
Die antiken Sonnenuhren Griechenlands. Festland und Peloponnes mit CD-ROM by Karlheinz Schaldach

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This is a carefully documented book on ancient sundials in mainland Greece and the Peloponnesus, beautifully illustrated, covering almost all the extant evidence. Numerous excellent photographs supported by a CD-ROM and generous, carefully laid-out diagrams provide a vivid visual impression and enhance the presentation of the measurement data. The measurements themselves were carried out with meticulous care, and the mathematical evaluation is presented in a way that makes it accessible to a general reader. The book is very useful as a reference tool. When supplemented by the already existing catalog of Roman sundials in the West (by the same author) and the planned catalog of Greek and Roman sundials on the islands, it will indeed replace the now current standard reference work by Sharon Gibbs [1976]. For it does constitute a genuine advance: more sundials are taken into account, more details and data are included, and improved measurements are provided. There are more illustrations and images, and criteria for a rough dating of sundials are developed. A new method of analysis is proposed with a simplified mathematical apparatus, in geometrical representation; it yields more specific, and arguably more descriptive, parameters for evaluating sundials. The author's main objective, which is to provide sufficient (if preliminary) documentation for further work towards a 'bottom-up' account of ancient sundialing that takes full account of the obtainable data, is duly met. In addition, as I have said, this book has the advantage of being accessible to a general reader, though it could be used as a source for academic study as well.

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The book falls into three parts:

1. A history of sundialing from the ancient Orient to Byzantium
2. A catalog of extant sundials on mainland Greece and on the Peloponnesus (this is the heart and core of the book), and
3. Mathematical analyses.

An appendix provides maps, diagrams on latitudes and *climata*, tables, a bibliography, and indices. Especially noteworthy are the beautifully illustrated catalog [part 2] and within it, the chapter on the Tower of the Winds [2.1]. The chapters on the history of Greek and Roman sundialing [1.2] and the methodological remarks [3.1, *passim*] are also well worth considering in more detail.

Survey of the book

1. History
 - 1.1 Pre-Greek (Babylonian and Egyptian) sundials
 - 1.2 Greek and Roman sundials
 - 1.3 Byzantine sundials
2. Catalog (descriptions with photos, rough dating, evaluation)
 - 2.1 The Tower of the Winds and its sundials, treated separately
 - 2.2 General remarks on the cataloguing of the other finds
 - 2.3 Catalogue of the remaining finds on the Greek mainland and the Peloponnesus
3. Analysis
 - 3.1 Methodological remarks on the mathematical tools for analysis, and on their status
 - 3.2 Documentation of the results of the mathematical analysis of the measurements, comparison with other evaluations

Introduction

According to Schaldach, Sharon Gibbs' book on Greek and Roman sundials [1976] is still the state of scholarship. He builds on her account everywhere, even the set-up and organization of his work parallels hers. Even so, he argues that a fresh look at the evidence is needed, and suggests a shift of emphasis in how one interprets the finds. A historical approach has so far tended, in Schaldach's opinion, to override, even sideline, the material evidence, and to overemphasize a purely mathematical interpretation of the lines on

ancient sundials. As a result, the emerging picture is unnecessarily poor in detail and unclear as far as the actual objects are concerned. Data collection and measurements on the actual objects do not take full advantage of what is available in the material. In addition, there are other interesting questions that are obviously relevant for a better understanding of the sundials in their cultural context but not often addressed in historical studies. They include: Who used the dials and for what purpose? Why were they erected in societies that otherwise showed scant interest in measuring time? By what criteria should their accuracy be judged? Who made them and how? Who paid for them? What was their cost? What was the source of the materials used? What do they imply about the societies that financed and erected them? Schaldach proposes an approach to the ancient sundials of Greece that would allow the pursuit of such questions by providing an analysis that places more weight on, and makes more extensive use of, the data that can be directly observed in an object as opposed to a few data that correspond, more or less (mostly less) to an ideal line distribution derived from some theory for an ideal sundial-shape.

1.1 Early sundials

Schaldach's historical overview begins with a survey of pre-Greek sundialing in Egypt and Babylonia, with the intention of conveying to the reader what the Greeks took over from the Orient and where their specific innovations lie. Among other things, the types of instruments for measuring time and the key item, the *gnomon*, are discussed. In my view, this chapter is not the strongest in the book. In particular, I am not sure that it achieves its declared goal because Babylonian and Egyptian sundialing does not become clear enough in outline so as to compare it with the specific Greek achievement. The main conclusions of the chapter are that there were Babylonian and Egyptian sundials; that the Babylonian approach to time measurement was predominantly arithmetical; and that time measurements in both cultures have a religious context. Moreover, Schaldach maintains that all pre-Greek sundials are flat, not hollow; and that the closest parallel to early Greek sundials is a flat semicircular disk attested in 13th century (BC) Egypt. This, according to him, is the type that was transmitted into Greece.

1.2 Greek and Roman sundials

This chapter is very interesting and stimulating. Schaldach labels it ‘preliminary’ because a fuller evaluation should, in his opinion, be based on the complete material evidence, including the sundials on the islands. Even so, a clearly argued, well-reflected general outline for the history of Greek and Roman sundials in their cultural context emerges.

Contrary to an established standard opinion, Schaldach maintains that the earliest sundials were not spherical. Eudoxus (fourth century BC) worked as a gnomonician. His device, the *arachne*, was a flat sundial with vertical gnomon. Sundials were taken over from the Orient; and in classical Athens, once scientists were given Eudoxus’ new geometrical model of the cosmos, they explained the lines on the dials in light of that model. The science of gnomonics was thus created. The dials constructed by the practitioners of gnomonics had at the outset no public role or place: they were of purely theoretical and scientific interest. Scholars, not engineers, were the ones who developed the sundials further, in the context of applied astronomy for its own sake. ‘*Sie waren—was im weiteren Text noch deutlich wird—vorrangig am Modell dargestellte Theorie und wurden damit zu Boten neuer wissenschaftlicher Erkenntnisse*’ [32].

This was not the case throughout antiquity, however. Schaldach makes a convincing case for a developmental story. *Ὥρα*, meaning ‘hour’ (not ‘season’), was introduced into society in Hellenistic times. Over time, the sundial changed from being a scientific ‘diagram’ or instrument to a commonly used clock. This development is reflected in the shapes, and in the presentation and function of the sundials.

With reference to the shapes for Hellenistic sundials, Schaldach differentiates three stages:

- equatorial,
- hollow cone, hollow sphere, and
- all other types.

In his account, spherical and conical sundials were a Hellenistic development. Alexandria and Rhodes, not Athens, were centers of gnomonics in the Hellenistic era. Even so, the most impressive achievement of Hellenistic gnomonics is the Tower of the Winds in Athens.

It was built *ca* 100 BC by Andronicus. No further development of theoretical dialing is attested in Greece after Andronicus.

Towards the end of the Hellenistic era, changes in attitude towards time and time measurements made themselves felt. They were reflected in the further development of the construction of such dials, but also in the place which they actually took in communities. While all other earlier dials come from sanctuaries, Andronicus' Tower stands in what soon became a public space (the Roman Agora in Athens). According to Schaldach, this is indicative of a changed perspective on sundials as objects and instruments. The transition to the public/secular sphere seems to be a takeover from Rome, according to Schaldach.

Most Roman sundials in Greece are in public spaces; there were presented either freestanding on a column or on walls so as to be publicly visible. Despite a general decrease in population, the number of sundials actually increased during this period. Schaldach argues that this means that time and timekeeping became more important as a factor in public life. At the same time, as the function of the dials changed, so did their nature. They were no longer seen as diagrams in connection with a scientific theory, or as implementations of a scientific world picture, or even as precise scientific instruments. The dials became rough and ready indicators of the hours of the day—their accuracy was tolerable—and the datelines on them (a feature that makes the dials useful as calendars) deteriorated until they become purely decorative. From the standpoint of accuracy, these dials are of much poorer quality. It appears as though the masons gradually lost the knowledge and the expertise needed to produce dials that implement gnomonic theory in detail. Nevertheless, as Schaldach correctly insists, one should not interpret these dials in the light of gnomonic theory alone because that is not what went into them and it does not take account of what they were for. The main reason for the 'decline' in gnomonic quality is a change in the purpose and function of the sundials, and we should try to account for the dials in a more contextualized way. We do more justice to the dials, and to what they meant to the people who produced and used them, if we accept their inaccuracy as scientific instruments for measurement, and explain them as the deliberate result of a less sophisticated design.

The third and fourth centuries AD represent a last stage in ancient sundialing. In concurrence with the general cultural trend, science, and generally rationalistic explanations of the physical world as a meaningful whole, fell out of favor. The sundials from this period show purely decorative date lines. The inexactitude even of hour lines increases drastically. In the cultural context, though, this makes perfect sense. The inexactitude was well within the range of tolerance for the user. These dials should no longer be viewed as tokens for gnomonics at all. The only valid criterion for their production was purely pragmatic and solely concerned their use as simple devices for indicating the hour. This is manifested in the material evidence in other ways too, apart from the inaccuracy of hour lines and absence of date lines. We find dials of irregular hollow shapes: some are spherical, some are cylindrical or conical, and others are mixed in shape. Often the dominant shape cannot even be determined. Yet this should not be interpreted as a failed attempt to produce a regular shape, one of the ‘canonical’ shapes in traditional gnomonics. The masons apparently just did not care about those aspects any more. Instead, the shapes are due to the fact that the masons strove to give their dials a more or less traditional look. In the end, we observe a reversion to the original simple, flat sundial with functional hour lines only. *‘Es ist die alte Idee aus dem Orient, die hier wiederkehrt und—weil sie so einfach umzusetzen war—bis ins Mittelalter Bestand haben sollte’* [36].

The above developmental line that traces a shift in emphasis and function leads to a new criterion for dating the extant sundials. Granted that later dials were used for hours only, a ‘sloppier’ dial is, in general, going to be later. Schaldach’s rough dating proposal in terms of periods—Classical, Hellenistic, Roman, and Late antiquity—seems sound.

Schaldach’s developmental story is convincing on the whole. Specifically, his insistence on taking the purpose, the function, and the intended user into account when evaluating ancient dials seems convincing, though I should have liked to hear more about ancient astronomical theory and gnomonics for the Hellenistic sundials, since the scientific context was relevant for them, as Schaldach himself maintains. The chapter on the Tower of the Winds only partially fills this gap. Is it possible that we could push a little deeper with our understanding of those “scientific” sundials by taking written docu-

ments about gnomonics into account, even if they are fragmentary and indirect?

1.3 Byzantium

The survey of sundials from the Byzantine era gives an interesting, rather general outline. It seems quite convincing to state that the role of time and time measurement in Byzantine culture led to a lack of interest in dials as instruments for telling the actual secular time. The dials, where they are found, became quasi-icons for true, absolute Time, and were subjected to a rather determinate ‘iconography’. They are found in the context of churches in monasteries, not in the cultural centers. Because of their distinct, canonical elements in design, Byzantine dials can be easily recognized as tokens of a single relatively stable type attested from AD 800 to the 17th century, that is, a flat dial of palmetto shape, directed south, with semicircles as well as partitions with 10, 11, and 13 lines (with preference for partitions with 11 lines) and idiosyncratic number signs. The dials are neither useful nor intended for telling the actual time. The ‘iconographic’ criteria serve to identify a Byzantine dial and differentiate it from ancient dials.

2.1 Tower of the Winds

As an extraordinary and superb monument of Hellenistic gnomonics, the Tower of the Winds receives a separate, more extensive, treatment within the catalog part of Schaldach’s book. Schaldach discusses not only the nine sundials that are integrated into the Tower, but also questions of its dating, purpose, historical significance, and ‘reception’. This chapter can be read on its own, and it provides a very compelling and attractive interpretation of the monument. The interpretation, though not the first one of its kind, is very well worth reading.¹ The exposition is accompanied by numerous suitable illustrations and diagrams. Of the nine sundials on the Tower, several are unique in their kind. In effect, the whole building is a kind of cosmic clock, symbolizing the power of the Sun and of the mathe-

¹ One might want to consult in addition the literature given in Schaldach’s references, especially the works by Gibbs, Hüttig, and Kienast.

mathematical theory that here captures the very regularities and working of nature. The sundials, indeed the whole Tower, were certainly constructed with recourse to gnomonics. The dials have a very high degree of precision. The complete design is also esthetically convincing and pleasing as a whole. Schaldach proposes a date of 100 to 90 BC for its construction. In his opinion, Andronicus himself commissioned the Tower. In this assessment, Schaldach agrees with some other scholars. At any rate, Andronicus certainly was the architect of the Tower as well as the designer for the dials. After discussing the 'reception' and interpretations given by observers of the Tower over time, Schaldach concedes that it is possible, though at present not verifiable, that the Tower once housed a mechanism for projecting the zodiacal signs in circulation over the year (in the interior, using the waterclock, of which remnants are still visible). He sees the main purpose, however, in the fact that the Tower, as a whole, is a kind of cosmic clock.

In der Symmetrie des Baus zeigt sich die Ordnung der Natur, in der Dominanz der N-S Richtung die massgebende Kraft der Sonne. Die Betrachtung des wandernden Schattens fordert dazu auf, die Sonne als den Motor der Natur und als ihren Regulator zu erkennen. Sie regiert sowohl die Winde als auch die Zeit. Sie ist das Zentralgestirn, das die regelmäßige Wiederkehr von Tag und Nacht, Sommer und Winter, Wachstum und Zerfall verantwortet und dem Menschen seine Bestimmung in den fortwährenden Kreisläufen der Natur zuweist. ... Mathematik wird so zu einem allseits sichtbaren Werkzeug, das die Vorgänge der Natur nachzubilden und sogar vorweg zu nehmen vermag. ... Die Sonnenuhren erhalten so eine metaphysische Bedeutung als Widerspiegelung einer naturwissenschaftlichen Weltordnung. [68]

Given that the dials on the Tower are clearly designed in accordance with gnomonic calculation, the question arises as to whether they were actually constructed beforehand or later introduced by way of measurements and adjustments on the finished building. In answering this, Schaldach proposes that in addition to the mathematical tools available one should also consider the planning and proportions of the stone heights in the walls as well as the position of the edges of the stones. His account of how the date and hour lines came to be in their present positions is altogether quite compelling.

2.2 Catalog of the remainder of the finds

The catalog, together with 2.1, is the centerpiece of Schaldach's book. It is very nicely done and extremely user friendly. The photographs provided for each individual sundial are of generous size and good quality. A detailed description and characterization of each piece is given. In addition, one finds an evaluation, a rough dating, and references to other literature where the dials are published or discussed. Because of its generous, visually satisfying presentation of the material and its thoroughness in documentation, the catalog is very useful as a reference tool with visual material. The accompanying CD-ROM with its visual material enhances the value of the catalog. The catalog will, in my view, prove very helpful for readers who find the book's language (German) to be an obstacle.

3.1. Methodological considerations for a mathematical analysis of ancient sundials

Schaldach names three major problems or obstacles for an unrestricted and exclusive use of mathematical apparatus in the interpretation of our evidence on ancient sundials. In principle there is, of course, always a problem involved in the relation of mathematics to reality when one evaluates objects that implement a mathematical theory for practical use. With regard to the ancient sundials, one has the additional problem that the theory in question is no longer accessible to us in detail, and that the extant dials themselves are often in fragmentary state and come from vastly different time periods, thus raising such questions as Which theory and what amount of theory, anyway? On the very basic level, the state of the evidence causes problems for actual measurements: there is a high degree of inaccuracy, not all of which is always due to the poor quality of the object under investigation. As an illustration of this fact, one might consider that different measurements in Gibbs' account of one and the same ancient sundial yield different categorizations for that same sundial. Finally, when theoretical concepts are imported into data, one has to be aware that they may not fully capture, and may not even concur with, the ideas that went into the production, so that the explanation in terms of the theory simply misses the point. In light of such observations, Schaldach proposes a new methodological approach, one that allows for more flexibility and is more cautious, even quasi-minimalistic, in its theoretical apparatus, while resting on

a larger amount of observed details and more detailed measurements as well. Schaldach draws part of his justification for his new catalog from improved and more numerous measurement data, and a more flexible and accessible theoretical apparatus for evaluation.

3.2 Documentation and analysis of the measurements

This chapter provides detailed documentation of the measurements, with introductory explanations, generous diagrams, description of mathematically relevant idiosyncrasies, and comparison with other existing measurements and results. It must be read in connection with 3.1 (and will be a more profitable reading, if taken in connection with 2).

Schaldach gives a coherent and comprehensive account of the evidence concerning ancient sundials in Greece and on the Peloponnesus following the plan of Gibbs 1976. The chapters of the book can be read individually or selectively. Some weak points, in my view, include the following. The author appears to be a bit ungenerous towards Gibbs, on whose work he constantly builds. Also, the chapters on Babylonian and Egyptian sundials are not as successful as the others. A somewhat more detailed discussion of gnomonics in the Hellenistic era would have been desirable. These minor drawbacks do not, however, diminish the value of this book.

There are many very interesting general points made in the book, which include the following:

- The cultural relativity of time and time measurements becomes visible and accessible in Schaldach's account of ancient sundialing. Changes of interests and perspectives with regard to measurement of time can be detected, and play out, of course, in the design and placement of dials. Shifts in the view on science and scientific explanation are thus reflected or materialized in the sundials.
- Schaldach's methodological remarks have more general implications for the history of science and technology. Though formulated for the evaluation of ancient sundials and in opposition to taking sundials merely as tokens for an astronomical theory, they argue for a more extensive consideration by historians of material evidence and its actual use in practice. His new evaluation of ancient sundials may serve as an exemplary point of departure in discussions

that aim to include so far underrepresented perspectives in the history of technology. The science of gnomonics, though relevant in attempts to take account of ancient sundials, was not necessarily the governing *leitmotif* for all ancient sundials in themselves, especially and increasingly so in the period after the Hellenistic era. Changes in purpose, cultural function, and practical use were reflected in the dials, and should find their way into any account of them as technological instruments. It seems to me that Schaldach makes a good case for de-emphasizing the role of astronomical theory in a comprehensive understanding of the sundials within ancient culture(s). Maybe something like this should be the case for other items in the history of technology as well, since any technological instrument is, as such, not merely an application of a scientific theory.

To sum up: this is a very accessible and rich source book on ancient sundials, as they are found in Greece and on the Peloponnesus. It is carefully crafted, beautifully illustrated, very informative, and stimulating. It will reward both the general reader and the specialist.

BIBLIOGRAPHY

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