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The Roman Centuriated Landscape: Conception, Genesis, and Development as Inferred from the Ager Tarraconensis Case

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Abstract

Although centuriation was only one system of Roman land division, its impact on the landscape and its visibility in modern field arrangements make it the most commonly recognized expression of Roman landscapes. Centuriated grid systems are usually analyzed from a materialistic point of view and consequently are regarded as an assertion of Roman dominance over conquered territories. In this sense, their productive function is clear. The hinterland of Tarraco (the ancient capital of the Roman province of Tarraconensis) offers one of the most clearly documented examples of multiple-grid centuriated systems. From 2006 to 2010, the Landscape Archaeology Research Group of the Catalan Institute of Classical Archaeology employed a wide array of digital and field methodologies at Tarraco to record the traces of centuriated land divisions and their Roman origin. Most importantly, these methods have allowed research to move beyond pure description of the traces to explore the concepts and ideas behind the making of a centuriated landscape. By using Tarraco as a case study, this article shows how centuriation was not only a system for dividing the land but also a conceptual appropriation of the landscape based on a strong mythical and religious background.*

INTRODUCTION

According to the *Corpus Agrimensorum Romanorum*, Roman models of landscape organization were diverse.[1] However, it is the type of Roman land division called centuriation, or *limitatio*, that has attracted the most interest during the last 30 years. This may be explained in two ways.

First, traces of centuriation are frequently visible in the modern landscape and may be investigated archaeologically. The orthogonal grid of roads and field boundaries separating the *centuriae* (grid units), with a constant distance between the grid axes, makes identification possible. Indeed, there has been a substantial increase in the number of centuriated systems identified over the past decades, especially in western Mediterranean regions.[2] Second, because some well-preserved examples (mainly in northern Africa and Italy) are stunningly large and regular, centuriation has become a paradigm of Roman technology and economy. In this sense, it has often been used as an example of Roman imperialism and domination over conquered territories and as one of the symbols of empire (*signa Imperii*).[3]

During the 1980s, the Besançon Group (University of Franche-Comté, France) developed a series of techniques aimed at identifying centuriated grid systems by their orientation and by the proportions of *centuriae* with modules based on multiples of the Roman *actus*, a length normally ranging from 35.0 to 35.6 m. They were detected in the modern landscape by cartographic and photographic interpretation. This approach, developed in particular among French researchers, helped identify several possible centuriations in France and other Mediterranean regions.[4] In fact, the success of the methodology increased the number of examples, many of which have not yet been verified and remain hypothetical. It also promoted the idea that it was possible to write the history of Roman landscapes exclusively from morphological studies.[5] During the 1990s, archaeological evidence correlated

* The authors would like to thank Editor-in-Chief Naomi J. Norman and Ana Ejarque and John Peterson for their helpful comments on earlier versions of this paper and the English revision. Santiago Riera provided unpublished paleoenvironmental data of the study area and was patient enough to discuss with us its integration in a wider landscape setting. The authors are also grateful to Marta Prevosti and Jordi López, who provided data on the location of sites and landscape structures, and Judit Ciurana, who provided the location of funerary monuments. Finally, undergraduate students from the University of Central Lancashire participated in the archaeomorphological survey. This work received financial support from the Agency for Administration of University and Research Grants and the Catalan Institute of Classical Archaeology.

[1] Campbell 2000.

[2] Chouquer et al. 1987; Perez 1996; Clavel-Lévêque and Vignot 1998; Clavel-Lévêque and Orejas 2002.

[3] Clavel-Lévêque 1993.

[4] Clavel-Lévêque 1983; Chouquer et al. 1987.

[5] Perez 1996.

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with rescue excavations showed that some suggested examples were in fact false.[6]

This failure to identify centuriated systems with certainty has sometimes resulted in the dismissal of archaeomorphological techniques and a lack of confidence in the methodological approaches originally developed by the Besançon Group.[7] This also might be the reason why the last 20 years have been characterized by research that is more conscious of interpretive and chronological problems and various methodologies, as reflected in the following tendencies:

1. A more cautious use of the modular approach. There is a certain consensus that the orientation of traces and their metrological relationship with the *actus* can no longer be the only argument used to identify centuriated grid systems.[8]
2. The study of the archaeomorphological sequence from a long-term perspective. In this sense, archaeomorphological research has evolved from an analysis of Roman centuriations at a particular time to the establishment of a diachronic sequence in which Roman morphologies are contextualized within earlier and later field systems.[9]
3. The use of open-landscape archaeological excavations to document historical field systems and other landscape-related structures.[10]
4. The incorporation of historical and environmental data, which has been extremely helpful for identifying and dating traces.[11] In this sense, the adoption of a perspective based on landscape archaeology has become essential in the study of centuriated landscapes from an interdisciplinary, diachronic approach. Environmental data can offer insights into the physical effects centuriation had on the landscape and can help discern Roman land-use practices.[12] The study of landscape dynamics adds a necessary chronological depth, allowing us to distinguish Roman traces from those that pre- or postdate them.[13]
5. The use of new techniques like GIS. New techniques have increased the accuracy and reliability of research on centuriation.[14]

From a conceptual stance, most of the research in the 1980s on Roman centuriation focused on issues of land ownership and the economy. Some groups still support strictly economic and materialistic positions,[15] but others have enlarged their focus to encompass more social and ideological explanations.[16] In addition, new approaches to reconstructing the landscape allow interpretations that include ecological and symbolic factors.[17] Nevertheless, the study of centuriated systems remains grounded in materialistic premises. Economic factors linked to the process of land division and distribution still draw most researchers' attention.[18]

Previous Work

The study on which this article is based started in 1999 as part of a wider landscape project aimed at investigating settlement in the Cossetania territory.[19] The archaeomorphological study undertaken by Palet documented different diachronic road networks. Four orthogonal grid systems (Tarraco I, II, III, IV) surrounding the city of Tarraco can be considered remarkable examples of centuriated field systems. These systems have been widely published[20] and have been accepted as a defining trait of Roman territorial organization in the area.[21] They have also been used to explain settlement patterns and landscape dynamics in the territory around Tarraco, which is of the greatest importance for the study of the Romanization of the Iberian peninsula.

In 2006, the Landscape Archaeology Research Group of the Catalan Institute of Classical Archaeology started a new study of Tarraco I, II, and III.[22] The study area (fig. 1) was set in the area of the Camp de

[6] Boissinot 1997; Leveau 2000.

[7] Peterson 1993, 55 n. 52; Fiches 1996; Favory 1997; Chouquer 2000; Ariño et al. 2004, 61.

[8] Chouquer 1996–1997; Palet 1997.

[9] Burnouf et al. 1997; Chouquer 2003, 2007.

[10] Boissinot and Brochier 1997.

[11] Berger and Jung 1996; Palet 1997.

[12] The few cases in which environmental data have been applied to centuriation analysis show a complex relationship between Roman field systems, settlement, and landscape change (Dall'Aglio and Franceschelli 2007; Riera and Palet 2008; Riera et al. 2009).

[13] Leveau 2006.

[14] Romano and Tolba 1996; Peterson 1998a; Romano 1998.

[15] Prieto 2002, 2008; Arrayás 2005; González 2007.

[16] Chouquer 2000, 2003.

[17] In fact, some recent developments emphasize the relationship between Roman territorial organization and landscape dynamics as inferred from paleoecological analysis (Clavel-Lévêque and Hermon 2004; Hermon 2009; Riera et al. 2009).

[18] Leveau 2000.

[19] Guitart et al. 2003.

[20] Palet 2003, 2005, 2007a, 2007b; Ariño et al. 2004, 49.

[21] López (2008) has used these grids to explain the Roman settlement evolution in the area. They have also been employed to analyze Roman colonization in Late Republican times (by the end of the second century B.C.E.) (Prevosti 2005, 348–58).

[22] This research project is developed within the Ager Tarraconensis Project of the Catalan Institute of Classical Archaeology, directed by Marta Prevosti and Josep Guitart.

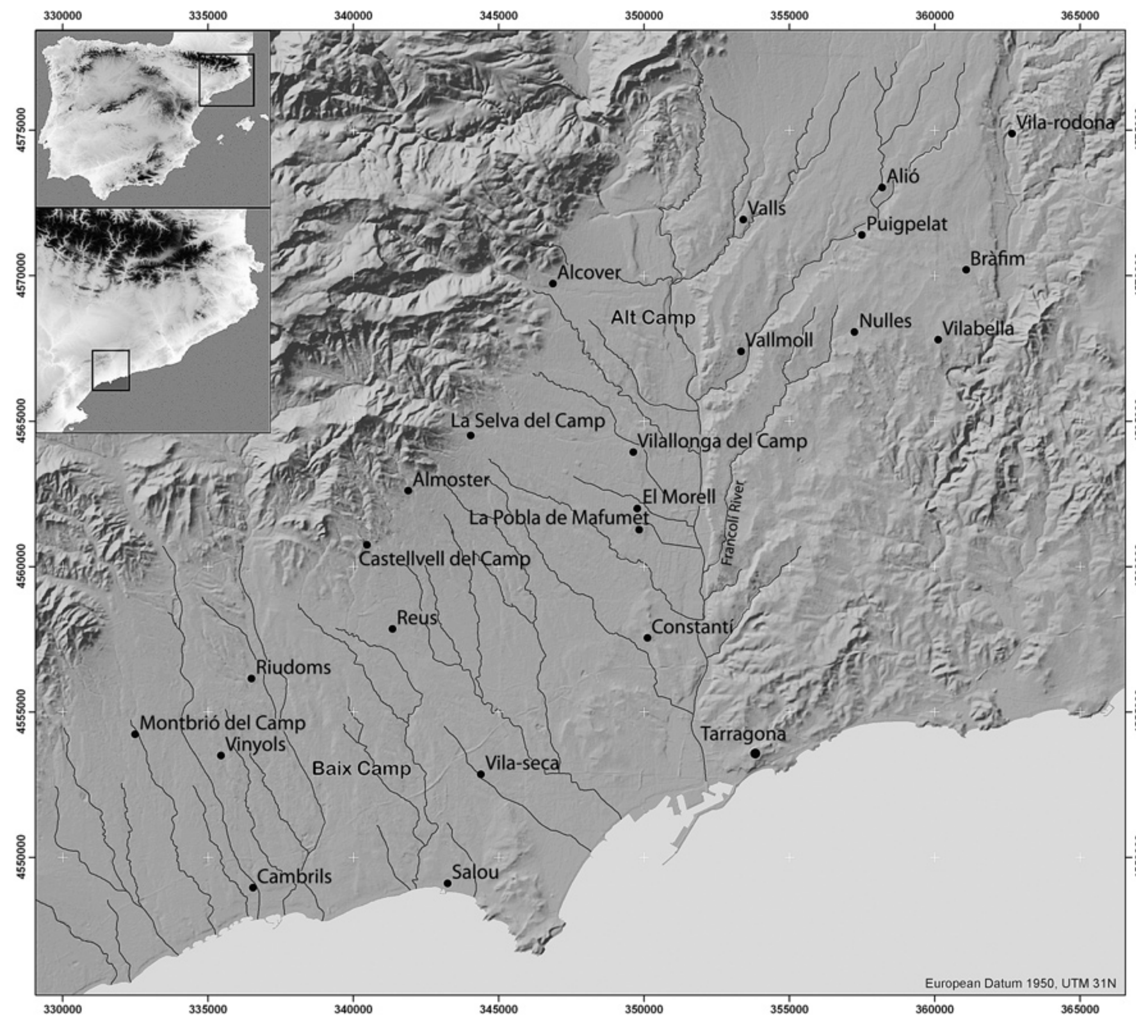

Fig. 1. Location of the Tarraco I, II, and III study area (drawing by H. Orengo).

Tarragona, which corresponds to the immediate hinterland of Tarraco (modern Tarragona, Spain), the ancient provincial capital of the Roman province of Tarraconensis. This study was intended to make advances from both a methodological and a conceptual point of view by incorporating new approaches. To achieve these objectives, two basic elements were essential: (1) the revision of the traces documented by previous archaeomorphological research[23] and (2) new advances in the archaeological knowledge of Tarraco's urbanism.[24]

Previous work has also been focused on the relationship between the city layout and territorial organization, mainly in the form of centuriated grid systems. Significant advances have been made.[25] In recent years, the problem has also been analyzed from a phenomenological perspective by generating viewsheds from Tarraco's *auguraculum*,[26] a temple located in an elevated central area near the city forum.[27] As has been often proposed, *auguracula* allow a strategic visual dominion of both the city and the territory surrounding it.[28] Those temples had an augural function; they were places from where the *inauguratio*, or foundation ritual, was performed by the religious figure of the augur. From this location, the augur perceived the landscape and defined the limits of the colony's terri-

[23] Palet 2003, 2007a, 2007b.
[24] Macias 2000; Salom 2006; Macias et al. 2007.
[25] Ariño et al. 2004, 164–76.
[26] Fiz et al. 2008; Palet et al. 2010.
[27] Salom 2006.
[28] Carandini 2007, 13–53; Gros and Torelli 2007, 25.

tory;[29] the *auguracula* thus worked as *prima loca gromae*. Evidence suggests that responsibility for the organization of the newly acquired territory given by the augur fell on the surveyor.[30] In this sense, it is revealing that the *agrimensores,* or Roman land surveyors, made the religious origin of their art clear in the *Corpus Agrimensorum Romanorum*. Thus, Hyginus Gromaticus suggests that the surveyor could have been present during the foundation ritual.[31]

These approaches can help produce interpretations ranging from identification of traces of the work to analysis of how the centuriation was conceptualized, planned, and executed. By employing such approaches, the research focus would move beyond the practicalities of Roman land division toward the conceptualization underlying the genesis and meaning of Roman centuriated landscapes.

METHODOLOGY

The archaeological identification of a centuriation is an arduous task. It is not sufficient to measure the distances between the axes of the plots and observe that they are constant and are a multiple of the Roman *actus*. Open-landscape archaeological excavation constitutes the most reliable proof of the existence of a centuriation, although there are currently very few examples of this.[32] This might be because of the sedimentary and erosive processes that modify the visibility of the archaeological record. In alluvial plains, the sedimentary covering of ancient roads and field boundaries may allow archaeological excavation of traces,[33] but in other cases, erosion may occur (e.g., deep paths, pits) that greatly hinders identification. Such eroded surfaces have been documented in most parts of the centuriated landscape of the Ager Tarraconensis where Roman soil levels are hard to find. This physical constraint has compelled us to adopt the diachronic multidisciplinary approach described here.

Archaeomorphological Research

Archaeomorphological research focuses on landscape morphological dynamics from a long-term perspective, even if the reconstructed traces do not form part of a centuriation grid.[34] Multiple cartographic and photographic sources are used to discern different morphological systems inside the study area. Selected traces are often dominant axes, which carry some morphogenetic character. This means that they have existed in the landscape beyond their date of creation, influencing the orientation of the surrounding field systems through different historical periods.[35] Reconstructions based on this approach usually include continuous lines that structure the landscape, linking traces that could have originated in different periods. It should also be noted that archaeomorphology studies the modern landscape and therefore documents only the traces that have been in continuous use and thus have been preserved. The chronological sequence that connects different systems can be evidenced by processes such as the "erasure" of older systems by subsequent ones or the "capture" of ancient but still active traces that alter their original shape to adapt to a new morphology. These relationships can help identify the morphology of a single period and date it with regard to previous and subsequent systems of morphology.[36]

It is important to identify not only the *centuriae* but also the road networks and field systems if one wants to establish a relative chronological sequence (fig. 2). After having selected and progressively removed modern morphologies, ancient traces become increasingly evident within their setting. This methodology forms the basis of regressive landscape analysis.[37] In this regard, the establishment of relative chronologies between forms under study provides more reliable results.[38]

The incorporation of written documents is useful for archaeomorphological regressive analyses.[39] Documents referring to different forms of land management, such as donations or sales, are especially helpful, since they take great care to define the land boundaries clearly. Boundaries can consist of landscape features such as roads, aqueducts, or other identifiable landmarks. Other types of useful written sources are inheritance documents, foundation documents, and cadastral documents. Although written sources only

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[29] Livy 1.18.6–10.

[30] Campbell 2000, xlv.

[31] Hyginus Gromaticus *De Limitibus Constituendi* 170.3–8 (Lachmann 1848).

[32] The open-landscape archaeological excavations associated with the construction of the Train à Grande Vitesse railway (1995) in the middle Rhodanian valley (France) pioneered the archaeological testing of centuriation hypothesis (Berger and Jung 1996).

[33] Berger and Jung 1996; Berger 2000; Franceschelli 2009.

[34] Recent archaeomorphological analyses have identified different phases of landscape construction from pre-Roman to modern times, including in noncenturiated Roman landscapes (Chouquer 1998, 2007).

[35] Favory 1997; Chouquer 2000, 149.

[36] Chouquer and Favory 1991, 209–25; Chouquer 2000, 150–53.

[37] Roberts 1987; Palet 1997, 32–3.

[38] Favory 1997; Ariño et al. 2004, 86–97.

[39] Palet 1997, 38–40; Miró and Orengo 2010.

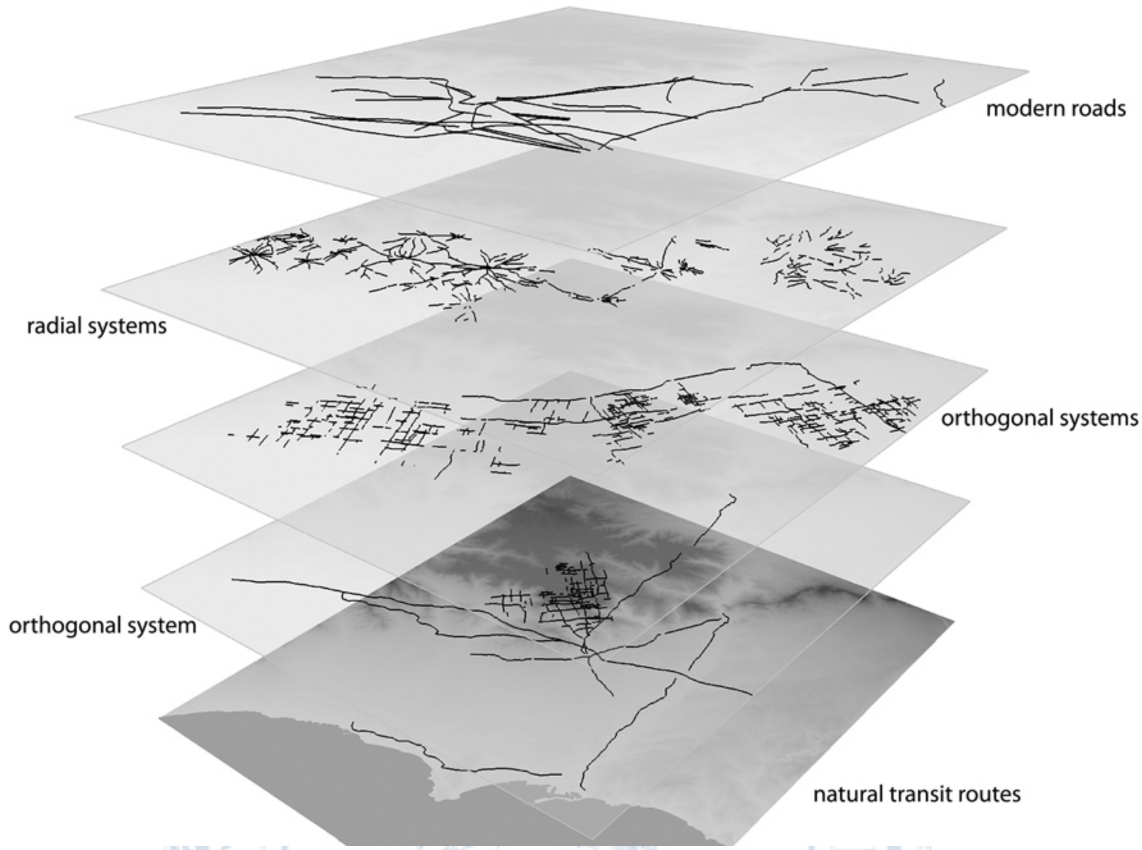

Fig. 2. Diachronic archaeomorphological analysis of the study area (drawing by H. Orengo).

provide ante quem dates, they can be used as a chronological framework within which the traces documented in written records and their associated morphology can fit. In this study, the main sources used to date the located traces were foundation documents and cadastral information. In several cases, these provided ante quem dates for paths defining medieval parish boundaries.

The Geodatabase

GIS provides a framework in which all geographically referenced information necessary to conduct archaeomorphological research can be included and analyzed in a multilayered and multiscale environment. It also provides for easy and effective management of the data, excellent graphical output, and, above all, high spatial accuracy. The importance of developing an exhaustive GIS-linked geodatabase must be stressed, since the reliability of the metrological analyses depends on its precision.

In this case study, the geodatabase holds both vector and raster data. Vector data were filtered from 117 vector maps at 1:5,000 scale provided by the Cartographic Institute of Catalonia. Different layers were created from these; field boundaries, hydrology, paths and roads, and elevation being only a few among the more intensively employed data sets. Modern cadastral divisions, geological and soil maps, vegetation maps, land-use maps, and wetlands maps are other vector layers included in the geodatabase. The following layers contained relevant archaeological information: the archaeological sites, the villa plans, and the layout of the Roman city of Tarraco. The last included some of the most prominent archaeological features of the city, among them the exact location of the *auguraculum*.

The raster components of the geodatabase were categorized into old maps, aerial orthorectified photographs, satellite and aerial multispectral images (comprising the visible bands of the electromagnetic spectrum and near, middle, and thermal infrared), continuous rasters (e.g., elevation data), integer rasters (e.g., geological or pedological maps), and Boolean rasters (e.g., viewshed maps). The geodatabase also included raster maps directly derived from topographic data. For this reason, the creation of an accurate digital terrain model (DTM) was deemed to be of the utmost importance. This 5 x 5 m cell DTM was developed from more than three million spot heights. It underwent a process of location and filtering of any sinks caused by the interpolation process. Major modern structures were manually removed. Human impact has affected several large areas, and for this reason, digital stereoscopic 3D models of the earlier landscape were developed from 1956 stereo pairs of aerial photographs. These models were incorporated into the DTM, which in turn allowed the generation of hydrologic models, viewsheds, least cost route models, and the like.

Other components of the raster geodatabase were equally important and needed extensive treatment. Particularly useful were the 1947 orthophotographs and the 1956 U.S. Air Force aerial stereo pairs. They allowed for the analysis of field structures obliterated by large landscape restructuring such as that at Reus International Airport.

Traditionally, much archaeomorphological research has been based exclusively on the analysis of aerial photographs without correlating the results with other geographically referred data. This approach has too often ignored that aerial photographs incorporate deformations caused by the camera lens, which can be considerable at the edges of a photograph. The exclusive use of these photographs to analyze ancient landscape morphology can thus lead to faulty results. This is particularly evident when applied to centuriated field systems, a discipline partially based on metrological analysis. The detection of centuriated grids as a result of such procedures should be considered potentially unreliable.[40]

In the present case, 32 aerial photographs of the study area from 1956 were rectified and georeferenced to avoid such deformations (fig. 3). Twenty ground control points were employed for each image, and a DTM was used to correct further deformations caused by the terrain relief, obtaining root mean square error values generally under 4.8 m.

The approach to rectification of old maps was much simpler. Only those maps drawn by geometric processes needed to be treated to correct small imperfections. Older maps and engravings (dating from the 17th–19th centuries) were used following a systematically developed approach;[41] they were considered relevant landscape documents, although they were never used in metrological analyses. The 1:25,000 Instituto Geográfico y Estadístico municipal maps (1914–1923) deserve a special mention; their accuracy and greater detail allowed the retrieval of much relevant information.

GIS-Based Analyses

Although there are many GIS techniques that can be successfully applied in archaeomorphological research, this study used only certain ones. These are listed below.

A polyline vector layer was created that included all the traces conforming to the axes of each grid. This layer was then linked to a table in which all relevant information related to each trace would be stored, such as orientation, type of trace, source, morphological features, and associated historical data. The layer and linked table stored all previously located traces and subsequently included all traces that were found by querying the GIS-linked geodatabase.

Multiband satellite imagery was analyzed to locate the traces not readily detectable in the visible bands of the electromagnetic spectrum that traditional photographic, cartographic, and morphological analyses would have left undiscovered.

Hydrological modeling allowed for the recreation of the seasonal flooding episodes of the Francolí River. And least cost route analysis (LCR) was carried out by means of a purpose-built algorithm that took into account environmental factors such as the Francolí River flood area. LCR is a GIS technique that suggests the best route given a cost surface that specifies the cost of going through the different areas of the landscape. Slope has traditionally been used as a major indicator in the generation of cost surfaces, but other factors such as rivers, bridges, or wetlands can also be added to the model to increase or reduce the cost of passing through certain areas. In this case, LCR was applied to the analysis of the Tarraco-Ilerda route.[42]

The results of GIS-based viewshed analyses were also used. Viewsheds were generated from the center of the *auguraculum* to recreate the augur's perception of the landscape from the *prima loca gromae* from which the city territory was defined.[43] Old maps of Tarragona showed that at this place a hill had been removed at the beginning of the 20th century.[44] This hill allowed a good view of both the city and its territory, an otherwise impossible task from any other spot. The exact location of the *auguraculum* was recreated using

[40] E.g., Olesti 1995; González 2002, 2007; Arrayás 2005; Decramer et al. 2006.

[41] Orengo and Fiz 2008a.

[42] A thorough explanation of the application of this model and the results obtained was published by Fiz and Orengo 2008.

[43] Fiz et al. 2008.

[44] Serra 1932.

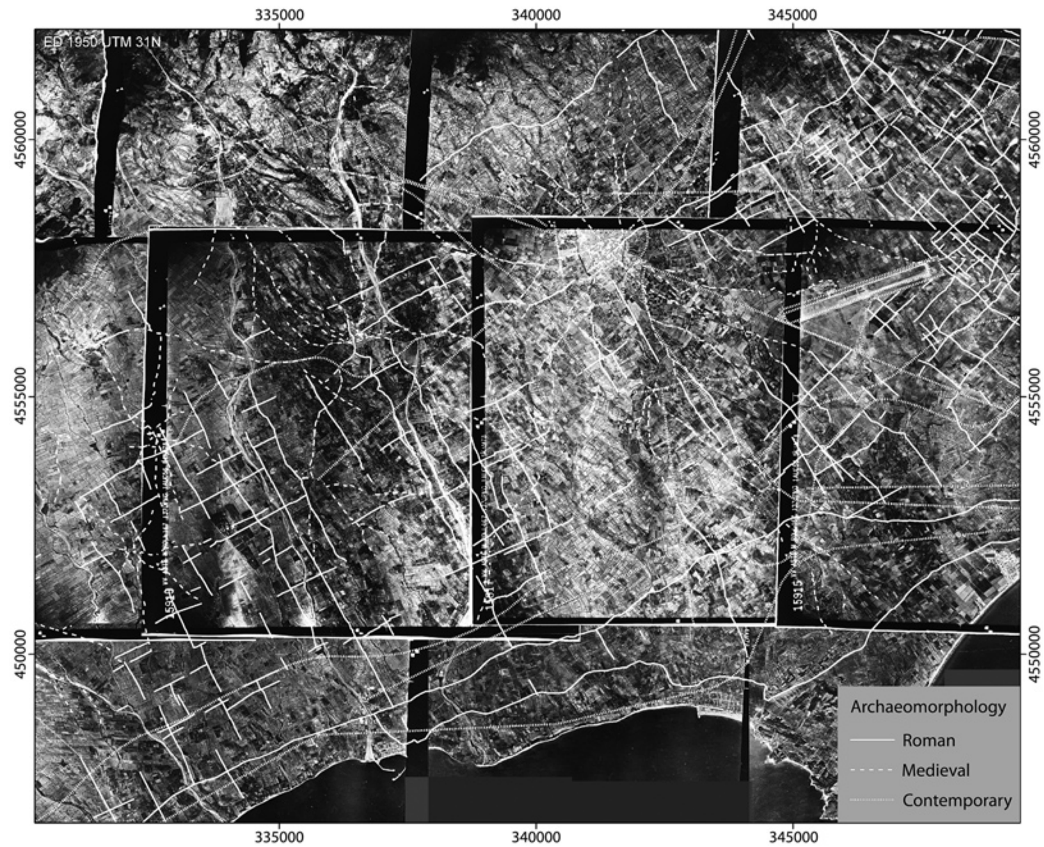

Fig. 3. Archaeomorphological analysis on the 1956 orthorectified and georeferenced orthopairs.

a combination of written evidence, old topographic maps, engravings, and photographs. Old excavation descriptions and plans were also used.[45]

The Archaeomorphological Survey

A specifically designed archaeomorphological survey was needed to evaluate the different hypotheses generated by the archaeomorphological analysis. We decided that this survey should aim to evaluate the documented traces, their morphology, and the stratigraphic relationship between them and also to identify all structures and scatters of material associated with them. This would include topographic markers, boundary markers, milestones, division walls and bridges, and ceramic findspots and standing archaeological structures (fig. 4). This has made it possible to ascribe chronologies to some traces by associating them with datable structures. It has also been useful in rejecting evident modern traces. Finally, it has permitted the establishment of relative chronological relationships between traces.

DEVELOPMENT: REDISCOVERING THE AGER TARRACONENSIS ANCIENT CENTURIATED LANDSCAPE

The Ager Tarraconensis' Centuriated Systems

Using this methodology, the study of the archaeomorphology of ancient Ager Tarraconensis has resulted in the reliable identification of three centuriated grids with different modules and orientations surrounding the city of Tarraco (fig. 5). The first grid, Tarraco I, is located in the area of Constantí, northwest of Tarraco (although this settlement existed during the Roman period, it was founded again after the Christian contest in 1159 C.E.).[46] It is the closest to the Roman city, and it has a module of 20 x 20 *actus* (ca. 710 x 710 m). Its decumani, the main axes of the grid, are oriented at 45° to geographic north; in

[45] A detailed account of the method used in the reconstruction of the ancient city's topography is described in Orengo and Fiz (2008b) and Orengo et al. (forthcoming).

[46] Palet 2003, 224.

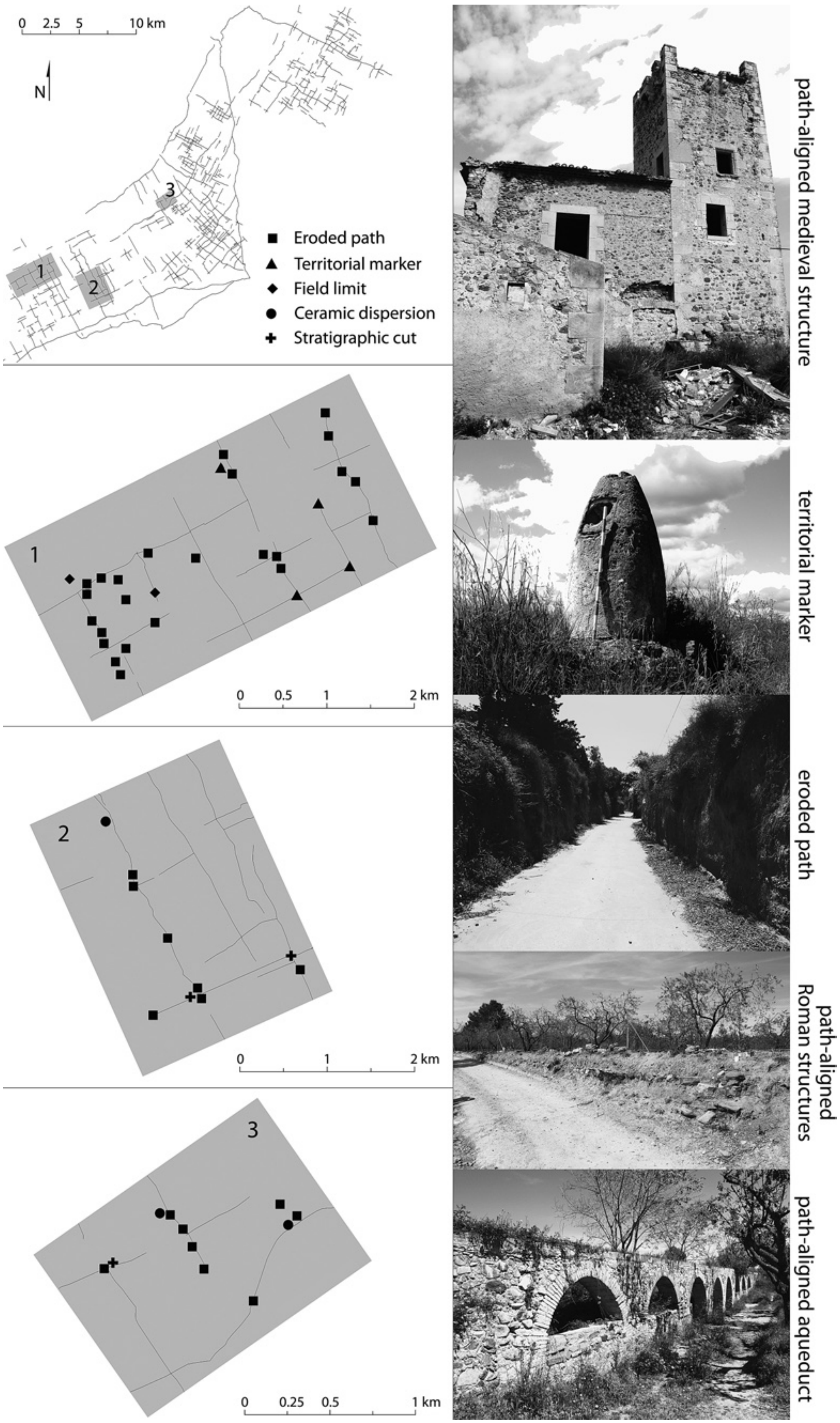

Fig. 4. Archaeomorphological survey.

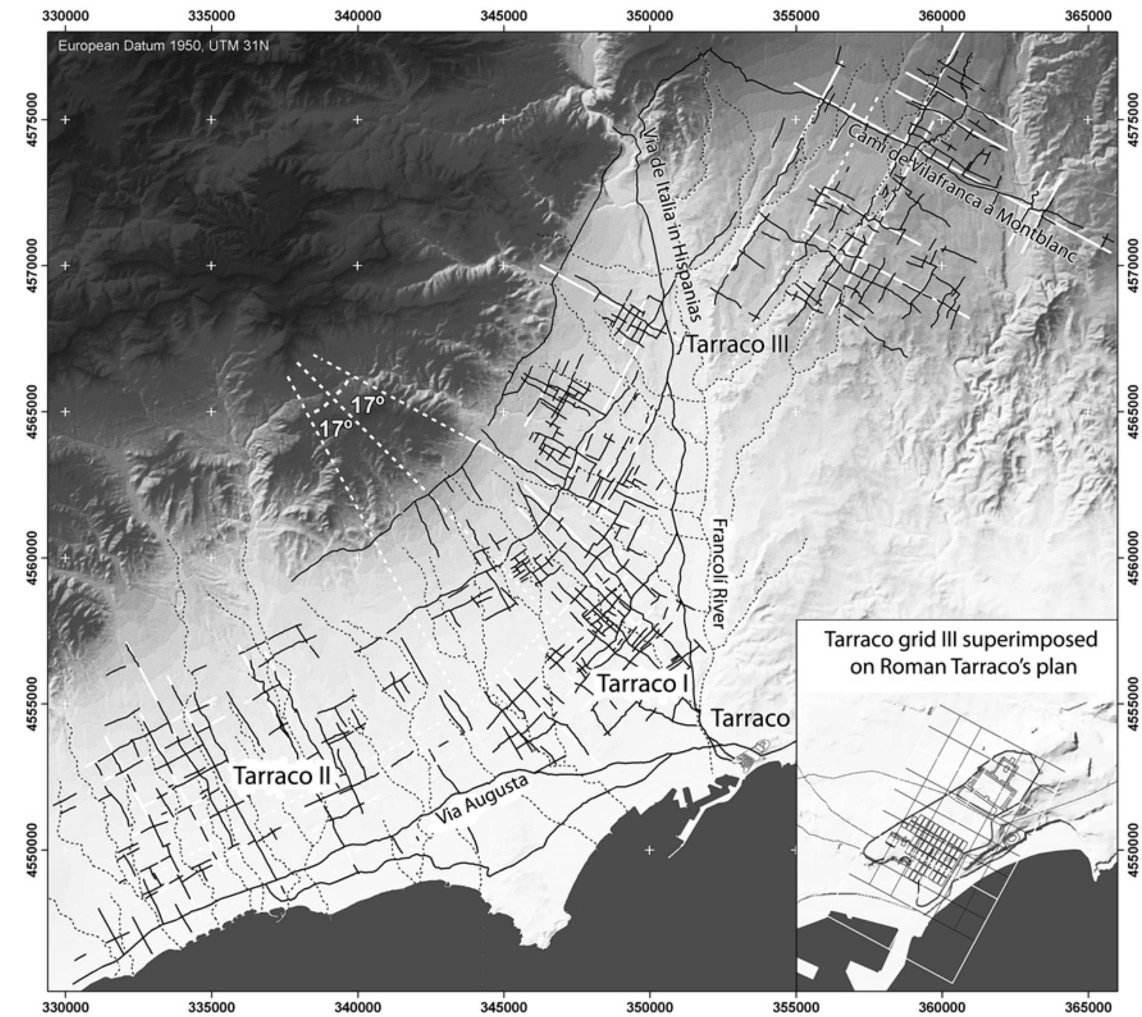

Fig. 5. Archaeomorphological analysis of the study area, showing locations of the three centuriated grids surrounding Tarraco (Tarraco I, II, III).

other words, the cardinal points coincide with the diagonals of the grid. The grid is bounded by the two main Roman roads in the area: the Via Augusta and the Via Tarraco-Ilerda (Via de Italia in Hispanias). They converge at the Francolí River crossing, where one of the main decumani of the grid starts. Five axes of this grid have been documented; they are arranged in parallel stretches 20 *actus* apart and more than 3.5 km long. In addition, four cardines have been documented, also at 20 *actus* apart. The main cardo corresponds to the road between the towns of Constantí and Vila-seca. Some Tarraco I axes are used by several medieval towns, such as La Selva del Camp or Constantí, as territorial boundaries. In some cases, these have been documented as belonging to the 12th century, which indicates the premedieval nature of this road network.

The second grid, Tarraco II, extends over the plain between the sea and the foothills of the Catalan Coastal Range in the Baix Camp area. It can be clearly seen in photographs from 1956, thanks to the presence of well-preserved *centuriae* with a 20 x 20 *actus* module. This second centuriated system is the best preserved, and it shows traces running parallel for 8 *centuriae* (ca. 6 km). The decumani are oriented 28° west of geographic north. They are well adapted to the slope of the terrain and the natural drainage. As a result, they are now represented by deeply eroded straight features and are better preserved than the cardines. As in the case of Tarraco I, some Tarraco II axes are coincident with 12th-century village boundaries. The boundary between Vinyols and Cambrils is a noticeable example but is not alone; all settlements in the Tarraco II area have employed, to some extent, Tarraco

II axes and, in some cases, the Via Augusta to form their boundaries. During the archaeomorphological survey, four 18th-century territorial markers delimiting these boundaries were recorded. Two of those were located in crossings of cardines and decumani at exactly 20 *actus* apart; the other two were aligned with cardines. The Via Augusta runs parallel to the coast. It undulates in this area, although some stretches run in accordance with the orientation of Tarraco II. The Roman road is still preserved in some areas, where it is shown by excavation to be approximately 5 m deep x 15 m wide.

Satellite and aerial multispectral images have revealed traces of a further five decumani and four parallel cardines that belong to this centuriated system. They are also oriented 28° west of north and have distances of 20 and 40 *actus* between them. The area has so far not offered evidence of any other oriented *limites*. Satellite images from band 5 of the Landsat 5 Thematic Mapper and from the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) visible near-infrared band have been particularly useful, especially when combined with meteorological reports of the study area, since this allowed those images taken just after rainfall to be selected. Between 1,000 and 5,000 short wave infrared digital aerial photographs provided by the Cartographic Institute of Catalonia and Landsat band 5 (1.55–1.75 µm) images were particularly helpful in discriminating soil moisture.[47] Subsurface centuriated traces could be identified thanks to the higher moisture retained in ancient pathways.[48] Differences in soil compaction may account for this.

The third centuriated system, Tarraco III, is located in the area known as Alt Camp, north of Tarraco (see fig. 5). It is divided into two sectors separated by the Francolí River and the Via de Italia in Hispanias, in response to the seasonal flooding episodes of the Francolí. The Romans would have been aware of this natural phenomenon and did not attempt to centuriate the areas affected by these floods, as is shown by local Roman site distribution. LCR also allowed a more efficient approach to the reconstruction of the Via de Italia in Hispanias. The road connects those sites bordering the flooding area, and it also serves to link together the Tarraco I and III grids.

Tarraco III's two sectors maintain the same orientation and have a module of 20 x 15 *actus*. The cardines are oriented 28° east of north. This fact deserves further attention since the urban layout of Tarraco has a very similar orientation, only differing from that of Tarraco III by 3°. This suggests simultaneous planning of both the centuriated grid and the city.

The sector closest to the city is on the west of the Francolí River, and it links with the Tarraco I grid through its southern cardines; the orientation of the cardines changes gradually to fit that of Tarraco II. Hydrology strongly determines the orientation and sometimes the distance between the axes as well. This becomes more evident in the case of the decumani. Morphological analysis suggests they have a module of 20 *actus*, whereas cardines appear to follow a module of 15 *actus*.[49] The second sector is located farther north, on the eastern side of the Francolí. The traces are articulated around a 12 km straight stretch of the Camí de Vilafranca a Montblanc, which corresponds to the Roman road from Barcino (Barcelona) to Ilerda (Lleida). Perpendicular to this road, at distances that are multiples of 15 *actus* (7 *limites* corresponding to the grid), cardines have been documented. These cardines, however, appear at intervals of 30 or 90 *actus* in some cases and are multiples of the 15-*actus* module. The decumani in this area are in a more deteriorated state, but they still use a module of 20 *actus*.

The general picture offered by the three grids is one of homogeneity. Their axes present a uniform and constant angular deviation of 17° when measured from the decumani (see fig. 5). Although text-based approaches have long denied the fact,[50] they also show excellent adaptation to the topography and hydrography of the study area.

Although the scope of this article does not include the analysis of medieval morphologies, radial road networks and concentric field systems have been identified in areas where orthogonal systems have been removed. A relative chronological sequence is especially visible in the contact area between Tarraco I and Tarraco II. Here, the *limites* disappear because of the presence of medieval villages like Reus and Vila-seca, which are the origins of important radial road networks that obliterate the previous orthogonal road system (see figs. 3, 4). In fact, regressive analysis and medieval written sources confirm that all the reconstructed radial networks converge on medieval churches, villages, and castles founded during the Christian colonization of the Tarragona region (12th–13th centuries).[51] The center of each medieval radial network, the medieval nucleus, is coincident

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[47] Shih and Jordan 1992.
[48] Orengo and Palet 2008.
[49] Palet 2007b.
[50] Prieto 2008.
[51] Pladevall 1995, 19–93.

with an axis marked by preserved centuriated traces. This might indicate the use of the Roman network until Medieval times. Ironically, the establishment of new villages alongside centuriated traces involved the erasure of the traces by the radial networks these villages developed. The best-preserved traces of the centuriation can more easily be found in areas that lack strong medieval morphologies. The Reus case study is typical of this process. Reus appears in 12th-century documents as "Reddis," a toponym related to a crossroad.[52] In fact, the medieval nucleus of Reus lies on one of the main decumani joining the three grids. This point was crossed by a perpendicular road also documented in medieval sources,[53] which corresponds to an archaeomorphologically documented cardo. The importance of Reus as the center of a settlement led to the development of a complex medieval radial network that erased the previous orthogonal system in the closest areas and "captured" centuriated traces, which were adapted to routes joining the medieval and modern nuclei.

The Centuriated Grids and Their Relationship to Settlement Patterns

As mentioned, it is useful to employ the perspective of landscape archaeology to add chronological depth to the picture. This perspective may allow Roman traces to be distinguished from those of earlier or later periods and may provide insights into the effects that centuriation had on the landscape. The different methodological approaches used in this study confirm the pre-medieval origin of the presumable centuriation plans. In this sense, the traces selected as forming part of a possible centuriation are mainly old roads that have formed long, deeply excavated features. They constitute the main axes of the ancient orthogonal systems. Stratigraphic correlations among the observed landscape forms, together with written sources, provide a relative chronological time frame for the different phases and reveal the influence of the orthogonal systems in Tarragona's medieval landscape.

In addition to these approaches, distance analyses, commonly acknowledged as an alternative means to assess the validity of a centuriation proposal,[54] were carried out between the identified ancient morphological traits and 134 Roman sites. The site locations were obtained from the GPS-informed survey developed by the Ager Tarraconensis Project of the Catalan Institute of Classical Archaeology during the last four years (fig. 6).[55] The results show a weak relationship between the location of archaeological sites and the reconstructed traces (fig. 7); 70 of the sites and archaeological structures (52%) are located at less than 100 m from the axes, when 48.4% would be expected if sites were distributed randomly. This is not statistically significant. We see higher proximity values in the 53 Roman milestones and funerary monuments, which have been analyzed separately because of their often direct relationship with roads in Roman times; 43% of the structures are located at less than 50 m from a trace, while 60% can be found at less than 100 m. By conventional criteria, this latter figure is statistically significant (chi-square test, $p = 0.0811$).

In this case study, proximity between archaeological elements and archaeomorphological reconstructions cannot be taken as absolute proof of the reliability of this centuriation hypothesis. This is mainly due to the methodology employed. As noted, archaeomorphological reconstructions do not aim at documenting the location of Roman roads as they were constructed but at locating those modern roads that had a Roman origin. These have frequently suffered changes and deformations over time. Consequently, the relationship between sites and reconstructed traces cannot be regarded as a direct one. It should be taken into account that these archaeological data are of different types and periods and therefore have a very complex, nonquantifiable relationship.

However, the orientation of the grids could be verified by analyzing their correlation to archaeologically documented rural structures. The orientation of the Tarraco III grid was validated by several landscape elements. A recently discovered Roman arched aqueduct near the villa of Centcelles in a flat area crossed by the Roman road aligns completely with its cardines.[56] This structure has an arch that allowed the crossing of a perpendicular road, the orientation of which, in consequence, matches that of the grid decumani. Centcelles villa itself also shows a remarkable coincidence with the grid orientation.

Another example can be drawn from the Mas d'en Gras villa excavation, where the existence of a Late Republican canal, 40 m long and perfectly aligned with the Tarraco II grid, was confirmed.[57] The orientation of paths and other structures linked to this site also coincides with that of the centuriation axes.

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[52] Coromines 1989–1999; Tort 2000.
[53] Gort 1998.
[54] Peterson 1998b, 111.
[55] Prevosti and Guitart 2010.
[56] Remolà et al. (forthcoming).
[57] Járrega and Sánchez 2008.

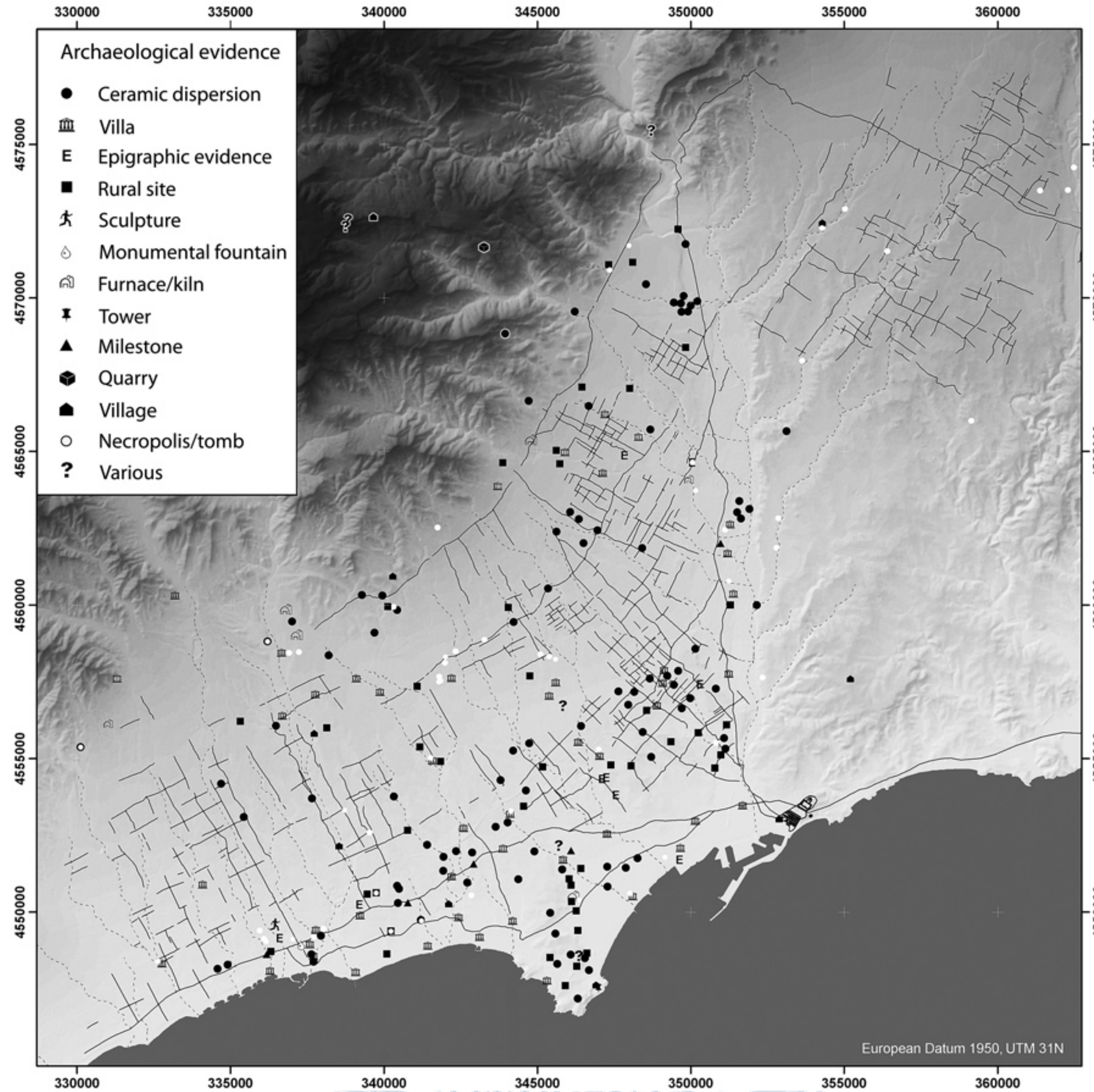

Fig. 6. Archaeological survey of the Ager Tarraconensis (after Prevosti and Guitart 2010).

The Impact of Centuriations on the Ager Tarraconensis Landscape

The influence of centuriated grids on settlement dynamics was also analyzed. This was especially helpful in making the chronology of the Roman grids more precise and in deepening the interpretation of their function and meaning. The map of rural settlement distribution shows a significant concentration in the area of Tarraco I. Several sites show that the date of the establishment of these settlements lies between the end of the second century B.C.E. and the middle of the first century B.C.E. (fig. 8).[58] These sites are always close to and aligned to Tarraco I centuriated traces. By the end of the Republican period (second half of the first century B.C.E.), this situation was reinforced. Contrary to this, the general map of Late Republican and Early Imperial rural settlement (see fig. 6) shows both extensive areas without evidence of occupation and settlement concentrations in specific sectors. In this sense, archaeological maps suggest that some extensive centuriated areas were characterized by low-intensity land use. This is especially evident for the Tarraco II

[58] Palet and Orengo 2010.

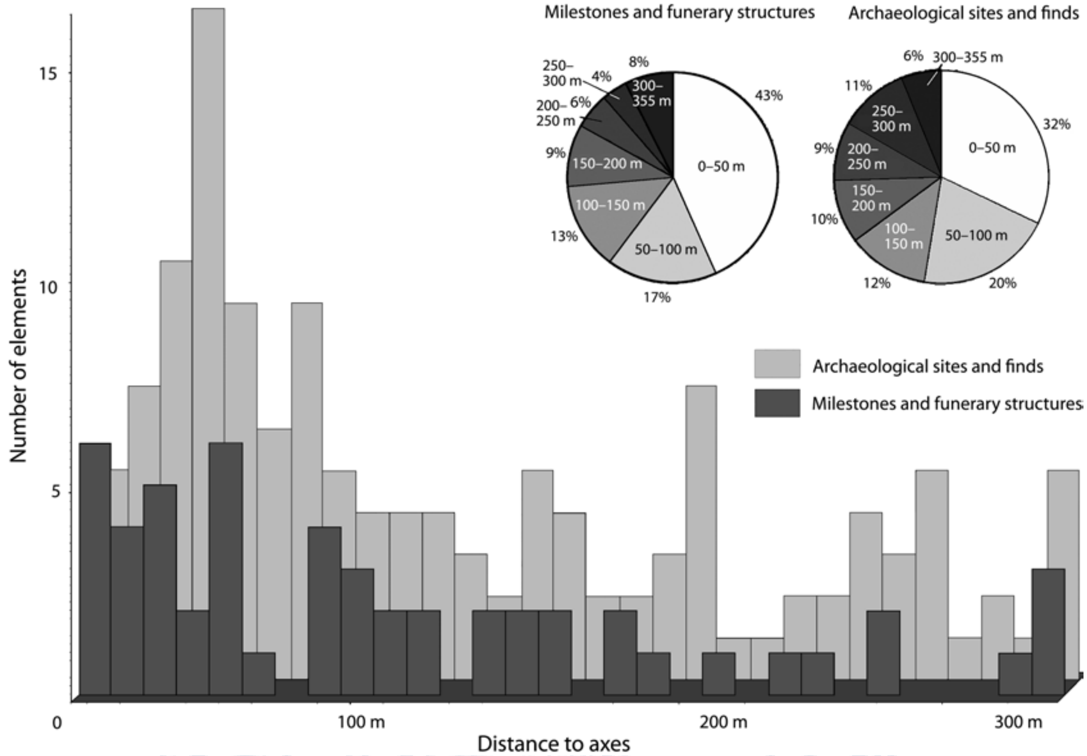

Fig. 7. Distribution of archaeological sites and finds and milestones and funerary structures relative to their proximity to archaeomorphologically restituted centuriated traces (drawing by H. Orengo).

area. To sum up, the impact of Ager Tarraconensis centuriations on settlement patterns was significant, but these operations did not mean a generalized and homogeneous occupation of the whole landscape. The occupation of certain sectors was favored.

The problem can be further explored by taking into account the palynological evidence available for the Ager Tarraconensis.[59] Pollen diagrams show an increase in forested areas from the second century B.C.E., while the evidence for agricultural and pastoral activities is scarce. Conversely, a decrease in pine is attested along the coastlines, which has been related to a stronger human impact in these sectors. At the local scale, landscape clearings were significant around Roman villas and productive areas. But extensive forested areas and the absence of a generalized open landscape are attested during the entire Roman period. This indicates that Roman centuriations did not have such a thorough impact on the landscape as the archaeomorphological and archaeological data alone would suggest. It should be taken into account that, in this case, pollen data reflect regional dynamics, while archaeomorphological and archaeological data provide evidence related to limited areas of the landscape.

The correlation of archaeomorphological, archaeological, and paleoenvironmental data provides information about complex Roman landscape organization and land use. While agrarian exploitation and occupation are well attested around the villas of the Ager Tarraconensis, the Roman centuriations had a much lower regional impact. This evidence does not support the exclusively agrarian function of Roman land divisions, which has already been proven for other centuriated areas of the Tarraconensis province, such as Barcino, where extensive paleoenvironmental and archaeomorphological research has provided many similar results.[60]

GENESIS: THE MAKING OF THE ROMAN CENTURIATED LANDSCAPE

Much work has been devoted to studying how centuriated landscapes were created, and the processes

[59] Riera 2003; Riera et al. 2009, 2010.
[60] Riera and Palet 2008; Palet and Riera 2009; Riera et al. 2009.

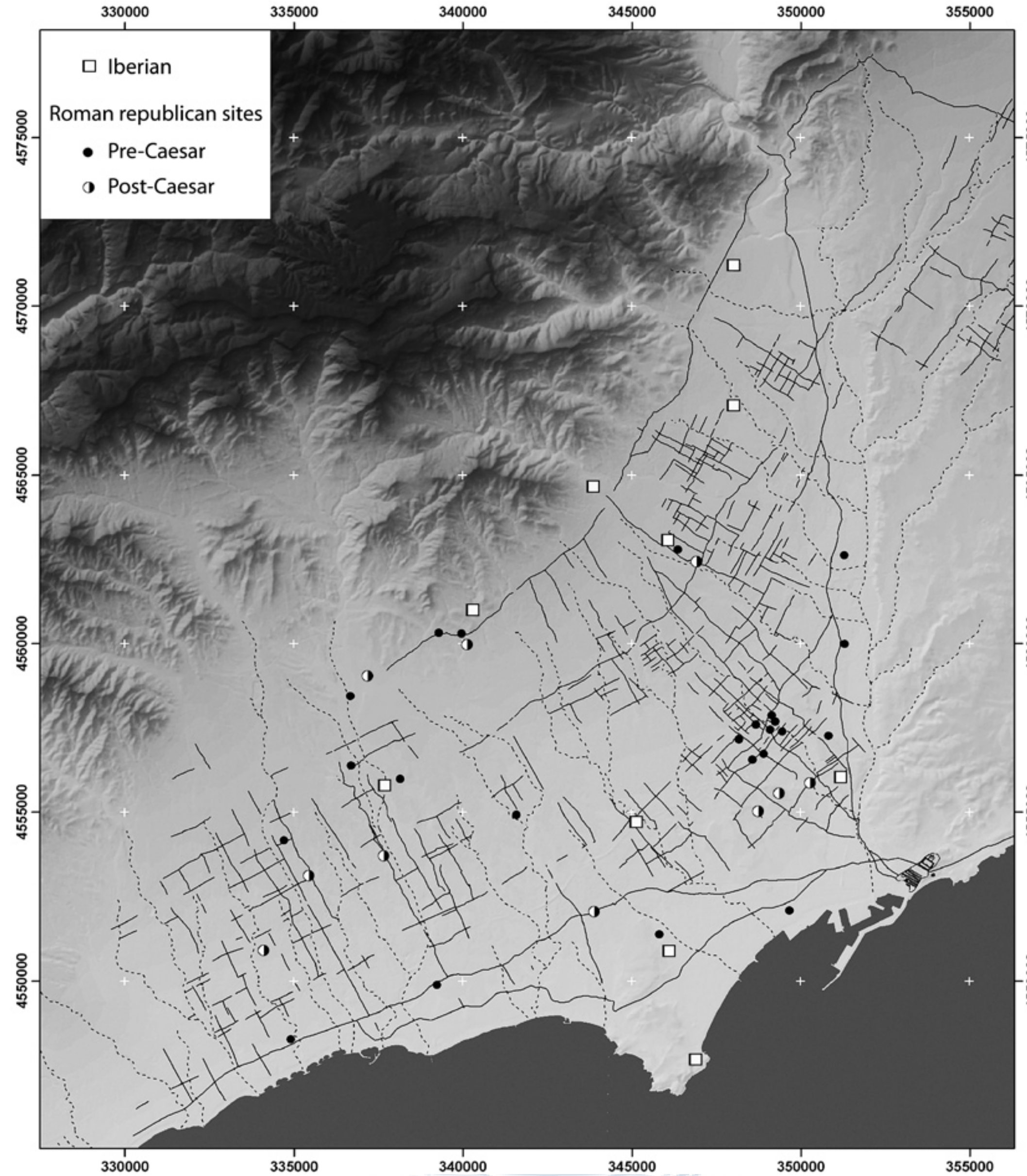

Fig. 8. Selected sites within the study area divided by chronology.

and practices of Roman land surveying have been thoroughly described. It is the purpose of this article to move beyond the practicalities of Roman field surveying and explore the concepts and ideas behind the making of a centuriated landscape. This study argues that the city layout was a vital part of this. In fact, the city layout and Tarraco III grid have practically the same orientation (with 3° of deviation). The projection of the grid over the city shows a significant concordance between urban and territorial axes. Also, one of the theoretical cardines of Tarraco III is coincident with the axis of symmetry of the city forum.

The question has also been analyzed using GIS-generated viewsheds from the *auguraculum*. These were superimposed on the results of the archaeomorphological study. The results show how the viewshed forms a triangular network of visual corridors (fig. 9). Three of these corridors are associated with the regular grid systems present around Tarraco.[61] In the case of Tarraco II and III, their axes passed through the diagonal

[61] Fiz et al. 2008; Palet et al. 2010.

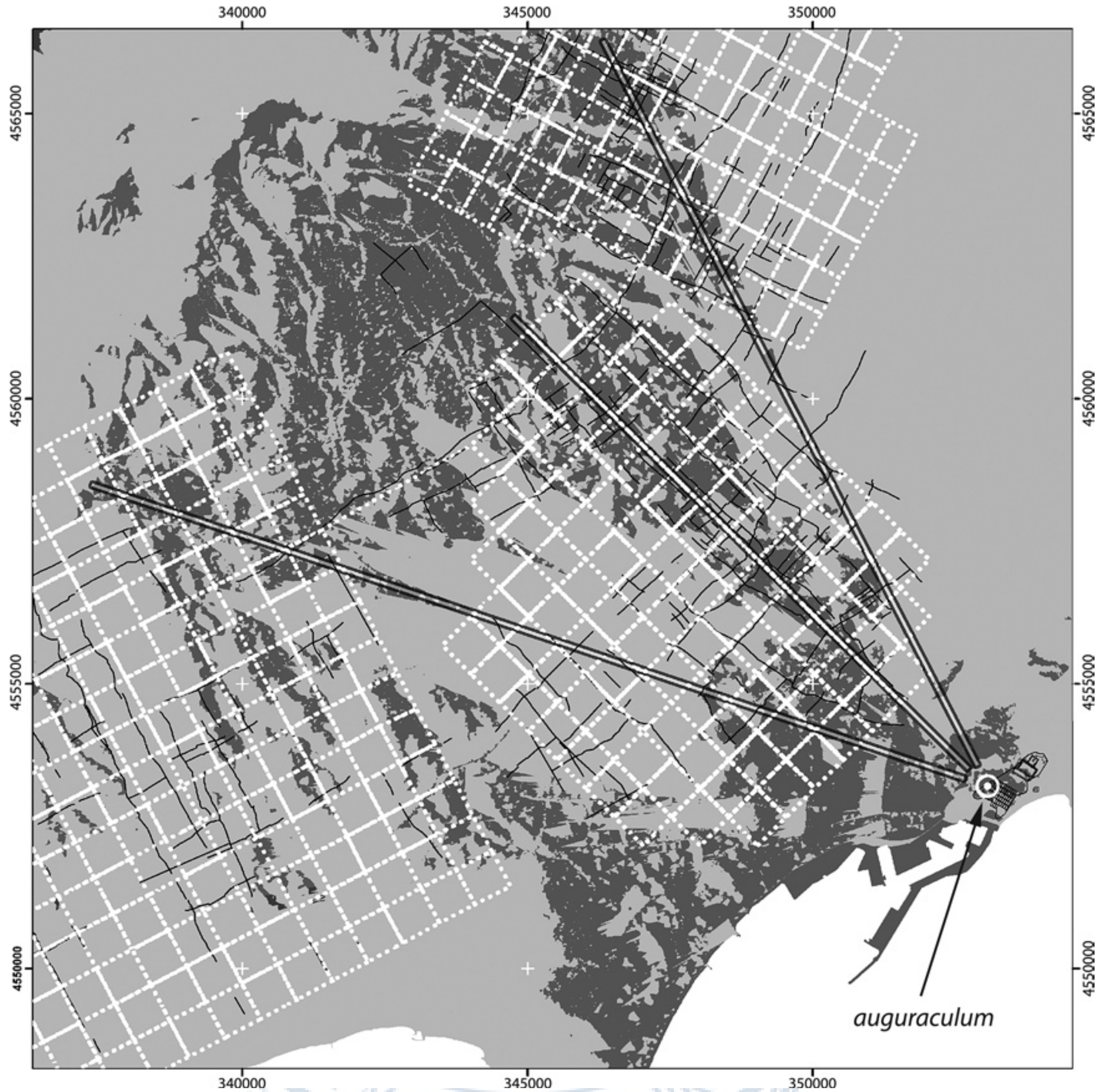

Fig. 9. Viewsheds and visual axes from the *auguraculum* and their relationship to the centuriated grids.

of the grid units. In the case of Tarraco I, the visual axis aligns with the grid decumani. It has been argued that centuriated systems were constructed from straight stretches of road, which would act as hypotenuses, or diagonal lines, of the grid units following the process known as *variatio*.[62] These diagonal lines could span a single or several grid units depending on (1) the angular relationship between the road and the *limitatio* and (2) the grid module. As the viewshed analysis demonstrates, Tarraco II and III followed the technique described by Roth,[63] whereas the alignment of the Tarraco I grid with the visual axis allowed a straightforward definition of the centuriation *limites*.

In this case, instead of straight stretches of road, the land surveyor used visual axes dictated by the augur, as he perceived the landscape from the *auguraculum*. This process could have been carried out by the land surveyor following a simple method of identifying landmarks and lining them up. This is an exhaustively documented technique in the corpus and one for which well-known Roman land surveying methods could have been practiced.[64]

[62] Roth 1996; Chouquer and Favory 2001, 301–2.
[63] Roth 1996.
[64] Lewis 2001.

The proportions of grid modules have often been used to date centuriated systems. While it is not the intention of this article to deny the preferential use of particular proportions during certain periods or in certain geographic areas, the visual axes defined from the *auguraculum* allowed multiple orientations of the grids by changing the proportions of the grid units or simply the number of grid units involved (fig. 10). This would have permitted not only the adaptation of the centuriated network to the environment (particularly to its hydrography) but also the development of a perfect geometric articulation of the different grids.

In the Ager Tarraconensis case, viewshed analysis shows that the *auguraculum* appears as the element that links the city layout and the land-division process. From this privileged viewing point, the augur perceived and identified a series of landmarks that the land surveyors would subsequently use to develop the *limitatio*. It is therefore reasonable to suggest that both the city layout and the land-division process were conceived and planned from the location where the *groma* was first positioned.[65] The relationship between the viewshed and the different grid units, together with the fact that the angular relationship between adjoining grids is constant, suggests that the three systems originated from a single conception. The modular and angular relationship between Tarraco III and the city layout suggests that *urbem agrumque* (the city and the country), in Livy's words (1.18.7–8), were planned at the same time.

CONCLUDING REMARKS: MATERIAL VS. CONCEPTUAL SIGNIFICANCE

The application of GIS-based technologies to the Ager Tarraconensis centuriations assures higher reliability when validating the traces of the Tarraco I, Tarraco II, and Tarraco III grids, thus showing that they are in perfect geometrical articulation. They have proved to be powerful tools for the study of centuriated landscapes, thanks to their ability to investigate the conceptualization and development of centuriated systems. They permit the study of the relationship between urban and landscape structures from a symbolic perspective. Viewshed analysis from the *auguraculum* reveals the value of this approach in understanding the conceptualization and geometric planning of the city *territorium*. The results reinforce the hypothesis that there was a single concept of the whole centuriated landscape. This comprehensive planning of the *limitatio* and the city can likely be linked to the promotion of Tarraco to the status of colony under Caesar's rule (ca. 45 B.C.E.), emphasizing the importance of the Caesarean program in Tarraco and the Ager Tarraconensis. This idea is supported by the documented change in the settlement pattern from the second half of the first century B.C.E. Large *fundus villae* emerged that coincided with dense population centers, thus leading to a reduction in the number of *ager* sites.[66] These settlement dynamics would be compatible with the impact of a programmed reorganization of the territory.

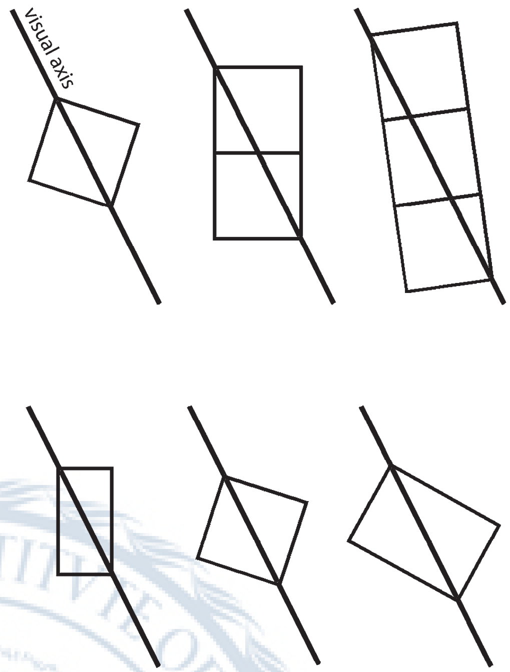

Fig. 10. Methods to adapt the grid orientation by the number of grid units involved (*top*) and by changing the module of the grid units (*bottom*) (drawing by H. Orengo).

Nevertheless, we cannot discount the possible existence of previous programs of Roman land survey, especially in relation to Tarraco I and the first urban development ca. 100 B.C.E.[67] In this sense, as was reflected in the distribution of sites examined when testing the centuriation hypothesis by proximity analysis, several sites that emerged in conjunction with the centuriated traces of Tarraco I could be placed within an earlier chronological frame, dating to the end of the second century B.C.E. In any case, there seems to have been a comprehensive and geometrically unified reorganization of the new *colonia* and its territory later in the first century B.C.E.

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[65] Fiz et al. 2008; Palet et al. 2010.

[66] Carreté et al. 1995, 278–79; Palet 2003, 221–22; López 2006, 102–7.

[67] Macias 2000.

In this article, we have shown how the emplacement of the centuriated systems could have been based on the alignments indicated by the portions of territory that the augur perceived while still being sensitive to the particularities of the environment. In this way, Roman land surveying techniques, by altering the modular relationships of the grid units, could have allowed the system as a whole to be adapted to the visual axes defined by the augur and to geographic constraints.

Paleoenvironmental evidence reinforces the symbolic background of centuriated landscapes. In this case study, a strong centuriated territorial organization is documented together with complex land use that does not necessarily imply an intensive exploitation of the whole territory. Pollen evidence shows a Roman landscape characterized by the absence of extended deforestation and agriculture. For this reason, the existence of an intensive exploitation around certain sites (*villae*) is proposed.[68]

These conclusions are at odds with the traditional concept of centuriation as an exclusively technical, economic process linked to Roman colonialism. Without denying the practical implications of centuriations, we stress their cultural and perceptual significance. In this sense, centuriations can be defined as "transported landscapes" in which the mythical home country has been conceptually recreated rather than just politically extended. By reproducing the rituals carried out at the foundation of Rome, the newly acquired territory became Roman. Roman centuriations represent both a system of land division and a true conceptual appropriation of landscape that is based on an established mythical and religious background. In this respect, the *auguraculum* reflects the Roman idea of the heavens; its cardinal orientation was related to the ordination and orientation of the world.[69]

This research also calls into question the idea of centuriation as an exclusively territorial imposition linked to the colonization process and the punitive expropriation of native land. In the case of Tarraco and many towns in the Tarraconensis and other Roman provinces, centuriations were a late development, dating mainly from the Caesar-Augustan period; some examples are Barcino (Barcelona), Emerita Augusta (Mérida), and Arausio (Orange).[70] In general, their development can be related to the desire of already Romanized native populations to prove their Roman status. We suggest that city and territory were planned in conjunction. Just as the citizens of Tarraco constructed its monumental provincial forum as a representation of the city,[71] they monumentalized its landscape to accommodate it to the idea of a truly Roman space.

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[68] Riera et al. 2009, 2010.
[69] Magli 2008, 63.
[70] Chouquer and Favory 2001, 228–34; Ariño et al. 2004.
[71] Orengo and Fiz 2008b; Orengo et al. (forthcoming).

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