28
Reconstructing a Bronze Age Site with CAD

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28.1 Introduction

The site of Toumba Thessaloniki is a tell site located within the urban pattern of the second largest city of Greece (see Figure 28.1). The tell is a huge mound raising approximately 23 metres above the modern ground and measures 1.7 hectares at its base. It spans a period of more than 2000 years starting from the Early Bronze Age (late 3rd millennium) and ending during the Iron Age (4th century BC)

Modern habitation has gradually reached the edge of the mound and occasionally has encroached in the settlement itself. As a result of recent development and following the needs of urban life, the surroundings of the tell have changed dramatically in the last two decades. Large blocks of buildings, streets, levelling and filling in of the nearby streams have distorted the relief of the landscape. The picture of the area today is very different from that during the First World War, when a military camp of the allies was established here. At that time, Toumba was a prominent mark of Thessaloniki (see Figure 28.2).

The excavation of the site started in 1984 as a training dig of the University of Thessaloniki and is carried out by the students of the Department of Archaeology. An area of 1000 square metres has been investigated so far, and stratigraphy of no less than 25 metres of depth has been exposed. Approximately 1300 cubic metres of earth have been painstakingly dug. The excavation has proceeded in two main sectors, one at the top of the tell, aiming at exposing horizontally the settlement pattern and one at the side of the mound aiming at the examination of the vertical succession of deposits (see Figure 28.3).

The element which characterises a large tell site such

Figure 28.1: Aerial view of the site of Toumba Thessaloniki

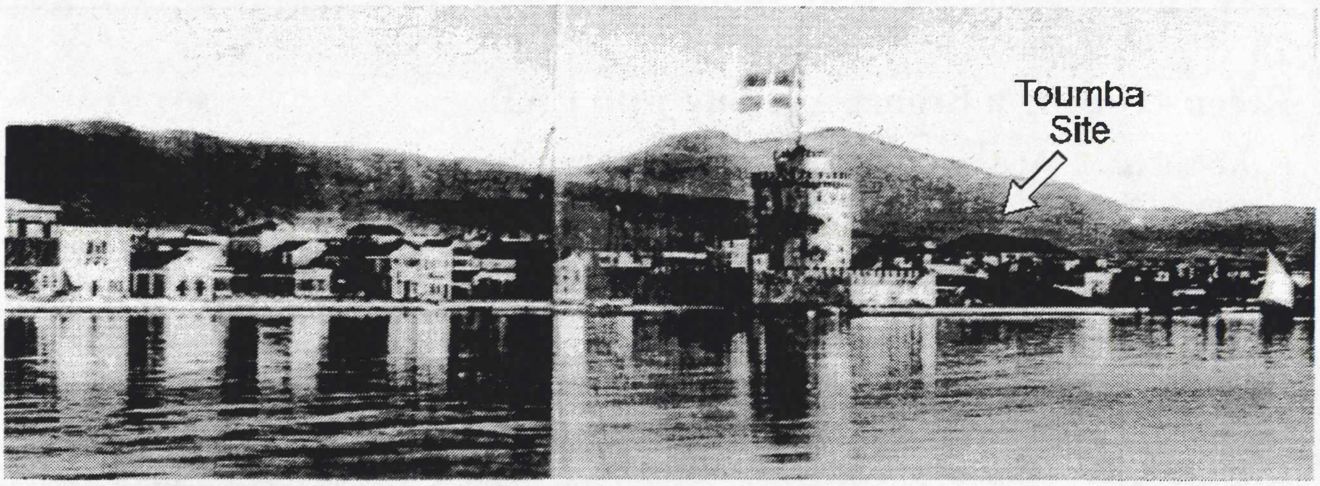

Figure 28.2: A view from the sea of the site. Beginning of this century.

as Toumba is the very complex stratigraphy. This stratigraphy results from the long-term use and the elaborate organisation of settlement space during the successive phases of occupation (Andreou & Kotsakis 1991, Kotsakis & Andreou 1990). As often happens with tell sites, architectural remains that are chronologically remote can be found on the same level while deposits and constructions of the same occupation period can be located at various depths along the side and at the top of the mound. Clearly an element of horizontal stratigraphy is intermixed with the normal vertical one. Although this sounds like a reasonable assumption, it had not been clearly demonstrated in earlier research in similar tell sites elsewhere in the region of Macedonia (Heurtley 1939, Hansel 1989). The Toumba excavations offered a wealth of data to support this observation which we now have reasons to believe applies to several other major sites in the wider region (Wardle 1987).

It has to be pointed out however that as a result of the excavation technique the stratigraphic data are divided into an overwhelming number of excavation units which presently reaches a figure of approximately 8000. Consequently, the handling of the information involved becomes an enormous task, especially if the question regards the combination of data from different, at times spatially unrelated, excavation units. This clearly calls for a well developed system of data management. The system should ideally integrate the excavation data with the topographical and stratigraphical information allowing for the inevitable increase in size and complexity in the future.

28.2 The Data Management System

The Data Management System of Toumba was originally conceived for manual operation. The initial quantification and classification of finds was carried out by means of pre-designed forms which were filled either on the field or later during the year in the excavation lab. There are two basic groups of data: statistical data and inventories. The first group consists of finds which are treated quantitatively, while the second group consists of special classes of finds such as stone implements, whole pots, samples. The finds in the two groups are related to each other by means of the excavational unit number which acts as the identity of each single find or group of finds. The manual data base was therefore designed from the start as a relational one.

The first attempts at the digitisation of the excavation of Toumba Thessaloniki took place in 1986 with the help of an 8088 computer. The aim was simply to transfer the existing system into the new medium by means of straightforward dBase programs, imitating the structure and the form of the pre-designed entry forms already in use. The feeding of data was exclusively done in the lab after the excavation, as the 8088 computer was considered too valuable to be exposed to the hardships of the excavation environment. On the other hand, the aim of recreating the complete picture of each excavation unit by combining all data of different types was not fulfilled to the extent of being really useful. However, we could still produce extensive and extremely useful inventories of the finds.

In the intervening years since 1986 the system was extended in various ways incorporating some of the new possibilities of the electronic medium. A crucial addition to the original system was the handling of topographical and architectural information through CAD software. This obviously required the upgrading of the hardware, which in 1988 moved to a 286 computer with the necessary peripherals, such as a digitising tablet and a laser printer. To some extent this was a response to the problems of interpretation of the stratigraphical complexities that were becoming evident through the process of the excavation. The accumulation of a whole mass of architectural information from different parts of the site made obvious the need for the creation of a basic reference electronic grid on which all the architectural finds would be placed according to their real co-ordinates. This would eventually permit the association of the seemingly separate finds into a more complete picture.

The structure of the present day data management system is divided into two parts. The first part consists of

Figure 28.3: The main sector of the excavation at the top of the site.

data entered on site. These are mainly data concerning the basic documentation of the excavation, the cataloguing of finds such as sherd groups, whole pots, metal finds, samples etc. The second part is done in the lab and consists of the transformation of the excavation plans and the topographic data into digitised form. They constitute a separate archive which together with the digitised photographs complete the data base of the Toumba excavation. Presently the combination of these data bases is in the process of being done through Superbase 4 software which brings together plans, information concerning finds, levels and excavational units.

Besides Superbase there is also a number of other commercial packages which are linked. The basic entry of data which mostly takes place on site is still carried out through dBASE IV software. This permits the use of cheaper and older machines such as the primordial 8088, produces files in standard format and secures compatibility with the initial system. Excavation plans and other graphics work is done with AutoCAD 11 which produces wireframe models of structures. Corel Draw 3 is also used for graphics work. The rendering of the models is executed with the 3D Studio package. Finally the digitisation of photographs and other material is done with software such as Photostyler and similar packages. Images are fed -in, either through scanning or directly through a videocamera. In addition to commercial packages, Runsect, a custom-made program which produces running sections of excavation units and simple descriptive statistics is being used (Kotsakis 1989).

The hardware used by the Toumba excavation consists of a 486 computer with 16Mb RAM, a SVGA colour monitor, 400Mb hard disk and a CD ROM drive. The computer is connected to a flatbed scanner, a digitising tablet, a videocamera and a number of printers. There is also a number of peripheral computers of various types and capabilities which are used mainly as terminals for data feeding and for storage. The total storage capacity of the system is approximately 1 Gbyte. The total cost of the system described does not exceed £10,000 which was spent during the course of the last six years. The cost has been covered mainly by the annual budget of the excavation which normally is about £12,000 a year.

28.3 Results

There is no need to elaborate further on the various types of output produced by the system which includes running sections of excavational units, simple descriptive lists, lists of special classes of finds, cross lists of finds, statistical descriptions etc. Most of these are normal outputs of data base systems. We shall dwell more on two types of output of our system which are connected with specific archaeological problems and objectives of this excavation.

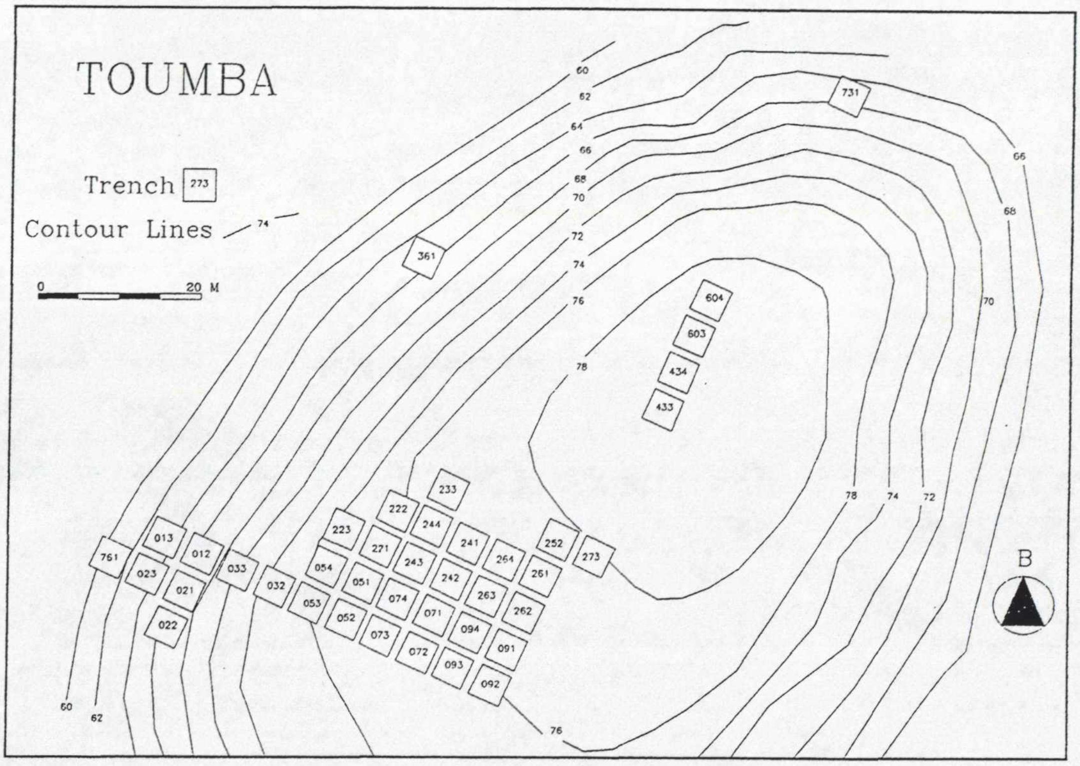

Figure 28.4: The contour plan of the mound with the excavation grid projected on it.

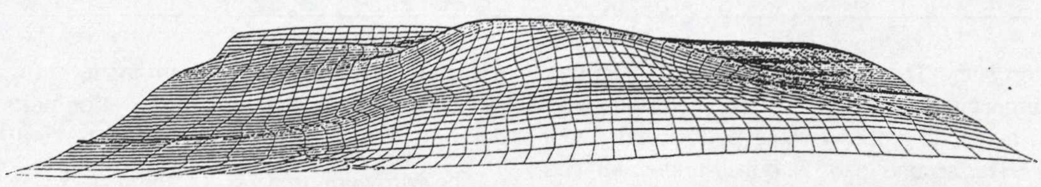

Figure 28.5: The contour plan transformed into a 3D polygon mesh.

We shall try to show the way these applications illuminate certain aspects of the site and help the archaeologist both in formulating the problems and suggesting possible solutions. At the same time some of the most complicated aspects of the excavation take a more comprehensible form which is easier to communicate to the broader public.

It has already been mentioned that Toumba is a multi-period site and with architectural remains belonging to a large number of occupational phases. A basic requirement therefore, is the production of phase plans which are easy to update and re-evaluate as the excavation proceeds. The problem was initially tackled by the digitisation of the topographical plan of the entire mound in 3D Cartesian co-ordinates (see Figure 28.4). The excavation grid was projected on this contour plan. The second step was to transform this contour plan into a 3D polygon mesh, thus preparing the background for accepting the digitised plans of the architecture in their real co-ordinates.(see Figure 28.5).

The next step is to transfer the excavation plans through the digitising tablet in polyline form (AutoCAD 1991, 102). Polylines were favoured for the complete digitisation of the actual excavation plans because they are easier and quicker to handle while at the same time they incorporate the essential information of depths and

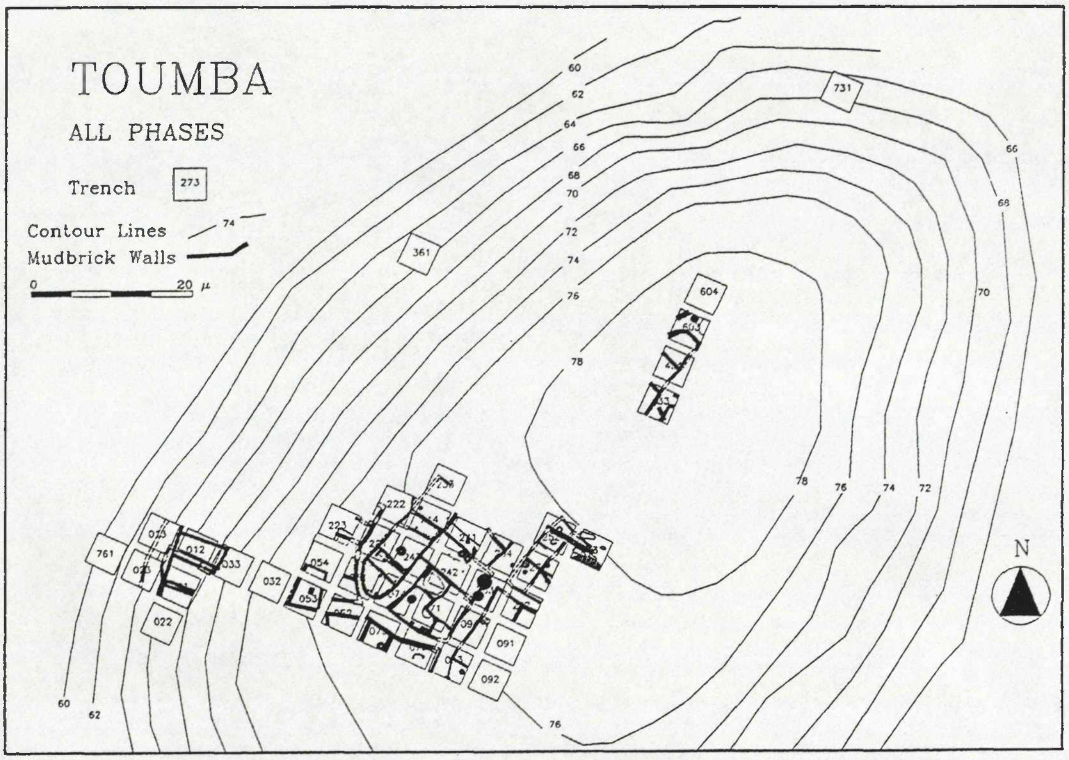

Figure 28.6: The architectural phases of the settlement.

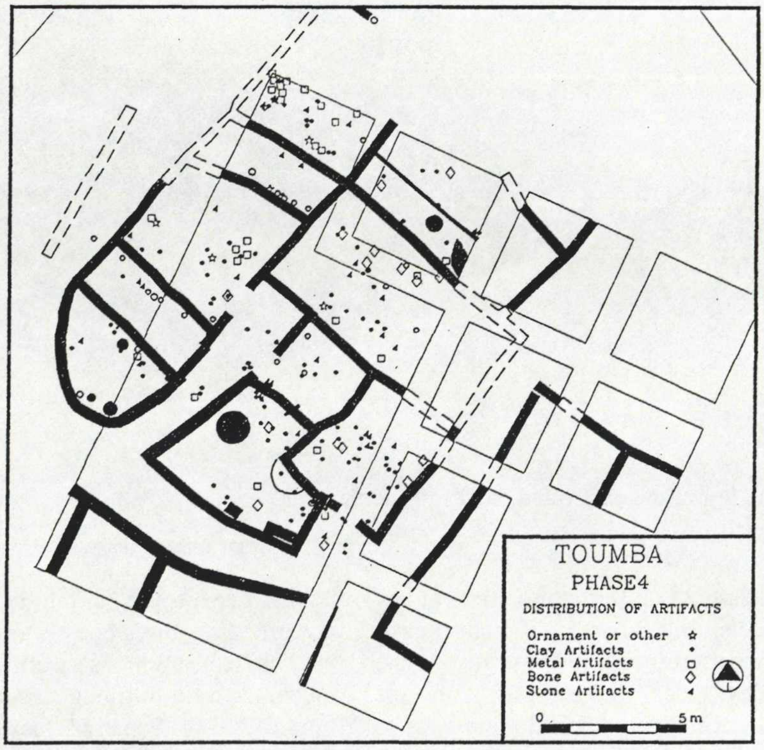

Figure 28.7: The distribution of artefacts in the main building of phase 4.

heights of walls and other architectural features. In addition they are treated by AutoCAD as solids which facilitates considerably the graphic reconstruction of the architecture. Figure 28.6 is a plan of the occupational phases produced by the computer. The relatively schematic appearance of the plan is a result of the use of polylines.

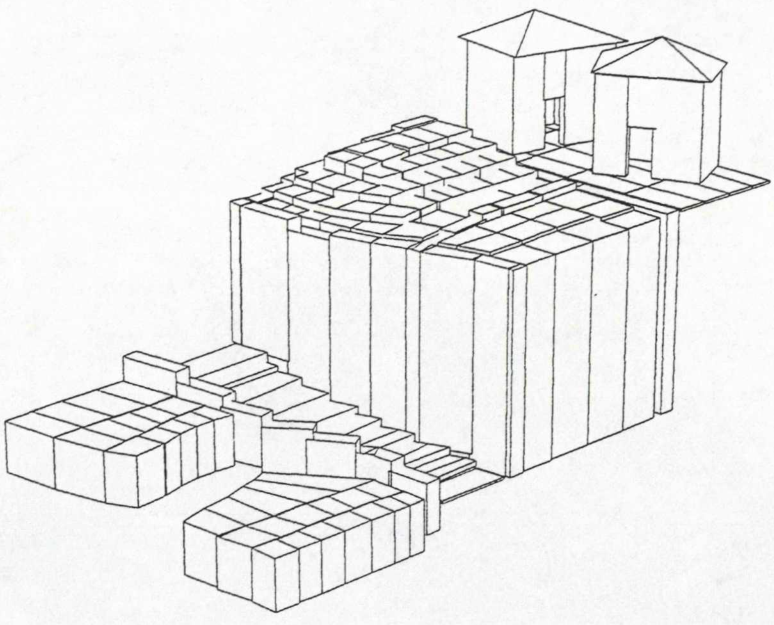

Figure 28.8: A wireframe model of the constructions at the side of the mound.

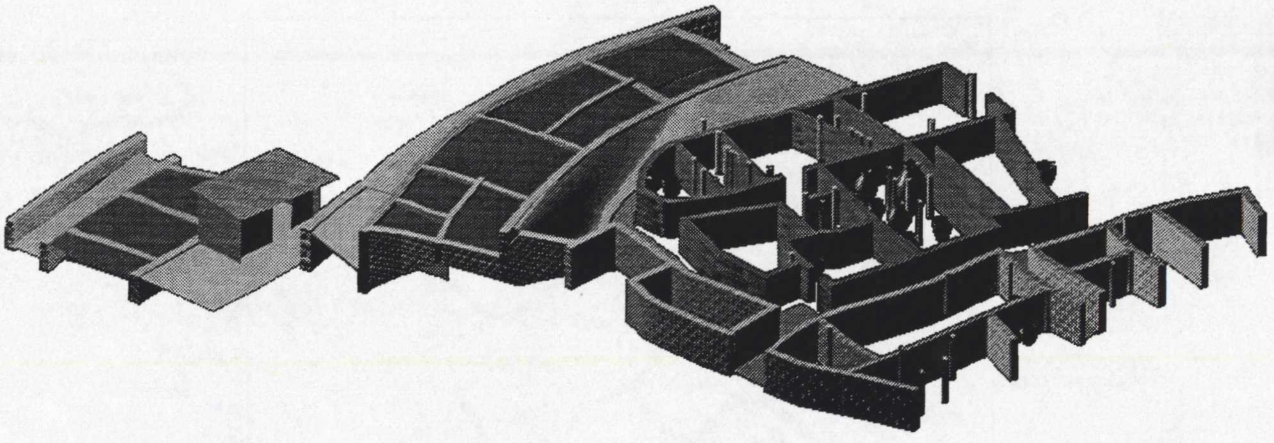

Figure 28.9: Reconstruction of the excavated part of the settlement.

Distributions of finds are a familiar requirement of any system with spatial aspects. In the case of Toumba the co-ordinates of finds are exported from the dBase files to the AutoCAD graphic files (see Figure 28.7). In the particular case illustrated in Figure 28.7, the aim was to test the hypothesis of differing functions within the distinct rooms of the main complex during phase 4. The distribution shown demonstrates that the majority of metal and other prestige objects was concentrated in one part of the complex while in the rest, objects related to everyday productive activities were more abundant (Andreou & Kotsakis 1991).

An unexpected discovery of the excavation was unearthed on the slope sector of the tell. A number of earthen constructions were uncovered, consisting of mudbrick walls forming large boxes filled with clay (see Figure 28.8). Some of these terrace-like constructions were no less than six metres wide. They were spread across the slope at different levels. Normally these features would be interpreted as successive phases of the terraces. However, there was stratigraphic evidence which indicated that at least some of the constructions lying at different levels should belong to a single complex (Kotsakis & Andreou 1990). The lack of large scale excavated sites in the region limited the possibility of interpreting this puzzling feature with the help of comparable material.

In order to visualise the relation of these features with each other, a model was constructed using AutoCAD. To this end, the real co-ordinates of the features were used and were connected according to their stratigraphic evidence producing first a ground plan and then a reconstruction in wire frame (see Figure 28.8). At the lower level there is a wall supported by a line of small retaining terraces. A narrow lane climbs uphill and is flanked by a massive box-like terrace. The stepped effect is a result of the low resolution and the insufficient computer power of a 286 computer available to our lab at the time. The rendered image is equally unrealistic.

According to the excavation evidence available at the time, we were only able to reconstruct isolated sets of terraces. As the excavation proceeded it became more plausible that these isolated groups actually belonged into a single complex, related stratigraphically to certain occupational phases found at the top of the tell (see Figure 28.9). The quality of the rendering in this case has improved considerably due to the upgrade in software and hardware.

The last sequence of reconstructions clarified the fact that the whole of the slope of the tell and up to the top was covered with a continuous group of terraces arranged in a step like manner. These earthworks which date to the 12th century BC, had a retaining function while at the same time were facilitating access to the top and possibly the defence of the Late Bronze Age site. This practice explains the initial observation that the normal vertical stratigraphy of the tell is upset by contemporary architectural features which were built at various levels. The use of a computerised system facilitated considerably this realisation and at the same time enhanced our understanding of spatial organisation and formation processes of tell sites in the region. It has also obvious consequences for the interpretation of stratigraphies of tell sites in general.

So far we have concentrated on the research benefits of computerising the excavation at the Thessaloniki Toumba. Another important aspect of an excavation carried out within a city is its potential for communicating with the wider public. This can be done by the presentation of the finds in a comprehensible form such as the reconstructions discussed here (see Figure 28.9). At a site like Toumba where the character of the remains and their state of preservation create additional problems of accessibility to the public this approach can become particularly useful.

References

ANDREOU, S. & KOTSAKIS, K. 1991. 'Excavations at Toumba Thessaloniki, 1991' *Archeologiko Ergo sti Makedonia ke Thraki*, 5, 209–220 (in Greek).

AUTOCAD 1991. *Release 11. Reference Manual*. Autodesk.

HANSEL, B. 1989. *Kastanas – Ausgrabungen in einem Siedlungshugel der Bronze- und Eisenzeit Makedoniens. 1975–1979: Die Grabung und der Baubefund*, Praehistorische Archaeologie in Sudosteuropa 7, Teil 1, Berlin, 336–338.

HEURTLEY, W. 1939. *Prehistoric Macedonia*, Cambridge University Press.

KOTSAKIS, K. & ANDREOU, S. 1990. 'Preliminary Observations on the Building Phases at the Settlement of Toumba Thessaloniki', *Archeologiko Ergo sti Makedonia ke Thraki* 3, 201–213 (in Greek).

WARDLE, K. 1988. 'Excavations at Assiros Toumba 1987' *Annual of the British School at Athens* 83, 383–384.