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# ASTRONOMY, METRICS, AND PROPORTIONALITY IN THE IBERIAN NECROPOLIS OF TÚTUGI (GALERA, GRANADA, SPAIN)

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**ABSTRACT**

In this study, a sample of 16 burial chambers (rectangular, square and two circular shapes), situated in the Iberian necropolis of the ancient Túgi has been characterized metrically and geometrically, as well as in terms of noteworthy astronomical orientation. Furthermore, information compiled from the excavation records of Cabré and Motos (1920) regarding the necropolis satisfactorily coincides with our current results. The first major result in the metric study was the use of a measured pattern (the Túgi foot) in all the monumental tombs of the necropolis, constituting a unit which we estimate at 0.294m. Also, the study classified the proportions of the burial chambers into three typologies: the golden ratio, the Cordovan proportion, and the one-to-one proportion. The first two proportions were found only in a specific zone (Zone I), which contained the largest and oldest graves, belonging to the founders of the lineage and the subordinates of that lineage. In addition, and as the most important result, all the burials were oriented astronomically, without topographical orientations of note. In these orientations we found the recurrence of certain stars and constellations, which present a scheme that we must interpret, though with scant data available on the religion and beliefs of the afterlife of the Iberian people.

**KEYWORDS:** Iberian Culture, Túgi, necropolis, Equinoxes, Lunar orientations, metrics, proportionality

## 1. INTRODUCTION

In the south-eastern Iberian Peninsula lies a set of mountains (*sierras*) and plateaus making up the Betic and Penibetic systems, where, according to classical writers such as Strabo (III,1,7; III,4,1), Pliny (III,4,19; III,4,25), and Ptolemy (2,4,6; 2,6,60), lived the Bastetani people.

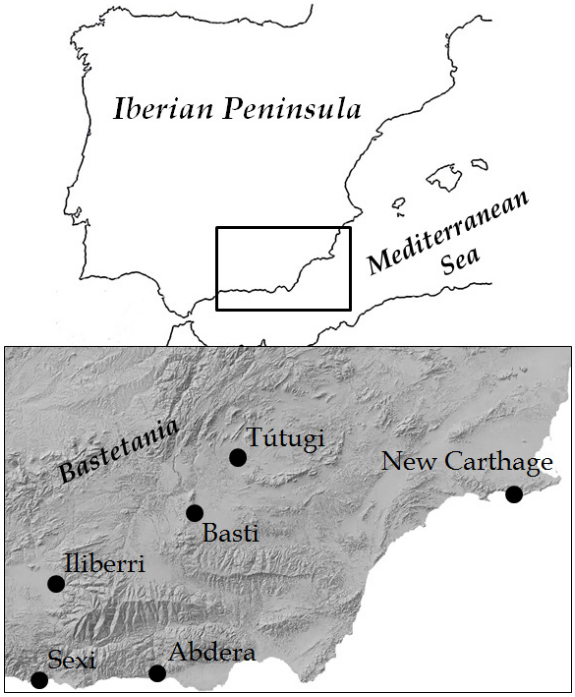


**Fig 1. Iberian Peninsula with the locations of Túgi, Iliberri and Basti (cities of Bastenati territory) and the Punic foundations of Sexi, Abdera and New Carthage.**

The Bastetani people are one of the Iberian peoples that occupied the entire Levant and the southern Iberian Peninsula from Andalusia to southeastern France in the period from the sixth to the first century BCE The term "Iberians" thus refers to a group of ethnic and political units that evolved under the influence of trade and barter with the Phoenicians, who came from the western Mediterranean, and afterwards with the Greeks, Punics, and Romans (Ruiz and Molinos, 1998).

Among the fundamental features that characterize the so-called Iberian Culture, and that unite this group of peoples is the organization of the territory, structured into settlements of different categories. In the upper range was the *oppidum* or fortified city, which was the political, administrative, economic, and sometimes even the religious centre of the communities. From the main settlement, the nucleus of the territory, the population was organized for the exploitation of their resources. The main settlement was situated in a high setting for reasons of prestige, control, and defence, near to the trade routes and the areas of economic exploitation. The necropolis of the leading families was situated near the *oppidum* to preserve the memory of the ancestors and the concept of belonging to the group of the dead (Ruiz and Molinos, 1998).

Outside the settlement lay the agricultural areas, generally located on flat land, where there could be farms or small rural population centres. Other fundamental economic activities included livestock, pottery, and mining.

Among the various cities mentioned by these ancient sources is the ancient city of Túgi (Galera, Granada Province), situated in the easternmost part of the Intrabetic plateaus. The archaeological ensemble of Túgi is composed of a settlement with several phases of occupation, one being Iberian (*Cerro del Real*), an Iberian necropolis (Túgi), and a pottery-production zone (Iberian *alfar*), all scattered throughout a broad area near the present-day town of Galera (Rodríguez-Ariza, 2014).

The necropolis of Túgi, covering an extensive area near the town of Galera, has three areas. The first two lie to the north of *Cerro del Real* or village, separated from this by the river Orce and the contiguous farmland. The topography consists of gentle rises and low hills of between 15 and 25 m over the farmland areas. In surface area, this is the largest Iberian necropolis excavated to date and contains a total of 165 burial chambers, almost all recorded in the older excavation list made by Juan Cabré and Federico Motos in the early 20th century (Cabré and Motos, 1920). Of the total of

165 burial chambers, about 40 are monumental in scale, while some are now lost to plundering as far back as antiquity. Most of the monumental tombs have a chamber or corridor access, which may be excavated into rock or constructed. These structures are covered by a tumulus of stone and soil that, in some cases, can have dimensions large enough that they are visible in the landscape.

The current work presents the results of measurements and observations made for a sample of 16 monumental burial chambers documented during recent excavations. All of these burial chambers have been dated between the fifth and third centuries BCE (Middle Iberian period, according to the archaeological materials recovered as well as to C14 tests; Rodríguez-Ariza, 2014).

For this sample, we provide the written and graphic information for up to 14 tombs listed in the excavation records of Cabré y Motos (Ibid.). From three tombs, we collate previous and current data, checking the results found in both cases, and consequently corroborating them.

## 2. METHODOLOGY SURVEY. HOW THE DATA WERE OBTAINED

The modern excavations of the necropolis were begun in the year 2006 using photogrammetric techniques, a topographical survey of some 170 ha, around the terrain occupied by the necropolis and the settlement of the ancient city of Túgi (quadrilateral with a SW corner at N37º44'07" W2º32'55" and NE corner at N37º45'30" W2º31'44"). The survey was made at a scale of 1:1000 and on ETRS89 in order to include later any other information gathered by classical techniques (Total Station) or GPS without any type of transformation. In addition, in the tombs excavated, planimetry (and stratigraphy) was performed at a scale of 1:20, in some cases completed with isopleths or contour lines. The data from both surveys made it possible to generate a Digital Terrain Model (DTM) that was used as support to determine (or confirm, in some cases) the altitude corresponding to each direction of interest of the burial chambers; that is, astronomical azimuths of the corridor axes and of their diagonals, as well as those directions to determine the magnetic orientations, using the graphic information from the Excavation Records of 1920 (Cabré and Motos 1920). This information was corrected by magnetic declination for the year of its observation (1918), according to the data provided by the NOAA Geophysical Data Center, and of a detected systematism

In the year 2011, to determine the possible astronomical orientations in the monumental tombs, a method of rounds on the horizon was observed. These were measurements of the azimuth and altitude for a total of 120 points of the horizon. This round on the horizon was oriented by a series of observations of the sun and the corresponding resolution of the Zenith-Pole-Sun triangle (positioning triangle), with 10" root mean square (for the mean of six observations). This round on the horizon was made for Tomb 20. For the rest of the tombs, the corresponding height correction was made on the horizon with the help of the generated DTM, although this correction was null for the great majority of the tombs.

For the simulation of the sky in the corresponding time period, the applications StarryNight Pro Plus and Stellarium (www.stellarium.org) were applied to each tomb. However, for the sky simulation, since all the tombs of the necropolis lay at a distance of no more than 600m from the main tomb, Burial 20, all tombs were considered to have the same position. Their geodesic coordinates on ETRS89 are:

- Latitude: 37º 44' 48.88423" N
- Longitude: 2º 32' 28.99281" W
- Ellipsoidal height: 920.242 m
- Orthometric height: 869.374 m

These were calculated from a static relative positioning (by carrier phase tracking) from the triangulation station CAAL (Calar Alto, Almería), belonging to the Andalusian Network of GNSS Positioning, with

the above-mentioned equipment and absolute precision better than 6cm.

Finally, the precise positioning of all the tombs was made by the method RTK (Real Time Kinematic) by two geodesic receptors of the bifrequency GPS LeicaSystem 1203 (10mm + 1ppm precision in kinematic positioning, as in our case).

The metrics of the burial chambers were determined from a precise measurement of the dimensions of the chambers and the corridors of each tomb that had a good geometric definition, together with low dispersion of the results (therefore, only the data of 10 burials were included instead of the 16 mentioned in Table 1). For this measurement, the Total SmartStation TPS Leica 1200 was used (angular standard deviation: 1" and, in non-prism laser distances, 2mm+2ppm), which provided a possible measurement pattern for the entire necropolis, as presented below.

The measurement and orientation data from the old excavation records were measured directly over the graphic material when no numerical values were available for some of the tombs and, of course, when no actual data exists. Of course great caution was exercised in adding these data to the overall result.

## 3. METRICS AND PROPORTIONALITY IN THE NECROPOLIS. PLANNING OF A SACRED SPACE

The necropolis was clearly planned in terms of a sacred space (Rodríguez-Ariza, 2014). The analysis of the construction techniques and of the funerary goods recovered indicates to us that the necropolis was spatially distributed from one of the two tombs of the founders of the lineage. The rest of the burials of the aristocracy and clients were situated in relation to the two main tombs (*ibid.*).

The key element may be the geometric layout. The value of the foot seemed to be used by the builders of Burial 20, which was among the oldest of the necropolis (fifth century BCE) and considered to be that of the founder of the lineage (Rodríguez-Ariza *et al.*, 2008; Rodríguez-Ariza, 2014). Precisely, this tomb contained the largest number of elements that can be metrically characterized in two construction phases, and it was calculated as 0.295m (Pérez Gutiérrez and Rodríguez-Ariza, 2013). This is completely consistent with the values of the pre-Iberian and Iberian foot found at sites throughout the Mediterranean coast of Iberia as well as among other sites of the Mediterranean from that period (Pérez Gutiérrez *et al.*, 2011; Pérez Gutiérrez *et al.*, 2013). The determination of the value of the foot in other tombs (funerary chambers and their corridors) that offered guarantees in their definition are listed in Table 1, which reflects mean quadratic errors in the different cases of between 1mm and 3mm. Except for Burial 139, which gives a clearly lower value for reasons that are not yet understood (and therefore has been removed from some of the rows), the values presented reaffirm that the builders of the necropolis had a high degree of precision in planning the construction.

**Table 1. Values for the calculation of the foot**

| Foot value obtained from topographical measures (all in meters) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **BURIAL** | **20** | **21** | **22** | **50** | **73** | **75** | **76** | **78** | **139** | **140** |
| **Foot value** | 0.295 | 0.295 | 0.286 | 0.292 | 0.293 | 0.286 | 0.297 | 0.294 | 0.274 | 0.292 |
| | | | | | **Total Mean** | **0.290** | | | **r.m.s. mean** | **0.002** |
| **Deviation** | 0.005 | 0.005 | 0.004 | 0.002 | 0.003 | 0.004 | 0.007 | 0.004 | 0.014 | 0.002 |
| **r.m.s** | 0.002 | 0.002 | 0.001 | 0.001 | 0.001 | 0.001 | 0.002 | 0.004 | 0.050 | 0.001 |
| **Mean without burial 139** | | | | | **Mean** | **0.292** | | | **r.m.s. mean** | **0.001** |
| **Deviation** | 0.003 | 0.003 | 0.006 | 0.000 | 0.001 | 0.006 | 0.005 | 0.002 | | 0.003 |
| **r.m.s** | 0.001 | 0.001 | 0.002 | 0.000 | 0.000 | 0.002 | 0.002 | 0.001 | | 0.001 |
| **Mean without burials 22, 75 and 139** | | | | | **Mean** | **0.294** | | | **r.m.s. mean** | **0.001** |
| **Deviation** | 0.001 | 0.001 | | 0.002 | 0.001 | | 0.003 | 0.000 | | 0.002 |
| **r.m.s** | 0.000 | 0.000 | | 0.001 | 0.000 | | 0.001 | 0.000 | | 0.001 |
| **Only burial 20 as reference** | | | | | **Mean** | **0.295** | | | **r.m.s. mean** | **0.003** |
| **Deviation** | 0.000 | 0.000 | 0.010 | 0.003 | 0.002 | 0.010 | 0.002 | 0.001 | 0.021 | 0.003 |
| **r.m.s** | 0.000 | 0.000 | 0.003 | 0.001 | 0.001 | 0.003 | 0.001 | 0.000 | 0.007 | 0.001 |
| **Only burial 20, without burial 139** | | | | | **Mean** | **0.295** | | **r.m.s. mean** | | **0.002** |
| **Deviation** | 0.000 | 0.000 | 0.010 | 0.003 | 0.002 | 0.010 | 0.002 | 0.001 | | 0.003 |
| **r.m.s** | 0.000 | 0.000 | 0.003 | 0.001 | 0.001 | 0.003 | 0.001 | 0.000 | | 0.001 |

To confirm this definitive value of the foot (0.294±0.003 m), we examined the information from the old excavation records (Cabré and Motos, 1920), which provide

metric information and/or orientations of up to 21 burials, both in graphic as well as written form. Five of these burials (11, 34, 57, 75, and 76) have dimensions that, except in the case of Burial 11, which has very imprecise definition due to having not been completely excavated, are completely consistent with the current measurements. This offers some certainty for the 16 remaining tombs, for which the dimensions are multiples of the entire foot, with a deviation of no more than 1cm for the definition of the foot. Burial 2 is excluded from this situation, as its dimensions indicate a chamber of 8′ x 5′, but with a foot value of 0.275m, in agreement with the metrics of tomb 139, i.e. 2cm less than the foot used in the rest of the burial chambers. For now, there is no convincing explanation for these anomalies, except that the measuring implement used (its dimension) was different from the local one, because of being misused, being defective, or perhaps having a different geographical origin. This foot of 0.275m has been used in other parts of the Iberian Peninsula of the period, as in the case of the Hellenic-influenced fortification of Castellet de Banyoles (Moret, 2008), or House C of the Vettonian people of La Mesa de Miranda (Pérez Gutiérrez, unpublished, 0.280 m). Also, there are striking coincidences with the Ionic foot (0.277m) and the Oscan foot (pes oscus, 0.275m) (Panchón and Manzano, 2002).

The fact that the burial chambers of the necropolis were constructed with a precise measure indicates planning in each case. The dimensions of the chambers vary from the smallest ones, of 5′ x 5′, to the largest, of up to 8′ x 8′, although some were not necessarily square. There are data from two circular chambers corresponding to Burials 21 (10′ in diameter) and 26 (11′ in diameter). Several larger tombs deserve mention: Burials 11, 20, 34, and 75 are undoubtedly the oldest and most important of the necropolis. What these mean in terms of orientation, we will discuss below. Burial chamber 11 is square, 12′ x 12′, has no corridor, and has a purpose that will also be discussed below.

Once this metric planning is accepted, the next step is to verify the use of the notable proportions in the construction of the chambers, as indeed appears to have occurred. In fact, it can be corroborated that the great majority of the chambers are square, the rectangle being reserved for some of the graves of Zone I, identified with the area that contains the oldest burial chambers of the necropolis (fifth-sixth centuries BCE). Specifically, of the 28 tombs for which we know the dimensions, 19 are square (or almost square), four have the golden ratio (Burials 2, 20, 29, 34), and five have the Cordovan proportion (Burials 22, 23, 32-I, 62, and the second phase of Burial 20), which is less stylized that the golden one (Hoz Arderius, 2002). The latter two proportions, together with the one-to-one proportion, appear in many of the sculptural objects (mainly ash boxes and their lids) with Greco-Oriental and indigenous decorations (Pérez Gutiérrez and Rodríguez Ariza, 2013).

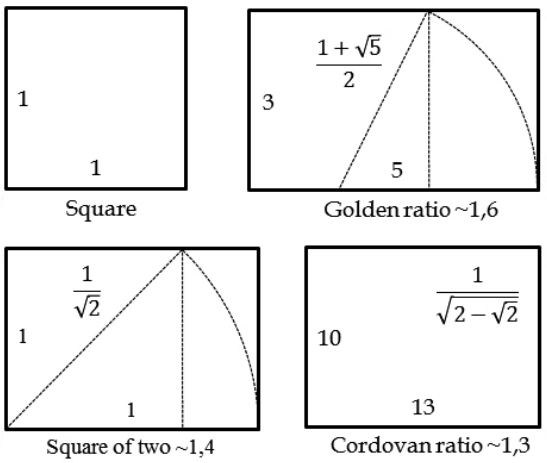


**Fig 2. Geometrical ratios and integers regularly used in building**

## 4. ASTRONOMICAL ORIENTATION OF THE BURIALS

The fact that almost all the tombs have a corridor, in general well-defined, suggests that their spatial orientation has some explanation. In fact, they are aligned with a point on the horizon having some astro-

nomical significance, since the rising and setting of a given star is the normal reason for orienting a funerary architectonic element, as in the present case of the Túgi necropolis. However, this does not exclude others, such as orientation towards some topographically outstanding element on the horizon, or towards the most important construction that abuts others of less importance, thus conveying clientelism, a prevailing social structure at that place and time.

Why the horizon? This is the line that separates the earth from the sky, the place where people live vs. where the gods dwell. Clearly, in a necropolis, this is of paramount importance. The stay there should be provisional, a place of passage to cross the thin line between the two worlds: terrestrial and celestial, human and divine.

Above, we mentioned that none of the tombs had an outstanding topographical orientation, since the territory surrounding the necropolis is a plateau. Only towards the north do peaks become notable, such as *La Sagra* (height 2400m), but none of the orientations point to them. Nor have clear orientations been detected among different burial chambers, except for some particular cases (Burials 11 and 20), possibly associated with the aforementioned clientele relations. Therefore, if there were some orientation of the tombs, this could be astronomical.

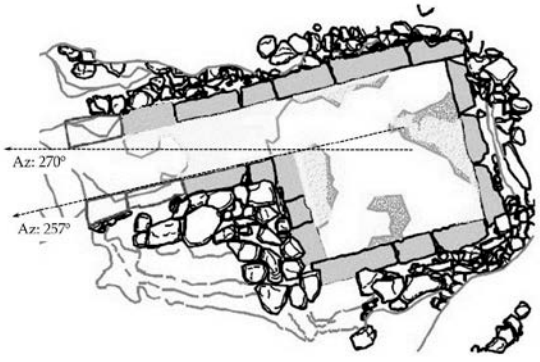


**Fig 3. Corridor and main diagonal directions for burial 75. From inside the chamber, the visible range of the horizon is 13º.**

Table 2 shows the relation of the azimuths and altitudes of each of the corridors. The orientation of the corridor axis and the interior diagonal to the chamber are specified, so that for each burial, these orientations mark the limits of the visible zone of the horizon from the interior of the burial chamber, to the way that Silva (2013) names the window of visibility. This would correspond to the view that the deceased would have from the burial chamber (Fig. 3), perhaps meant to facilitate access to the afterlife.

In this table, we can distinguish between the orientations found in the recent excavations (text in bold) and those of the old excavation records (underlined text), the latter calculated from the magnetic orientations provided by Cabré and Motos (1920). These magnetic orientations have been appropriately corrected from the magnetic declination using values from the NOAA Geophysical Data Center for the year 1918, i.e. 13ºW. In addition, the comparison of the orientations of Burials 57, 75, and 76, in the periods of 1918 and 2011, enabled the determination of a systematic error of -6º±1º (Pérez Gutiérrez and Rodríguez Ariza, 2014), which has been applied to all of them. This approach renders completely consistent results, as there are multiple coincidences with other burials recently measured (in all cases with precision of 1º-2º).

**Fig 4. Burial 75 after recent excavation. In the bottom right corner we see a photograph of the entrance taken in older excavation.**

As reflected in Table 2, practically all the corridors have a westerly orientation, cov-

ering the entire western horizon. Only two burials have an eastern orientation, this appearing to be more of an anomaly than a desired orientation. In fact, Burial 32-I, with an orientation of 56º (rise of the major lunar standstill at the winter solstice), was replaced later in the Iberian period by another, Burial 32-II, oriented to the setting of the major lunar standstill at the summer solstice, which clearly has a western orientation.

Furthermore, the entrance corridor might not have been planned in this way, given that it is wider (2.5') than deep (2').

Burial 11, with an orientation having an azimuth of 102º, is a special case. Although bone remains have been detected, it appears to have been an open grave and therefore lacked a tumulus, with access by steps. It would be a place to perform rituals related to fire in the two *ustrina*, which contained a place open to collectivity, possibly of the lineage that made offerings to ancestors.

**Fig 5. Burial 20 (phase II) after restoration. The kink and the holes of the entry correspond to the later elimination of the tumulus, leaving the grave opened**

All the indices point also to an association of Burial 11 with Burial 20, which could be considered as having been dedicated to a duality that appears in the oriental cults between the male sun god and the female deity (Rodríguez-Ariza, 2014). It should be borne in mind that Burial 20 is among the largest and oldest of the necropolis, and unquestionably the most important. It has the peculiarity of being the only one to have an interior eccentric pillar rotated to the same orientation as the diagonals of the corridor. However, above all, it is the most important for lodging the goddess of Galera, or Lady of Galera, a figure of 20cm in height sculpted from a single block of alabaster, presumably representing the goddess Astarte, of Phoenician artisanship and dating to the seventh century BCE (Almagro-Gorbea, 2009).

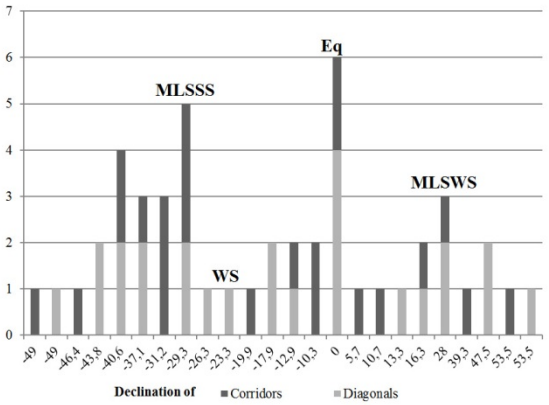


**Fig 6. Declination for the burial orientations and its recurrences**

Table 2 illustrates the incorporation of diagonals as relevant orientations. More than half of these points in the same directions as the corridor axes, consistently with the precision indicated above. There are 13 recurring directions, seven of these double, while the other directions are repeated three, four, and up to six times.

Of the total of 50 directions, thirty aim towards the region of the horizon where the sun or moon sets. However, only six of these aim towards the sunset at the equinoxes and only one aims towards the sunset at the winter solstice, whereas another eight aim towards the major standstill of the moon, three to the north and five to the south. Of these eight lunar orientations, four correspond to the axes of the corridor and another four to the main diagonals. Thus, what remains to be explained is the orientation (solar or lunar) of another 15 directions of seven burials, to which we

must add 20 remaining orientations for which the direction falls outside the zone of the horizon where the sun and moon set, for a total of 35 directions, which cover the rest of the western horizon.

There are, however, two curious cases which appear to break the rule of the western orientation, but which we believe again support the use of the axis and the diagonal of the corridor with the aim of defining a specific region of the horizon and its immediate sky. These are Burials 116 and 134, both in Zone II. In the first case, the orientation is practically southern. The axis of the corridor has an azimuth of 173º, eastern, while the diagonal is 189º, western, practically symmetrical with respect to the local meridian. The second case, Burial 134, is similar to the previous one but with a northern orientation. The axis of the corridor has an azimuth of 352º, while the diagonal has an azimuth of 8º, also symmetrical with respect to the local meridian.

### *4.1 Equinoctial and lunar orientations*

The declination diagram in Figure 6 shows the regions of the sky to which the axes and diagonals of the corridors point, clearly marking interest in the position of the solar equinox. In this case, the orientations correspond in large part to the oldest and most important burials. Notable among these, as mentioned above, are Burials 20 and 34 (fifth century BCE), with their chamber constructed in the golden ratio. Likewise, Burial chamber 2 is also notable, with its profuse and spectacular decoration (Cabré and Motos, 1920) and the golden ratio for its chamber, and as well Burial chamber 75 (fourth century BCE), with its square plan, considered the main tomb of the easternmost area of the necropolis and the most monumental of all the chambers for the stonework construction as well as the tumulus covering it (see Fig 4). The tumulus of Burial 75 reached more than 20m in diameter and more than 5m in height, as the tumulus of Burial 29 (also built with the golden ratio, according to the geometric references of the old excavation records, although without information on its orientation).

The two remaining chambers with an equinox orientation, Burials 57 and 62, also have characteristics that make them outstanding among the others, although they are later in age. Burial 57 (third century BCE), situated on the northern slope of Zone Ib and visible from the village, is the main tomb of the group of eight burials. Burial 62 (without precise dating) is situated over a group of six burials and was built with the Cordovan proportion, although in this case it is not possible to affirm its preeminence over the rest of the graves, as the site is not completely excavated.

The following group of orientations of interest correspond to the major standstill of the moon, with three orientations for the one at southern position and with five for the northern position. All eight lunar orientations belong to tombs of medium size, although all are monumental and situated in the main zone of the necropolis (Zone I), except for Burial 139 (fourth-third century BCE), which lies in Zone III of the necropolis, the closest to the village.

### *4.2 Do the rest of the orientations have an astronomical explanation?*

The equinox and the major standstill of the moon explain almost one-third of the orientations found in the necropolis. For the rest of the orientations, 35 directions spread throughout the entire region of the horizon, limited between the celestial declination parallels -50º and 54º (the entire western horizon), have no definitive explanation beyond what has been discussed above concerning the western orientation of all the burials (except in the exceptional cases mentioned). However, close examination of the declinations towards which the axes and diagonals of the burials are oriented reveals at least three singularities that deserve at least an attempted explanation.

The first singularity is the repetition, between two and four times, of most of the orientations, in the order of precision with

which these occur —that is, in 12 of the 19 possible cases. There is a striking orientation towards the declination of -3.5º of the axes of Burials 22 and 65 and of the diagonals of Burials 21 and 32. Three recurrences are found in the orientation of the declination of -37 of the axis of Burial 76 and of the diagonals of Burials 23 and 78. With such recurrence, the choice of the orientation does not appear to be random.

The second singularity detected is that the directions of the axes of the corridors as well as the diagonals match in a very high percentage. This singularity supports the idea of preferential orientations of the diagonals and also their explanation.

The third singularity concerns the two peculiar cases of southern and northern orientation (Burials 116 and 134, respectively), where the azimuths of each axis with its diagonal are symmetrical with respect to the meridian of the site. Being very similar in height above the horizon in each direction, both appear to point in the same declination, one towards the rising and the other to the setting of the same star, though evidently they can be limited to observing the north and south region.

Table 2 presents a detailed study of the stars that, in the period spanning the construction of the necropolis, had the same declinations as those calculated from the azimuths and altitudes and for the latitude of our study area. The choice of the star indicated in each case is due exclusively to the proximity of the setting (or rising) with respect to the point of the horizon to which each axis or diagonal of the burials aims, although it is not possible to state definitively that the burials were oriented specifically towards those stars.

## 5. DISCUSSION

In the case of the existence of various possibilities for the star orientation (as in fact happens), the table 2 lists the one of the least apparent magnitude. Even so, it is not possible to discern the declination of 39º, where two of the brightest stars in the sky appear: Capella and Vega. In any case, with our current data, we cannot state unequivocally that the builders of the tombs chose the orientations in order to provide a view of the setting stars mentioned (or any other), and only the determination of the orientations in other necropolis of Iberian peoples that inhabited the Mediterranean coast of the peninsula could (though not necessarily) confirm the preferential nature of these orientations.

Despite the relatively precise orientations of the same groups of stars, it is more prudent to refer to the visibility of a given region of the sky from the interior of each burial chamber through the corridors. The stars to which the axis and diagonal of the corridor are oriented act as a visual limit, and possibly identify a constellation. This one is the reason for which we have considered the utilization of the axis and main diagonal of the corridor, which are the limits of the window visibility from inside burial chamber. In the cases in which the corridor is central, we had considered the two diagonals. In this way, each burial might be oriented in an unequivocal manner to the constellation worshipped by the members of the lineage buried there.

In any case, we think, the diagram of the orientations shows a preference for the solar and lunar orientations that can be confirmed by the hypotheses raised in the Iberian sanctuaries (Esteban, 2002 and 2006) and also in some tombs of the Phoenician necropolis of the Spanish and Sardinian coast (Gonzalez-García *et al,* 2007).

**Table 2. Orientations of the burials and their corresponding declinations. The third column lists the altitude of the star for the azimuth of the corridor of the chamber. The sixth column lists (in a manner taken from the Tycho-2 catalogue from European Space Agency) the declination of the stars for mid-fourth century BCE. We indicate the recent excavations data with bold text and old excavation data with underlined text. Likewise, the corridors are written in normal type and the diagonals in cursive type.**

| BURIALS' ORIENTATIONS | | | POSSIBLE STAR DATA | | |
|---|---|---|---|---|---|
| **Corridor** *Diagonal* | **Azimuth** **Altitude** | **Star Altit.** | **Name** | **Mag** | **Dec.** |
| 116, *116* | 189°/*173°*<br>2° 50′/*2° 50'* | 2° 30'<br>2° 50' | Rigil Kent (α Cen) | -0.04 | -49° 20′ |
| **22**, | 196°<br>3° 30' | 3° 20' | Becrux (β Cru) | 1.25 | -46° 40′ |
| ***76***, *119* | 203°<br>3° 10' | 3° 20' | Gacrux (γ Cru) | 1.56 | -44° 00′ |
| **22**, 65<br>***21***, *32* | 211°<br>3° 20' | 2° 40' | Fomalhaut (α PsA) | 1.15 | -40° 20′ |
| **76**, ***23***, ***78*** | 217°<br>2° 20' | 2° 40' | Sargas (θ Sco) | 1.84 | -37° 20′ |
| **21**, 82, 119 | 227°<br>1° 50' | 2° 10' | Shaula (λ Sco) | 1.59 | -31° 30′ |
| **23**, **32-II**,<br>**78**, *26* | 232°<br>1° 40' | 0° 20' | Major Lunar Standstill | | -29° 20' |
| *65* | 234°<br>1° 50' | 2° 10' | Wei (ε Sco) | 2.28 | -26° 40′ |
| ***21*** | 238°<br>1° 40' | 1° 50' | Sunset Winter Solstice | | -23° 45' |
| 26 | 242°<br>1° 30' | 3° 00' | Tau Scorpii (τ Sco) | 2.80 | -20° 00' |
| ***23***, *82* | 246°<br>1° 00' | 1° 30' | Antares (α Sco) | 1.03 | -18° 00' |
| **50**, *26* | 251°<br>1° 00' | 3° 00' | Dschubba (δ Sco) | 2.28 | -13° 10' |
| **34**, **75** | 257°<br>0° 10' | 0° 15' | Graffias (β Sco) | 2.53 | -10° 40′ |
| 2, **62**<br>***20***, ***34***<br>***57***, ***75*** | 270°<br>0° 40' | | Equinoxes | | 0° 00' |
| **20** | 276°<br>1° 20' | 1° 50' | Altair (α Aql) | 0.75 | 5° 40' |
| **11**, **57** | 282°<br>2° 20' | 2° 10' | Hamal (α Ari) | 2.00 | 11° 00′ |
| ***20*** | 286°<br>1° 40' | 1° 30' | Deneb el Okab (ζ Aql) | 2.96 | 13° 20' |
| **73**, ***62*** | 290°<br>1° 50' | 1° 20' | Alpheratz (α And) | 2.06 | 16° 30′ |
| **139**, ***32-I***<br>***50***, ***73*** | 305°<br>2° 30' | 1° 40' | Major Lunar Standstill | | 28° 00' |
| **140** | 321°<br>2° 50' | 2° 00'<br>1° 30' | Capella (α Aur)<br>Vega (α Lyr) | 0.06<br>0.00 | 39° 30′<br>38° 40' |
| ***139***, ***140*** | 333°<br>2° 30' | 3° 20' | Gamma Cassioppeia (γ Cas) | 2.12 | 47° 40′ |
| 134, *134* | 352°/*8°*<br>2° 40'/*2° 20'* | 2° 20' | Alderamin (α Cep) | 2.43 | 53° 40′ |

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