readership very clear in terms of these groups:

> It seemed to me [...] that there was room for yet another work on this subject intended for mathematicians and the general public, rather than for Egyptologists who will find philological matters fully discussed by Professor Peet. [Chace 1927/1929, vol. 1, Preface, p. [1]]

This was echoed by Peet in his review of the edition that "[t]he work is intended in the main for mathematicians rather than Egyptologists" [Peet 1930b, p. 266]. Once again, language ability was the deciding factor in characterising these different audiences: whereas Peet's edition of the RMP was targeted at readers who could understand and cared about linguistic detail (although, by ignoring certain passages, it could still be used by those who could not and did not), Chace was writing explicitly not only for those categories of readers whom we have characterised as mathematicians and mathematician-historians, but also, more ambitiously, for the generally interested public.[219] Chace was in effect attempting to write for everyone *except* the philologists, which perhaps gives an indication of how exclusionary a purely philological format could be for some audiences, despite Peet's stated aspiration for his commentary (see above in section 5). With this aim in mind, Chace used modern symbolism throughout, and without comment. The focus of Chace's edition of the RMP was placed very much upon the processes of mathematics, and unsurprisingly he did not hesitate to ascribe a 'scientific' character to ancient Egyptian mathematics, citing the organisation of the problems [Chace 1927/1929, vol. 1,

218 Chace appears to have been aware of the criticism that might come his way from Egyptologists: in his preface, he acknowledged the assistance of Ludlow Bull of the Egyptian Department of the Metropolitan Museum, New York, without whose aid Chace "could scarcely have hoped to escape severer strictures than will now be meted out to me by Egyptologists" [Chace 1927/1929, vol. 1, Preface, p. [2]].

219 Chace provided a very brief outline of the main features of ancient Egyptian language in the introduction to his second volume.

p. 39]. Indeed, Chace saw in the RMP the study of mathematics for its own sake, with such examples as Problem 40, discussed by us above, providing the evidence. Mathematical readers had been able to access detailed information about the RMP before, through the editions of Eisenlohr and Peet, as well as the many digested versions of these (particularly of the former), but in Chace's edition, they had the most readable, accessible and visually appealing version yet, which gave particular attention to those aspects of the papyrus —the strictly mathematical ones—in which they were most interested. [220] Moreover, the juxtaposition of facsimiles, line-by-line translations and mathematical interpretations gave these readers a greater sense of engagement with the original source than they had ever had before, while making philology almost into an exotic and decorative background for the mathematics. Along with this engagement, there may also have come a sense of ownership—modern mathematicians could now see more clearly and directly the writings of Ahmose, their intellectual predecessor. Thus, the appearance of Chace's edition of the RMP may be taken as marking a shift in the positioning of ancient Egyptian mathematics within the academic landscape: with the waning of the rather meagre interest in mathematics by Egyptologists, and the exchange of Egypt for Mesopotamia by the mathematician-philologists, the custodianship (if not the continuing study—for there seemed to be little left to say) of ancient Egyptian mathematics passed into the hands of mathematicians.

9. CONCLUDING REMARKS

We have presented a picture of the growth of interest in ancient Egyptian mathematics by various groups during the 1920s, sparked by the appearance of Peet's edition of the RMP. As we have seen, this growth was not sustained by all groups, and even by the time of the appearance of Struve's edition of the MMP in 1930, interest was beginning to wane, at least amongst Egyptologists and mathematician-philologists. The very small selection of surviving original texts simply did not provide a sound basis for sustained research on ancient Egyptian mathematics for those scholars who were engaging actively with the original materials. But we have seen that other groups, most particularly mathematicians, were

220 Ritter [2002a, p. 303] sees the persistence of the (unfounded) notion of 'Horus-Eye' fractions (see note 164) as a consequence of mathematicians' preference for Chace's edition of the RMP, since it resulted in them overlooking Peet's (justified) reservations about these supposed fractions.

putting recent findings concerning ancient Egyptian mathematics to other (rhetorical) uses.

Mathematicians' concern for ancient Egyptian mathematics emerged as part of a broader trend. Although interest in the history of mathematics was certainly not new in the 1920s, the subject was gaining a fresh respect among mathematicians as an academic discipline, thanks in large part to Neugebauer, the 'mathematician's historian'. His emphasis on the understanding of technical detail in ancient texts in a bid to bring a greater rigour to the study of historical mathematics appealed to mathematicians. In a review of Neugebauer's dissertation, the Berlin mathematician Ludwig Bieberbach (1886–1982) remarked that

> [i]t is gratifying to see how the history of mathematics, in the hands of some researchers, is gradually being raised from the stage of reportage or chronicle to science. It is precisely the modern interest in fundamental questions that also seems to sharpen the researchers' view of historical contexts and historical judgement.[221]

Neugebauer was a product of the Göttingen mathematical school whose historical researches had been supported by such prominent mathematicians as Richard Courant, David Hilbert, and Felix Klein, and as such, he was to be taken seriously, and so, by extension, was the history of mathematics. His position as Courant's assistant at the Göttingen Mathematical Institute and his founding editorship of the Springer reviewing journal *Zentralblatt für Mathematik und ihre Grenzgebiete*, with the mathematical contacts that this entailed, meant that he was particularly visible to mathematicians.[222] More than that, Neugebauer was fully embedded in the mathematical community: he was a fully-fledged mathematician who just happened to work on historical topics. A clear indication of Neugebauer's standing within the mathematical world is given by the fact that he was invited to deliver one

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221 "Es ist erfreulich zu sehen, wie die Geschichte der Mathematik unter den Händen einiger Forscher allmählich aus dem Stadium der Reportage oder Chronik zur Wissenschaft erhoben wird. Gerade das moderne Interesse an Grundlagenfragen scheint den Blick der Forscher auch für historische Zusammenhänge und das historische Urteil zu schärfen." [Bieberbach 1929] Neugebauer himself "had no patience for those who simply wanted to chronicle the great names and works of the past" [Rowe 2016a, p. 129]—hence his disdain for the work of Sarton.

222 From 1932, Neugebauer was also editor of *Zentralblatt*'s associated monograph series, *Ergebnisse der Mathematik und ihrer Grenzgebiete*, and from 1933 founding editor of *Zentralblatt für Mechanik*. After his move to the United States at the end of the 1930s, he would found *Mathematical Reviews*.

of the plenary lectures at the 1936 International Congress of Mathematicians.[223]

Something that mathematicians learnt in particular from Neugebauer was that it was indeed possible to say something interesting about 'pre-Greek' mathematics.[224] Since Neugebauer was always fulsome in his acknowledgement of his debt to Peet, and continued to cite Peet in his few subsequent writings on ancient Egyptian mathematics, we might therefore speculate about Peet's own visibility to mathematical readers. The publication of his edition of the RMP in 1923 certainly did not go unnoticed in the mathematical community at large: in addition to the attention that it received in the Egyptological world, the edition was reviewed in a number of journals concerned with mathematics, and in particular with mathematical education.[225] These of course included the Danish *Matematisk Tidsskrift A* in which Neugebauer's review appeared—significantly, it had been commissioned for a different strand of the journal, *Matematisk Tidsskrift B*, a publication of the Danish Mathematical Society, but was diverted into the more general 'A' strand in order to reach a wider mathematical readership, including mathematics teachers.[226] The articles of mathematicians such as Archibald, Karpinski, and Miller (cited earlier in the present paper), all refer to Peet as the major source of their knowledge of ancient Egyptian mathematics—at least until the appearance of Chace's edition (see below). In addition, the general histories of mathematics that were published during the middle part of the 1920s also turned to Peet as their main ancient Egyptian reference.[227] By the second half of the decade, Peet's name was well enough known in mathematical circles that in a review written for the *Bulletin of the American Mathematical Society*, David Eugene Smith could criticise a book on ancient science for, among other

223 See the references in note 103 above.

224 'Pre-Greek' (or 'vorgriechisch') is a term that Neugebauer used only for a short time. As he increasingly considered each strand of ancient mathematics (particularly Mesopotamian mathematics) in its own right, rather than being 'preparatory' to Greek ideas, the term disappeared from his work: see the comments in [Swerdlow 1993, p. 147].

225 Namely (and non-exhaustively): *The American Mathematical Monthly* [Archibald 1924], *Bulletin of the American Mathematical Society* [Smith 1924a], *Časopis pro pěstování matematiky a fysiky* [Vetter 1925], *L'enseignement mathématique* [F[ehr] 1923], *Jahresbericht der Deutschen Mathematiker-Vereinigung* [Sethe 1925], *The Mathematical Gazette* [[Greenstreet] 1924], *The Mathematics Teacher* [Smith 1924b], *Nieuw Archief voor Wiskunde* [van der Waerden 1925–1928], and *Zeitschrift für mathematischen und naturwissenschaftlichen Unterricht* [Wieleitner 1925].

226 See the remarks in [Ritter 2002b, p. 139].

227 See, for example, [Smith 1923/1925, vol. 2] and [Karpinski 1925b].

things, its failure to cite Peet [Smith 1927]. Looking beyond the RMP to Peet's other writings on ancient Egyptian mathematics, we see that these too would have been visible to mathematicians, as they were indexed and reviewed both in *Zentralblatt* and in *Jahrbuch über die Fortschritte der Mathematik*. Unsurprisingly, *The Journal of Egyptian Archaeology* was not otherwise routinely indexed by either of these mathematical reviewing journals; we may reasonably suspect Neugebauer's influence in the case of *Zentralblatt*.

Thus, Peet's work was known within the European and North American mathematical communities of the 1920s, but unlike Neugebauer, Peet was clearly not considered to be a part of these communities. By his own positioning, he was very firmly an Egyptologist, and although he had become clearly identified (by himself and others) as the 'mathematician' within Egyptology, his work on ancient Egyptian mathematics formed only one small part of his wider research into texts and culture. With regard to the communication of his findings, we have seen from the preface to his edition of the RMP that Peet included mathematicians among his intended readers, but there is no evidence that he ever delivered a seminar directly to mathematicians, although he did give lectures on ancient Egyptian mathematics for general audiences: for example, the 1931 Rylands lecture upon which we have drawn so heavily, and, somewhat earlier, a lecture entitled simply 'Ancient Egyptian Mathematics', addressed to a joint meeting of the Manchester Egyptian and Oriental Society (of which Peet was then president) and the Manchester Literary and Philosophical Society.[228] In contrast, Neugebauer appears to have been an active communicator of his ideas to specifically mathematical audiences:[229] for example, in 1926, he was invited by Otto Toeplitz to the mathematical colloquium in Kiel to deliver a seminar ('Über die Mathematik im alten Ägypten') on the content of his doctoral dissertation [Rowe 2016b, p. 33], and two years later he offered a contribution ('Grundzüge der altorientalischen Mathematik') to the historical section at the International Congress of Mathematicians in Bologna.[230] Neugebauer built his reputation rapidly:

228 A brief account of the lecture, delivered in December 1920, by an anonymous audience member appears on pp. ix-xi of volume LXIV (1919–1920) of the *Memoirs and Proceedings of the Manchester Literary and Philosophical Society*.

229 We note in passing David Rowe's observations on the weight given to oral communications within the Göttingen mathematical school [Rowe 2004].

230 In fact, Neugebauer arrived late in Bologna, and so his lecture "was presented by the Secretary" ("fu presentata dal Segretario"), presumably the general secretary of the congress, Ettore Bortolotti, who also spoke in the historical section [?, vol. 1, p. 131]. Neugebauer's title is misprinted in the congress proceedings as 'Grandzüge der altorientalischen Mathematik'.

by the mid-1930s, mathematicians were increasingly turning to him with praise as their source on ancient mathematics in general: for instance, in a review of Neugebauer's *Vorlesungen über Geschichte der antiken mathematischen Wissenschafte,* Smith remarked of the author that "[f]or several years [he] has been known to readers of the history of mathematics as one of the most promising scholars in this field" [Smith 1935, p. 162], and in a review of the same book, Archibald described Neugebauer as "the chief vitalizing force in connection with present research in the history of mathematics" [Archibald 1935, p. 151]. In 1938, when Neugebauer received an honorary degree from the University of St Andrews, the Professor of Greek, Herbert Jennings Rose (1883–1961), who introduced the recipients at the award ceremony, presented Neugebauer as an interpreter of ancient science through whom modern mathematicians had been granted access to the antiquity of their discipline. [231]

In addition to Neugebauer's relative standing with mathematicians, as compared to that of Peet, a comparison of their styles of work provides a further reason for mathematicians to have turned to Neugebauer over Peet for their ancient mathematics. In his published papers on ancient Egyptian mathematics, Peet's arguments are largely, though not exclusively, philological rather than mathematical—this is particularly true of his argument against Struve's interpretation of MMP Problem 10, for example. Neugebauer's writings, on the other hand, although they had their philological aspect, were much more often mathematically driven. Neugebauer wrote in a language that mathematicians could understand and appreciate more fully. Moreover, the caution and general reluctance to theorise that Peet displayed in his work might be set beside Neugebauer's greater willingness to engage in mathematical speculation, which aligned more comfortably with the creative practices of mathematicians. Neugebauer's 'puzzle-solving' approach to ancient mathematics would have appealed to the mathematical mind, and was probably the point of origin of some of the wilder mathematically-led speculations and attempted systematisations of the subject that appeared in print in the following decades: [232] if Neugebauer, as the leading authority on ancient

231 See [Anonym 1938]. Honorary degrees were awarded on the occasion of the tercentenary of the mathematician and astronomer James Gregory (1638–1675); besides Neugebauer, the other recipients, all of them mathematicians, were George David Birkhoff (1884–1944), Arthur W. Conway (1875–1950), and Roland Weitzenböck (1885–1955).

232 We are thinking in particular here of the writings of van der Waerden alluded to above in note 159.

mathematics, saw fit to speculate, then it must be permissible. There are hints within Peet's writings that he was aware of the point of opposition in which he reluctantly found himself: we have seen his reference to "the mathematicians" and their "abstruse" communications. Elsewhere, we find the rather pointed comment, made in connection with Vogel's interpretation of the $2 \div n$ table in the RMP, that "there exists a science of palaeography before which even mathematics must sometimes bow" [Peet 1930a, p. 271]. This was not a point of view that was likely to find sympathy with mathematicians.

Peet's edition of the RMP remained, until 1927, the most complete, reliable, and accessible version of the papyrus to be available to any readers, and it was therefore read by mathematicians. However, with the appearance of Chace's edition that year, this began to change. Peet's edition was still praised by mathematical writers, but it started to be pushed aside by Chace's more easily accessible presentation of the papyrus. For example, in 1929, we find Smith, in yet another book review, this time of O. Gillain's *La science égyptienne* [Gillain 1927], decrying the author's treatment of the RMP and referring the reader to "the much better edition of Peet"—or "the still better [...] one by Dr. Chace" [Smith 1929, p. 407]. During the following years, the editions of Peet and Chace continued to be cited side-by-side, [233] but a clear preference for Chace's version emerged amongst mathematical writers, for the partly practical reasons outlined in section 6. [234] By the early 1970s, with the publication of Richard J. Gillings' highly

233 See, for example, [Sanford 1930, p. 81].

234 The other potential readers of ancient mathematics with whom we have not dealt here (and with whom we will not attempt to deal, for reasons of space) are the more general historians of science. We might expect these readers to align themselves with the cultural studies of Egyptologists rather than with technical mathematics. Curiously, however, in the bibliography of his essay *The study of the history of mathematics* [Sarton 1936], the historian of science George Sarton gave Chace and Struve as the main texts on the study of Egyptian mathematics, with no mention of Peet. A clue to a possible explanation of this may be found in a later article by Sarton, entitled 'Remarks on the study of Babylonian mathematics' [Sarton 1940], in which he discussed certain disagreements on this subject between Neugebauer (who, naturally, took a mathematical approach) and Thureau-Dangin (who was more philological). Sarton seems to suggest that from an outsider's point of view, technical mathematical details look much the same as technical philological details: "[w]hen the experts disagree the non-experts are in an awful quandary" [p. 398]. It may be that when we move away from the details, Peet's and Chace's editions look very similar. Neither Sarton's review of Peet's edition [Sarton 1924], nor his review of Chace's [Sarton 1930], says anything on the specific mathematics of the RMP; the latter gives little impression of the differences between the two editions, aside from a comment on Chace's photographs of the papyrus. On the differences between the styles of work of Sarton and Neugebauer, see [Rowe 2016b, pp. 52–55]. We note also that Sarton was in favour of

mathematically-led *Mathematics in the time of the pharaohs* [Gillings 1972], we find Peet listed quietly in the bibliography but barely cited in the text, in contrast to the frequent references to Chace's edition. Around the same time, in Morris Kline's more general and popular *Mathematical thought from ancient to modern times* [Kline 1972], Peet does not appear at all, but Chace does. Even more recently, in a new undergraduate textbook on the history of mathematics, published by the Mathematical Association of America and the American Mathematical Society, all quotations from the RMP are drawn from Chace's edition [Barrow-Green et al. 2019, § 2.2]. As is explicit in the subtitle, *A source-based approach*, the focus of the 2019 textbook is the study of the history of mathematics through primary sources: and it is still Chace's edition that provides the most convenient access for the non-specialist to the original text and content of the RMP.

In our opening comments on the 'reawakening' of the study of ancient Egyptian mathematics in the 1920s, we noted that this development could be credited to either Peet or Neugebauer. From the foregoing discussion, it seems clear that whilst Egyptologists would naturally have attributed this research direction to Peet (one of their own) and his edition of the RMP, mathematicians, had they ever commented on this explicitly, would have been more likely to have cited Neugebauer as the source of this renewed area of study. It was not simply a matter of his greater visibility to mathematicians—his mathematically-inclined style of work was also a factor. This, in combination with the appearance of Chace's very accessible edition of the RMP, meant that mathematicians had no particular reason to turn to Peet. He was by no means invisible to them, but the intersection of various factors, including his early death, his disciplinary alignment, his approach to the study of ancient mathematics, and the presence of a rival edition of the RMP, meant that his writings did not seem relevant to mathematical readers. Moreover, at least part of Peet's visibility to mathematicians was passively mediated by Neugebauer through citations of the former's works, and when Neugebauer shifted his focus to Mesopotamian topics (or even to ancient Egyptian astronomy, a subject that Peet barely touched upon), these references inevitably became fewer and further between.

Going into the 1930s, we see that there were two major approaches to the study of ancient mathematics: Peet's contextualising 'second stage',

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the non-experts staying away from topics in ancient mathematics until the specialists had reached agreement [Sarton 1940, p. 401]—not an approach that mathematicians were willing to adopt, as we have seen.

and Neugebauer's mathematical systematisation. What happened next—namely, the loss of interest in ancient Egyptian mathematics by both Egyptologists and mathematician-philologists—might be seen as a natural consequence of the presence of these rival approaches, since both impose natural bounds on the further work that may be done. The cautious contextualisation that was reluctant to stray beyond the content of the surviving written texts, and which retained sufficient perspective to recognise mathematics only as one small part of a wider culture, was not conducive to further extensive work on ancient Egyptian mathematics by Egyptologists. Any attempt at systematisation, on the other hand, by its very nature seeks a state of completion, but even with a willingness to extrapolate from the available source material, this approach must necessarily run up against the paucity of that same material. Thus, for the next several decades, it was only mathematicians who retained an active interest in ancient Egyptian mathematics. However, their handling of the topic consisted mostly of general summaries of the prior scholarship of (mathematician-)philologists, and although it did sometimes venture into speculation, this was rarely with any firm basis in the hieratic sources. It can thus be characterised as 'custodianship' rather than an active process of research. Instead, ancient Egyptian mathematics took on the rhetorical foundational role that we have described. This is observable as early as 1936, with Lancelot Hogben's popular *Mathematics for the million*, which contains frequent but vague references to ancient Egyptian mathematics throughout [Hogben 1936]. This casual invocation of Egypt in popular books on mathematics, its history, and its teaching, remained throughout the rest of the twentieth century, as part of the widespread myth of 'eternal Egypt'.[235]

After a fallow period during the middle years of the twentieth century, the study of ancient Egyptian mathematics was revived once again in the writings of Richard J. Gillings, in particular in his monograph *Mathematics in the time of the pharaohs* [Gillings 1972], which went back to the original sources, but with a heavily mathematical approach.[236] It is only during the past 30 years, principally in the works of Jim Ritter and Annette

235 See, for example, [Moreno García 2015, pp. 52–54].

236 Imhausen [2021a] emphasises the writings on mathematics of the Egyptologist Walter-Friedrich Reineke (1936–2015), beginning in the 1960s. However, his works do not seem to have been particularly visible to mathematicians and historians of mathematics—certainly not as visible as Gillings's. Moreover, Reineke's largely unpublished work does not appear to have sparked much interest in mathematics amongst Egyptologists until the beginnings of Imhausen's own investigations.

Imhausen,[237] that the study of ancient Egyptian mathematics has returned to the careful, context-led approach originally advocated by Peet:

> The first step in dealing with any problem is to satisfy ourselves, if possible, that our translation of the Egyptian words is beyond criticism. Not until this is done should our view of what may be mathematically probable be allowed to influence us. [Peet 1931a, p. 106]

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