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Greco–Roman and Qin–Han Chinese Sundials: A Comparative Study

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Abstract. This article compares how sundials arose and were shaped in the Greco–Roman world and in early China between the fourth century BCE and the fourth century CE. It uses published historical sources together with archaeological catalogues to group the Mediterranean examples into the usual types—spherical, conical, planar and cylindrical—and to comment on several portable pieces. For the Chinese side, it turns to excavated instruments and transmitted texts to follow their appearance and early find contexts, and to note the main disagreements about how they were used and how they should be classified. Viewed together, both traditions start from measuring a shadow cast by a vertical gnomon, but later forms moved in different directions because the social tasks assigned to timekeeping and the technical choices were not the same. Placing the two bodies of evidence side by side helps to show what was common to early time measurement and what was specific to each cultural setting.

Keywords: sundials, Greco–Roman world, Qin–Han China, comparative timekeeping

1. Introduction

Time was a practical concern in both the Mediterranean world and early China, and reading the sun's shadow was one of the simplest ways to deal with it. A sundial does not need wheels or escapements: a rod that casts a shadow and a surface that receives it are enough. Long before mechanical clocks appeared, such devices were used in different regions as the routine way to tell the hour of the day.

In the Greco–Roman sphere, surviving literary notices and excavated pieces show that sundials were made in many shapes and were widely displayed. On the Chinese side, the basic method of using a vertical indicator (biao) together with a measuring surface (gui) to fix solar noon was already in place very early and later became part of state timekeeping. Over time, Chinese artisans and officials added other instruments, such as water clocks, to meet needs that shadow dials alone could not satisfy.

This paper looks at how sundials took shape in these two settings between the fourth century BCE and the fourth century CE. For the western material, it follows the well-known account that Greek scholars adopted gnomonic techniques, probably from Mesopotamian practice, and that developments in geometry and astronomy encouraged the making of stone, metal and even portable dials of different designs. For the Chinese material, it turns to pre-Qin and Han finds and to early calendar texts, which show sundials being used to determine orientation and to support calendar promulgation, while also leaving some uncertainty about their exact names and procedures. Putting the two strands together makes it possible to see that both traditions rested on the same shadow-reading principle but were drawn apart by the specific social tasks and technical solutions adopted in each region.

2. Greco-Roman sundials

2.1. Origins of Greco-Roman sundials

To date, it remains unknown who invented the first sundial or who first used a device approximating a sundial. Our understanding of its origins comes mainly from ancient textual records. In the Western tradition, one of the earliest written references to a sundial appears in the Old Testament:

Behold, I will cause the shadow of the dial, which is gone down on the sun-dial of Ahaz, to return backward ten degrees. So the sun returned ten degrees, by which degrees it was gone down [1]. (Isaiah 38: 8)

A similar account appears in 2 Kings 20:9 [1]. The Ahaz mentioned here was a king of Judah in the late 8th century BCE. Although these texts describe a supernatural event rather than the functioning of a sundial, they indicate that by this time, sundials were recognized as timekeeping tools in Assyria or Judah.

Beyond textual records, the earliest surviving sundial (sun clock) can be traced to around 1500 BCE, during the reign of Pharaoh Thutmose III in Egypt. This sun clock, made of schist, resembles the letter “L” in shape, with inscriptions of Thutmose III’s titles on its sides (Figure 1).

Figure 1. Earliest surviving sun clock, housed in the Egyptian Museum, Berlin [2]

According to the Greek historian Herodotus (c. 484–425 BCE) in The Histories, Greek sundials were derived from Babylonian technology [3]. A widely accepted view holds that the Greek philosopher Anaximander of Miletus (6th century BCE) introduced the earliest sundial knowledge into the Greek world [4].

Regarding Roman sundials, Pliny the Elder (c. 23–79 CE) in Natural History records that the first Roman sundial may have been set up by the Roman general Lucius Papirius Cursor around 290 BCE, in the Temple of Quirinus, eleven years before the Pyrrhic War [5]. Pliny further records a more detailed account: the first public Roman sundial was brought from Sicily by Consul Manius Valerius Messala during the First Punic War, after seizing Catina (modern Catania), and installed on a column near the Rostra in Rome. However, sundials imported in this way did not match Roman local time, and thus could not provide accurate timekeeping for the city. The first sundial calibrated to Roman time and specifically set up for the city was established only in 164 BCE by Consul Quintus Marcius Philippus, considered one of his most popular achievements [5]. The enthusiasm for an accurate timepiece suggests that timekeeping held social importance, otherwise such attention to the installation of sundials would have been unnecessary.

2.2. Types of Greco–Roman sundials

Our earliest explicit description of Roman sundials is the short passage in De Architectura 9.8, where the engineer Marcus Vitruvius Pollio names several kinds of dials but does not explain in detail how each was laid out. He lists semi-circular and hollow (scaphe) dials and also mentions more specialized patterns such as the Arachne (with its web-like grid) and the Plinthium or lacunar dial. Vitruvius connects these designs with individual makers — among them Berosus the Chaldean, Aristarchus of Samos and Scopinas of Syracuse — which at least shows that, in his time, different dial forms and their authors were remembered as distinct items rather than as a single, anonymous technique [6]. What the text does not tell us is how common each type was in everyday settings.

Later studies have tried to fill in this very gap. On the basis of excavated or museum pieces, several catalogues of classical sundials were compiled; Sharon Gibbs's survey collected just over two hundred examples, and Eva Winter's more recent work raised the number to roughly four hundred. Most of these objects are of stone, which is hardly surprising given its survival rate and its ready availability for architectural uses [7] [8]. A much smaller group consists of portable bronze dials; because they form a distinct technological strand, they are treated separately elsewhere in this paper. Drawing on this material, Gibbs proposed to classify Greco–Roman dials by the geometric relation between the dial surface and the celestial sphere, and she reduced the corpus to four main families: spherical, conical, planar and cylindrical [8]. The outline below follows this practical scheme.

The spherical dial is formed on part of a sphere and normally carries hour lines together with curves for the solstices and the equinox. Within this family, Gibbs marked off several sub-types — hemispherical, cut or segmental, quarter-spherical and roofed dials — because the amount of the sphere that is preserved and the way light reaches the surface are not the same in every case [8,9]. A hemispherical dial is made by carving a full hollow half-sphere in a stone block and setting a gnomon vertically at (or near) the centre (fig. 2). A cut spherical dial keeps only a segment smaller than a full half-sphere but is still organised around a central shadow point. A quarter-spherical dial repeats the same idea on only one quarter of the sphere, i.e. a hemisphere divided again by a vertical plane, with the time lines laid out on the remaining surface. The roofed dial differs from the others in that the concave cavity is covered and daylight is admitted through a slot or small opening, producing a moving light spot on the interior (fig. 3).

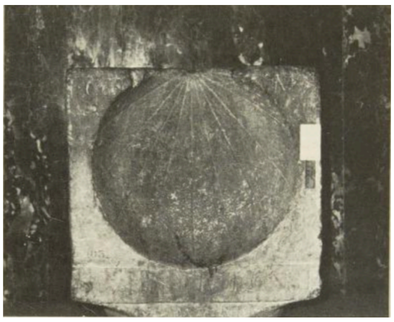

Figure 2. Hemispherical sundial. From Gibbs, Plate 13, p. 182 [8]

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Figure 3. Roofed spherical sundial, Louvre, inv. ME1178 [10]

The conical sundial typically features a stone surface shaped as a conical section, with the vertex positioned either above, below, or on the horizontal plane [8]. The location of the vertex determines the sundial's orientation: when the cone's apex is above the upper edge of the dial plane, the instrument faces south (south-facing installation); when the apex lies below the dial's upper edge, the sundial is north-facing; and when the apex coincides with the plane of the dial's upper surface, it forms a special subtype known as the roofed conical sundial. Conical sundials were among the most common types in the Greco–Roman world, with a large number of examples preserved. A typical conical sundial consists of a concave conical dial surface whose upper edge forms a straight line parallel to the horizon. The front of the cone is truncated by a plane parallel to the celestial equator, producing a circular rim. The gnomon is usually positioned at the vertex of the cone, while the dial face bears three date curves corresponding to the winter solstice, equinoxes, and summer solstice, as well as eleven curved hour lines that follow the conical geometry (Figure 4).

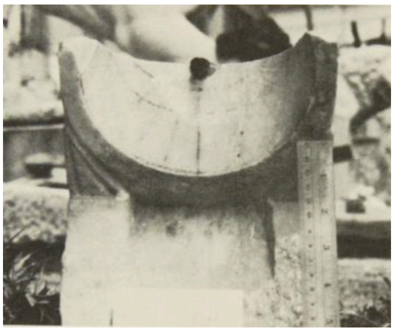

Figure 4. Conical sundial. Gibbs, Plate 32, p. 245 [8]

The planar sundial features a flat dial surface. Depending on the orientation of the plane, four traditional subtypes can be distinguished: horizontal, vertical, meridian, and deviating dials [8]. The horizontal sundial has a dial plane parallel to the horizon and is installed on a level surface (Figure 5). The vertical sundial has an upright dial parallel to the prime vertical plane (i.e., the east–west vertical plane); it often takes a semicircular form, with the gnomon hole at the center dividing the

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dial symmetrically (Figure 6). The meridian sundial features a vertical dial parallel to the meridian plane (the north–south vertical plane), and thus generally faces due east or due west (Figure 7). The deviating sundial has an inclined or obliquely oriented dial plane that is not aligned with either of the principal directions (east–west or north–south), thereby deviating from the standard orientations (Figure 8). Like the spherical and conical types, planar sundials also bear hour lines and date curves —for the summer solstice, winter solstice, and equinoxes—whose functions are identical despite differing surface geometries.

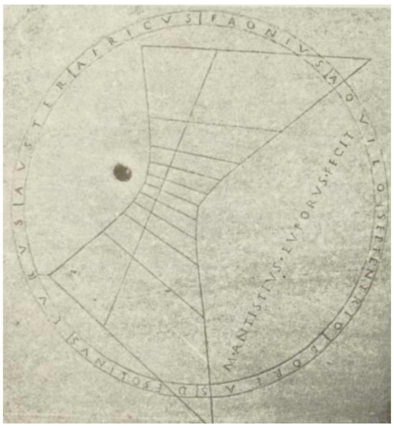

Figure 5. Horizontal sundial. Gibbs, Plate 53, p. 330 [8]

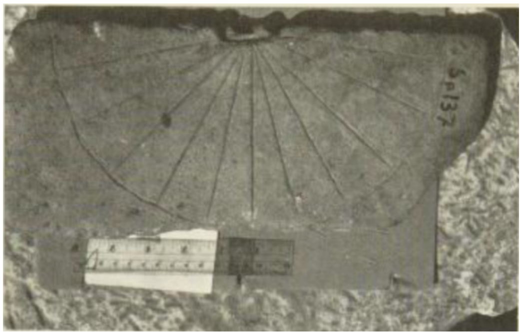

Figure 6. Vertical sundial. Gibbs, Plate 58, p. 364 [8]

Figure 7. Meridian sundial. Gibbs, Plate 60, p. 367 [8]

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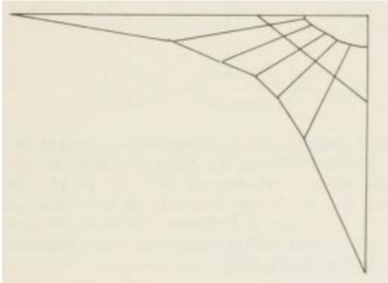

Figure 8. Pattern of hour lines and day curves on a deviating sundial. Gibbs, p. 49, Fig. 29 [8]

The cylindrical sundial has a dial surface formed by part of a cylindrical surface, with the gnomon casting its shadow onto the curved wall (Figure 9). Based on the spatial orientation of the cylinder's axis, these sundials are divided into two subtypes: inclined cylindrical and vertical cylindrical sundials [8]. In the inclined cylindrical sundial, the cylinder's axis is parallel to the Earth's rotation axis, meaning the cylinder itself is tilted relative to the horizontal plane. In the vertical cylindrical sundial, the axis stands perpendicular to the Earth's axis (i.e., the cylinder is upright, with its axis pointing toward the zenith). The different orientations result in distinct patterns of lines on the dial surface. On inclined cylindrical sundials, the hour lines appear as a series of arcs parallel to the equatorial plane, while the summer and winter solstice curves are symmetrically spaced on either side of the equinoctial line. In contrast, the layout of the hour lines and the positioning of the gnomon on vertical cylindrical sundials are more complex, becoming geometrically balanced only when the dial is oriented precisely north–south [11].

Figure 9. Cylindrical sundial, National Archaeological Museum of Athens, inv. no. 3159 [11]

In summary, although Vitruvius mentioned only the names of sundials in De Architectura, this is sufficient to show that people in the Greco-Roman period already possessed a clear understanding of the diversity of sundial forms. Modern archaeological catalogues further indicate that sundials of the Greco-Roman era were predominantly fixed and made of stone, while metal and portable types were relatively rare. Subsequently, based on the classification proposed by Gibbs—spherical, conical, planar, and cylindrical—these four main types, though differing in form, all embodied the same set of hour lines and other markings, adapted through their respective structures to meet the requirements of time-telling in different locations.

2.3. Roman portable sundials

Although portable sundials were relatively rare among early sundials, their mobility marked a significant distinction from the fixed stone types. It is clear that as early as the 1st century BCE, people recognized that sundials need not be stationary; portable versions could also be constructed. The Roman architect Vitruvius (late 1st century BCE) specifically mentioned portable sundials at the end of his summary list of sundial types and their supposed inventors, though he did not attribute

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this type to any particular individual [6]. Earlier in the same work, Vitruvius referred to a sundial "suitable for all regions/latitudes," crediting its invention to Theodosius and Andreas—the former presumably a well-known mathematician active in Bithynia during the 2nd or 1st century BCE, and the latter of unknown identity [12]. By definition, this type was likewise designed for portability. These brief references are unique in the surviving literature, as the extensive sources cited by Vitruvius have mostly been lost. Notably, Vitruvius treated portable sundials as commonplace instruments, rather than newly invented or remarkable innovations.

Many designs of portable sundials have survived to the present. According to Richard J. A. Talbert, they can generally be understood through two basic designs [13]. The first design, like fixed stone sundials, was intended for use at specific latitudes. These could be placed independently or suspended, often taking a simple cylindrical form. Talbert notes that two Roman-period bone cylindrical sundials of this type are known; the better-preserved example is now housed in the Museo Nazionale Atestino in Este, Italy. It was discovered in 1884 near a northern Italian town in the tomb of an ophthalmologist dating to the late 1st century CE (Figure 10).

Figure 10. Cylindrical sundial found in the tomb of a late 1st-century CE ophthalmologist near Este, Italy; currently in the Museo Nazionale Atestino [13]

One Roman cylindrical dial can be recognised by the way its inner plug slides inside the hollow tube. The plug carries at each end a small bronze rod that acts as the gnomon. When the instrument was used, the plug was pulled up or turned by means of a ring fixed to the top until the proper rod projected sideways and could be set against the scale for the month. The shadow of this rod then fell on the calibrated outer surface of the cylinder and marked the hour. To cope with the changing height of the sun, the maker provided rods of two lengths — the longer for the low winter sun, the shorter for the high summer sun — so that the shadow would still reach the engraved lines [13].

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Around the outside ran the Latin names of the twelve Julian months and a division of the day into twelve equal parts, which together made the dial readable to its owner (fig. 11).

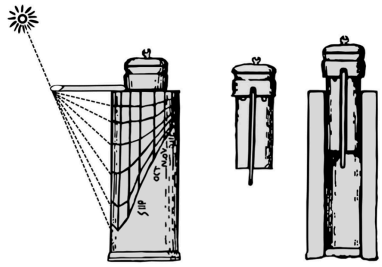

Figure 11. Working principle of the cylindrical sundial [13]

A different portable form is the small bronze box often called a pillbox dial [13]. Unlike the cylindrical type, which must hang for use, this one stands upright on a flat surface. Light comes in through a tiny opening in the side and strikes a fine pointer set inside, usually near the centre. The shadow from the pointer moves across an internal plate engraved with a network of curves and in this way gives the time (fig. 12). Several surviving pieces were made for a single latitude, so their grids are only correct for one place; others have no such indication. A 19th-century find near Forbach in north-eastern France, now in the Musée de La Cour d'Or in Metz, is about 4.9 cm across and 1.2 cm deep and bears no latitude marking, having been reported from the area of Mont Hérapel on the present French–German border (fig. 13). The design is compact and protects the scale inside the box, while the side hole admits just enough light for the shadow to be followed.

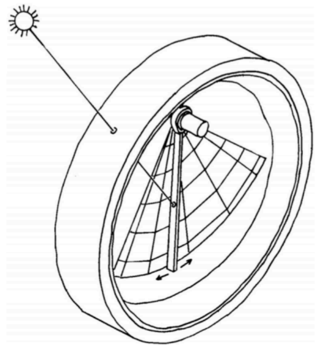

Figure 12. Working principle of a pillbox sundial [13]

Figure 13. Pillbox sundial, supposedly found in the 19th century on Mont Hérapel near Forbach on the France–Germany border; now in the Musée de La Cour d'Or, Metz, France [13]

The design of the pillbox sundial could be both complex and ingenious. For instance, a Roman pillbox sundial in the Kunsthistorisches Museum, Vienna, with a cover featuring the portrait of

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Emperor Antoninus Pius, included multi-latitude adjustment [13]. This sundial consists of two main components: the upper part, serving as a lid, displays a stereographic projection with meridians and the horizon inside, both decorative and functional for reference (Figure 14); the lower part forms the main box, hollowed internally with a central peg to hold interchangeable discs (Figure 15). Each disc bears a grid of hour lines and monthly scales calibrated for a specific latitude (Figure 16). Some discs also include the names of Roman months and geographic locations such as Rome, Alexandria, and Hispania. By replacing the discs, the user could adapt the sundial for different regions, adjusting for local solar altitudes—essentially achieving a “one sundial for multiple locations” function.

Figure 14. Upper component of the Vienna Kunsthistorisches Museum pillbox sundial [13]

Figure 15. Lower component of the Vienna sundial [13]

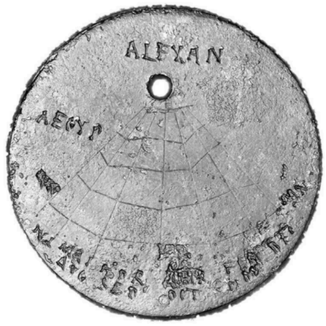

Figure 16. One of the interchangeable discs of the sundial [13]

In summary, although portable sundials were relatively rare compared to fixed stone instruments during the Roman period, their existence demonstrates that as early as the turn of the era, Romans had already liberated sundials from fixed bases, transforming them from public architectural features into personal, portable, cross-regional timekeeping devices. Vitruvius, in his De Architectura (1st

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century BCE), mentions sundials suitable for travelers, indicating that such instruments were not considered particularly novel at the time. The surviving artifacts, with their diverse designs, illustrate the ingenuity of Roman craftsmen in combining astronomical knowledge with practical innovation: whether by adjusting projection rods to match seasonal solar angles or preparing multiple discs for multi-location use, these clever devices allowed travelers to carry "time" with them wherever they went.

3. Ancient Chinese sundials

3.1. Origin of Chinese sundials

Similar to Greco-Roman sundials, the precise origin of Chinese sundials is difficult to determine. Current scholarship generally agrees that the earliest Chinese astronomical instrument was a vertical rod called a biao, standing upright on the horizon. Observers measured the changing shadow of the biao from sunrise to sunset. At noon, the shadow pointed due north, and its length at the winter and summer solstices reached its maximum and minimum, respectively, allowing the determination of the two solstice dates. If time scales were marked on the horizontal surface, one could read the hour by noting where the shadow fell—this constitutes the simplest form of a sundial.

The practice of observing shadows with the biao is believed to have originated very early. Xiao Liangqiong suggested it began in the Shang Dynasty, interpreting the oracle bone term "li zhong" as referring to erecting a rod to measure shadows, where zhong denotes the shadow-measuring rod [14]. According to this view, the practice of standing the biao to measure shadows dates back at least to the Shang period.

Associated with the biao was the gui, and together they were often called guibiao . The gui is a long, flat object placed horizontally along the north-south axis at the base of the biao, with engraved measurement marks to determine the length of the noon shadow [15]. The earliest textual mention of the gui appears in the pre-Qin work Zhou Li: Kao Gong Ji, which records ancient handicraft techniques: "The tu gui measures five cun (a traditional Chinese unit of length); it is used to determine the position of the sun and to measure the land." [16] However, since gui has not yet been found in oracle bone inscriptions, it clearly appeared later than the biao.

From the above, it is evident that the guibiao is essentially analogous to the earliest Western gnomon or even an obelisk used for time measurement; there is little essential difference. According to Zunqi Chen's writings from the 1980s (republished in 2016), the earliest known extant gui biao is a miniature bronze instrument unearthed in 1965 from an Eastern Han tomb in Yizheng, Jiangsu [17] (Figure 17).

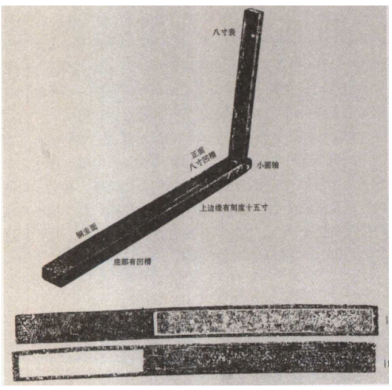

Figure 17. Miniature bronze guibiao unearthed from the Eastern Han tomb in Yizheng [15]

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This guibiao's gui measures 34.5 cm long, 2.8 cm wide, and 1.4 cm thick, with 14 engraved marks representing 15 cun, each subdivided into 10 parts. Rectangular grooves run along the front and back of the gui; the front groove measures 20.8 cm × 2.2 cm × 1.1 cm, housing the biao. The biao itself is 20.3 cm long, 2.15 cm wide, and 1.2 cm thick, with a small circular hole (0.5 cm diameter) located 3 cm from the top. When erected, the biao stands 19 cm above the gui surface. This artifact is now housed in the Nanjing Museum.

Recent finds have allowed scholars to date the actual use of the gui–biao combination in China a little earlier than previously thought. In 2002, excavations at the Taosi site in Xiangfen, Shanxi, revealed a large installation interpreted as an astronomical observation area, dated to about 4,100 years ago. Among the objects were lacquered wooden rods and measuring boards with incised scales, which have been tentatively read as an early form of the gui and biao (fig. 18). If this identification is accepted, it would mean that communities in north China, already before the Shang period, were experimenting with shadow observations of the sun.

Figure 18. Guibiao from the Taosi site [18]

The observation principle of the guibiao laid the foundation for more refined time-measuring instruments such as sundials. Since the shadow of the biao at noon aligns with the north-south axis, non-noon hours result in the shadow deviating from true north. Ancient observers had long noticed the correspondence between shadow direction and time, making it possible to divide the day into hours using shadow positions.

In conclusion, although the exact dating of Chinese sundials cannot be definitively established, scholarship generally agrees that as early as the Shang Dynasty or even earlier, Chinese people had used rod-and-shadow observation. The earliest Chinese astronomical instrument, the guibiao, composed of a vertical biao and a horizontally placed north-south gui, was used to observe the shadow to determine noon and seasonal points, functioning in principle similarly to early gnomons or obelisks in Greco-Roman culture.

3.2. Examples of Qin–Han Period Chinese sundials

As ancient Chinese astronomers gradually understood the daily and hourly movement of shadows, they began to mark the shadow paths on flat surfaces, giving rise to the invention of the sundial, a timekeeping instrument specifically designed for measuring hours. In simple terms, the sundial is an "upgraded" version of the guibiao: it retains a gnomon, while the horizontal plane receiving the shadow is engraved with hour markings. During daylight, as the sun moves, the gnomon's shadow shifts across the scale; when the shadow points to a predetermined line, the corresponding time can be read. In this way, the sundial became a reliable daytime timekeeping device, partially overcoming the limitation of the guibiao, which could only measure noon and could not subdivide time more finely.

When exactly China began using fully graduated sundials remains debated. Textual records confirm that sundials existed by the Han dynasty. In History of Ancient Chinese Material Culture, Feng Shi notes that the Hanshu · Yiwen Zhi (Book of Han, Treatise on Literature) records 34 volumes of the "Sundial Text", clearly evidencing the presence of sundials in Han times [19]. From the perspective of archaeology, sundials likely existed at least by the Qin dynasty, though their names and precise functions remain contentious.

Currently, three archaeological examples of ancient Chinese sundials have been discovered, which for convenience are all referred to as sundials.

First, Jade Disc Sundial – Excavated in Tuoketuo, Inner Mongolia, at the end of the Qing dynasty. Documented by Duan Fang (1861–1911) in Tao Zhai Cang Shi Ji [20]. This sundial is approximately square, with sides measuring 27.4 cm, thickness 3.5 cm. A central small hole has a diameter of 1 cm, depth approximately 1.2 cm, not penetrating the disc. It is currently housed in the National Museum of China, Beijing (Figure 19).

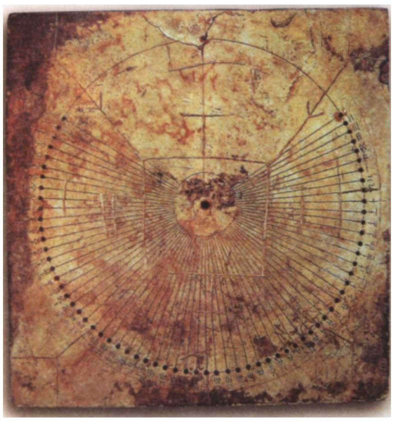

Figure 19. Tuoketuo sundial [15]

Then, Stone Sundial from Luoyang, Henan – Unearthed in 1932 and acquired by Canadian missionary W.C. White (1873–1960). Now in the Royal Ontario Museum, Canada (Figure 20). The disc measures 28.4 × 27.5 × 3 cm. Its shape and engraved lines closely resemble those of the Tuoketuo sundial.

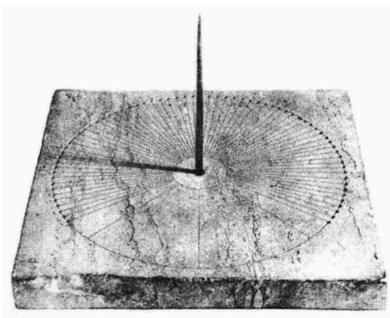

Figure 20. Luoyang sundial [21]

Fragment from Youyu, Shanxi – A small fragment showing the characters "卅一" to "卅八", with the last four characters accompanied by small circular holes [22]. Recorded in Zhou Jin's Juzhen

Caotang Han–Jin Shi Ying [23], the rubbings are shown in Figure 21. The fragment measures approximately 2 × 2.7 cun and was excavated in Shanxi.

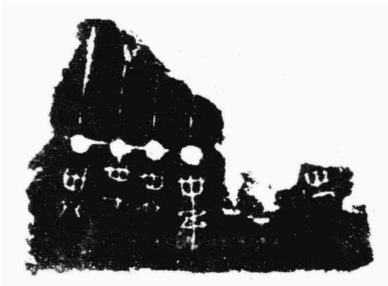

Figure 21. Rubbing of Youyu sundial fragment [21]

Although these three sundials were excavated at different times and locations, they share similar form, inscriptions, and markings. Questions remain regarding whether they are indeed sundials, their exact dating, their specific type, and whether they should be referred to as Ri Gui (sundial in Chinese). Scholars hold divergent opinions on these matters.

3.3. Controversy over Qin–Han Period Chinese sundials

The Qin–Han period (roughly 2nd century BCE) saw the emergence of some of the earliest stone discs that may have functioned as sundials, but their precise nature has long been debated. Scholars generally agree on their approximate date, inferred from the small-seal script numerals carved on the discs, but controversies focus on whether they are truly sundials and, if so, what type of sundial they represent.

Liu Fu argued that these discs were inclined equatorial sundials. He based his interpretation on the 69 evenly radiating lines on the disc surface and the 69 small peripheral holes, proposing an equatorial timekeeping scheme: a fixed dingbiao (gnomon) is erected in the central hole, and a movable youyi (a small portable shadow instrument) is inserted into an outer hole, allowing the shadow of the youyi to cooperate with the shadow of the dingbiao to read the time. This, he suggested, solved the problem of equatorial sundials lacking back-face lines or gnomons [22].

Chen Meidong and Hua Tongxu found Liu Fu's interpretation plausible but unnecessarily complicated, as it required constant manual adjustment of the youyi. Furthermore, the excavated stone discs only had one side inscribed with lines and lacked inclined mounts. They argued that the discs were more likely intended for horizontal timekeeping—that is, horizontal sundials. The 69 holes on the disc could have been used to mark the beginning and end of time periods or assist observation (e.g., by inserting small markers), consistent with the Han Dynasty system of dividing the day into a hundred periods of daylight [21].

Pan Nai adopted a more cautious view. He suggested that these stone discs primarily served orientation measurement and to calibrate a water clock called a "louke", rather than functioning as independent time-reading sundials. According to Pan, the scale system on the disc derived from the louke's operation rather than from the shadow of a gnomon, implying that these artefacts should be termed guiyi (instruments for measuring orientation) rather than conventional Ri Gui (sundial in Chinese) [15].

Joseph Needham, in his Science and Civilisation in China, also discussed this debate without reaching a definitive conclusion. He observed that, given the fundamental celestial pole and equatorial concepts in Chinese astronomy, it was conceivable that early instruments inclined toward

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the equatorial plane, with the biao pointing at the pole, could serve as solar timekeepers. For users familiar with the xuanji (a jade model of constellations), this was a natural practice, as it too had to be aligned with the plane of the equator. He further speculated that the Han Dynasty may have employed two sundials, one facing upward and one downward [24].

However, Needham also noted that such double-sided, equatorially aligned sundials seem not to have been used in the Han Dynasty. For Zeng Nanzhong, a Chinese scholar of the 12th century, it was evidently his belief that he was adopting something novel at the time. Zeng Minxing (likely his son or grandson) wrote in Duxing Zazhi (Miscellaneous Records of the Awakened Mind, 1176) about his ancestor Zeng Nanzhong's reaction to this type of sundial, noting that he clearly regarded it as something new [24]. Although further evidence is needed to attribute this entire system specifically to Zeng Nanzhong around 1130, it nonetheless suggests that sundials aligned with the equatorial plane were unlikely to have existed as early as the Han dynasty.

Excavated Chinese sundials that can be dated to the late Qin and early Han seem, on present evidence, to have been laid out as horizontal dials rather than as equatorial ones. It also appears that they were used above all for determining direction and for checking the rate of the louke water clock, instead of serving as independent daily timekeepers. This usage pattern points to an early Chinese way of integrating shadow instruments with calendrical and metrological work.

4. Conclusion

Looked at over the period from the fourth century BCE to the fourth century CE, both the Greco–Roman world and early China began from the same simple principle — reading the shadow of a vertical rod — but the two traditions did not grow in the same way. On the Mediterranean side, literary notices from the late Republic and the many surviving dials show a taste for varied designs and for technical refinement. After the Greek adoption of Mesopotamian gnomonics, later Greek and then Roman makers multiplied forms, from large public installations to small portable pieces with exchangeable scales for different latitudes; Vitruvius's list at the end of the first century BCE is only the clearest written sign of this broad experimentation. In that milieu a sundial could be at once a practical indicator of the hour and an object that displayed geometrical skill.

Chinese evidence for roughly the same centuries points to a narrower, more task-oriented use. Qin–Han dials that have been recovered were often employed to fix direction, to determine seasonal points and to check the pace of louke water clocks, rather than to provide the ordinary population with hour-by-hour time. The instruments themselves could be carefully made, but they occur in far smaller numbers than their western counterparts, which suggests that shadow dials in China remained close to official astronomy and calendar work and were handled by specialists.

The difference is therefore less a matter of "Chinese interest in time" than of the institutions that managed time. In the Mediterranean cities, commercial and administrative needs created room for both public dials and personal ones; in China, time regulation was concentrated in state observatories, while daily rural life followed the sun and the agricultural calendar. Each tradition, however, shows a distinctive strength: Greco–Roman sundials developed a wide technical vocabulary and geometrical sophistication, whereas Chinese practice folded shadow measurement into an already established calendrical system. Reading the two together makes clear how strongly social setting and technical goals could shape even so simple a device as a sundial.

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