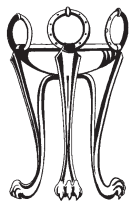
Yoshiyuki Suto (ed.) · Transmission and Organization of Knowledge

In Memoriam
P. J. Rhodes (1940 – 2021)

# Transmission and Organization of Knowledge in the Ancient Mediterranean World

Yoshiyuki Suto (ed.)



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## Contents

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# Introduction

**Yoshiyuki Suto**

On 26 October 2010 a renovated reconstitution of an Ionic column with a fragmentary two-line epigram was solemnly introduced to the public in the Archaic Acropolis Gallery of the Acropolis Museum in Athens.[1] Most visitors might have overlooked it as just another ordinary archaic dedicatory column but for the prominent statue of Nike, also very fragmentary, that was set on its top.[2] But this ceremony was not held for the artistic attraction of the marble statue; it was announced that the column once stood on the Acropolis and was dedicated by a certain Callimachus, an Athenian citizen who served as polemarch in 490 B. C. According to Herodotus, Callimachus greatly contributed to the illustrious victory of the Athenians and Plataeans over the Persians at Marathon by supporting the audacious tactics proposed by Miltiades. Although the monument was explicitly called the *Nike of Callimachus,* some attentive members of the audience must have been perplexed by the total absence of the name Callimachus in the extant epigram. It was not the information available from the fragmentary texts in archaic letters inscribed on the column, but the knowledge of Herodotus' famous reference to the alleged dialogue between Callimachus and Miltiades just before the start of the battle of Marathon that enabled the audience to comprehend the historical implication of this monument even though the name of the dedicator has been completely lost.[3]

Contrary to modern-day visitors to the Acropolis Museum, ancient Athenian citizens in the 480s, seeing this monument on the Acropolis for the first time, might have been astonished to find the name of the dedicator on the column conspicuously placed in such a prominent spot close to the northwest corner of the Older Parthenon.[4] The project of building this grandiose temple, still under construction when the Persians razed the Acropolis in 480 B. C., was undoubtedly conceived to commemorate the unprecedented victory of the Athenians at Marathon. It may thus be legitimate to assume today that the votive column nearby was also a memorial to posthumously honour Callimachus for his great contribution at Marathon, where he was killed on the field after heroic fighting. But if this was the case, we should feel quite uneasy about restoring the name of Callimachus in the lost part of the epigram, because we know from later sources that the Athenians of the day were quite unwilling to mention individuals by name in public monuments celebrating war victory, as Aeschines put it in 330 B. C.:

> There were those who in that period, men of Athens, endured much labor and great dangers and defeated the Medes at the river Strymon. When these men returned home, they asked the people for a reward, and the people gave them great honors by the stan-

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1 *Kathimerini* 27.10.2010.

2 Raubitschek (1940) 53–55.

3 Hdt. 6.109–114. Of course, the historicity of the dialogue is not the point. See Rhodes (2013) for the concise and valuable overview of the recent controversies on the various topics concerning Marathon.

4 For the problem of location of the column, see Keesling (2010) 101, n. 4.

> dards of the day, namely the right to set up three stone Herms in the Portico of the Herms, on condition that they did not inscribe their own names on them, so that the inscription would be perceived as belonging to the people, not the generals.
>
> (Aesch. 3.183; tr. Carey)

This incident allegedly took place in Athens in 476/5 B. C. But a few years earlier, the Spartans had famously erased the two-line *elegeia* inscribed on the tripod dedicated by the Greeks to Delphi after the Battle of Plataea, because it contained the name of Pausanias as the dedicator, the leader of the Spartan contingent, as if he alone was credited with the victory, not the whole Greek poleis who had joined the battle.[5] As regards the *Nike of Callimachus,* it is difficult to suppose on stylistic grounds that the name of the dedicator in nominative case was absent in the original epigram, hence some suspect that the dedicator was not Callimachus but some corporate body, such as the deme of Aphidona with which he was officially affiliated.[6] But most scholars still believe with reason that the formal dedicator was actually Callimachus, even though it might have originally been set up to commemorate his victory in some athletic games such as the Panathenaia, not specifically for his remarkable conduct at the Battle of Marathon.[7] But considering all the evidence together, it is difficult to dismiss the orthodox interpretation that the column was erected as a sort of war memorial. Then why did the Athenians permit the name of Callimachus to be inscribed on this monument?

Undoubtedly Herodotus, or more precisely his informant, seems to have had certain critical knowledge of the primary qualification of Callimachus. When Herodotus introduces Callimachus in his narrative, he deliberately comments that he was the polemarch *chosen by lot.*[8] Scholars unanimously dismiss this remark on the grounds that Ps-Aristotle definitely states that the archons were first chosen by lot in 487/6 B. C., three years after the Battle of Marathon, and all their predecessors were elected.[9] But the important point is not the historical accuracy of Herodotus' observation but the fact that he represents Callimachus as the champion of the newly founded Athenian democracy in contrast to Miltiades, the symbol of a traditional aristocrat with the air of a tyrant.[10] The dramatic role of Callimachus, an ordinary citizen chosen by lot who held the casting vote at the most crucial point, must have been most fitting for the protagonist of free and democratic Athens at the beginning of the fifth century B. C. It is thus tempting to suggest that the name of Callimachus was virtually synonymous with the Athenian citizen body, whose members shared the common knowledge that he was not elected but chosen by lot. Later, Cimon, son of Miltiades, was obliged to put the figure of Callimachus along with that of Cimon in the painting at the

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5 Thuc. 1.132.2–3; ML 27; [Dem.] 59.97.
6 For the various restorations of the epigram, see Petrakos (1996) 47–49.
7 Harrison (1971) 11–12; Keesling (2010) 108. *Cf.* ML (rev. ed. 1988) Addenda 309.
8 Hdt. 6.109.2.
9 *Ath. Pol.* 22.5. Pausanias also has Callimachus elected. Paus. 1.15.3.
10 Miltiades was from the wealthy aristocratic clan of Philaïdai and was in fact the tyrant of Chersonese before coming back to Athens in 493 B. C. after joining the Ionian Revolt.

Stoa Poikile in order to carefully balance the commemoration of the glorious deed of his father with the popular sentiment of the Athenian citizens.[11]

The above observation on the *Nike of Callimachus* vividly shows the importance of organized knowledge, not just a random accumulation of information, in both contemporary and ancient historical perception. In any social group, organized knowledge transmitted and shared through various media is indispensable for its members to comprehend the specific visual or verbal message of its own cultural product in order to confirm their corporate identity. For the modern-day visitor to the Acropolis museum, knowledge of the history of the Persian Wars, which has been transmitted through the narrative of Herodotus and taught in classrooms all over the world for generations, is a necessary prerequisite for an appreciation of the significance of its exhibitions. For the ancient Athenians the knowledge of the whole events from the reforms of Cleisthenes to the subsequent victory against the Persians as well as the contemporary democratic spirit to exclude personal glory from public action must have been orally transmitted as a public memory and collective wisdom for regulating the democratic social order of the time. This may sound all too obvious, but the intricate relationship between knowledge and monument and other media surely deserves further examination for the purpose of fostering a better understanding of the ancient Mediterranean World.

Moreover, it should also be emphasized that a monument such as the *Nike of Callimachus* often contributes in turn to the further organization and enhancement of knowledge by demonstrating its physical presence in a certain privileged temporal and spatial context. In fact, the inauguration of the new exhibition of the *Nike of Callimachus* took place to celebrate the 2500th anniversary of the Battle of Marathon. Admittedly it didn't attract as much public attention as the various events commemorating the 2500th anniversary of the birth of democracy in 1993, but the event was surely instrumental in highlighting the knowledge about one of the most glorious episodes in the history of the Greeks to visitors from abroad, together with other fine sculptures exhibited on the same floor of the Acropolis Museum. In the same way, visitors to the Athenian acropolis in the 480s must have perceived and enriched the story of Marathon as divine knowledge by viewing the Callimachus memorial against the background of the Older Parthenon under construction. If it were not for the Persian ravages, the column might have continued to appeal to the valour of the goddess Athena and Athenian democracy to later visitors together with the portrait statues of Phormio or Olympiodorus against the background of the Parthenon.[12]

The present volume grew out of the Fourth Euro-Japanese Colloquium on the Ancient Mediterranean World that took place at Nagoya University in September 2018. The colloquium, first established in 2005 by Catherine Morgan (Oxford) and Mariko Sakurai

[11] For the Marathon painting, see Ferrario (2014) 40–41. Cimon need not have worried much about such popular democratic sentiment when he dedicated the statues of the Athenian gods and heroes including *only* Miltiades to commemorate the Athenian victory at Marathon at the international sanctuary of Delphi. Paus. 10.10.1.

[12] Paus. 1.23.10 (Phormio), 25.2f. (Olympiodorus).

(Tokyo), is a quadrennial venue in which scholars from Japan and Europe (now also from the US) investigate the various facets of ancient Greek, Roman, and Egyptian culture and society through intercultural perspectives. The main agenda of the fourth colloquium was the dynamics of knowledge, in particular the transmission and organization of it in ancient Greece, Rome, and Egypt.

One of the primary features of ancient Mediterranean civilization is undoubtedly its remarkable uniformity and resilience based on the communal solidarity of its principal members and their collective initiative in its public actions. Although many factors contributed to their successful achievements, the efficient transmission and organization of knowledge must have been highly important for creating and vitalizing their society, as has been demonstrated by Josiah Ober specifically in the case of democracy in classical Athens.[13] The aim of this colloquium was to bring together scholars working on ancient Greek and Roman history, classical archaeology, ancient philosophy, and art history, with a view to understanding how the various media, such as the colloquial, the textual, and the visual, and their intricate and effective combination enabled the productive transmission and organization of knowledge in the ancient Mediterranean world.

This volume consists of three interrelated parts. Part 1 focuses on the various tools and media used in transmitting knowledge. Josine Blok deals with how the two contrastive systems of denoting numbers, alphabetic and acrophonic numerals, were used in ancient Greek recording practice. While the idea of using alphabetic numerals seems to date back to the eighth century B. C., acrophonic numerals were apparently devised in Athens in the mid-sixth century B. C. because they were more useful for recording complex amounts of money. Blok notes that acrophonic were more efficient than alphabetic numerals in cognitive terms, and were more fitting for a society where people with modest literacy played an important role in the democratic convention of public accountability.

Inscribing documents on stone stelai or monuments were the most authentic and widely accepted way of disseminating public knowledge in the ancient Mediterranean world. In examining the honorary decrees concerning the sanctuary of Machaon in Gerenia, Andronike Makres makes it clear that the combination of creating and preserving multiple copies of documents, inscribing them on hard material, and displaying them in prominent sanctuaries was a fundamental way to transmit knowledge to the public in the Greek city-states.

Yasuhira Yahei Kanayama sheds new light on the significance of writing in Greek philosophical thinking and concentrates specifically on the cognitive function of the wax tablet, on which Plato arranged the beginning of the *Republic* in various orders. Plato, who is generally considered to have neglected the importance of writing, did recognize the essential contribution of writing to refining one's thought and to discovering new ways of thinking. In improving the wax tablet of our mind, Kanayama suggests that we are able to obtain a survey-knowledge of the world, which provides a better understanding of how the routes in the intelligible world are connected with one another.

[13] Ober (2008).

We will never know whether Plato or his elite followers, who were used to tending to their mental wax tablet to calmly improve their inner soul, also enjoyed shouting out rude remarks in the assemblies or the law courts, but it is quite certain that many ordinary Athenians led a life full of energetic and sometimes heated oral communications. Noboru Sato discusses the phenomenon of *thorubos,* or heckling, in public life and concludes that Athenian orators skillfully developed and employed different techniques of transmission of their expert knowledge depending on the different natures of public space.

An aggregated knowledge of the supreme ruler, either divine or secular, has been ubiquitously transmitted through his/her idealized and authorized visual representation in polytheistic societies, and the case of the Roman Empire was no exception. Kyoko Sengoku-Haga examines the six heads of Augustus (the Prima Porta Type) using the 3D shape comparison method and convincingly argues that the official image of the Emperor was transferred to the provinces in the form of a plaster model. The sculptors in the provinces skilfully copied the head with local modifications following the taste of local recipients.

The central concern of the contributions included in Part 2 is the intercultural transmission of knowledge at different levels of geographical scale. Kostas Vlassopoulos neatly provides a conceptual overview of issues in understanding the nature of intercultural communication in the archaic and classical Mediterranean. He argues that neither the traditional diffusionist approach nor the alterity approach can aptly account for the complex and variable forms of intercultural communication, and that the difference between self-referential and hetero-referential cultures had a significant impact on the history of intercultural exchange of knowledge.

Archaeological and environmental remains are often the only available evidence to investigate the fascinating process of transmitting technological knowledge in the prehistoric period. Lilian Karali reviews the history of purple dye production from prehistory to the Byzantine period and shows how the interdisciplinary project contributes to the reconstruction of the trade network and processing of purple shellfish in the Aegean.

Catherine Morgan treats the two geographical units, the Saronic Gulf and the Corinthian Gulf, where she has been working for a long time, to highlight the role of landscape and environment that engendered the potential for connectivity, growth, supply, and the accumulation of social capital transcending political boundaries. She also suggests how agendas for archaeological landscape research might address the need to model and retrieve knowledge, which intersects the written, visual, and oral.

The great pan-Hellenic sanctuaries of the Greek world were important loci of knowledge exchange in antiquity. Judith M. Barringer looks at the marked phenomenon that poleis and individuals in Magna Graecia were particularly eager to send dedications to such sanctuaries. Through the detailed analysis of offerings by the western Greeks she argues that we should assume multi-dimensional networks of power and prestige as well as competitive patronage in the major international sanctuaries.

Marion Meyer's contribution deals with the use of the Greek image by the ancient Phoenicians. In the fifth and fourth centuries B. C., Greek images reached Phoenicia with Greek marble, the medium representing wealth and luxury. In the Hellenistic period,

Greek images served as an additional means of communication. The Sidonians, in particular, made Greek culture an intrinsic part of their own in a trilingual way by using the Phoenician language, the Greek language, and Greek images.

Yoshiyuki Suto is concerned with the remarkable resilience of Egyptian society in the Hellenistic period and provides an explanation of the hypothesis that an effective and efficient transmission and organization of knowledge made it possible for the Ptolemies to attain such social stability. Through the examination of three conspicuous phenomena of the era, the propagation of synodal decrees, the adoption of a bilingual recording system at local quarries, and the spread of the custom of erecting statues for prominent priests, he suggests that harmonious manipulations of traditional and new knowledge contributed to the relative success of Ptolemaic rule in the turbulence of the Hellenistic period.

Part 3 deals with the various ways that ancient people appreciated and promulgated human and divine knowledge. Elizabeth A. Meyer convincingly argues that inscribed documents were intended to transmit knowledge that created a frame of expectations into which the relevant information fit and allowed the information to be understood. The inscribed accounts and legal documents in sanctuaries transmit knowledge of the gods and their material and financial concerns as well as their preferred forms of transactions with humans.

One of the most important channels mediating divine and human knowledge was the oracle. Irad Malkin explores the subtle relationship between them by discussing the two types of knowledge sharing through oracles: inspired prophecy and lot oracles. The ancient Greeks articulated and projected panoptic geographical knowledge onto Apollo. Apollo's divine knowledge, not directly accessible to humans, was endowed through inspired prophecy, while lot oracles operated mainly within the constraints of human knowledge and limitations.

Mariko Sakurai deals with the dissemination of human knowledge, particularly that concerning the characteristic public/private distinction in classical Athens. By examining the relevant passages from Solon's laws to Aristophanes' comedies, she argues that Athenian citizens of the classical period could acquire the necessary knowledge on public/private distinction through their daily civil service as officials and jurors.

Shared knowledge on historical events is universally indispensable for the creation of a strong corporate identity of social groups from a small informal association to an empire, and it is no wonder that the ancient Mediterranean world boasts an illustrious tradition of historiography. P. J. Rhodes examines the sources of information incorporated into the works of Greek historians in the fifth and fourth centuries B. C. The primary sources for Herodotus, Thucydides, and Xenophon were oral information they collected on their own, while later historians extensively relied on earlier written accounts.

J. E. Lendon explores how such history was learned, "piped into the student's mind through the twisted, clogged, and scaled conduits" of standard rhetorical education in the Roman empire. The history of the Hellenistic period and the period of Roman domination was not part of Greek education under the empire. Similarly, the historical knowledge of a Latin-speaker was largely restricted to the themes before the death of Cicero. Greeks and Romans with rhetorical education were both profoundly ignorant of their recent past.

Knowledge of local history interwoven with Greek mythology also mattered in constructing a Lycian corporate identity under the Roman Empire. Akiko Moroo convincingly argues that the Lycian identity and their indigenous history were promoted using Greek rhetoric in the Hellenistic period which provoked heated competition among the Lycian poleis over their superiority.

The proper transmission of religious knowledge was of great concern in late antique Christianity. Hajime Tanaka analyses the compositional process of a fourth century church decree and makes it clear that it combined and unified several chronologically different decrees. In the fourth to fifth centuries, the Christian Church often made creedal or canonical documents without much care in specifying their time and place so as to emphasize the unity of belief with the Nicene Council, though this custom gradually fell out of fashion in the following centuries.

To conclude this short Introduction, it is pertinent to cite the following observation by Catherine Morgan at the conference. "A longer-term, 'bottom up' approach, tracing knowledge and information across and between media, to build context and understand the paths taken towards eventual political association, is not only methodologically sound, but as a number of papers in this volume indicate, greatly thickens our understanding at all scale of analysis."

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# Greek Numerals and Numeracy

**Josine Blok**

The transmission of knowledge is shaped on the one hand by the social, cultural and institutional contexts in which transmission takes place, and on the other hand by the tools enabling such knowledge to be communicated and preserved.[1] In ancient societies these tools were oral communication, visual representations, material culture and the scripts used for writing, which for actual communication were often combined in multiple ways. This article investigates the ancient Greek ways of writing numbers and the contexts of their use. Numbers were written either in full (number words) or as numerals (numerical symbols). In the archaic age, several numerical systems emerged of which two came to prevail: alphabetic and acrophonic numerals.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| α | β | γ | δ | ε | ϝ | ζ | η | θ | ι alph. |
| I | II | III | IIII | Γ | Γ\| | Γ\|\| | Γ\|\|\| | Γ\|\|\|\| | Δ acroph. (Attic) |

The question when and how these two systems came into existence has been asked before, but here I shall do so again using new evidence, which also invites us to examine who may have been the users of these numerals. A formal and a cognitive analysis suggest that these numerals circulated in different communities. Furthermore, the distribution of these numerals in the epigraphic record is strikingly uneven: acrophonic numerals were used nearly exclusively in public inscriptions until the third century, when alphabetic numerals virtually took over everywhere, except in Athens, which only followed suit in the first century.[2] Many scholars have observed this uneven occurrence, but few have proposed an explanation. With the analysis I propose here I hope to shed some light on this issue.

Systematic research of Greek numerals was pioneered by Marcus N. Tod (1878–1974).[3] As an epigraphist, his interest was mainly in the acrophonic numerals abounding in inscriptions, but he also recognised that epigraphical evidence offered excellent material for tracing the historical distribution of numerals more broadly. Since his last publication (1950), the evidence has multiplied, changing the historical picture in important respects. Yet, Greek numerals have been studied less intensively and systematically than, for instance, the scripts for language representation and forms of visual communication. A reason for this might be that alphabetic numerals appear overwhelmingly in discursive (literary, philosophical, scientific) texts and acrophonics in inscriptions. Depending on their specialisation,

[1] I warmly thank our hosts in Nagoya, especially to Yoshiyuko Suto, for their hospitality and for the inspiring conference, and to all participants for their comments on my paper. I am also greatly indebted to Elon Heijmans, Robin Osborne and Janric van Rookhuijzen for invaluable comments on drafts of this article, to Elon for discussions throughout, and to John Kroll for sharing his work on the Artemision account prior to its formal publication. References to epigraphic evidence follow the abbreviations of *PHI Online* and dates are BCE, unless otherwise indicated.

[2] An exception from Athens is *IG* I$^3$ 1387 (mid-fifth c.), an as yet unexplained list of alphabetical numbers.

[3] Tod (1911/1912), Tod (1913), Tod (1926/1927), Tod (1936/1937), Tod (1950).

classical scholars tend to focus on one such group of texts and less on the others.[4] Historical numerals are primarily the domain of interest of historians of mathematics and linguistic and cognitive anthropologists, but recently interest in ancient numeracy is increasing also among classicists.[5] Although both numerical systems have been discussed in conjunction, they have not been systematically compared.[6]

Since alphabetic and acrophonic numerals are not familiar to all classical scholars in equal measure, I will first discuss the main features of each system. Next, I shall tentatively answer the question when and where they originated, and new evidence may have an unpredictable impact on present results. Some ideas about the users of these numerals are to be distilled from the material objects on which numerals appear and their epigraphic formats, as well as from cognitive aspects of each system. This line of research is still at an exploratory stage. Whereas alphabetic numerals have drawn attention from cognitive scientists, this is not yet the case for acrophonics,[7] nor for the relationship between acrophonics and language as an element of their use.[8] In sum, in many respects this article is a new attempt at understanding the origins and use of Greek numerals, inviting further research.

**How do numbers work?**

Numerical systems rest upon and are the carriers of numerical cognition: understanding 'number' means understanding magnitude (quantity) independent of the format in which the magnitude appears.[9] Understanding number is an innate cognitive capacity, just like the capacity for language, and both capacities are developed in interaction with the two systems created to render them in visible form: numerals and writing script. Scholars agree that humans' innate numerical faculty consists of two core systems. One is comprehending small numbers: human beings and some animals can grasp, in one glance, up to four units correctly, a mental skill called *subitising;* amounts above four need to be counted, unless clearly ordered in a fixed pattern, as on dice.[10] The second is the capacity to estimate large

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4 Typically, digital word-processing programs for writing Greek and Greek fonts by default have tools for writing alphabetic numerals, including *digamma, koppa* and *sampi,* but no acrophonic numerals, let alone the other archaic numeral signs. To render these, I use here signs as close as possible to the originals, for which I refer to the primary publications.

5 Classicists: Netz (2002), Hawke (2008); Cuomo (2013); Van Berkel et al. (2021) take stock of work on numerals and numeracy in Greece.

6 Mathematicians Ifrah (2000); Menninger (1969), mathematician and anthropologist Crump (1990), linguistic anthropologist Chrisomalis (2010) and linguist Gvozdanovič (1992) discuss both systems, but without systematic comparison.

7 That common sense will not do to clarify the use of numerals is exemplified in the claim of Netz (2002: 328) that alphabetic numerals as symbols stay close to spoken language: once one knows that Λ is 30 and B is 2, one can immediately read ΛB as "thirty-two", whereas ΔΔΔ|| reading "ten ten ten click click" does not exist in spoken language. This claim is unconvincing, because a) "lambda beta" does not exist in spoken language either; they are *recognised as numeral symbols* and transposed into thirty-two, just as ΔΔΔ|| is transposed into thirty-two via "three times ten two times one" (see also below). b) numerals were normally written in descending order and number words in ascending order; *καὶ* was usually added in number words reflecting spoken language, but obviously absent in written numerals. In other words, ΛB is *not* close to *δύο-καὶ-τριάκοντα*.

8 Cuomo (2013) 258, note 20 observes: "learning enough letters to be able to recognize acrophonic notation would have made you barely literate, but moderately numerate", but she does not go into more depth.

9 Brysbaert (2004) 23.

10 Brysbaert (2004) 23–4.

and indefinite magnitudes, called the approximate number system (ANS); this is essential to (human) numerical ability.[11]

In order to grasp larger quantities and work with them, numbers need to be rendered in visual shape. There are three ways of doing so: analogue representation (∴); writing number words (five), and numerals (5, V). Numerals are a symbol or a string of symbols representing numbers.[12] Some were created specifically for numbers, such as our present-day system of (Hindu-)Arabic numerals (1, 2, 3 etc.). Numerals enable multiple practical and arithmetic applications of numbers. To this end, numbers are ordered into systems with a base: 10-base systems are common (because they are aided by the fingers of two hands), but 12- and 60-base systems were also widespread in the ancient world.[13]

To clarify the typical features of Greek numerals, it may be helpful to recall the familiar principles of our own system. It has a base of ten, in which the nine principal numbers are each represented by a specific symbol (1, 2, 3 etc.). Their value is defined by their symbolic shape (two is 2, not 11) and next depends on their position in a string in descending order of magnitude, from left to right, *i.e.* thousands, hundreds, tens, units (for instance, in 1278 the 1 is one thousand, in 415 the 1 is ten). If a power is not represented by a number, a zero fills this space (for instance, 405 or 100). The system is so efficient and clear that it can be used directly for calculations on writing material. The Greek systems, by contrast, were used only for notation; calculations were made on counter boards and abaci, supported by mental arithmetic for multiplication (tables) and division.[14]

**Alphabetic numerals**

Greek alphabetic numerals are also known as the Ionic system for its reputed region of origin.[15] It has a base of ten and represents numbers by the letters of the alphabet, often but not always written with a diacritical sign (α' = 1, β' = 2, γ' = 3) and divided into three groups of nine signs for units (α'–θ'), tens (ι'–ϟ'), and hundreds (ρ'–ϡ'). For these 27 signs, three letters were used in addition to the common 24 of the classical Greek alphabet: the *digamma* (Ϝ) for 6, the *qoppa* (Ϙ) for 90 and the Phoenician *sampi* (Ϡ) for 900; thousands begin again by *alpha* with a different diacritical sign.[16] The numerals have a fixed value, represented by the signs and irrespective of position, always written in descending order from left to right (for instance, 1278 = ͵ασοη). Obviously, it is not easy for us to decide if

[11] Ansari (2015); Hiraiwa (2017).

[12] McCloskey and Macaruso (1995) 351.

[13] In all Indo-European languages, the words for one to ten share the same roots. In semantic-lexical terms, one, two and three stand on their own (have no relation to any other word), four may be a compound but is as yet unclear, five appears to be related to "fist"; ten may be related to "two hands", but this is not certain. Numerals above ten are all compounds, and here languages diverge in the composition of such numerals; see Winter (1992). The linguistic irreducibility of the number words one to three may cognitively be related to subitising.

[14] On counter boards and their application Lang (1957), Lang (1965), Keyser (1986), Schärlig (2001), Netz (2002).

[15] For the relation between the Ionic numerals and the Ionic alphabet, *LSAG* 326–27.

[16] The classical 24 letters were also used as ordering labels. For the allotment plates for the jury courts in Athens, which use labels for ten sections of each phyle numbered A to K, see Kroll (1972) 91. The date and context of the origin of letter labels has hitherto not been explored.

a single sign is a letter or a number, but usually combinations of signs and the context where they appear suggest the one or the other. Alphabetic numerals served as cardinals and ordinals, and they could render fractions when combined with additional signs. They were used for a wide range of purposes, such as trademarks, book numbers, notation of mathematical and scientific calculations, and in inscriptions increasingly for money.[17] In discursive texts, the transmission of which on papyrus can be traced back to the third century, alphabetic numerals are the rule, beside number words.[18] But this full, classical shape of the alphabetic system was the outcome of a long process.

What appear to be the earliest inscribed numbers in the Greek world are trademarks on Late-Geometric Greek vases, originating from all over the eastern Greek Mediterranean and found in the international trade hub of Methone, an Eretrian colony on the Pierian coast, opposite Chalcidice. Samuel Verdan tentatively proposes that these marks are numbers: single strokes for 1, V and ∧ for 5 and X for 10.[19] These signs resemble tallies, which also grew into a system of simple numerals circulating in the sixth and fifth centuries as trademarks.[20] But in the signs on the Methone vases Verdan sees influence of alphabetic writing, supporting the hypothesis of J. Walter Graham, that the signs V = 5, X= 10, 8 = 100 and Ψ = 1000 found in fourth-century Olynthus were alphabetic numerals, with a possible origin in a much earlier network connecting Lydia, Euboea, Chalcidice, Cyme in Aeolis and Italian Cyme.[21] Since also in the much larger body of trademarks in the Euboean trade down to the early sixth century studied by Alan Johnston just a limited set of such signs was used,[22] I label these numerals proto-alphabetic. The context of their occurrence fits the picture of early literacy proposed by John Papadoupolos, based on his studies of potters' marks.[23] Potters, their trade and their contacts played a crucial role in the creation and transmission of the alphabet in Greece, originating, as Benjamin Sass has cogently argued, in the meeting of Greek, Phrygian, Phoenician and Aramaic in the eastern Mediterranean.[24]

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[17] The earliest case of alphabetic numerals used as ordinals seems to be the list of regulations in the Naupaktos decree (ML 20; first half of fifth c.); the signs running from A to Θ must be Ionic numerals, since the series as rendered by ML includes H (*eta*), a letter not used in Ozolian script, and F (*digamma*), not normally included in letter labels; see also *LSAG* 106. The earliest account is probably Halikarnassos 31 (Keil (1894)) of the second half of the fifth, perhaps early fourth century (see also below).

[18] Stichometry used acrophonic signs for the number of words counted, while the sections of a manuscript were marked by alphabetic numerals; Canevaro (2013) 13.

[19] Verdan (2017). See for comparable signs also Chrisomalis (2010) table 4.1. These signs were used in trade throughout the Mediterranean and may have been adopted by the Etruscans along with the alphabet.

[20] These non-alphabetic, non-acrophonic numerals have signs of single and combined strokes for 1, 5, 50 and 100, so a ten-base with a subbase of 5. See also Chrisomalis (2010) 100, table 4.5, who labels them archaic Greek numerals, and Johnston (1979), (1982) and (2006), who labels them 'primitive'.

[21] Graham (1969). He identifies these numerals as the last four letters of the Chalcidic and Western-Greek alphabets V X Φ Ψ; *LSAG* 79–82 argues that the earliest scripts of Eretria and Chalcis were still largely the same.

[22] Johnston (1974), (1979) 27. For instances of X = 10 in the west beyond Cyme, see Johnston (2006) 17–18: Taranto 6511: a lekythos of the later 6th c. from Faggiano (Apulia), with XII III (marks may be locally made); and XII on the handle of a local amphora from Pithekoussai ca. 600, whose owner was an Apulian, Dazimos, in Pithekoussai.

[23] Unlike the trademarks on pots made in one place and found (and therefore brought) elsewhere, studied by Johnston, the pots studied by Papadopoulos were made, used and found locally. Both types of marks were nearly all made before the firing of the pot.

[24] Papadopoulos (1994), Papadopoulos (2017); Sass (2005).

The first attestations of what seem to be Ionic alphabetic numerals are again found in the trademarks studied by Johnston. The earliest case is a dipinto on the foot of a middle-Corinthian krater, dated to ca. 580, showing the signs *ΣYMI,* interpreted by Johnston as a shorthand of *ΣYM(MIKTA)* and a capital *zeta* for 7.[25] Next comes a group of black-figure hydriai dated ca. 550–525 with a dipinto of a double H (*eta*) indicating 8.[26] More examples appear on pottery from Attica and Corinth found in Etruria in the late sixth and early fifth century.[27] A particularly interesting case concerns a dipinto on a vase of the Leagros group (c. 525–500) with the number 29 in alphabetic numerals and in numerals used on Cyprus, which originated in the Near East.[28] Most of these sixth-century vases with alphabetic numerals were found in Etruria, and all numerals and other phonetic signs on them are in Ionic script.[29] Apparently, in early sixth century Ionia, a larger set of alphabetic numerals was in use, and applied to pottery for the Etruscan market.

These numbers are still low, not exceeding the tens. This is relevant when it comes to understanding the emergence of alphabetic numerals. Some scholars have supposed that the full set of alphabetic numerals originates in the seventh century, since they explain the appearance of letters not used in later Attic script, notably the *digamma* and *koppa,* in late seventh-century abecedaria from Attica by the use of these letters for numbers.[30] This inference is hard to maintain in the face of the epigraphical evidence that shows only this very limited set of alphabetic numerals in Athens and elsewhere until the fifth century. A better explanation of the abecedaria with *digamma* and other letters might be that in the seventh century the alphabets still contained various types of letters.[31]

Stephen Chrisomalis supposes that by the sixth century the full set of alphabetic numerals were used in the cities of Ionia.[32] They were inspired by Egyptian demotic numerals, developed in the late eighth century, because both demotic and alphabetic numerals have different signs for all numbers in the base and for the power of 10 (*i.e.*, nine different signs for 1–9, and nine others for 10–90), unlike most other systems in the Mediterranean, which were cumulative or multiplicative in the tens (*e.g.* 30 is rendered as 10, 10, 10 or as 10 and a sign for 3). Furthermore, Chrisomalis argues, the Greek way of writing fractions derived from the Egyptian. The spread of alphabetic numerals across the Mediterranean by the second quarter of the sixth century suggests a somewhat earlier date of ori-

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[25] Paris, Louvre, Camp. 10479, by the Detroit-Painter. See further Johnston (1973): 185–88, who estimates the date ca. 550; for a slightly earlier date, Bakır (1974): 57–58, cat. K 37, in the 'third group' of 590–575. To the first volume Johnston (2006) adds a formidable quantity of evidence, which does not, however, change the spread of numerals and the earliest attestations (Johnston 2006: 17).

[26] Johnston (1979) cat. 4D 1–3, pl. 21–22.

[27] For alphabetic numerals in pottery of the Leagros-group, see Johnston (1979) 31, and cat. 2F 27–37.

[28] Louvre F211; Johnston (1979) 31; cat. 2F 32, fig. 11d; Chrisomalis (2003) 487–88. The Cypriotic signs are a long horizontal line for 10, and a single stroke for 1.

[29] Johnston (1979) 27; Chrisomalis (2003) 488.

[30] See Langdon (1976) no. 20, and comm. on 17–18, and a mid-sixth century Attic abecedarium with sigma, san and digamma, Langdon (2005).

[31] Excavator Young (1942) surveying a large group of such abecedaria, states: "[the] alphabet was not yet established, and each individual wrote as he happened to whether through Corinth, the Euboean cities or Ionia."

[32] See table 5.2 (Chrisomalis 2010: 138), but it is unclear to me from which evidence he derives this.

gin, in the context of Ionian trade in Egypt following the foundation of Naucratis, which Chrisomalis dates to the time of Amasis (580–70).[33]

However, Chrisomalis' argument is not completely convincing because it explains neither all peculiarities nor the essential issue. First, demotic numerals show multiplicative features in the hundreds and thousands (*i.e.* adding strokes to the sign of 100 for 200, 300 etc.), derived from hieratic. By contrast, for alphabetic numerals higher than tens, still different alphabetic signs were used for hundreds, and still later multiplicative diacritical signs were applied for thousands.[34] Second, the proto-alphabetic stage hypothesised by Graham and supported by Verdan suggests a long gestation of alphabetic numerals well before the early sixth century. Third, and crucially, even if we accept Egyptian influence on alphabetic numerals in the *diversity* of signs, we still need to explain the idea of using *letters* for this, a choice suggesting that the order of numerals was associated with the order of the alphabet. Egyptian scripts did not do so, nor any other script before the Greeks that is presently known.[35] Many other cultures used alphabetic numerals, but all did so later than the Greeks.[36]

An interesting view was developed over a century ago by Bruno Keil.[37] In a discussion of what was by then the earliest evidence of alphabetic numerals in an inscribed contract from Halikarnassos of the second half of the fifth to the early fourth century, he argued that the full alphabetic numeral system must have been created in a region where the (Doric) *digamma* was in use, where and when the Ionic alphabet with Ω was accepted and where a non-Greek sound (σσ) was rendered by the *sampi.* He identified this region as Caria, more precisely perhaps the city of Halikarnassos, between c. 550–425.[38] However, this date is low considering the evidence of the vases, which points to Ionia in the use of *eta.* Keil's views nevertheless deserve further study. For understanding the degree of numeracy, it is worth noting that in the Halikarnassos contract the highest amount is 55 (NE).[39] Larger numbers do not appear on epigraphic material before the third century, when compound alphabetic numbers over a hundred become widespread also on coins.[40] The evidence suggests a development in stages of the numeral system, in tandem with increasing numeracy over time (see below).

In sum, the use of letters for numbers seems to be a Greek invention, perhaps dating back to the eighth century and belonging to the early stage of the Greek alphabet itself. In the proto-alphabetic stage, Euboean traders literally made their mark on early alphabetic nu-

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[33] Chrisomalis (2003); Chrisomalis (2010) 54–56; 140–43. However, the foundation of Naucratis is commonly dated to c. 620 based on archaeological evidence.

[34] As Elon Heijmans observed and as Chrisomalis, too, notes (2010: 54 and 45, table 2.7: hieratic numerals of the Twentieth Dynasty, to be compared with Chrisomalis (2003) 490 fig. 3, demotic numerals.

[35] Possible sources might be Lydian or Phrygian, but no numerals have so far been identified in Lydian, and only two verbal numerals in Phrygian (Polomé 1992). *Cf.* Menninger.

[36] Some systems were derived directly from the Greek. For instance, Hebrew adopted alphabetic numerals in the Hellenistic era. Other systems, such as the Gothic one, had Latin as an intermediary; for a tabled overview, Chrisomalis 2010: 135–37.

[37] Keil (1894).

[38] Keil (1894) 280.

[39] Halikarnassos 31, c, l. 46.

[40] Keyser (2018); see table 9 for hundreds in ascending order.

merals using symbols up to twenty before they joined or were replaced by the traders from Asia Minor who used a mixed-Ionic alphabetic numeral script for numbers up to multiples of ten. The limited use of only a few alphabetic numerals could have served as a basis on which the more extensive and finally the full alphabetic numeral system was anchored.[41]

**Acrophonic numerals**

Unlike the alphabetic numerals that spread widely across cultures in the Mediterranean, the acrophonic system was and remained uniquely Greek.[42] The grammarian Aelius Herodianus (second century AD) claimed that he saw acrophonic numerals in Solon's laws; hence the system also came to be called 'Herodian'.[43] We cannot be certain, however, that he saw the originals of Solon's laws. More likely they were later copies, notably the laws transcribed and edited by the Athenian *syngrapheis* between 410 and 399. Comparison with other archaic public documents rather suggests that in Solon's original laws numbers were written as number words (discussed below).

Acrophonic numerals are a 10-base system with a sub-base of 5. Numbers are represented by the first letter of the Greek word: Γ (*πέντε*) = 5, Δ (*δέκα*) = 10, Η (*ἑκατόν*) = 100, Χ (*χίλιοι*) = 1,000, Μ (*μύριοι*) = 10,000. The sign Γ could be combined with another sign in smalltype to indicate the sign multiplied by five (e.g., Γ is 50). Units were indicated by simple strokes (|||) normally used for obols; single drachmas were written ⊢⊢⊢. Like the alphabetic system, the values are defined by the shape of the signs, not by their position. Written numbers are cumulative within each power, normally in descending order. For instance, in Attic 1278 is ΧΗΗΓΔΔΓ⊢⊢⊢. Acrophonics indicated cardinals only, not ordinals or fractions. The use of a sign for 5 (Γ) may be explained by the phenomenon of subitising discused above: as we saw earlier, we need to count units of five and above. Hence, a sign for five is helpful for quick reading. Yet, as discussed below, in many epichoric acrophonics 5 (Γ) is missing.[44]

Acrophonics were used overwhelmingly to represent values of money, beside weights and measures. Money came in the shape of weights (usually silver) before it was coined. Money values needed to be divided easily, and therefore in money matters the decimal system, which is less suitable for fracturing, was aligned to a duodecimal system, which allows fraction by 2, 3, 4 and 6.[45] Such fractions appear in the subdivisions of the obol, in the equivalent of the stater to 2 or 3 drachmas, of 6 obols to the drachma and of 60 mnae to the talent.[46] Since in acrophonics fractions were not written as numeral symbols (as was

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41 For the necessity to anchor innovations on familiar knowledge to be acceptable, Sluiter (2016).

42 For the name "acrophonic," see Keil (1894) 253 n. 1. Tod (1911/12) 129–30 defended and established it as the common designation of this system.

43 Ael. Her. *Περί τῶν ἀριθμῶν*, ll. 3–6.

44 See Tod (1926) 143 for counter boards with a table for 5, showing the actual use of the subbase.

45 Lang (1965) argues that in the accounts of the Other Gods a refined system of calculating interest was introduced: "individual principals were rounded off *to the nearest multiple of three* so that the roundings-off upward and downward would for the most part cancel out (…)." (226; emphasis added). For an adjustment of a decimal system to a duodecimal as the base of coinage in later Roman times, see Wigg (1991).

46 The 60-base system was prominent in Mesopotamian mathematics, which were of great importance to Greek mathematics, but Mesopotamian numerals had no influence on Greek ones; see Chrisomalis (2010) 228; Crump (1990) 45.

the case in alphabetic numerals) but appeared only as single, smaller units (½ obol, chalkous), it is plausible that acrophonics were originally meant to write amounts of money. In the classical era, acrophonics indicated sums of money by default. When used for weights and measures, this was added explicitly (*stathmos*).[47]

The first evidence of acrophonics is found in the sixth century, again as trademarks on vases. Several Attic black-figure vases from Etruria and dating to the second half of the sixth century, the oldest of which is a hydria decorated by the Euphiletos Painter, all carry the sign Γ|.[48] A neck-amphora of ca. 520–10 shows the glaze dipinto numeral ΔΔΔΓ||||.[49] What did these numerals refer to? In order to distinguish prices from other uses, Johnston refers to a group of Attic black-figure and red-figure vases dating ca. 510–460, some with 'archaic' numerals, others with the Etruscan numeral for fifty, and many with the letters ON (all graffiti).[50] On a vase bearing TI (= *τιμή*) and the number 7, it must be a price,[51] and likewise a skyphos at ¾ obol, hydriai of 4 and 7 obols, and belly amphorai of 5 and 7 obols.[52] It is hard to decide whether single Γ and Δ are numerals or letters.[53] But on comparison with the other evidence, the signs Γ and Γ|, which could be the initials of a personal name, are more likely to be the acrophonic numerals 5 and 6, notably prices.[54] Other, higher numerals such as the ΔΔΔΓ|||| rather indicate a batch or a measure, while ON might be shorthand for a form of *ὠνέομαι* (to sell). Most trademarks are pre-firing, but who added them to these wares and for whom is not always clear.[55] The Etruscan numeral in this group confirms that these numerals were used in the international trade between Athens and Etruria and Southern Italy. In this trade, Ionians were prominently involved, but also others, such as Etruscans, Aeginetans like the merchant Sostratos, and Athenians themselves.[56] The presence of Γ suggests, but cannot prove an Athenian hand to the exclusion of other scenarios.

The comparative evidence closest to this trade material consists of five (sets of) items dating to ca. 500–480. The first is a lead plaque from Rhamnous in Attica, of ca. 500,

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47 For gold and silver objects, weights and values had to be differentiated, *e.g.* in inventories of temples at Athens in the fifth and fourth centuries; *e.g.* *IG* I$^3$ 128 (ca. 440?) weight (*σταθμός*) in silver; *IG* I$^3$ 129: inventories of the Tamiai, ca. 434, weights of phialai in silver; *IG* I$^3$ 467 account of the golden nikai, ca. 430, their weights in gold; etc. Tod 1936/37 no. 25: dedication in Thebes by women. Measures: *e.g.* *IC* IV 143 (Gortyn, fourth c.); content of a pithos (Tod 1926/27 no. 60a, Callatis); distance on boundary stones in Priene (*IPriene,* 153–155 with Tod 1911/12 no. 55). Plots of land in plethra: Koutsopodi (near Argos) *IG* IV 553 (mid-fifth c.?); Argos, Heraion, *IG* IV 523–525 (fourth c.?) = Tod (1911/12) no. 4 and 5. Rare exception: *IG* II$^{3,}$ 1 370, col. II l. 73–74: *τὴν δὲ βουλὴν τοὺς* Γ.

48 Johnston (1979) cat. 2D 1–9; the hydria by the Euphiletos Painter is Munich 1703, *ABV* 324, 26.

49 Johnston (1979) cat. 17B 4, Palermo 1908, fig. 5a (referring to 17B 3).

50 Johnston (1979) cat. 10F, with discussion 226–27; 2006: 22–23 for a full list. Archaic numerals: Johnston (1979) cat. 10F 4, 5, 7 and 21; fig. 12 n, m, k and p. Etruscan numeral 10F 1, pl. 7.

51 Johnston (1979) 227; the vase with TI is 10F 22, a neck-amphora by the Berlin Painter (Oxford 1930) 169.

52 Johnston (1979) 33; all prices noted here are until ca. 480.

53 Johnston (1979) 28.

54 Comparison: Johnston (1979) cat. 1B 7, a skyphos by the Theseus Painter (Syracuse 52263) ⊢Γ; 1B 8 Taranto 20198, a cup of ca. 510–500, Γ||.

55 See also Johnston (1979) 33.

56 Etruscans and others: Johnston (2006) 28. On Sostratos, whose mark SO is found on 95 vases, and whom Herodotus mentions (4.152) as an exceptionally successful merchant, Johnston (1972) who dates him to the late sixth century.

with an account of money owed under auspices of *epistatai,* probably of the sanctuary of the goddess Nemesis.[57] Lead was a soft, cheap material that could easily be inscribed, re-used and stored, and nearly imperishable until re-use, unlike wax tablets or papyrus, making it ideal for loan contracts and accounts. In the Rhamnous plaque, the acrophonic numerals used are 1, 10, 50, 100; the 5 is absent, probably because the amounts here did not need one.[58]

The second set of evidence consists of eight such plaques from Corcyra, also of ca. 500, with contracts of private debts.[59] Amounts are written both verbally (ϝεξεϙοντα) and in acrophonics, with the numbers |, Δ and H; the numbers for five and fifty are clearly missing. That is also the case on the third item, a *horos* stone of just slightly later date in a sanctuary at Corinth, setting a fine for trespassers at eight obols.[60] The fourth item, a vase of about the same date, shows twelve Δ's and ||| (= 123), *i.e.* without using H for hundred.[61] Finally, a bronze weight in the British Museum of uncertain provenance, possibly Sybaris, tentatively dated by Johnston between ca. 550 and 475, is inscribed with the number 75 (ΓΔΔΓ in a local script).[62]

In sum, it appears that acrophonic numerals were circulating by the mid-sixth century, when a few numerals (| = 1, Γ = 5 and Δ = 10) are attested as trademarks in the Mediterranean trade of Attic vases. By the last decades of the sixth century, the system also comprised H = 100, combinations of Γ with the powers of ten, 1 drachma usually written ⊢, and ½ obol = C, attested in slightly diverse versions in Rhamnous, Corcyra, Corinth, and probably Southern Italy. For this epichoric diversity, an origin of the system must be projected several decades back in time, perhaps not far from the first appearance of acrophonics in the trademarks. An origin of acrophonic numerals ca. 550 is therefore not implausible. After 500, they are found all over the Greek world, combining basic similarity with epichoric diversity,[63] and they were used overwhelmingly for amounts of money in decrees and accounts. In the fifth century, more signs (X = 1,000, T = 6,000 and M = 10,000) are attested in Athens and elsewhere.

Chrisomalis proposes that acrophonics were created in ca. 575–550 from Etruscan numerals on the Italian peninsula and Sicily with some Phoenician influence; he ascribes the subsequent spread and disappearance of acrophonics to the rise and fall of Athenian dominance between 450 and 300.[64] Both views seem unconvincing. Nearly all these vases

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[57] Petrakos (1999) no. 181; *IG* I$^3$ 247 bis; Blok (2010).

[58] The amounts: for Neokles 162 (HΓΔ⊢); for Pythodoros 161 (HΓΔ⊢); for Teisamenos 100 (H).

[59] Calligas (1971); for the date, *LSAG* 232, 234. no. 1: HH|; no. 2: HΔΔΔΔΔΔΔ; no. 3: ϝεξεϙοντα; no. 4: H|||||||||⊢; no. 5: HΔΔΔ|||||||; no. 8: H|. Ordinals in the feminine genitive probably refer to tribal subdivisions. The sign for five Γ appears in Corcyra later, see below note 67.

[60] Corinth 8,1 22 = Meritt (Corinth); *cf.* Tod (1926/27) 142 (2A); (1936/37) 238. The eight (obols) are written here as ||||||||.

[61] Paris, Cab. Méd. 244; fig. 13n; Johnston (1979) 223–24. He gives no specifics on this vase, but on comparison with the Panathenaic vases of his cat. 4F of ca. 500–470 he supposes that the numbers represent measures of oil. Next to this acrophonic number are two signs which could be either the number eleven in the (proto)alphabetic numerals *chi* and *iota,* or the letters *psi* and *iota* (in Ionic) as initials of a personal name.

[62] Johnston (1975) 366.

[63] Dow (1952): 23: 'acrophonic numerals [are] a measure of Greek separatism'.

[64] Chrisomalis (2010) 103–105. Phoenician influence would appear, according to Giuseppe Nenci (1995), in

were not made in, but traded to Italy, and most numerals were added before firing. Neither Etruscan nor Phoenician numerals have any similarities with acrophonics.[65] If the various epichoric numerals were all derived from or adapted to Athenian numerals, one would expect them to include the Γ for five and the combined signs for 50, 500 etc., because with these signs a system is more efficient. In some poleis, notably smaller ones dependent on Athens, including Keos, Paros, Naxos, the Attic numerals indeed appear.[66] Yet a sign for five is also attested in cities with weaker or no ties to Athens, some with signs for five that differ from the Attic one. In some poleis there is no sign for five, but there is one for fifty, and in others all signs for five and powers are lacking.[67]

Yet, because acrophonics originated in an area where the obol was the standard unit,[68] and because the earliest acrophonic numerals appear on Attic wares, including the Γ, while Euboean and Ionian trade already had their own 'archaic' and alphabetic numerals, Athens might be the place of origin. Spread of literacy throughout society in the sixth century is attested at Athens in the graffiti made by herders in the Attic countryside.[69] The evidence is too scarce to make this a solid conjecture, but it is sufficient to suppose that other poleis did not necessarily adopt Athens' model wholesale, but developed their own varieties.[70] To get closer to the appearance of all numerals, we need to scrutinise their cultural and social context more closely.

**Numerals and formats**

Until the late sixth century, extant inscribed numerals are limited to units and multiples of ten. These numerals are preserved on durable wares (mainly pots) of modest value and they circulated among traders, for whom presumably such limited numbers were sufficient. By the late sixth century, (acrophonic) numbers rise above a hundred, and above the thousands in the fifth century. Is this early, restricted numeracy typical of traders alone, or representative of Greek society more widely? And how can we trace the degrees and social contexts of numeracy?

Obtaining a realistic picture of how numbers were used is complicated by their uneven presence in the various types of sources. Many scholars assume that alphabetic numer-

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Decree A1 of Entella (Sicily), of ca. 250, see (http://lsa.sns.it/index.php?id=109) where acrophonic numerals are written ascending from right to left. For Athens Chrisomalis relies on Tod (1911/12) 128, who had no evidence of acrophonic numerals earlier than the mid-fifth c.

65 Chrisomalis admits as much (2010: 100) when he notes differences between the archaic and Etruscan signs on the one hand and acrophonics on the other.

66 Tod (1911/12) no. 30 Keos, no. 31 Paros, no. 35 Naxos, a counter board (*IG* XII 5, 99).

67 A sign for five: Tod (1911/12) no. 3 Argos, no. 5 Argive Heraion, no. 6 Nemea, no. 18 Thebes, Thespiae, Orchomenos (but unlike the Attic five), no. 26 Akarnania, on a counter board (but unlike Attic five), no. 27 Corcyra, no. 55 Priene. No sign for five at no. 4 Koutsopodi, no. 7 Epidauros, no. 36 Amorgos, on a counter board. On p. 113, fig. 4: a Γ present at Corcyra, Carystos, Naxos, Thera, not on Kos, but Ꟊ is present; the same occurs at no. 51, Smyrna. See also Tod (1911/12) 130–31, supposing that the sign for five was 'regarded as least necessary', but once one tries to count the strokes in the fine at Corinth (above) to get the amount one is facing, redundancy does not seem the most plausible explanation.

68 Keil (1894) 254–55.

69 Langdon (2015). In other poleis, literacy probably spread likewise.

70 Even within Attica itself there is some variation: Tod (1936) 237–38 notes that in Rhamnous (*IG* I$^3$ 248) multiples of 6,000 are not rendered in talents (T), as in Athens, but in strings of M (10,000) and X (1,000).