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Living by the Clock II: The Diffusion of Clock Time in the Early Hellenistic Period

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Summary: By the mid-second century BC, and possibly even earlier, clock time was widely known: from Rome to Bactria, from rulers to men of modest means. This is striking, as Greco-Roman clock time was not fully conceptualized until 300 BC. In this article, I aim to explain its rapid diffusion, by examining which groups in society were the first to adopt clock time and how they communicated the concept and its related practices to others. I make use of Everett Rogers' model of the diffusion of innovations, which identifies various adopter categories and their typical characteristics. I identify two groups of early adopters of clock time. Firstly, there is the cosmopolitan elite at the intellectual hubs Alexandria and Athens. Through the travels and written word of this mobile group, the idea of clocks as prestige monuments and the use of clock time for precisely scheduled parties rapidly gained traction in other urban centers. The more important early adopters were, however, Hellenistic soldiers, in particularly the Ptolemaic cleruchs. Armies already had a tradition of carefully keeping track of time. Because they relied on the direct participation of a considerable portion of the male population, armies had direct ways to communicate usage of this innovation to a wide section of the non-elite population. Via mercenaries, military practices could also easily spread from one Hellenistic army to another. Back at home, the soldiers took their temporal regimes to (among other places) the gymnasia, which played an important role in teaching the artificial concept of clock time to the next generations.

Keywords: Clock Time, Hellenistic, Diffusion, Army

Introduction

In a 2021 article in this journal, I argued that the Greco-Roman hour as we know it from the Hellenistic and Roman imperial period was first introduced in Alexandria around 300 BC. From this point on, hours were counted from sunrise using ordinal numbers, in order to locate events in time, which is the essential function of clock

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time.[1] These hours were seasonal: in summer, the twelve hours of daytime were longer and the twelve hours of nighttime were shorter, and in winter the other way round. I also argued that this new concept of the hour built on earlier experiments with equinoctial hours (that is hours of equal length) attested in fourth-century BC Athens, and, towards the end of that century, elsewhere in Greece.[2] Derived from astronomical divisions, this artificial subdivision of the day caught on in the mid-fourth century in non-astronomical contexts and the not astronomically trained users coined the rather vague word ὥρα for the hour. In this phase, just before proper clock time was developed, they counted ὧραι with cardinal numbers to express duration, but they did not yet have the idea of hours as fixed times. The idea was germinating, however. This is suggested by the construction of a large water clock in the Athenian agora (and a similar one at the Amphiareion at Oropos) around 320 BC. In 350–320 BC, there were only so-called equinoctial sundials to mark the (likewise equinoctial) hours. On these, sunrise made a poor starting point for counting, as the place on the dial where the first rays of daylight cast the shadow of the pointer was not fixed. The tab of the water clock, however, would always be opened at sunrise. In the late fourth century BC, the Athenian scholar Theophrastus (Fr. 159) shows that users of this clock already expected every day to have twelve hours, which suggest that they were trying to use it to locate moments in time. The passage implies some frustration that the water clock did not in fact show twelve hours every day. Theophrastus did not yet understand that the core of the problem was not the functioning of the clock, but the underlying concept of equinoctial hours. By the beginning of the third century, this realization came when Alexandria took over from Athens as the major center of astronomy and engineering. Here the confrontation with the Egyptian seasonal hour helped astronomers to reconceptualize the Greco-Roman hour as seasonal and inspired them to create concave sundials correctly measuring these seasonal hours. Soon after, they adapted water clocks to mark the seasonal changes as well. By this point, the civil practices, instru-

1 The habit of physically numbering the wedges between the hour lines on sundials is much later than the habit of verbally numbering the hours. The earliest datable example of a sundial with engraved numbers dates from the third century AD. See Schaldach 2021, 142–143.

2 The spread through Greece is evidenced by equatorial sundials with dials representing equinoctial hours from Oropos, Olympia and Delos: Dialface ID 235 = Schaldach i 23; Dialface ID 736–737 = Schaldach i 54; Dialface ID 708 = Schaldach ii 20. The Delos sundial was not mentioned in Remijsen 2021. All Dialface ID numbers refer to the online catalogue 'Ancient Sundials' by Gerd Graßhoff e.a. (Edition Topoi; DOI 10.17171/1-1). The Schaldach numbers (only for the Greek mainland and surrounding islands) refer to Schaldach 2021 (nrs. I 1–43 are first discussed in Schaldach 2006), which contains a more detailed discussion. In most cases, I refrain, for reasons of economy of space, from adding further bibliography (e.g. to Winter 2013) as these references can be found via the 'Ancient Sundials' catalogue.

ments and conceptualization of the hour all lined up to create a workable system of clock time.

Likewise in 2021, Karlheinz Schaldach published a detailed history of Greek sundials. He carefully analyzed all texts referring to sundials as well as all preserved examples from mainland Greece and the islands. He likewise observed a shift from equinoctial hours in the (later) fourth century BC to seasonal hours at the beginning of the third century BC under Egyptian influence.[3] His detailed survey of Hellenistic sundials, often with solidly justified improved datings, shows the ubiquity of clocks in the Mediterranean in the second century BC. A question he does not address, however, is how they became popular. Why did people want to adopt these strange new contraptions? Who inspired people to locate events in time by superimposing an artificial grid of twelve hours on the day? Schaldach's focus is primarily on clocks as objects, including their makers, commissioners and symbolic meanings; mine is on clock time, that is on the concept of locating moments in time with reference to hours that underlies the instruments and on the complex of practices that surrounds them.[4] The present article aims to explain how this innovative system for locating events in time spread across most of the Mediterranean in less than 150 years. I will do so by analyzing which groups in society were the first to adopt this custom and how they inspired others to do the same.

The Spread of Clock Time as a Process of Diffusion

As an artificial scheme for locating events in time, clock time was highly innovative. Robert Hannah has rightly pointed out that its development must have been driven by social change, but his reference to the new political landscape of the early Hellenistic period does not yet offer sufficient explanation.[5] People in the third

3 See esp. Schaldach 2021, 125–131. On some aspects of the early development our ideas diverge: he does not come to a conclusion on the meaning of *polos* in Herodotus 2.109 (see his experimental dialogue with Herodotus on pp. 22–24) and he dates the equatorial sundial from Olympia earlier, assuming, unlike myself, that the time telling function of the sundial predated its calendrical function (see Remijsen 2021). The suggestion that the time telling function of clocks was secondary to their astronomical function was also made by De Solla Price 1975.

4 In early modern studies, a shift from cultural histories focusing on clocks (e.g. Cipolla 1967 or Landes 1983) to cultural histories of clock time as a complex of practices (esp. Glennie – Thrift 2009) took place about 15 years ago. At the center of the debate is how far the growing importance of clock time (which is, in this field, all too easily identified as the time told by mechanical clocks) is linked to industrialization and can be seen as a characteristic of modernity. Improving our knowledge of clock time in antiquity can bring important nuance to such discussions.

5 Hannah 2009, 83.

and second centuries BC could live perfectly well without clock time, navigating through time by checking the position of the sun or the length of their own shadow, or by referring to the order and duration of common activities, as they had done before and they continued to do in many social contexts.[6] Natural and social cues offer sufficient information for communities to synchronize lives. Nevertheless, in some contexts, the artificial division of time into hours did supersede these natural and social time indicators.

By the end of the second century BC, clocks can be found virtually everywhere in the extended Greek world: from well-connected and centrally located hubs in the Mediterranean such as Athens, Delos, Rhodes and Rome[7] to minor towns such as Agrinion (Aetolia), Petres (in the interior of ancient Macedonia) and Aletrium (near Rome)[8] as well as on the periphery of the Greek world including Bactria.[9] They could be seen in public settings, such as agoras, temples and gymnasia, but also in private houses.[10] The surviving examples range from large monuments such as the Tower of the Winds in Athens to small, even portable objects.[11] Sundials were not

6 For the use of human shadow lengths as temporal markers, see Hannah 2009, 75–80. A typical temporal marker rooted in social activities are references to the filling or emptying of the agora, cf. LSJ, s. ἀγορά IV.

7 For Athens, Delos and Rhodes, see Schaldach 2021, 253–261, with discussion of the main examples. For Rome, see infra.

8 E.g. Petres: Schaldach i 39 = Dialface ID 217. Agrinion: Schaldach i 57 = Dialface ID 414. The latter was too faulty to be used. Schaldach supports his convincing suggestion for a date in the third or second century BC for these two concave sundials with typological arguments (the decorated base that becomes normal from the mid-second century BC is missing) and with reference to the archaeological context (the abandonment of the settlement at Petres in the first century BC and the date around 200 BC for the building in which the Agrinion example was found). The setting up of a *horologium* at Aletrium is recorded in CIL X 5807 (150–90 BC), cf. Schaldach 2021, 173–174, who includes a translation.

9 Dialface ID 418, 419 = 770.

10 Winter 2013, 183–207; Schaldach 2021, 146–148. Public architecture is generally better studied than private housing, so more surviving examples can be identified as coming from public contexts, but even in the Hellenistic era, sundials were also common in private houses. It is relevant in this respect that 15 of the 22 Hellenistic sundials from Delos that can be linked to a specific location belong to private contexts. See Schaldach 2021, 255. For inscriptions recording the dedication of a clock (e.g. IG Cyrenaica 063800 = SEG XVIII 739, about a clock dedicated by the *ephoroi* of Kyrene) a public context can be presumed.

11 See Kienast 2014 for the Tower of the Winds (ca. 100 BC). Vitr. 9.8.1 (late first century BC) mentions unspecified and now lost Hellenistic writings about hanging portable sundials. No Hellenistic examples of such sundials have survived, but we do know of miniature sundials. A rare ivory example (Dialface ID 317) was found in a private house at Tanis (Egypt), and can be dated to the first century BC on the basis of the objects that were found with it. For a discussion of the archaeological context see Evans – Marée 2008, 10–13.

rare anymore: in cities with a rich material record from the Hellenistic period, multiple clocks are documented.[12] That people were inclined to set up clocks in various settings indicates that clock time had spread to a wide range of users, both in terms of geography and of demography.

The clustering of the Hellenistic sources in the late second and first centuries BC cannot, however, be taken as evidence that it was only in the course of the later second century BC that clock time really took off, as part of the problem is the source record itself. The archaeological evidence is naturally skewed towards the later Hellenistic period. A substantial number of the Hellenistic sundials have been found on sites that declined rapidly at the end of the second century BC or in the course of the first century BC; sites with similar third-century clusters of material are rare.[13] But among the earlier sundials are those from as far away as Ai Khanoum in present-day Afghanistan. This was a new foundation of the early third century BC that was abandoned in the mid-second century BC. Here, two high quality pieces adapted to the latitude of the site have been discovered. Exact dates cannot be given, but the archaeological circumstances offer a *terminus ante quem* of ca. 150 BC.[14] Also the sundial from Dimale in Illyria (modern Krotine in Albania) is notable in this respect, as this town was likewise peripheral to the main Greek communication networks. The accompanying inscription, dated to the late third century or second century BC, mentions that it was constructed by a specialist from Tarentum.[15] These early examples of sundials and the knowledge surrounding

12 See n. 7 and 13.

13 The best example is Delos, a city from which we have more Hellenistic sundials than from any other; Schaldach 2021, 627 lists no fewer than 27 Hellenistic sundials. This city flourished as a center of trade in the second century BC, but rapidly declined after the destruction by Mithridates VI in 88 BC. These destructions and the temporary abandonment of parts of the city preserved Hellenistic clocks that are lost in many other cities where Hellenistic structures were replaced by Roman-period ones. Another good case is Ai Khanoum in Bactria which was founded as a new Seleucid settlement around 300 BC but abandoned when the Greco-Bactrian kingdom collapsed in 145 BC. One of the two sundials found here is a further development of the traditional equatorial sundial, in which the winter and summer dial are brought onto the same plane by drawing them on the inside of a cylinder, and adapted to seasonal hours. The rare circumstances of preservation explain why it is in Ai Khanoum that the only example of this specifically early Hellenistic type was found (single dials were increasingly preferred). See Dialface ID 419 and 770, with references to further literature.

14 See n. 9 and 13.

15 Dialface ID 390. Inscription: SEG XLV 685. See also Schaldach 2021, 122. A sundial from Istros on the Black Sea (Dialface ID 45) which has previously been dated to the third century BC on the basis of the shapes of the letters would likewise fit in this list. Alexander Jones (2014, 181), however, has already critically observed that he sees no letter forms on this fragment that would be impossible to date to the second or first century BC.

them having spread widely both to East and West presuppose that the diffusion of clock time must have been well on its way in the third century BC in more central locations.

Unfortunately, completing the picture with the help of literary works is virtually impossible, as few longer literary works from the third and early second century BC have survived. This also means that new discoveries can substantially alter our views. It is telling that the new Posidippus epigrams (from the second quarter of the third century BC) brought us the first literary evidence of the new word *horologion* for sundial (via the verb ὡρολογέω), which previously was not attested before the mid-second century BC.[16]

Because of the scarcity of third century BC sources, the early users of clock time inevitably remain mostly out of sight. But we can identify some, and sociological models can help to question their role in the spread of this new custom. My analysis will make use of the model of Everett Rogers. It was developed for studying the diffusion of 20th century innovations, but his focus on communication strategies is also useful for analyzing ancient diffusion processes, as these too depended on the successful communication of new ideas and practices. Diffusion is defined by Rogers as "the process in which an innovation is communicated through certain channels over time among the members of the social system".[17] The whole Eastern Mediterranean, where Greek became the main language in the public sphere in the aftermath of the conquests by Alexander, can be regarded one social system. There was intensive contact between the communities across this large area, not

16 Posidippus, Ep. 52. See Danielewicz 2005 for an interpretation of this poem. This epigram refers to the sundial itself as a σκιό[θηρον], a much rarer term which in later Roman-period works is identified as an early Greek term and associated with scientific usage. Schaldach 2021, 57–58 suggests, therefore, that *skiotheron* was the technical term for sundial in use in third-century BC Alexandria, and that the word *horologion* arose only in the second century BC as the more generic term. He (62) accepts as the earliest attestation for the word *horologion* FGrH 369 F1, a fragment of what appears to be a Hellenistic *periegesis* of Athens preserved via a second-century AD papyrus (P.Hawara 81). All his other examples are second-century BC or later. Even though the location of a sundial at the harbor Piraeus and the traveler's need to explain what it does (indicate each hour by its shadow) would fit the situation of the early Hellenistic period neatly, the date of a fragment by an unidentified author is necessarily conjectural. The main problem with Schaldach's hypothesis is that Posidippus was not a technical writer, but a poet who chose words to fit the meter of his poem. Once the neologism ὡρολογέω (telling the hours) existed, as it clearly did in early third-century Alexandria, it is such a small step to substantivizing it to ὡρολόγιον (the thing that tells the hours), that we must assume that both words appeared around the same time in the third century. Fragment 2.14 of the mid-third century Athenian comedian Bato (from his *Androphonos*) already uses ὡρολόγιον in the sense of a water clock (a character is constantly tracking the oil in his flask, as if it were a water clock).

17 Rogers 2003, 5.

only via the monarchs who bound many poleis together in large kingdoms, but also through peer-polity interaction across territorial borders.[18] This social system also extended into Italy: it had included southern Italy since the archaic period and by the third century BC there was also increasing contact between Greek communities and Rome.

Within a social system, Rogers identifies five adopter categories: innovators, early adopters, early majority, late majority and laggards.[19] Each adopter category has access to different communication channels.[20] For our current purposes, the earlier adopter categories are of most interest, as they were essential for spreading clock time to a socially diverse group of users across the Mediterranean cities and villages (i.e. the early majority). Unlike today, however, clock time never became standard. In several areas of life, the practice remained uncommon, in the lives of non-elite women to name but one example.[21] As there remained large groups in the Hellenistic and Roman imperial social system that barely used the hour, one could say that the diffusion of the hour stagnated at the phase of an early majority of users. But it reached this early majority rapidly, as we shall see: within two generations in Egypt, and probably not much later in the rest of the Mediterranean.

In the following sections, we will start by identifying the innovators, and then move to the early adopters and early majority. In each section, most of the attention will be on Egypt. This is not only the region from which the fully-formed concept of clock time spread, it is also the findspot of a group of sources that Schaldach did not fully include in his overview, and that will turn out to be essential for identifying the shift from early adopters to early majority: documents on papyrus.

The Scholars of Athens and Alexandria as Innovators

The first group of people within the Greek world to divide the path of the sun into twelve parts were astronomers. As I discussed in my previous article, the early evidence mostly stems from Athens, which had a strong astronomical tradition at that time. Many scholars who had trained in Athens in the late fourth and early third century ended up working in Alexandria, which was actively promoted as the new center of knowledge by the Ptolemies. It was here, as mentioned earlier, that

18 E.g. Ma 2003.
19 Rogers 2003, 282–285.
20 Rogers 2003, 211.
21 For the gendered aspects of the use of the hour, see Remijsen 2023, 165–171.

the full conceptualization of the hour as seasonal took place, once again among astronomers.

The first Greek astronomer who can be identified as having understood the added value of clock time for astronomy is Timocharis, who worked in Alexandria in the beginning of the third century BC. He recorded at what time of night he made certain astronomical observations.[22] Ptolemy gives several of his observations in his "Almagest" *(syntaxis mathematica)*.[23] Timocharis' time description as passed on by Ptolemy is quite precise: e.g. towards the end/at the beginning of the third hour or "when as much as half an hour of the tenth hour had gone by".[24] Ptolemy systematically converts the seasonal hour counted from sunset to his own system of giving both seasonal and equinoctial hours before or after midnight. On one occasion Ptolemy argues in his conversion that Timocharis must have recorded the wrong hour.[25] This debate proves that, even if we may not have the exact wording of Timocharis in the "Almagest", Ptolemy must have stayed close to Timocharis' description of the time when he records it, and that Timocharis thus used seasonal hours. In my previous article, I mistakenly identified one of Timocharis' 283 BC observations as the first evidence for the seasonal hour. In fact, Ptolemy also records observations from 295 and 294 BC.[26] These earliest attestations of numbered seasonal hours were written at least two decades before any references to seasonal hours in other contexts.

Rogers views innovators as cosmopolitan individuals with access to financial resources and geographically wide networks, who maintain intensive contact with other innovators.[27] Greek astronomers indeed traveled from one center of education to the other, and were interconnected through lasting teacher-student relationships. The contact between Athens and Alexandria must have been particularly intensive; this also applied to the scientists that actively worked with clocks. Little is known about Timocharis, but he seems to have been educated in Athens. We can infer this from the way he recorded dates. Ptolemy gives the observations of earlier astronomers in a set order: name of the astronomer, place of observation, calendrical date according to the system used by the astronomer, seasonal hour, astronomical observation. Ptolemy then converts the timing to his own dating system, i.e. the era of Nabonassar, the Egyptian calendar, and the number of seasonal and equinoc-

22 Hipparchus (second century BC) had no earlier records of observations than those by Timocharis and the slightly later Aristyllos, see Ptol. Alm. 7.3.3 (= 1.2.3 in the Teubner edition by Heiberg).
23 Alm. 7.3.25–26 (283 BC), 28 (294 BC), 29–30 (283 BC) and 32 (295 BC); 10.4.310 (272 BC).
24 Alm. 7.3.25, 28 and 29. Translation quoted from G. J. Toomer 1984, 336.
25 Alm. 7.3.30.
26 I would like to thank Bilgi Gülgeç for pointing out these omissions in an email.
27 Rogers 2003, 282–283.

tial hours before or after midnight. Timocharis' observations are always dated to the year of the first Kallippic Cycle, which was used among Athenian astronomers, and the day is given both as an Athenian and an Egyptian date. The Athenian connection is also clear when it comes to his successors at Alexandria. Aristarchus of Samos, who was a few decades younger than Timocharis, is identified by Vitruvius as important for the development of concave sundials.[28] Aristarchus was taught in Alexandria by Straton of Lampsacus, who had in turn been trained in Athens, where he also returned late in life. A few decades after Aristarchus, Eratosthenes used concave sundials in his experiment for measuring the circumference of the earth. Eratosthenes was another product of the Athenian Academy.[29] All these scholars could build directly on the ideas developed initially in Athens and adapted in Alexandria, and could pass them on to the equally mobile scholars with whom they made lasting connections.

But astronomers' contacts were not only with other astronomers. Scholarly fields were not strictly separated from each other. Many scholars had broad interests, and combined several fields. Through the peer networks of astronomers, therefore, clock time would naturally find its way to associated fields, especially to fields in which it was likewise important to make records of observations. One of the first would have been geography, which is closely related to astronomy as a field, because of the importance of the shadow length of the gnomon for calculating latitude. Unfortunately, little is known about geography in the third century BC. Geographers working in Alexandria in the second century BC certainly did use the hour, however. Agatharchides of Cnidus has been identified as the main source for the geographical descriptions of the coast of the Arabian Gulf in the work of Diodorus, which also includes observations made at certain hours of the day. Two of these observations are, in fact, about the sun, and therefore very closely related to astronomy.[30]

Another specialism which had an established habit of recording observations was medicine. As soon as it was available, keeping track of the hours became a diagnostic tool. The hour helped doctors to make more detailed reports, and on the basis of these more precise data, to make more precise predictions. An affinity with astrological phenomena for determining the seasonal factors affecting the patient

28 Vitr. 9.8.1. Cf. Remijsen 2021, 25.

29 Geus 2002, 18–26.

30 Diod. 3.15.4 (the flood tide of the Arabian Gulf usually happens around the third and the ninth hour); 3.41.1; 3.48.3 (both about the behavior of the sun at latitudes close to the equator). The latter passages are related to Arr. Ind. 25, which is based on the fourth-century BC account of Nearchus. His description is similar, but does not yet include notations of the hour.

is already observable in the Hippocratic corpus.[31] In the whole corpus, however, there is only one reference to a counted hour, namely in Epid. 4.1.12. The related second, fourth and sixth books of "Epidemics" represent a collection of case notes of multiple physicians, rather than a single text. A number of these case notes relate to a plague that struck Thrace in the fourth century BC, when the bulk of the work must have been compiled, but single passages could have been added at later points and are thus harder to date.[32] As there are no parallels further in the corpus, nor in the rest of fourth-century literature, I am inclined to date the single reference to the seasonal hour to a Hellenistic editor, perhaps even in Alexandria where a lot of such editing work took place.[33] If the manuscript tradition is correct, that is. Smith doubts that and emendated τρίτην ὥρην to τὴν αὐτὴν ὥρην, which occurs repeatedly in the "Epidemics".[34]

In the Alexandrian literature of the third century BC, we can find two references to medical advice or diagnoses specifying the hour. Machon is a representative of New Comedy working in Alexandria in the middle of the third century. References to his work can only be found in later authors with a clear link to Alexandria, so he was clearly writing to a local audience.[35] Fragment 9 relates a humorous anecdote about the gluttonous Philoxenos, who got indigestion after feasting on a giant octopus. The prognosis of his doctor was that he would die by the seventh hour. Philo Mechanicus, a military engineer from the second half of the third century BC, describes a highly calorific concoction with opium that could stave off the feeling of hunger during a siege, if eaten in small quantities at the second and tenth hour.[36] In later medical literature, the importance of the hour is very clear. In the extensive corpus of the Roman doctor Galen, for example, notations of the hour are ubiqui-

31 Hulskamp 2012, 167; Miller 2023, 40–43.

32 As already established by Deichgräber in 1933 (e.g. 169).

33 A related passage in the Hippocratic corpus is the reference to ὥρα with a cardinal number to express duration in [Hippocr.], *De morbis internis* 7.238.22–23. For this usage, there are a few parallels in the later fourth century BC, cf. Remijsen 2021, 13–14. This little-studied treatise has been attributed to a single author on stylistic grounds (Cañizares 2005), and might be from the fourth century BC, but Langholf's (1973, 383) more precise dating to the early fourth century BC (after an oral communication by Hermann Grensemann) remains unsubstantiated. Miller 2023, 43–44 finds the arguments for a classical date insufficient.

34 In the 1994 Loeb edition (LCL 477). See also Miller 2023, 44. The most interesting parallel is 7.1.25: τὴν αὐτὴν ὥρην περὶ πλήθουσαν ἀγορήν ("at the same hour, that of the filling of the marketplace"), which clearly suggests a pre-clock time context.

35 Machon's date and link to Alexandria is based on Athenaeus (14.664a–b), who calls him a contemporary of Apollodorus of Carystus (dated to the first half of the 3rd century BC) and teacher of Aristophanes of Byzantium (fl. ca. 200 BC). For a full discussion see Gow 1965, 3–11.

36 *Paraskeuastika kai poliorketika* 88.70 (B48 in the 2016 edition with commentary of Whitehead).

tous.[37] The discovery of a portable sundial among the medical tools of an oculist in a late first-century AD grave confirms that even the less-famous doctors closely monitored the time of day.[38]

Of course, scholars also had a network outside of scholarly circles. Some, like the famous Meton, who was the object of mockery in the theater, can even be regarded as public figures. Greek astronomers were part of the elite: they stemmed from families that were wealthy enough to invest in education; and they were sometimes funded by cities or rich individuals (such as the Ptolemies in the case of the Museum of Alexandria) to further develop their research. This fits Rogers' description as individuals with access to financial resources.[39] It is through their personal networks that the next significant step could be taken: the spread of clock time to non-scholarly contexts.

Urban Elites as Drivers of Geographical Spread

Because they moved in the same social circles, the lines of communication between scholars and other members of the elite of intellectual hubs such as Alexandria and Athens were short. That the leisured classes rapidly adopted clock time and applied it in their daily lives is most visible in comedy, where the new fad for keeping track of the hours by means of clocks is mocked. For Athens, I previously mentioned Menander (ca. 300 BC), exaggerating the artificial precision of hours with the word ἡμιώριον, and Timon of Phlius, one generation later, who mocked the sophist Prodicus for charging his students by the hour. It has also been pointed out that Plautus' mockery of regulated meal times in his "Boeotian Women" must go back to a play with the same name by Menander (or one of his contemporaries) which Plautus adapted.[40] To this list of Athenian comedians, one can add Bato (ca. 250 BC), who describes a character behaving as if carrying around a water clock.[41] For Alexandria, I just mentioned Machon (ca. 250 BC), whose fictional protagonist, the glutton Philoxenos, was told he was going to die at the seventh hour. Somewhat prior to this, the court poet Posidippus (270s–250s) wrote a jokey epigram (nr. 124) about a drinking party that started at the fifth hour and for which more wine quickly had to

37 For a detailed study of hourly timekeeping in ancient medicine, in particular by Galen, see Miller 2023.

38 Talbert 2017, 10–11.

39 Rogers 2003, 282–283.

40 Gratwick 1979, 309, 311–314.

41 Men. Fr. 1015; Timon Fr. 792; Bato Fr. 2.14. See also n. 16 and Remijsen 2021, 20.

be procured through trickery. Clearly, specifying the precise timing could increase the humorous character of an eating or drinking scene.

Posidippus' epigram 52, on the other hand, was not meant to have comical effect. In this short poem he describes a sundial erected on a grave. The purpose of placing a sundial on a tombstone, which is also archaeologically attested, was on the one hand symbolic (a reference to the brevity of life and the untimeliness of death) but at the same a practical means to ensure eternal memory (the passer-by would use the instrument, and be thus invited to read the name of the deceased).[42]

All these authors referring to clock time are educated members of the urban elite, as are their protagonists, who, in addition to using clock time, are lecturing, eating and drinking large amounts in the middle of the day and putting up monumental funerary monuments. The authors are clearly expecting that their literate audiences would understand what they were talking about. That urban elites quickly incorporated clock time in their lives can probably be explained by a pre-existing need for a means of making middle-of-the-day appointments – a need that rarely figured in those with a simpler existence. In Aristophanes' "Assembly-women", for example, the protagonist Praxagora tells her husband that he has to be ready for dinner when his shadow measures 10 feet, while the slaves do the work on the land.[43] Looking at a clock is clearly more practical.

In the ancient world, ideas could easily pass from the elites of one city to those of another. The higher echelons of society were fairly mobile. For the period between 350 and 150 BC this elite mobility is, for example, documented by proxeny networks. These were made up by *proxenoi*, rich individuals who hosted the (equally distinguished) ambassadors from the city which granted the proxeny. That the hosting of ambassadors was institutionalized is in itself an indicator of the frequency with which representatives traveled on diplomatic or religious missions.[44] Not only individuals traveled along such networks, but their written word did as well. Most members of the urban elites were literate. Once they had seen how clocks worked in one city, seeing practical applications of clock time in letters or literary texts would confirm the value of clock time to this group, and increase their readiness to adopt the innovation.

Communication along elite networks follows logical patterns: mostly the contacts were regional, and when they cover larger distances, this usually happened via maritime networks and through important centers. A recent study of proxeny

42 Schaldach 2021, 198 mentions a first-century BC example from Alexandria, with inscription OGIS 742. See more on this practice in Schaldach 2021, 161–162, 181.

43 Aristoph. Eccl. 651–652. A similar dinner time specified in shade length in Eubulus Fr. 119 (4th century BC).

44 For a recent study of these networks, see Mack 2022.

networks confirms that international hubs like Athens, Rhodes or Alexandria had much stronger networks than smaller and less centrally located cities.[45] Harbors in general had a favored position with regards to knowledge exchange. This seems to have been the case for clock time too: the few surviving third-century BC sundials practically all come from coastal cities. A sundial from Phalara on the Malian gulf, for which the archaeological context suggests a date around 280 BC, suggests that the idea of the seasonal hour had already traveled there, but the mathematical knowledge to show this correctly had not. A sundial of a higher quality excavated at Herakleia ad Latmum (at the mouth of the Meander in Asia Minor) has been dated on the basis of its inscription and form to the reign of Ptolemy II (285–246 BC). The inscription specifies it was made by an Alexandrian, so we can see here a direct line of communication.[46] The Topoi database of sundials contains three more sundials that have been dated specifically to the third century BC on the basis of lettering, and were, again, all found in coastal cities: one on Delos (Dialface ID 2), one at Paphos (Dialface ID 590) and one at Istros (Dialface ID 45). It must be noted, however, that all three are fragments with a limited number of letters, which offers an uncertain basis for such precise paleographical datings.[47] Istros on the Black Sea is surprisingly far from the main hubs of Alexandria and Athens to have a sundial from, supposedly, at the latest the early third century. Alexander Jones has already critically observed that, although a third-century date is possible, he sees no letter forms on this fragment that would be impossible in the second or first century BC.[48]

Another early third-century clock is recorded through Pliny. He names two candidates for the earliest sundial of Rome. The first is a sundial that was supposedly set up as early in 293 BC by L. Papirius Cursor.[49] Pliny is skeptical about this option, however, because he found no supporting information (such as a source, a

45 Mack 2022, 29.

46 Dialface ID 738 + 809 (Phalara) and 149 + 150 (Herakleia). Cf. Remijsen 2021, 25 for literature on the date.

47 The one from Delos was, moreover, found in the agora of the Delians, which was constructed in the second century BC. That Delos had a sundial in the third century can hardly be doubted, however, as the city had a whole range of them by the second century BC. Schaldach has more convincingly dated Dialface ID 708 (also Delos) to the third century BC, as this is an equatorial sundial for equinoctial hours, which suggests that they were inspired by Athens. Although a much better preserved text, also I.Pergamon I 183, which records the construction of a water clock on the agora of Pergamon, has been dated variously from the third century BC and to the late Hellenistic period. Cf. Winter 2013, 468–469. Without text, dating is even harder, see e.g. Dialface ID 107, dated by Winter 2013, 294 to the third century, but by Schaldach 2021, 405, 150–50 BC.

48 Dialface ID 45; Jones 2014, 181.

49 Plin. nat. 7.213–215.

maker or provenance). As this date is earlier than any of the known sundials for seasonal hours – Berosus and Aristarchus, working in the first quarter of the third century, are said to have developed the design – this does indeed seem suspicious. There are no reasons to doubt his second anecdote, however, namely that a sundial was set up in Rome in 263 BC by M. Valerius Messala. He adds that the instrument was part of the spoils from Catania. Pliny explains that, because it was adapted to the latitude of Sicily, time was not told accurately in Rome until a better sundial was set up 99 years later. It is doubtful, however, whether anyone actually noticed this imprecision, or found it to be a problem.[50] More interestingly, the anecdote implies that for some years before 263, Catania in Sicily, again a port town, already had a custom-made sundial adapted to its location. It likewise shows that by 263 BC, the Roman army commanders overseeing the plundering of Catania – generally men of the senatorial class well-versed in Greek literature – understood the function of the instrument and wished to set it up in a Roman context. As mentioned before, Rome was an integral part of the social system of the Greek world.[51]

If we can believe Plautus (born around 250 BC), more sundials were set up in Rome by the end of the third century and by then at least part of the population started to pay close attention to them. In a fragment from "The Boeotian Women", a character complains that the city is full of sundials, and people have become slaves to them, eating dinner only when the clock says it is the right time to do so, and that this was not the case in his youth (and presumably not in Plautus' youth either).[52] This play is, like many Plautine plays, probably an adaptation of a Greek comedy of the same name, but the incorporation of this particular scene would only have worked if it was recognizable for his second-century Roman audience. Three times in this fragment, Plautus refers to a sundial as a *solarium*, suggesting that Latin coined its own word for this new instrument, which by the second century BC was superseded by the Greek loan word *horologium*.[53] Although we do not know the full content of this character's complaint, he is characterized by Aulus Gellius as

50 It is interesting in this respect that early mechanical clocks (invented ca. 1300) were so inaccurate even in the 17th century they would still tell the time differently throughout the city (and would be reset with the help of sundials). Here too there was more interest in adding showy effects than in improving their precision. Cf. Cipolla 1967, 43–46. Jones 2019, 137–143 studied the Catania-Rome case in detail and concluded that the displacement would have more strongly affected the calendrical function of the sundial than its function as a clock.

51 Mack 2022, 29, 32 shows on the basis of proxeny decrees (mostly stemming from 350–150 BC, i.e. the relevant period for our discussion) that Rome comes third after Athens and Rhodes in terms of centrality within the network.

52 Preserved in Gell. 3.3.5. He describes the character who is complaining as a *parasitus esuriens*, a hungry parasite.

53 For the term *solarium*, see also Schaldach 2021, 68–73.

a parasite: a stock character who wants to get free meals and for this reason tries to attach himself to his social superiors. In Plautus' *pseudolus* (1302–1304) we find another time related joke assuming good understanding of seasonal hours among the audience. The titular character is said to be able to drink four harvests of wine in a single hour and adds "make that a winter hour!". The connection between hours and feasting is reminiscent of contemporary Greek comic texts. This suggests that not only had the idea of clock time spread to Rome, but also its literary associations.[54]

So, at the latest by the 260s, the idea of clock time was spreading via the cosmopolitan elites of Athens and Alexandria to harbor cities along the Mediterranean. The sources discussed so far mostly point to a well-off and educated community of users. The elites of well-connected urban hubs enjoyed a high level of social standing, an important characteristic of early adopters in Rogers' model. This does not yet prove, however, that they were indeed those primarily responsible for spreading the innovation to a demographically more diverse community of users. We first need to establish what routes of communication are most compatible with the details embedded in the primary sources for the early majority.

Towards an Early Majority via the Army and the Gymnasium

That the innovation trickled down equally quickly to non-elite sections of the population is clearest in Egypt. In the chora, the inland of Egypt, non-elite Greek men were using clock time by the 250s. There are five documents mentioning a numbered hour from the 250s and the 240s: an administrative document from a postal station (P.Hibeh I 110, 259–253 BC) in which movements of couriers are recorded by the hour; a letter from the high-ranking Ptolemaic official Apollonios to his estate manager Zenon, under which the latter noted the time of arrival (P.Lond. VII 1973, 254 BC); an administrative note explaining that another letter was written at the second hour and handed off to the guards (P.Cair.Zen. II 59214, 254 BC); a note by a potter to the aforementioned Zenon (his archive forms the largest group of documents from Hellenistic Egypt)[55] stating that letters had arrived at the eleventh hour, but that the ship had not yet arrived (P.Cair.Zen. IV 59611, ca. 250 BC); and a letter to a local policeman ordering him to arrest someone if this person did not

54 For a fuller recent discussion of the Plautus passages see Ker 2023, 25–26, 32, 41–46.
55 For an accessible introduction to the archive, see Clarysse – Vandorpe 1995.

pay before the sixth hour (P.Hib. I 60, ca. 245 BC). Also of interest is P.Petr.Kleon 17 (257 BC), in which an estate manager complains that the architect Kleon did not come by for "a part of an hour" (l. 4: ὥρ[α]ς μόριον) to check the irrigation system. All writers of these documents are male and Greek. Their positions in society are diverse. Zenon is a man of influence, the manager of a large estate belonging to one of the most powerful men in the country. The potter and local administrators are, however, of much lower social standing.

The Greek males from lower social strata using the hour in their professional communication in the 250s BC can be identified as an early majority. But which early adopters inspired them to adopt clock time? Rogers identifies early adopters as individuals with a powerful local reach: unlike the cosmopolitan innovators, they are localites who serve as role models for other members of the social system.[56] Can we identify the Alexandrian high society, who used the hour in the time of Posidippus (270s–250s), i.e. before the early majority was reached, as the early adopters who inspired the Greeks in the *chora*?

The Alexandrian high society certainly enjoyed prestige, but it is not clear how, living in cosmopolitan Alexandria, they could have directly influenced opinions in the local communities in the *chora*. For some of the men from the documentary papyri a direct line of communication with Alexandrian high society can of course be identified. For example for Zenon, who managed the estate of the high-ranking Ptolemaic official Apollonios. When interacting with his employer and his acquaintances, he moved exactly in those Alexandrian circles where clock time had been quickly embraced. But this is not enough to identify the Alexandrian elite as the driving force behind the wider spread of clock time in the *chora*. The lines of communication between Alexandrian high society and most Greek males in the countryside were sporadic and indirect. Some locals would of course have visited Alexandria, and would perhaps have noticed the first clocks appearing in the urban landscape there, or interacted with people who already used clock time, but it is unlikely that such occasional encounters inspired them to adopt this new concept of time as part of their own lifestyle. Some Alexandrian socialites also owned estates on the countryside, and would have brought their concepts of time along on occasional visits, but apart from the servants who had to prepare their meals, few locals would, again, have been directly affected by this.

To understand the diffusion to the early majority we should instead be looking for a context in which the Greek males who ended up as small property owners on the Egyptian countryside had a chance to interiorize clock time. An option that could be considered is the temple, as some of the earliest clocks in Greece are found

56 Roger 2003, 282–283.

in the context of temples.[57] An inscription from Delphi dated to 160 BC attests the use of clock time for ritual purposes in Hellenistic Greece.[58] In Egyptian temples, moreover, seasonal hours had been used for more than a millennium before the Greeks adopted this idea, and their ritual observance of clock time continued into the Ptolemaic and Roman periods.[59] However, whereas the simultaneous appearance of clock time in urban and temple contexts in Greece can be explained by the fact than the same elite families who performed priesthoods also filled political offices, this overlap did not exist in Egypt. The Greek immigrants who started using clock time did not perform rituals in the Egyptian temples, which in the early third century were still bulwarks of the traditional Egyptian elite.[60]

A hint at where to look for an alternative context is already embedded in the early documents themselves: clock time was almost exclusively used as an element of reporting. In the majority of the documents from the 250s and 240s, the authors use the hour to report the timing of the arrival or sending of messages or of an important event. More evidence for this predilection for the hour in reports can be found later in the third century BC (SB VI 9068: a petition about burglary and assault at the second hour of the night; P.Petr. II 10: a letter of a secretary who deposited accounts in an office at the first hour and then was arrested; P.Sorb. III 133: a petition about a robbery at the tenth hour). The use of hours in reporting was also typical of the early scientists we discussed above, but an in-between step is necessary for their practices to reach the rural population. We are, in other words, looking for a context in which males – primarily of Greek descent although this seems to cease being a factor by the end of the century[61] – learned clock time and began to associate it specifically with reporting significant events, such as the arrival of a message.

The military fits this context well. The first argument in favor is that more than half of the Greek males in the *chora* were cleruchs or military settlers. The

57 This is the case for the early sundials from the Amphiareion and from Olympia: Dialface ID 235 = Schaldach i 23; Dialface ID 736–737 = Schaldach i 54.

58 F.Delphes III.3 238, l. 9 (a procession starting at the second hour).

59 Remijsen 2021, 22 n. 71 and 72. Two traditional Egyptian water clocks from Leontopolis, presumably used in a temple context, can be dated to the reigns of Alexander and Philip Arridaeus by their names in cartouches. These suggest a ritual use of clock time in the first decades of Greek rule. The addition of inscriptions referring to Roman months on one of them suggests it was used into the Roman period. Cf. Winter 2013, 407–409.

60 Clarysse 2010, 284, 286–288; 2019, 300.

61 In SB VI 9068 and P.Sorb. III 133, from the late third century BC, the petitioners have Egyptian names, but the petitions are in Greek and were probably written by an amanuensis. But, even if the amanuensis may have chosen the exact words, they were based on the petitioner's report of the crime, including their description of the timing.

Ptolemies made immigration financially attractive to Greeks by offering them a plot of land (a *kleros*) on which to settle if they joined the non-standing army. By the end of the third century, the stream of immigrants subsided and new soldiers were increasingly recruited from the local population.[62] Four of the six attestations of numbered hours from the 250s and 240s come from the Arsinoite nome, the other two from the neighboring Herakleopolite nome. The Arsinoites, better known as the Fayum, is not only an important findspot for Ptolemaic papyri, but also an area that was densely settled with cleruchs, as new agricultural land was created there when Ptolemy II had part of the lake drained.[63]

A second argument for identifying the military as early adopters of clock time is that attention to the time of day was an established military practice before clock time took hold. In the army of Alexander the Great, military reports expressed the time during which a specific military operation took place, or when ships arrived in a harbor, by reference to the number of the watch of day or night. This is clear from a series of such time indications in the *anabasis* and *Indica* of Arrian, which are heavily based on the works of Ptolemy I and Nearchus who both had a leading role in Alexander's campaign and hence had access to (and were presumably authors of) military reports.[64] There is, moreover, explicit evidence that the Ptolemaic army switched from watches to the more precise hours in the third century BC, at least for day time. W.Chr. 1 contains part of a military report of the third Syrian war (246–241 BC).[65] On lines 17 to 19 it mentions ships leaving the harbor of Seleukeia at the beginning of the first night watch and dropping anchor again at the garrison town of Posideon at the eighth hour of the day.

It is unclear which instruments military men used to determine the hour. That the Ptolemaic army travelled with heavy marble sundials or complex water clocks is certainly unlikely, so we should probably imagine designated soldiers closely

62 The Cyrenaica, Macedonia and Thracia are best attested as regions of origin of cleruchs, but a number of poleis from the Greek mainland and islands and from Asia minor are attested as well. Having a small standing army complemented with cleruchs was financially advantageous for the Ptolemies, as they only had to pay the cleruchs when they were mobilized, but earned revenues from the land they were cultivating in between those times of mobilization. See Fischer-Bovet 2014, 166–177, 199.

63 Fischer-Bovet 2014, 202–203.

64 An. 1.23.2, 2.4.3, 3.9.2, 5.23.5, 6.7.1, 6.25.5; Ind. 26.2 (unmooring at the second watch), 27.6 (at the first watch they anchored). For Arrian's reliance on Ptolemy see the *praefatio* and Bosworth 1980, 16–27. Ptolemy is also explicitly mentioned as present in 1.23 and 5.23. Arrian is explicit about his reliance on Nearchus for the *Indica*, e.g. 19.9, but also 26.7, 27.8. The *Indica* systematically lists the various steps in the journey including distances and sometimes moments of departure or arrival. This is indicative of a reliance on military reports.

65 For an easily accessible translation of this document see Bagnall – Derow 2004, no. 27.

observing the length of shadows and the arc of the sun (and at night the stars), perhaps with the help of simple and light tools, such as small plaster sundials, shadow length tables, or simple terracotta clepsydrae emptying during a single watch.[66] Even if the results would have been imprecise, such a close observation of the passing of time could become the basis for camp routines and it are the routines that would have ingrained living by the clock in the soldier population.

How early the Ptolemaic army started using clock time is, unfortunately, hard to establish. Documentary military reports are extremely rare finds, and for this period even narrative descriptions indirectly based on military reports are missing. We can, however, take the daybook of the Ptolemaic post (259–253 BC) as reflecting military practice. This daybook, P.Hib. I 110, records the hours at which nine different packages were transferred from one messenger to another over a period of seven days. The messages are usually from or to the king or the high-ranking official Apollonios, so the purpose of the postal system was administrative. The messengers, however, seem to have been cavalrymen, so the organization does seem to have been connected to the military.[67] This parallel allows us to trace the introduction of measuring and recording the hour in military contexts to circa 260 or even earlier, that is, early enough to explain the boom of references to the hour from the 250s.

There is no comparable evidence for the military as early adopters elsewhere in the Mediterranean, but it is certainly possible that the army played a role in the initial spread of clock time across the whole region. Hellenistic soldiers were a particularly mobile group: mostly recruited from those areas where Greek was already spoken in the classical period, they covered enormous distances on campaigns and, afterwards, took all their experiences back home, or – as many did not in fact return – to the new settlements in the East. Because mercenaries were an important feature of Hellenistic armies, and mercenaries sometimes changed employer (e.g. switching to the victorious party after a defeat), military practices employed by one army could easily become known to others.[68] In such a context, the use of clock time in the Ptolemaic army could have been picked up by other armies within a decade. It is striking, in this respect, that in 263 someone in the Roman army already recognized the Catanian sundial and valued it enough to include it among

66 For a small plaster sundial from Ptolemaic Egypt see Dialface ID 448.

67 As I argued in Remijsen 2007, 133.

68 Chaniotis 2005, 82–85. Fischer-Bovet 2014, 56, 76–81, 116: The Ptolemaic army of the third century BC included Greek (esp. Thessalian and Cretan), Thracian and Galatian mercenaries. Because the cleruchs were slow to be mobilized, sudden threats would require extra recruitment of mercenaries, as for the battle of Raphia in 219 BC. In 275/274, just before the first Syrian war, 4,000 mercenaries revolted against Ptolemy II.

the spoils, although it cannot be said whether this recognition was linked to general military practice or to one well-traveled individual.

In any case, clock time was clearly an established practice of multiple Hellenistic armies in the later Hellenistic period. The detailed literary descriptions of military operations by Polybius and Diodorus indeed contain occasional hour indications. Polybius (first half of the second century BC) uses the same combination of hours for day time and military watches for night time we already saw for Ptolemaic Egypt.[69] Moreover, he mentions hours for both Roman and Achaean operations. It is likely that some of this information derives from original military reports. Because he focuses on recent history (his starting point is 220 BC) and was as a high-ranking Achaean connected to the Scipiones at Rome, Polybius would certainly have had access to such reports. Polybius even explicitly thematizes the importance of time in military strategy, in particular of knowing "the differing lengths of day and night" and of observing the times of day and night by keeping track of shadow lengths, the sun's path and the position of the stars at night.[70] Indirect evidence from Livy supports our general impression: it has been observed that he only rarely mentions the hour in his earlier books, but that the frequency picks up in his discussion of the second Punic war in the late third century BC.[71]

The few instances of hours in Livy's earlier books point at later rephrasings. Polybius similarly uses an hour once for an early fourth century BC episode about Epaminondas (9.8.5). Diodorus (first century BC) once uses the hour in a description of a siege carried out by Dionysius in 392.[72] Such episodes took place well before the introduction of clock time, and are, given the greater chronological distance to the authors, unlikely to have been based directly on military reports. They can, therefore, not be accepted at face value. Because watches can easily be translated to hours (e.g. the third hour: the end of the first watch; the eighth hour: the middle of the third watch), such remarks say little about the fourth-century situation. They can, however, be taken as evidence for the Hellenistic authors' ideas about how the timing of a military operation should be expressed.

It was as soldiers that men would have learned about clock time in the centralized setting of military training or campaigning, but it was as settlers that they

69 Pol. 1.46.6 (fourth hour); 9.8.5 (third hour); 9.17.6 (fifth hour); 9.18.1 (third watch in the night); 10.12.2 (third hour); 14.4.1–2 (first and third watch of the night); 15.29.4 (four hours); 31.14.11 (third watch in the night).

70 Pol. 9.14.6–15.15.

71 Ker 2023, 57. To explain the increased frequency Ker supposes that Livy "smuggled a new precision into his source material, colonizing the past with an anachronistic temporal schema" but this interpretation seems to be based on an underestimation of late third-century evidence for the hour.

72 Diod. 14.105.2.

were responsible for communicating this idea to others. In Egypt, cleruchs could disseminate the innovation they became familiar with on military campaigns to civilians in the Egyptian chora. Cleruchs fit Rogers' characteristics of early adopters better than the Alexandrian elite: cleruchs were clearly localites, living in the villages and cities of the chora; they were not necessarily rich, but through their link with the reigning regime, they enjoyed a degree of opinion leadership in their local communities. This would certainly have been true for the officers, who belonged to the local elites. From a slightly later period, we have a good example of how the diffusion process could work. An inscription from the Fayum from the second or first century BC memorializes the setting up of a clock (with a water basin so presumably a water clock) by a *hegemon*, a military commander, and his wife. The participation of the wife in the benefaction clearly suggests that the clock was set up in a civilian context.[73]

One institution (among other, no doubt) that could play a role in disseminating the military practice to a broader civil use is the gymnasium. Just like clock time, the gymnasium was a Hellenistic innovation. Though based on classical predecessors, the development of the gymnasium as an institution deemed essential for a town to become a *polis*, was a third-century BC phenomenon.[74] This was the place where boys from different backgrounds were trained to become the next generation of citizens through an athletic regime with a clear military overtone.[75] In Egypt, this was a space that cleruchs certainly frequented together with other Greek immigrants. The Egyptian gymnasium was not a specifically military institution, but military settlers are known to have been founders and members of gymnasia (which in Egypt are not only attested in cities, but also in villages, especially in those with a large concentration of cleruchs).[76] Clocks could be part of the facilities. An inscription from the first century BC, again from the Fayum, records the dedication of a sundial to Hermes by a former gymnasiarch.[77]

Better and earlier evidence for the connection between gymnasia and clock time can be found elsewhere in the Greek-speaking Mediterranean. Several early sundials were set up in a gymnasium context. This was the case for the two sundials (both pre 150 BC) from Ai Khanoum.[78] It is also well attested on Delos. Inventory

73 I.Fayoum III 206 = CIJ II 1351.

74 Gehrke 2007 and other articles in the same volume.

75 Kah 2007; Chankowski 2010, 380–382.

76 Fischer-Bovet 2014, 280–290; Paganini 2011, 225–227 or 2021, 70–72. A good example of a military officer founding a gymnasium in the Arsinoites is P.Enteux 8 (221 BC).

77 SEG XLIV 1448 (153/152, 141/140 or 88/87 BC). For the sundial, see Dialface ID 660. See also Schaldach 2021, 163.

78 Bernard 1975, 193 and 1976, 299–302.

lists of the gymnasium from around 160–150 BC contain three mentions of clocks, two of which are definitely different instruments.[79] In Pergamon, the Hellenistic gymnasium featured a water clock.[80] This connection between clocks and the gymnasium further developed in the late Hellenistic and Roman periods.[81]

The famous gymnasiarchical laws from Beroia of the early second century BC give a hint at the practical use of sundials in the gymnasium. This unusually detailed epigraphic regulation for the practical organization of the gymnasium of Beroia stipulates that trainers were expected to come to the gymnasium twice a day at hours fixed by the gymnasiarch (B l. 17: τὴν ὥραν ἣν ἂν ὁ γυμνασίαρχος ἀποδείξῃ) for the training of the boys.[82] If they did not turn up at the right time, they could be fined. But it was of course not only the trainers, but also the boys that had to arrive at the right hour. A few later gymnasium inscriptions also mention opening hours.[83] Gymnasia were institutions for the socialization of young men into the world of polis citizens. By the first half of the second century BC, therefore, each new generation of citizens could interiorize a lifestyle led by the clock through their education at the gymnasium.

By the time clock time became an aspect of gymnasium life, one can clearly speak of an early majority of users across the whole Greek social system. The swiftness with which this artificial way of orienting oneself in time spread to a group that was both geographically and demographically diverse can be explained well by the mobility of Hellenistic soldiers as early adopters, and by their opinion leadership in local communities once they had settled down. The enthusiastic uptake of the practice by the elite in cosmopolitan harbor cities no doubt affirmed this custom, but the reach of their social networks was not as diverse.

79 I.Délos 1412 l. 23; 1417 A Col. I l. 149; 1423 B fragm. a Col II l. 5. Schaldach 2021, 338–341 identifies Dialface ID 74 = Schaldach ii 14, which was found in the late Hellenistic gymnasium, as one of the clocks mentioned in the inventories.

80 Winter 2013, 206, 471.

81 Schaldach 2021, 163, 171, 249.

82 I.Beroia 1 B ll. 15–21. Also of interest are B ll. 1–2, which mention a flag (σημεῖον) to visually separate the periods in which the gymnasium was open to men over 30 from those in which it was open for those under 30.

83 I.Priene 68, l. 61–62 (Priene, 1st cent. BC); IG X.2 2 323, l. 2–3 (Macedonia, 1st cent. AD).

Summary

This article aims to explain the rapid spread of clock time across the Mediterranean and across different social groups in the early Hellenistic period. At the latest by the mid-second century BC (and possibly earlier) clocks and clock time were everywhere: from Rome to Bactria, from rulers to men of modest means. This is striking, as Greco-Roman clock time was not fully conceptualized until 300 BC. The early Hellenistic evidence is too patchy to trace the exact rate of its dissemination or the precise routes across which it spread, but, I argue, it contains a number of indications for groups responsible for spreading the new practice. The innovators making the necessary conceptual leaps can be found in the milieu of Greek astronomers. For their ideas to be taken up outside of a scientific context their elite contacts were important. This article identifies two groups of early adopters of clock time that saw practical implementations for this new concept and had the means to communicate it to others. Firstly, there is the cosmopolitan elite at the intellectual hubs Alexandria and Athens, who welcomed the new tool enabling better synchronization of their social obligations. Through the travels and written word of this mobile group, the idea of clocks as prestige monuments and signals of precisely scheduled dinner times rapidly gained traction in other urban centers. Secondly, the idea of clock time was also picked up by the Ptolemaic army command. Armies already had a tradition using time to structure tasks, which could now be refined. The army relied on the direct participation of a considerable portion of the male population, which means that the army had direct ways to communicate usage of this innovation to a wide section of the non-elite population. Via mercenaries, military practices could also easily spread from one Hellenistic army to another. Soldiers must have been important instigators of the further diffusion of clock time. Back at home, the soldiers took their temporal regimes to (among other places) the gymnasia, which, it is argued, played an important role in bringing the innovation to the next generations.

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