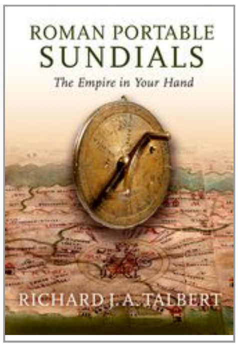


Roman Portable Sundials: The Empire in your Hand
Richard J. A. Talbert

Print publication date: 2017
Print ISBN-13: 9780190273484
Published to Oxford Scholarship Online: January 2017
DOI: 10.1093/acprof:oso/9780190273484.001.0001

Sundials and Their Place in the Roman Empire

Richard J. A. Talbert

DOI:10.1093/acprof:oso/9780190273484.003.0001

Abstract and Keywords

This three-part chapter first introduces the contexts (public and private) for the use of sundials within the Roman empire. It next outlines the thinking (traceable back to the Hellenistic period) behind the design of these instruments, which mark the successive stages of a day divided into twelve equal, “seasonal” hours from dawn to dusk. The chapter ends with a nontechnical explanation of the characteristics and functioning of Roman portable sundials, both the “pillar” type made for use at a single latitude only, and the “pillbox” and “suspended” types, which can be adjusted by various means for use across a spread of latitudes.

Keywords: Roman Empire, hour, ancient sundials, time

Because this book’s subject is in fact just *one* type of *portable* sundial in the Roman empire, at first glance it could well seem an absurdly narrow project. It is fair to say that ancient sundials are altogether little known, portable ones still less so, and this unique type of the latter in effect not at all. Moreover, a perusal of modern scholarship soon strengthens the predictable impression that sundials at any stage of classical antiquity (or later) have seldom attracted much interest for purposes beyond comprehending their operation and gauging the precision of their timekeeping.[1] Anybody willing to continue reading this introductory chapter could therefore reasonably anticipate a technical study with just this focus, lacking appeal beyond the limited circle of chronometric specialists.

To all who already feel deterred, however, let me at once offer encouragement by declaring such a pessimistic expectation mistaken. Mine is a cultural study, emphatically not a technical one. Only quite recently was it realized that the individual sundials that are the book's subject *do* together constitute a distinct type—a surprisingly uniform one in key respects—*and* that they preserve a remarkable store of detailed geographical information. Moreover, from such information it is possible to outline the geographical grasp of the makers and users of this type of sundial, and thus to gain at least a glimpse of their "worldview," the overall perspective from which they visualize and interpret their surroundings. Hence the book aims to contribute especially to the ongoing advancement of a newfound appreciation of "informal **(p.4)** geography," the elusive and varying spatial *mentalités* that inhabitants of the Roman empire somehow acquired and carried in their heads. This is a large, challenging, and important topic. During recent years, scholars have skillfully elucidated tantalizing insights into Roman worldviews from an extraordinary range of source materials not yet exploited for the purpose.[2] This book aims to extend that quest, and in so doing to recover something of the broad intellectual and social contexts within which the sundials it investigates were made and used. In other words, in its scope the book even ranges beyond geography and timekeeping to tap into the values, preoccupations, and imagination of at least part of Roman society empirewide. The prospect that such tiny instruments can prove so revealing may seem farfetched, but it is nonetheless realistic; we truly can recover something of the mentalities that they reflect.

1. Sundial Environment

Any educated persons today who could magically return to experience for themselves life in Rome's vast empire during the second century CE (see Map 3.1)—its most prolonged spell of peace and prosperity—would soon become conscious of three broad features that underpin the present study**.** First, those among the empire's sixty million or so inhabitants who might be termed educated by the standards of the period—a limited elite among the population, though not tiny in number[3]—shared two principal languages, Latin and (in the East) Greek, which were both spoken and written. Second, this elite also shared a deeply embedded traditional concern to calculate, record, and control time—both longer-term (days, months, years, even centuries), and shorter-term (divisions of day and night, especially hours). Even so, they never developed genuinely practical instruments that could take measurements with precision (of distance in particular). A mix of custom and Roman authority had resulted in empirewide adoption of the "Julian" calendar (instituted at Rome from 45 BCE)[4] and other shared conventions for timekeeping, although this standardization had not **(p.5)** necessarily led to abandonment of alternative, regional practices derived from other, non-Roman cultures (Egyptian, for example); both the standard Roman practices and others could be maintained concurrently.[5] Third, instruments that recorded shorter-term time (divisions of the day in particular) were a common sight in both public and private places, most obviously in the cities of an empire that was quite urbanized by premodern standards, notably so in the East.[6]

Figure 1.1 Monumental sundial erected at Aphrodisias in the early third century CE, now in the courtyard of the Selçuk Museum, Turkey. Diameter 1.18 m.

Photo: Carole Raddato.

Various devices—lamps that burned a specific amount of oil, for example, or containers (Greek κλεψύδρα, Latin *clepsydra*) into which or from which water flowed—were in use for marking defined intervals of time.[7] The most typical timekeeping devices, however, were sundials, usually termed ω῾ρολόγιον in Greek, *horologium* or *solarium* (also *horarium*) in Latin.[8] The vast majority were fixed stone objects, not portable. They were designed in a range of sizes and shapes—spherical, conical, and planar being the most common—and installed in, or close to, such prominent public locations as a marketplace (agora/forum), shrine, bath, gymnasium, or theater, as well as in private houses and even tombs.[9] The credit for installing a sundial in a public place is regularly claimed by one or more magistrates, for example, or priest, or private benefactor.[10] Their timekeeping function aside,[11] most such sundials were decorative, and some of them even monumental, such as that erected at Aphrodisias in honor of the emperor Caracalla and his mother Julia Domna early in the third century CE (Fig. 1.1).[12] We learn from an inscription that the important Italian port Puteoli boasted a sundial originally funded by an emperor and at some later date repaired at the city’s expense.[13] It is tempting to imagine that this was the **(p.6)** sundial (near a stadium?) apparently referred to among the city’s memorable features, and perhaps even pictured, on one of the glass flasks (several are known) produced as souvenirs for tourists and other admirers (Figs. 1.2a, 1.2b).[14]

Figure 1.2a Well-preserved glass flask illustrating memorable features of the Italian port city Puteoli. It was manufactured in the third or fourth century ce perhaps, and was supposedly found in North Africa. Full height 15.1 cm, maximum diameter 10 cm. Now in the World of Glass museum, St. Helens, UK (inv. no. SAHGM 1974.002). The self-standing T-shaped feature below the AR of STADIVSOLAR seems likely to be a conspicuous (fixed) sundial (*solarium*), perhaps near a stadium.

Photo: Pilkington Glass Collection, The World of Glass, and Nicola Bibby.

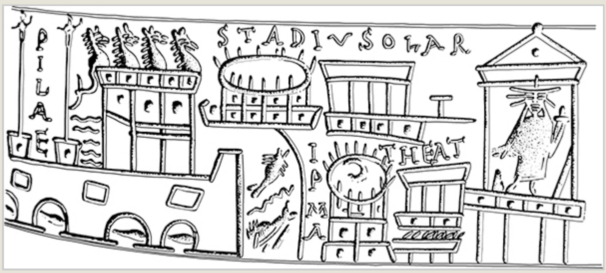


Figure 1.2b Memorable features of Puteoli engraved on the glass flask.

Ancient World Mapping Center after P. Compton in K. S. Painter, “Roman Flasks with Scenes of Baiae and Puteoli,” *Journal of Glass Studies* 17 (1975): 54–67, fig. 13.

2. Sundial Thinking

The thinking behind the general design of sundials in the Roman world was evidently transmitted from classical Greece, but cannot be attributed more **(p. 7)** **(p.8)** specifically. This thinking is both simple and sophisticated.[15] Its simple concept is the realization that the shadow cast by a rod (Greek *gnomon*) onto a semicircular or semispherical surface sectioned off with lines can record successive divisions of the day as the sun seems to pass overhead from dawn to dusk. Considerably more sophisticated is the related realization that a sundial works accurately only if its design and installation take into account where exactly on the earth's curved surface it is to be located. In other words, attention to what both postclassical Greeks and we still today term latitude (see further section 3 below) is essential to ensure a sundial's accurate operation. This said, the installation of fixed sundials in the Roman world did not in fact invariably reflect the exact latitude of the location; precision was in any event hard to attain. In such instances, moreover, it emerges that users were not necessarily dissatisfied, nor even aware of the inaccuracy. For most practical purposes, the difference between the latitude for which a fixed sundial was designed and the location where it was installed would have to be substantial before it became really noticeable. It was certainly not regular practice to inscribe on a sundial the location or latitude for which it had been designed.

The sections into which Greeks and Romans by convention divided the period of daylight for timekeeping were the Babylonian ones of twelve "hours," with sunrise marking the start of the first hour and noon occurring at the start of the sixth hour. It is essential to keep in mind that most timekeeping devices in the Roman empire did *not* record "equinoctial" hours of fixed, equal length, which is the type of hour in common use today. To be sure, a *clepsydra* (above) was designed to record a fixed period of time, but even so—as in the case of most other measures too—among the empire's communities there was never a standard definition for the length of an hour, let alone subdivisions of it.[16] The hours that Roman sundials typically recorded were merely twelve equal divisions of the period of daylight—a period that varied in length according to the latitude where the sundial was installed and the time of year, hence the term "seasonal" hours (in contrast to equinoctial ones of fixed length).

Strictly speaking, daylight varies in length at every location every day, and so correspondingly do the twelve seasonal hours into which the sundials divide it. In practice, of course, the differences are not likely to be detected within short periods or across short distances; but over an extended period or considerable distance they are unmistakable. At Rome, for example, in the course of **(p.9)** a year daylight diminishes to as little as just over nine (fixed, modern) hours at the winter solstice (December 21–22 in our calendar, the day when the tilt of the earth is most inclined away from the sun in the northern hemisphere), and grows to as much as about fifteen and one-quarter hours at the summer solstice (June 20–21, when the tilt there is most inclined toward the sun).[17] This difference becomes increasingly more extreme at locations further north. Thus at Rome one of the twelve (seasonal) hours in the day could be as short as three-quarters of a (fixed, modern) hour, or as long as one and one-quarter (fixed, modern) hours, according to the time of year.

3. Portable Sundials: Types and Functioning

Undoubtedly well before the first century BCE there was recognition that sundials did not have to be fixed objects, and that portable ones could also be produced. At the end of his summary list of many types of sundial and their supposed inventors, the Roman architectural writer Vitruvius (late first century BCE) includes specific mention of the portable type, though without naming any inventor:

> Item ex his generibus viatoria pensilia uti fierent, plures scripta reliquerunt.[18]

> Again, several [*sc*. experts] have left writings about ones derived from these types [just mentioned] for taking on a journey and hanging up.

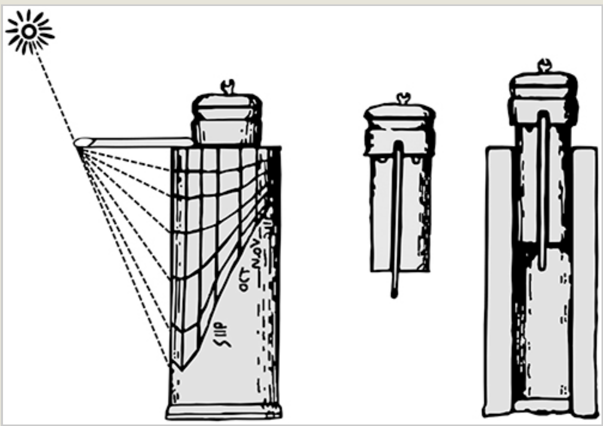
Earlier in his list Vitruvius mentions separately a πρὸς πᾶν κλίμα (Greek "for every zone/latitude") type, the invention of which he attributes to Theodosius and Andrias, the latter not otherwise known, the former presumably the notable Bithynian mathematician active in the second or first century BCE.[19] No doubt this type, too, was by definition intended to be portable.

These fleeting references are unique in surviving literature, and the extensive writings that Vitruvius has in mind are all lost. If nothing else, it is striking that he evidently considers portable sundials to be unexceptional rather than recent novelties or matter for special comment. There is no knowing how he would assign the surviving examples among his categories.[20] A considerable **(p.10)** variety of designs survives, not all of them needing to be suspended. Two designs merit immediate notice.

The first of these two designs—intended (like a fixed sundial) for use within a single (unspecified) latitude—could be either self-standing or suspended to function, and has a neatly compact cylindrical or "pillar" shape; in a relatively uncomplicated way it embodies the principles developed further in more versatile portable sundials. Two Roman examples of this design are known, both made of bone. The better preserved of the two is now in the Museo Nazionale Atestino, Este. It was discovered in 1884 near this town in northern Italy among the objects in the well-preserved late-first-century CE tomb of an oculist (Fig. 1.3).[21] The latitude (45) for which it was made is reckoned to be more or **(p.11)** less that of the region in which it was found. A "stopper"—into which two bronze shadow-caster rods (*gnomons*) are fitted on either side—can be raised with the help of a ring, and the appropriate shadow caster is then extended to line up with the month at the moment of use (the longer of the two shadow casters for winter months, the shorter for summer). A network of lines for the months (named in Latin) of the Julian calendar and six seasonal hours is inscribed along the outside of the cylinder (Fig. 1.4). As is typical for portable sundials, users noting the hour marked by the shadow caster must be alert to whether they are checking before midday

Figure 1.3 Cylinder sundial found in the late-first-century CE tomb of an oculist near Este, Italy; now in the Museo Nazionale Atestino di Este.

Photo: Museo Nazionale Atestino di Este.



(when the sun is highest in the sky), or after it, because the same network serves both the first six-hour period and (in reverse order) the second such period in the twelve-hour day. Correct identification of this object as a sundial—not made until 1984, a full century after its discovery—was a surprise. It overturned the presumption that this type was invented during the Middle Ages rather than centuries earlier during antiquity.[22]

Figure 1.4 Functioning of the Este cylinder sundial.

Ancient World Mapping Center.

The other ancient example of the same design emerged in 2006 during excavations of a burial area on the outskirts of Roman Samarobriva (modern Amiens, France), and has been dated to the first half of the third century CE **(p.12)** **(p. 13)** (Fig. 1.5).[23] Its cylinder—now in the Musée de Picardie, Amiens—happens to be approximately the same height as the Este example (6.2 cm; diameter 2.95), and it too seems to have been made for use around the latitude (50) at which it was found (Fig. 1.6). The cylinder is the only component of the Samarobriva sundial to have survived.

Figure 1.5 Cylinder sundial excavated at Samarobriva (modern Amiens, France) in 2006. Note VIII KIVL (“8 days before the Kalends of July,” the summer solstice) clearly visible near the middle toward the right. Now in the Musée de Picardie, Amiens.

Photo: INRAP Nord-Picardie, and Stéphane Lancelot.

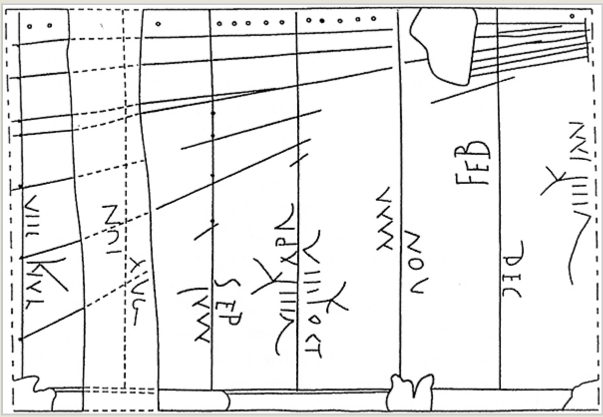


Figure 1.6 Samarobriva cylinder sundial: lettering and line work for months and hours. VIII KIVL is clearly visible at the far left.

The second of the designs meriting immediate notice is a bronze "pillbox" type. It stands on a surface rather than being suspended. Rays of the sun passing through a small hole in the side then fall onto a "hand" (as of a clock) and a network of lines inside to mark the hour (Fig. 1.7). Examples of this type are known made for a single latitude, with or without any location specified.[24] The example in the latter category shown here is reported as found near Forbach in northeastern France during the nineteenth century; its diameter is 4.9 cm, **(p.14)** and depth 1.2 cm (Fig. 1.8).[25] Two other examples offer greater versatility because they incorporate loose discs with locations inscribed on them, which may be inserted or removed in accordance with the user's whereabouts at different latitudes. These two examples are therefore to be grouped with the bronze sundials that form the main subject of this book, and consequently merit inclusion in Chapter 2.[26]

Christine Hoët-van Cauwenberghe and Éric Binet in *Cahiers du Centre Gustave Glotz* 19 (2008): 117, fig. 4a.

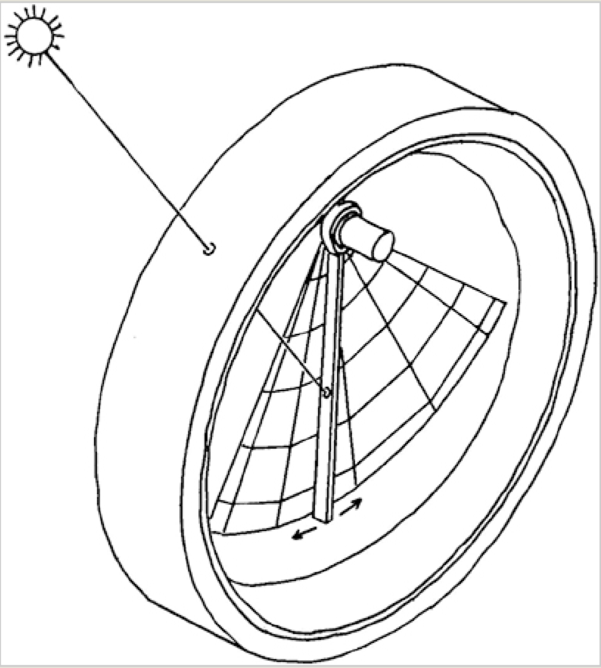


Figure 1.7 Functioning of a pillbox sundial.Paolo Auber in *Bulletin of the British Sundial Society* 16 (2004): 128, fig. 10.

Figure 1.8 Pillbox sundial, supposedly found during the nineteenth century on Mont Hérapel near Forbach on the border between France and Germany;

diameter 4.9 cm. Now in the Musée de La Cour d’Or, Metz, France.

Photo: Musée de La Cour d’Or, Metz, and Laurianne Kieffer.

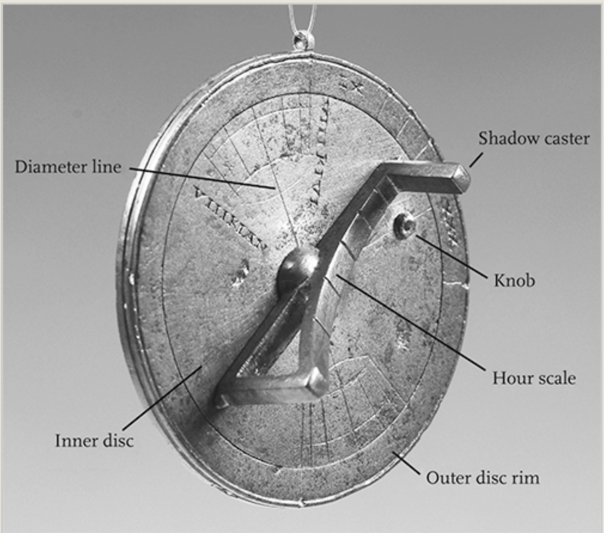


Figure 1.9 Oxford sundial, no. 7: obverse, comprising inner and outer discs, with hour scale and shadow caster.

Photo: Museum of the History of Science, University of Oxford, with author’s labeling added.

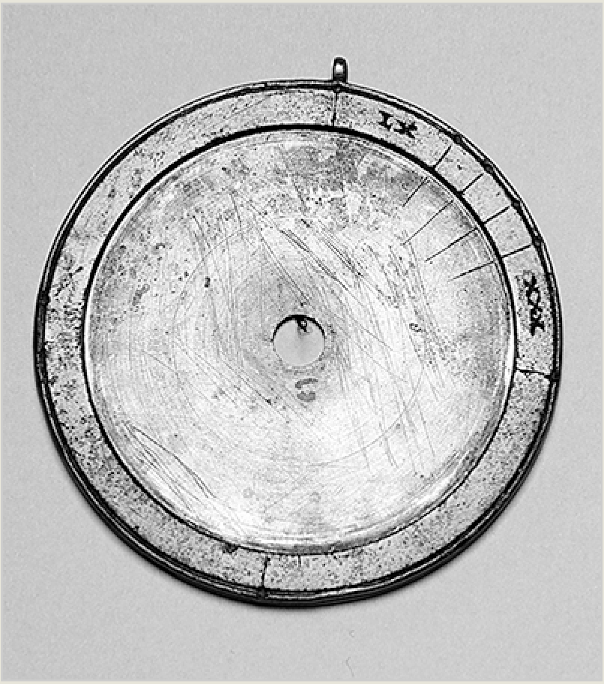


Figure 1.10a Components of the Oxford sundial: outer disc (obverse).

Photo: Museum of the History of Science, University of Oxford.

Most surviving Roman portable sundials are of a further type that *does* need to be suspended in order to function. The names of locations—each usually with its latitude figure—are to be found inscribed on fourteen of these sundials. Chapter 2 is devoted to illustrating and describing them all, together with the two examples just mentioned. To outline in the first instance the principal characteristics and operation of the fourteen, it is most useful to refer to **(p.15)** sundial no. 7 in Chapter 2. All its components are preserved (Fig. 1.9). Its *obverse* (or top or front) comprises an outer disc (Fig. 1.10a) and an inner one shaped to sit within the outer one's rim (Fig. 1.10b). This pair of discs is held together by a bolt, which the *hour scale and shadow caster* (a single component) straddles (Fig. 1.10b). The bolt is inserted through the hole at the center of both discs; below the *reverse* or underside of the outer disc, a pin passes through a hole in the bolt to secure the inner disc in place.

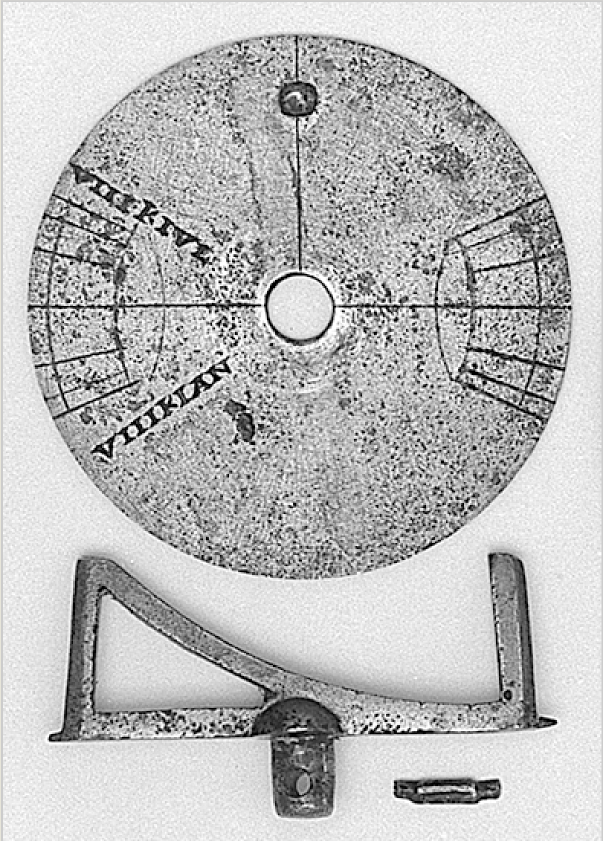


Figure 1.10b Components of the Oxford sundial: inner disc (obverse); bolt straddled by the hour scale and shadow caster; pin, which passes through the hole in the bolt to keep the inner disc in place.

Photo: Museum of the History of Science, University of Oxford.

For a user to determine the time of day accurately, the sun must of course be shining. In addition, a user first needs to know as precisely as possible the latitude at which he or she is situated *and* which day of the year it is, because his position in relation to the sun varies according to both, wherever he may be. For the day, if he does not already know it (or the month at least), he must make inquiries. The same applies to the latitude, although he can be conveniently informed at once if he is aware of being in (or near) one of the provinces or regions or cities listed with its latitude on the reverse of the sundial's outer disc (see Fig. 2.25). Once he knows the latitude, he rotates the inner disc on the obverse with the aid of the *knob* there, so that the radius line that runs through the knob meets the relevant latitude as marked on the *rim of the outer disc*.

Here, a succession of four equally spaced short lines is inscribed, with the Latin figures XXX and LX beyond each end counterclockwise. These figures signify latitudes 30 and 60 respectively, and thus the two intermediate lines mark latitudes 40 **(p.16)** and 50. In addition, the figure XXX is placed equidistant between the latitude 30 line and another line beyond (for latitude zero); LX is placed likewise, equidistant between the latitude 60 line and another line beyond (for latitude 90). On this sundial no further lines are inscribed on the rim of the outer disc, so a user who wishes to rotate the inner disc to, say, latitude 44 is left to estimate just where it occurs between the lines for 40 and 50.

For a user to set the sundial for the day of the year on which it is to be used according to the sun's declination—the angular distance of the sun north of the equator, which varies with the seasons according to the earth's rotation—another straight line forms a *diameter* on the inner disc. This diameter marks the equinoxes (when the sun has zero declination), although there is no notation to that effect. At each end of this diameter line an identical fan-shaped network of lines is drawn. At one end (only) the network is framed by the Latin abbreviations VIIIKIVL (*VIII Kal Iul* = June 24 in the Julian calendar) in one direction, and VIIIKIAN (*VIII Kal Ian* = December 25) in the other, the summer and winter solstices respectively. At both ends the network includes two subdivider lines inscribed on either side to distinguish the passage of time between solstice and equinox according to the sun's declination; thus each subdivision **(p.17)** created in this way spans one month (none of them named on this sundial). So—with all these indicators understood—it is to the relevant date here that the user turns the pointer below the *shadow caster* (*gnomon*), again needing to estimate for lack of more defined divisions.

With the requisite latitude and day of the year now both set, the user must next suspend the sundial by passing a thread through the ring attached to the outer disc. The user then turns the suspended sundial until its position causes the upright shadow caster to throw a shadow directly along the hour scale, which rises in an arc away from it. Five divisions are marked along this hour scale (at successive 15° intervals), making it possible to distinguish six hours. Before noon, the second hour begins when the shadow has retreated to the division on the hour scale furthest from the shadow caster, and so on until at noon (the sixth hour) there is no longer shadow at all along the hour scale. Thereafter, through the twelfth hour, which ends at sunset, the progress of the seventh to twelfth hours is shown in reverse by the movement of the shadow along the hour scale away from the shadow caster.

(p.18) A considerable range of departures from this outline in one respect or other will emerge in Chapter 2. Even so, the fourteen comparable sundials described there are all fundamentally similar to no. 7 in their characteristics and operation. Two points in conclusion: first, analysis of various issues arising from the outline is held over until Chapters 3 and 4. Second, it is important to keep in mind that the names and figures listed on the reverse of the sundial, as in the case of no. 7, do not regulate its functioning. Rather, they serve merely as an optional aid: users remain free to set the sundial to any latitude within the range marked.

Notes:

([1]) See, for example, Karlheinz Schaldach, *Römische Sonnenuhren: Eine Einführung in die antike Gnomonik* (3rd ed., 2001); and in greater depth Eva Winter, *Zeitzeichen: Zur Entwicklung und Verwendung antiker Zeitmesser* (2 vols., 2013), with the review by Karlheinz Schaldach, *Gnomon* 87.2 (2015): 144–49. Note further Denis Savoie, *Recherches sur les cadrans solaires* (2014), 17–51 (with scant concern for the limitations of the latitude data, on the Oxford sundial especially).

([2]) See, for example, Benet Salway, “Putting the World in Order: Mapping in Roman Texts,” in R. J. A. Talbert (ed.), *Ancient Perspectives: Maps and Their Place in Mesopotamia, Egypt, Greece, and Rome* (2012), 193–234; and, with impressive scope, Klaus Geus and Martin Thiering (eds.), *Features of Common Sense Geography: Implicit Knowledge Structures in Ancient Geographical Texts* (2014).

([3]) On the challenges of determining levels of literacy see, in brief, *OCD4*[4] s.v. literacy (by Rosalind Thomas).

([4]) For reflections on this calendar and its impact, see, for example, Denis Feeney, *Caesar’s Calendar: Ancient Time and the Beginnings of History* (2007); more briefly, id., “Time and Calendar,” in Alessandro Barchiesi and Walter Scheidel (eds.), *The Oxford Handbook of Roman Studies* (2010), 882–94.

([5]) Note in this connection Sacha Stern, *Calendars in Antiquity: Empires, States, and Societies* (2012), especially 299–353. For a concise overview, see Leofranc Holford-Strevens, *The History of Time: A Very Short Introduction* (2005), especially 31–33, 91–96.

([6]) Overviews in Winter (2013), 185–232; Jérôme Bonnin, *La mesure du temps dans l’Antiquité* (2015), 229–50.

([7]) Lamps: Robert Hannah, *Time in Antiquity* (2009), 96–97. *Clepsydrae*: Bonnin (2015), 87–98.

([8]) The Greek and Latin terms are usefully reviewed by Bonnin (2015), 73–87.

([9]) Winter’s catalog (2013, vol. 2, 251–617) includes a detailed record of about 400 such sundials known from throughout classical antiquity, a marked advance on the 256 listed by Sharon Gibbs, *Greek and Roman Sundials* (1976). Bonnin

(2015), 11 and 387–401 claims to have identified about 600. See further repository.edition-topoi.org/collection/BSDP

([10]) For such inscriptions on these sundials, see Winter (2013), 173–77.

([11]) On fixed sundials in general, note G. W. Houston, “Using Sundials,” in L. L. Brice and Daniëlle Slootjes (eds.), *Aspects of Ancient Institutions and Geography: Studies in Honor of Richard J. A. Talbert* (2015), 298–313.

([12]) Hannah (2009), 88–90; Winter (2013), 268–69.

([13]) *CIL* X.1617; Winter (2013), 509.

([14]) Altogether three of the flasks mention a *solarium*, but on only one does it seem to be illustrated. Discussion by S. E. Ostrow, “The Topography of Puteoli and Baiae on the Eight Glass Flasks,” *Puteoli* 3 (1979): 77–137 at 94, 121–22 (a ninth such flask has since come to light, but does not refer to this feature: *AE* 2005.763a–c). See more generally Ernst Künzl and Gerhard Koeppel, *Souvenirs und Devotionalien: Zeugnisse des geschäftlichen, religiösen und kulturellen Tourismus im antiken Römerreich* (2002), 25–27; and Bonnin (2015), 78, 81–82, 245. To be sure, the authorities at Puteoli use the term *horologium* in the inscription, while all three flasks use *solarium*, which may equally refer to a terrace; even so, these concerns do not suffice to rule out the identification conjectured.

([15]) See, for example, James Evans, *The History and Practice of Ancient Astronomy* (1998), 129–39; Hannah (2009), 68–144; and, in brief, id., “Timekeeping,” in J. P. Oleson (ed.), *The Oxford Handbook of Engineering and Technology in the Classical World* (2008), 740–58.

([16]) For practical purposes, a half-hour seems to be the minimum span of time by which contemporaries reckoned. Notably, the same could be remarked of country districts in continental Europe even in the late nineteenth century; see Vanessa Ogle, *The Global Transformation of Time 1870–1950* (2015), 68.

([17]) For the progression in Rome over a year at five-day intervals, see R. J. A. Talbert, *The Senate of Imperial Rome* (1984), 501–3.

([18]) *De Architectura* 9.8.1, ed. Pierre Gros et al. (1997).

([19]) See P. T. Keyser and G. L. Irby-Massie (eds.), *The Encyclopedia of Ancient Natural Scientists: The Greek Tradition and Its Many Heirs* (2008), ss. vv.

([20]) Jean Soubiran, in his Budé text of the sentence quoted above (Vitruve, *De l’architecture*, livre IX, 1969), inserts a comma between *viatoria* and *pensilia* in the belief that Vitruvius is referring to two distinct types of sundial rather than just one (so translate “for taking on a journey or hanging up”); see his commentary, pp. 254–56, 266–70. The possibility cannot be ruled out, but—as Bonnin (2015), 127 concludes (cf. 112)—no such clear distinction can be made among surviving sundials.

([21]) See Simonetta Bonomi, “Medici in Este romana 2: La tomba del medico,” *Aquileia Nostra* 55 (1984): cols. 77–108, esp. 82 (object no. 29), 87–90; further discussion by Mario Arnaldi and Karlheinz Schaldach, “A Roman Cylinder Dial: Witness to a Forgotten Tradition,” *Journal for the History of Astronomy* 28 (1997): 107–17; Winter (2013), 290 (Ateste no. 1).

([22]) See further Chapter 5.

([23]) See Christine Hoët-van Cauwenberghe, Éric Binet, and Annick Thuet, “Cadran solaire sur os à Amiens (Samarobriva),” *Cahiers du Centre Gustave Glotz* 19 (2008): 111–27; Éric Binet, “Le cadran solaire portatif d’Amiens: Circonstances d’une découverte exceptionelle,” *Dossiers d’Archéologie* 354 (2012): 34–39; and further Chapter 4.

([24]) With a location specified: see no. 2 (Kircher Museum) in Chapter 2.

([25]) Winter 2013, 425 (Metz no. 1), with A. Schlieben, “Römische Reiseuhren,” *Annalen des Vereins für Nassauische Alterthumskunde und Geschichtsforschung* 23 (1891): 115–28 at 116–18; cf. Winter (2013), 602–3 (Fundort unbekannt, nos. 8, 9).

([26]) No. 5 (Vienna/Wien) in particular; also no. 4 (Aquileia).