Article

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The Greek portable sundial from Memphis rediscovered

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Abstract

Experts studying antique astronomic instruments are well aware of a small class of so-called portable sundials from the Roman Empire. Over the past few decades, they have been considered in several important publications, including a recent book by Richard J. A. Talbert, in which he systematized the available information. Talbert and earlier J. V. Field described eight portable sundials of a "geographical" type, dating from about 2nd–4th centuries. Five are inscribed in Greek, the other three in Latin. The list of Greek dials also contains a dial from Memphis, information about which has been very scarce so far. Some authors even considered it lost. Fortunately, this instrument is stored in the collection of the State Hermitage Museum (St. Petersburg) and now we have an opportunity to study it more closely.

Keywords

Alexandrian calendar, Constantin von Tischendorf, gazetteer, Hermitage Museum, Memphis, portable sundial, Roman Empire

Introduction

A well preserved brass disc with a shackle for suspension and a gnomon mounted on its axis are stored in the East Department of the State Hermitage Museum, St. Petersburg. The disc's inventory number is W-1531 and the gnomon's number is DV-2177. (Below the author will explain why there are two numbers.) The disc is 133.6 mm in diameter and 1.8–1.9 mm thick; its height with the suspension is 150.0 mm. (The diameter is about the same as that of a similar disc in the Science Museum, London,[1] 135 mm; all other known portable sundials are smaller). Only two instruments available for research have retained such an important element as the gnomon: the Hermitage disc and the disc from the Oxford History of Science Museum.[2] All the inscriptions on the Hermitage disc are

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in Greek. Some other portable sundials have Greek inscriptions, too; others are inscribed in Latin, though the evidence links them also to the Hellenistic tradition.

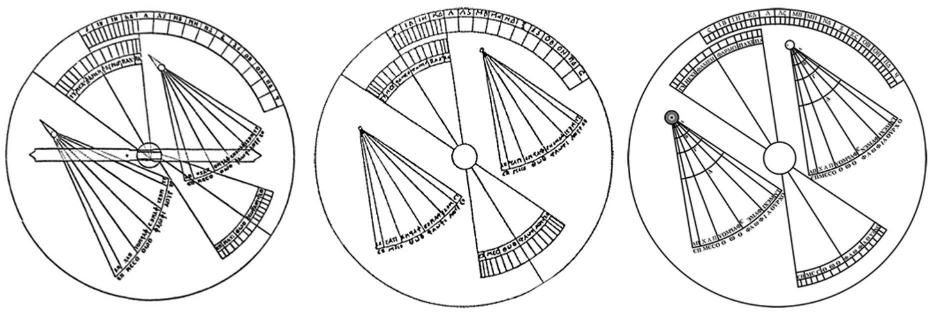
The Hermitage disc arrived from Egypt. In the middle of the 19th century the disc, originally from the necropolis of the ancient city of Memphis, was discovered in Cairo by Constantin von Tischendorf (1815–1874), German biblical scholar and specialist in ancient languages. In 1859, during the scholar's third visit to Egypt, he managed (with the help of the Russian diplomatic mission) to gain access to rare manuscripts. Monks from the Orthodox Monastery of St. Catherine on Sinai Peninsula agreed to hand the manuscripts over to Russian emperor Alexander II who was considered to be the protector of the Greek Orthodox Church. Later Tischendorf delivered the manuscripts and artefacts (including the disc) to the Imperial Academy of Sciences in St. Petersburg. Codex Sinaiticus was published shortly afterwards. The scholar was also the first to make a detailed description of the disc (in 1860), although he was unable to explain its operating principles. Probably, this can account for the inaccuracy in the drawing of the scales. The size of the disc was not specified either.[3]

The instrument may have been initially stored in the St. Petersburg Kunstkamera Museum. Waves of turbulent Russian history brought some of the exhibits from the Kunstkamera to the other side of Neva River, to the Hermitage Museum. Twice Hermitage collections were evacuated away from the front lines, during World Wars I and II. In the end, the disc came to rest in the Department of Western Art, where it was kept as an "unidentified object" together with the collection of bronzes by French master Pierre-Philippe Thomire. In the meantime, the movable gnomon somehow made its way to the Egyptian Department. The disc and the movable gnomon were stored separately for a rather long time.

In 1969, Derek J. de Solla Price (1922–1983), a famous historian of science, made another attempt to trace the history of the disc from Memphis. He writes: "A recent search by Professor V. Chenakal of the Lomonosov Museum in Leningrad has confirmed that the gnomon of this dial is still preserved in the depository of the Foreign East section of the Hermitage Museum in Leningrad; presumably the circular dial plate may also still be there."[4] This not quite accurate information confirms that the objects were stored separately for a length of time.

At some point, Doctor of Arthistorical Sciences Vera Zalesskaya of the East Department identified the names of some cities inscribed on the disc and moved it to the East Department. In June of 2015 the author of this article studied the Hermitage collection of astrolabes and came upon the disc, which was also listed as an astrolabe. After that the author initiated the search for the gnomon. Once found, the gnomon was transferred to the East Department. The two parts were reunited in 2017.

As already noted, the original drawing of the obverse of the disc performed by Tischendorf was clearly inaccurate and caused understandable doubts. However, as early as in 1971 German scholar Edmund Buchner (1923–2011) tried to reconstruct the appearance of the instrument.[5] Now it is obvious that he was rather close to the truth (see Figure 1): on the obverse of the disc we see four calendar scales (in every sector), 2 hour scales (to the left and to the right of the center), and a 90-degree scale on the limb (see Figure 2). Below we will describe them in greater detail.



(a) (b) (c)

Figure 1. Obverse drawing (a) by Tischendorf, 1860; (b) by Buchner, 1971; and (c) the actual appearance.

Gazetteer

On the reverse side of the disc (Figure 3), there is a table of cities and provinces, or gazetteer. Thirty-six names are inscribed in Greek, each with the corresponding latitude. Table 1 closely coincides with the table presented by Tischendorf, except for one letter—Tischendorf had missed the letter Є in the name ANTIOXЄIA—and two digits. First, the latitude of Meroe (#2) is 16⅓, not 16½. The sign for ⅓ is used here only once. It is not found anywhere else on this disc. Second, the latitude of Thrace (#35) is 41, not 44 (Figure 4).

Before restoration, which began in 2018, three lines (#12–14) were unread because they were obscured by the tightly fixed suspension arm. But after the restoration we were able to identify the missing items (Figure 5). For comparison, the table shows the latitude values according to Ptolemy and the correct values.

The main conclusion about the dating of the Memphis disc based on the Gazetteer has already been made by other authors: the disc could not have been produced before AD 330, the year when Constantinople was founded. The latitude of Constantinople on our disk is the same as given by Ptolemy for ancient Byzantium, on the site of which it stands, that is, 43 degrees. Later, the latitude of the city was refined to 41 degrees.[6] Therefore, it is considered that the disc from Memphis is one of the earliest, possibly made in the 4th century, as it was originally dated by Tischendorf (but without explanation).

Calendar scales

Four calendar scales in the form of fan-shaped sectors represent the months of the Alexandrian calendar, as shown in Figure 6. (See Table 2 for the relation of the Alexandrian calendar to the Julian calendar.)

Figure 2. Obverse of the disc. Photograph © The State Hermitage Museum.
Source: Photo by Grigory Yastrebinsky.

The calendar scale is more detailed in two central sectors—each month is divided into three decades (except for two outside months that are bisected). Of these two scales, the upper one (contacting the degree scale on the limb) presents spring months (ΤΥ, ΜЄΧΙ, ΦΑΜЄΝ, ΦΑΡΜΟ, ΠΑΧ, ΠΑ), from the winter solstice to the summer solstice. The bottom one denotes autumn months, from summer solstice to winter solstice (ЄΠ, ΜЄCΟ, ΘωΘ, ΦΑωΦΙ, ΑΘΥΡ, ΧΟ).

On the shadow scales 6 months are listed in the direct order (ЄΠ, ΜЄCΟ, ΘωΘ, ΦΑωΦΙ, ΑΘΥΡ, ΧΟ), and six in the reverse one. Those that are arranged from right to left are also read from right to left, and the letters are mirrored (the so-called Greek boustrophedon-style)—ΑΠ, ΧΑΠ, ΥΟΜϤΑΦ, [Ν]ЭΜΑΦ, ΙΧЭΜ, ΥΤ. Here and in Table 3, in letters in square brackets are those that are listed not on all four scales, but only where there was enough space for them.

The calendar scales simultaneously show the declination of the Sun at certain dates of the year. The central line of each of the four sectors corresponds to the equinoxes. The outside lines of the sectors correspond to the solstices.

In the 4th century A.D., the assumed time of production of our disc, the cardinal astronomical moments corresponded to the following Julian dates:[8]

Figure 3. The reverse. The dark stripe on the right was formed due to the fact that the suspension was fixed in this position for a long time (maybe many centuries). Photograph© The State Hermitage Museum.
Source: Photo by Alexander Lavrentyev.

Vernal equinox: March 20 = Phamenoth 24 (not 1st Pharmouthi, as can be seen from the drawing);

Summer solstice: June 22 = Payni 28 (not 1st Epiphi);

Autumn equinox: September 22 = Thoth 25 (not 1st Phaophi);

Winter solstice: December 20 = Choiak 24 (not 1st Tybi).

Thus, the astronomical moments correspond to the beginning of the months with an accuracy of 3 to 7 days.

The sun's declination at the vernal equinox and the autumn equinox is zero. Solar declinations at the summer and winter solstice, June 22 and December 20, are equal to obliquity of the ecliptic, 23°51, positive in summer and negative in winter. The maker could use the angles from Ptolemy's *Almagest*[9] (see Table 3).

Table 1. Gazetteer.

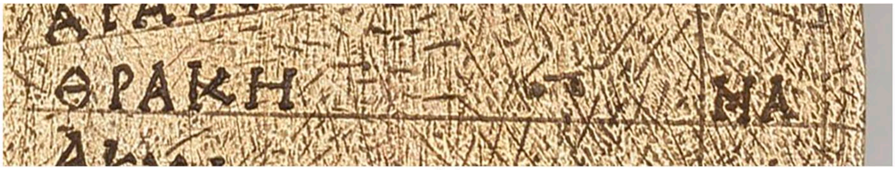
	Inscription		Locality and latitude		Ptole-my	Correct latitude	Comments
1	ΙΝΔΙΑ	Η	India	8°	–	?	?
2	ΜЄΡΟΗ	ISΓ	Meroe	16⅓	16°25′	16°56′	Ancient city in Sudan
3	CΟΗΝΗ	ΚΓ<	Syene	23½	23 50	24°05′	Modern Aswan
4	ΒЄΡΟΝΙΚΗ	ΚΓ<	Berenice	23½	23 50	23°55′	Ancient city on the Red Sea
5	ΜЄΜΦΙC	Λ	Memphis	30	29 50	29°51′	Ancient city in Egypt
6	ΑΛЄξΑΝΔΡΙ	ΛΑ	Alexandria	31	31	31°12′	City on the Mediterranean
7	ΠЄΝΤΑΠΟΛΙC	ΛΑ	Pentapolis	31	–	?	Greek colonies in N. Africa
8	ΒΟCΤΡΑ	ΛΑ<	Bostra	31½	31 30	?	Ancient city in S. Syria
9	ΝЄΑΠΟΛΙC	ΛΑΓο	Neapolis	31⅔	33	32°13′	Modern Nablus, Palestine
10	ΚЄCΑΡΙΑ	ΛΒ	Caesarea	32	32 30	32°30′	Ancient city in Palestine
11	ΚΑΡΧΗΔωΝ	ΛΒΓο	Carthage	32⅔	37 55	36°51′	Ancient city in Tunisia
12	CΑΛΔΑΙ	ΛΒ<	Saldae	32½	32 30	?	? Modern Bijayah, Algeria ?
13	ΤΥΡΟC	ΛΓΓο	Tyre	33⅔	33 20	33°16′	Ancient city in Lebanon
14	ΒΗΡΥΤΟC	ΛΓΓο	Beirut	33⅔	33 40	33°53′	Capital of Lebanon
15	ΓΟΡΤΥΝΑ	ΛΔ<	Gortyn	34½	34 50	35°04′	On the island of Crete
16	ΑΝΤΙΟΧЄΙΑ	ΛЄ<	Antioch	35½	35 30	36°12′	Ancient Syria, modern Turkey
17	ΡΟΔΟC	ΛS	Rhodes	36	36	36°26′	City and Island
18	ΠΑΜΦΥΛΙΑ	ΛS	Pamphylia	36	–	37–38°	Region in the Asia Minor
19	ΑΡΓΟC	ΛS<	Argos	36½	36 15	37°37′	Among oldest cities in world
20	CΟΡΑΚΟΥCΑ	ΛΖ	Syracuse	37	–	37°05′	On the island of Sicily
21	ΑΘΗΝΑΙ	ΛΖ	Athens	37	37 15	38°00′	Capital of Greece
22	ΔЄΛΦΟΙ	ΛΖΓο	Delphi	37⅔	37 40	38°29′	Ancient city in Greece
23	ΤΑΡCΟC	ΛΗ	Tarsus	38	36 50	34°53′	Ancient city in the Asia Minor
24	ΑΔΡΙΑΝΟΥΠΟΛΙC	ΛΘ	Adrianople	39	–	39°06′	Stratonicaea?
25	ΑCΙΑ	Μ	Asia	40	–	36–40°	Region in the Asia Minor

(Continued)

Table 1. (Continued)

	Inscription		Locality and latitude		Ptole-my	Correct latitude	Comments
26	ΗΡΑΚΛЄΪΑ	ΜΑΓο	Heraclea	41⅔	42 20	40°58′	Lyncestis, former Perinthus
27	ΡωΜΗ	ΜΑΓο	Rome	41⅔	41 40	41°54′	Capital of Italy
28	ΑΓΚΥΡΑ	ΜΒ	Ancyra	42	–	39°52′	Modern capital of Turkey
29	ΘЄCCΑΛΟΝΙΚΗ	ΜΓ	Thessalonica	43	40 20	40°38′	City in Macedonia, Greece
30	ΑΠΑΜΙΑ	ΛΘ	Apamea	39	38 55	38°04′	Apamea Kibotos in Phrygia
31	ЄΔЄCΑ	ΜΓ	Edessa	43	40 20	40°48′	City in Macedonia, Greece
32	ΚωΝCΤΑϛΤΙΝΟΥΠΙ	ΜΓ	Constantinople	43	43 05	41°01′	Modern Istanbul
33	ΓΑΛΛΙΑΙ	ΜΔ	Galliai	44	–	43–51°	Region of Western Europe
34	ΑΡΑΒЄΝΝΑ	ΜΔ	Ravenna	44	44	44°25′	North Italy
35	ΘΡΑΚΗ	ΜΑ	Thrace	41	–	41–44°	Roman province
36	ΑΚΥΛΗΙΑ	ΜЄ	Aquileia	45	45	45°46′	Ancient city in N. Italy

(a)



(b)

Figure 4. Portions of the gazetteer with localities whose latitudes have been corrected.

In order to verify this assumption, we measure the angles using the Corel Draw program. The presence of four calendar scales, in which declination is drawn on both sides of the equator allows us to obtain eight values of the angles. Thus, for the solstice, the values of angles 23.81; 24.13; 23.94; 23.93; 23.67; 23.61; 23.49; 23.79 have been obtained, which yields the mean value of inclination of the ecliptic $\varepsilon = 23.80° = 23°48'$. This value is very close to Ptolemy's value (23°51′).