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WEST IBERIAN MEGALITHIC TOMBS AND THE "LUNAR SEASON POINTER"

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ABSTRACT

Recent investigations of Danish and Swedish passage graves and their orientation patterns show a dominance of orientation directions which can be explained primarily in relation to full moonrises during the summer period. Both the Danish and Swedish passage graves tend to form clusters. Each cluster has a very similar orientation pattern, and this calls for an astronomical explanation.

About 200 Portuguese and Spanish megalithic tombs seem to have similar orientation patterns to the Scandinavian ones; these will be the subject of further studies.

A group of megalithic tombs located in West Iberia in central Alentejo and the surrounding area have been chosen for a statistical test case using the same model used for the Scandinavian passage tombs. The test model is based on 1) the Equinoctial Full Moons (EFMs), i.e., the "spring full moon" and the "autumn full moon", 2) the first and last summer full moons (defined as the second full moons in this paper) and 3) the southernmost full moon. These are used in the hypothesis for the test case.

The model fits 99% of the observations and the test results show a high statistical probability factor p ($p = 0.56$) when the observed distribution is matched with the model, meaning that the model distribution and the observed distribution likely have the same origin. The comparison between the main body of the observations (98%) and the model is interesting because the probability factor reaches the value of 0.86, which supports the null hypothesis.

KEYWORDS: Archaeoastronomy, lunar orientations, megalithic monuments, West Iberia

1. INTRODUCTION

Scandinavian megalithic monuments, passage tombs (sometimes referred to as passage graves), and simpler dolmens were constructed from approximately 3500 BC to 3200 BC. The great concentration of Swedish passage graves located between Lake Vänern and Lake Vättern, which are typologically the same kind of constructions as the described ones, has been interpreted to represent a Danish colony (Blomqvist, 1991) within the funnel beaker culture. The funnel beaker culture is also known in the German literature as the *Trichter-randbecherkultur* (TRB) culture. The group of Scandinavian megalithic monuments (i.e., passage tombs and dolmens) belongs to the northern TRB group.

With regard to Danish dolmens and passage tombs, a great variety of forms can be seen (see figure 1). The final late constructions were very complex constructions with double or twin chambers (one chamber divided into two parts), both types constructed with two passages. Even triple graves were constructed, containing three separate single chambers or one twin chamber and a separate single chamber. Interpretation of their orientation patterns favours a lunar explanation (Hård and Roslund, 1991 and Clausen et al., 2008). The lunar interpretation, in particular, makes some Portuguese and Spanish passage tombs located at West Iberia in Central Alentejo and its surroundings (see figure 2) of interest (Da Silva, 2004).

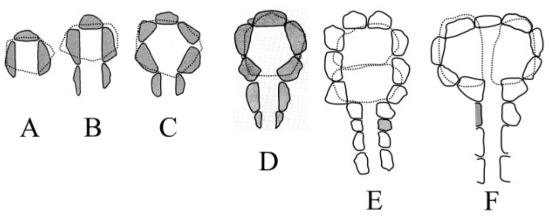

Figure 1 Development in the ground plan of Danish megalithic monuments, from (A) simple dolmens to (F) fully elaborated passage graves. Note that all constructions have well-defined symmetry axes.

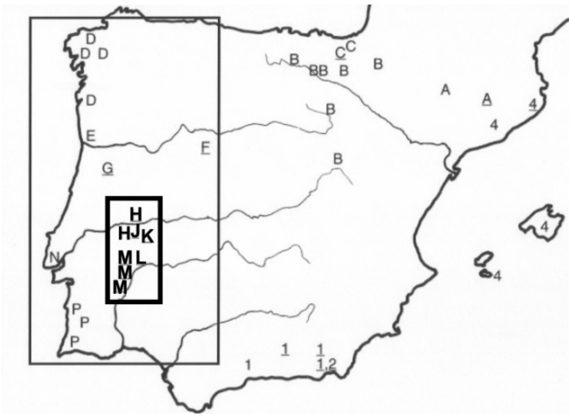

Figure 2 The locations for the chosen West Iberian tombs measured by Hoskin and Roslund (insert in the rectangle). The group of tombs marked with capital letters are adapted from Hoskin *et al.*, 1998.

For these reasons, this paper tests the "lunar season pointer" model (Clausen, 2013) for the chosen group of tombs. For this purpose, data extracted from measurements made by Michael Hoskin and his colleagues in 1998 (Hoskin *et al.*, 1998), denoted by Hoskin as group H, J, K, L, and M, (see figure 2) are used, along with some supplementary measurements made by Curt Roslund (Roslund, 2000) in the same area.

The megalithic monuments on the Iberian Peninsula are believed to have been built from Neolithic times to the Chalcolithic or early Bronze Age, i.e., from about the middle of the fifth millennium BC to about the second millennium BC (De Laet, 1994). The tombs in the target area are mainly the seven-stone chamber tombs with a passage and the simpler dolmens with polygonal chambers (see Figure 3). In Alentejo the multi-stone chamber tombs (including the seven-stone chamber tombs) are assumed to have been constructed in the last half of the fourth millennium BC and some of the simple dolmens probably in the last half of the fifth millennium BC (Chapmann, 1990), i.e., up to 1000 years before the Scandinavian structures. The megalithic monuments in Alentejo were dated by use of the thermoluminescence method (Chapmann, 1990).

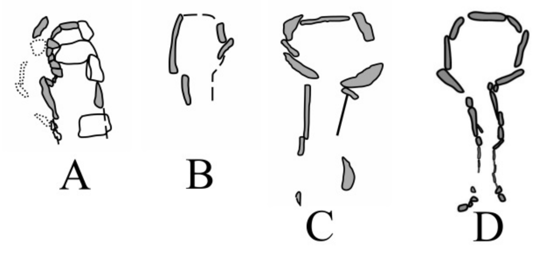

Figure 3 Examples of ground plans for different types of megalithic monuments in the chosen target area. (A) is a dolmen from group H, (B) is a dolmen from group M, (C) is a seven-stone chamber dolmen also from group M and (D) is a seven-stone chamber dolmen from group L. Note that these megalithic monuments are less symmetrical than the Danish ones. Note also that the drawings are not in the correct scale; i.e. throughout the relative sizes in the drawings do not reflect those in real life.

2. THE DATA USED

In Hoskin *et al.*, 1998, data is given on 397 Iberian megalithic monuments, of which 206 are located in central Alentejo and the surroundings (see Figure 2, insert in the rectangle). Out of the data on the 206 tombs of the chosen group of West Iberian monuments, it is only possible to correct the measured azimuth for the observed apparent horizon (h_a) to the astronomical horizon ($h_a = 0$) for 201 tombs by using the given h_a, tabulated in Hoskin *et al.*, 1998. All these tombs have an orientation that displays directions on the eastern horizon (González and Belmonte, 2010). Supplementary measurements made by Curt Roslund (Roslund, 2000) in the M group adds seven more measurements to the data set. So, in total, the group of tombs counts 208 units (see Figure 4). Roslund's supplementary measurement includes eight measurements that also were provided by Hoskin. Of these eight measurements, seven are in close agreement with Hoskin, and the deviation is kept to within a few degrees or less. The eighth measurement differs by +9° from Hoskin, and for all eight measurements the mean deviation is approximately +/- 3°. Both Roslund and Hoskin determine the centre line (i.e., the axis of symmetry) to be from the interior of the passage to the exterior or the opening of the tomb (as the case may be); and from the direction of this line, they deduce the azimuth using a compass. The azimuth is hereafter corrected for magnetic variation.

It is interesting that Hoskin himself even encourages the use of his measurements for interpretations other than the solar one: "*It has always been the primary purpose of our fieldwork to assemble data, which archaeologists and archaeoastronomers will then have at their disposal and may interpret as they see fit*" (Hoskin *et al.*, 1998, p. S41).

In the following, all histogram presentations use 6-degree intervals for the bins with the starting point 0.5° along the x-axis (i.e., the azimuth axis). A bin interval is counted as an example from 90.5° to 96.499999......°. Along the y-axis, the number of directions within each bin is counted.

The size of the 6°-bin interval is determined by the mean deviation of +/-3°. Choosing a 6°-bin interval will therefore minimize the negative effect of the deviation between the azimuths measured by Hoskin and Roslund when the two data sets are added. Choosing a broader bin interval will smooth out details in both the observed distribution and the distribution produced by the model. This will affect the outcome of the statistical test for the method used (see Section 4) when the observations are compared to the model.

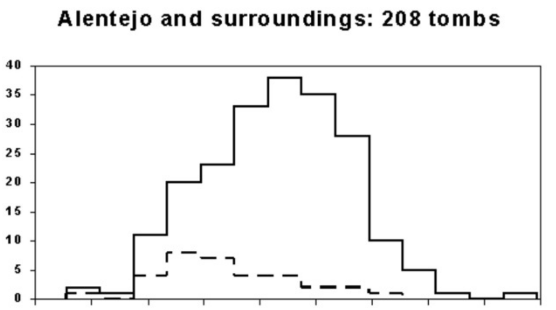

Figure 4A Alentejo and surroundings: 208 tombs. Histogram showing the azimuth distribution on the 208 West Iberian megalithic monuments (solid line) used for testing in this paper, corrected to the astronomical horizon. The dotted line represents the contribution from group K monuments, which affect the distribution so that it twists a little more to the left. The peak mean value is 98.5°.

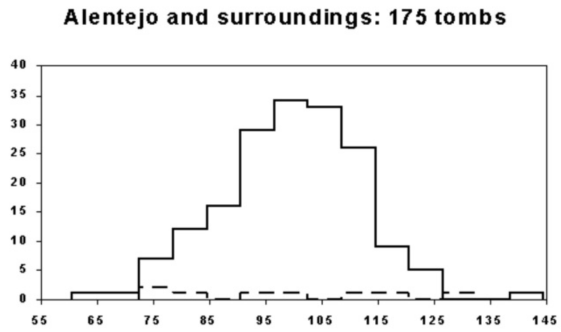

Figure 4B Histogram of azimuth distribution of the 175 West Iberian megalithic monuments (solid line) used for a secondary test in this paper, corrected to the astronomical horizon. The dotted line represents the contribution of eight small dolmens in group M, which does not affect the main distribution. The peak mean value is 99.9°.

3. CONSTRUCTING THE TEST MODEL

The model (the lunar season pointer) used in this paper is based on the concept described in Clausen (SEAC 2011 proceedings). However, some of the computing limits have been changed a bit.

The main idea is that it was not possible during Neolithic times to determine whether the full moon was a genuine full moon (phase > 99%) or simply very close – with, for example, a phase = 97%. Thus, a full moon was an event spanning several days for the Neolithic man, depending on the phase of the moon. Obviously, this situation leaves no choice other than to take all the possible full moons into account in the calculated distribution, because we do not know which of the possible full moons would be the right one to choose. This is because the full moon selected could differ from one local area to another, depending on local traditions.

3.1 Calculation limits for the model

The coordinates for the calculations are chosen to be centred at latitude 40.0ºN and longitude 8.0º W, which corresponds to the central part of Portugal. The data set ranges in the latitude interval from 39.8ºN to 38.4ºN. Moving the latitude centroid to, for instance, 39.0ºN only moves the southernmost and northernmost lunar standstills about 0.5º towards equinox (90º). The effect is therefore counted as negligible.

For calculation purposes, Alcyone Ephemeris AE2.8 software is used and program output was saved to a Microsoft Excel file for further use. The phase of the moon is given a lower limit of 96%, which allows the full moon to be a three-to-five day event plus or minus two days around the genuine full moon. Therefore in the following, the term "full moon" is equivalent to a three-to-five day full moon event, depending on the phase of the moon.

During a year, the rising points of the full moon and the rising sun move in different directions along the horizon. This has as a consequence that the rising points of the full moon and the sun switch over at least two times per year somewhere in spring and in autumn. This is known as a crossover and is related to the Equinoctial Full Moons (EFMs) (Silva and Pimenta, 2012).

For winter full moons, the rising azimuth (Maz) must be less than the rising azimuth of the rising sun (Saz):

Maz < Saz

For summer full moons, the rising azimuth must exceed the rising azimuth of the rising sun:

Maz > Saz

The abovementioned criteria for separating winter and summer full moons has as a consequence that the EFMs will be identified both by the last winter full moon and the first summer full moon at spring and by the last summer full moon and first winter full moon at autumn (see Subsection 3.3 for further details and table 1 for examples).

3.2 Double crossovers

Using the 96% limit for the phase of the moon has another consequence. Crossovers can take place more than two times per year, with a variation of two to four times per year. The most common is two times, once in spring and once in autumn, in the

200-year period used for calculations. A spring crossover will normally take place in March (spring full moon) and/or in April and in the autumn in September (autumn full moon) and/or in October.

A special feature in this case is that a crossover in principle can take place from a moon phase of <96% to a phase which is >=96% or from a moon phase of >=96% to a phase of <96%. Unfortunately, the algorithm misses these crossovers both because of the 96% phase limit and the plus or minus two-day limit. Some of these missing crossovers have been manually selected from the data in the phase interval from 92% to 96%. Table 1 is an example from the programme output file that shows a situation with four full moon crossovers in one year.

This illustrates clearly how difficult it is to deal with natural definitions. It is not possible to work with fluent limits in computer programming unless you work with a series of models where you change the limits according to the calculation algorithm.

3.3 Building the model

The EFMs occur either in March/April in the spring or in September/October in the autumn.

The second full moons appear from April to May and from August to September (the "harvest" moon) and are counted as the first full moon after the last crossover in spring and the first full moon before the first crossover in autumn.

The southernmost full moon is easy to determine simply as the southernmost rising point for the full moon for a certain year, depending on the 18.61-year lunar cycle. The southernmost full moon reaches its most southern rising point either in June or July.

The "lunar season pointer" is therefore a kind of fluent lunar calendar with no exact dates but instead with season periods with variations of about one month based on the direction towards the full moonrise, i.e., the azimuth of the full moon; for example, the direction towards the full moon indicates the beginning of spring in March or April.

The net result with the calculation limits used is that the model produces two full moon peaks for the EFMs, one corresponding to the spring full moon and another corresponding to the autumn full moon.

Here it must be noted that the full moon just before (one to two days before) the crossover in springtime and after the crossover in the autumn produces equivalent peaks, and vice versa.

Due to the fact that the calculation limits produce a full moon event of three to five days, full moons will be seen at both sides of the crossover point. For example, during a spring crossover, the full moon will have the following azimuth (az) rising series A: day 1 az = 73.93°, day 2 az = 82.77°, day 3 az =91.8° and finally day 4 az = 100.56°. During the same four-day time period, the sun rises at about az = 96°. The crossover then takes place from day 3 to day 4. During the same year at the time of the autumn crossover, the full moon has the following azimuth (az) rising series B: day 1 az = 104.9°, day 2 az = 97.8°, day 3 az =90.39° , day 4 az = 82.9°, and day 5 az = 75.55° (phase = 0.92). During this five-day time period, the sun rises at about az = 80°, so the crossover takes place from day 4 to day 5. Note here that the two rising series A and B are very similar except that they run in opposite directions. See also Table 1 for more examples. Each crossover event is represented by a rising series A in the spring and B in the autumn. The mean value, for instance, of the part of the A series in spring where Maz < Saz should equalize the part of the B series in autumn where Maz < Saz.

For the 200-year calculated period, the first half (i.e., the days before the crossover) of all the approximately 200 A series has a mean value for the azimuths = 82.7° and the most frequent values (mode) are found within the interval between 82.0° and 82.9…°, represented by the number 82.2°. Taking the last half (i.e., the autumn full moon) of all the approximately 200 B series, the mean value of the azimuth is 82.2°

and the mode is again 82.2°. The mean value after adding both distributions is 82.6° and the mode is still 82.2°. This means that if the full moon rises with an azimuth of around 82° to 83° (+/- a few degrees), it is either the full moon a few days before the EFM in spring, or it is probably the EFM in the autumn that will be observed (see the rising series A: day 2 and the rising series B: day 4, which is very close to being the EFM in the autumn).

The situation is similar for the EFM azimuths corresponding to the EFMs in spring. The mean value here is 97.9° and the mode is 97.4°, which means that if the full moon rises at around 97° to 98° (+/- a few degrees), it is either the full moon a few days before the EFM in autumn or the EFM in spring.

This is a sort of Yin and Yang principle, so to speak. Or, in other words, if the full moon in the autumn has the same rising azimuth as the spring full moon, it indicates that the crossover will take place within the next few days. Therefore, it must be underlined that the EFM peaks in the model used include contributions from both spring and autumn, but they are only represented by one peak each in the model.

The second full moons produce two similar peaks, one for the beginning of the summer and one for the end (i.e., the "harvest" full moon) of the summer, but contribute as well to the model with one peak with a mean value of 107.7°.

Finally, the southernmost full moon contributes with a distribution that has no distinguishing peak except for the limits at the southern minor and major lunar standstills caused by the lunar 18.61-year cycle.

The mean value for the overall distribution is 98.9° for the calculated 200-year period.

When all things are taken into account, the model produces four distributions, which will be added into a sum model. Figure 5A shows the four distributions separately and Figure 5B shows the resulting sum model distribution for the calculated period compared to the 208 observations.

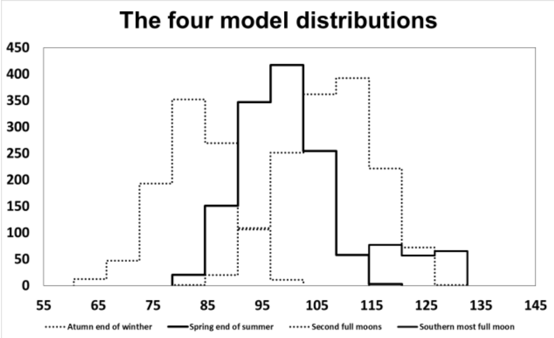

Figure 5A The four distributions produced by the model. The first peak from the left (dotted line) corresponds to the autumn full moon, the next peak (solid line) corresponds to the spring full moon, the third peak (dotted line) corresponds to the full moon defined as the second full moon and the last distribution (solid line) is the contribution of the southernmost full moon.

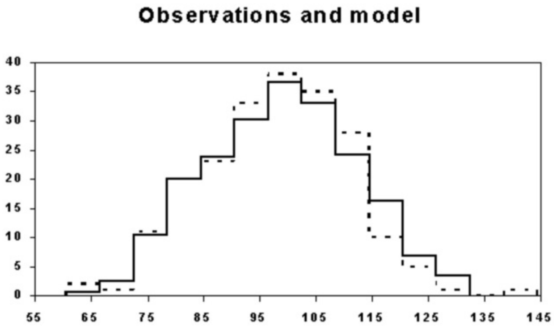

Figure 5B The sum model (solid line) compared to the 208 observations (dotted line). Visually, the two distributions are very similar.

4. THE STATISTICAL APPROACH

The model data covers an azimuth interval from 63° to 130°. This interval includes 207 of the total 208 observations, which means that the model fits 207/208 = 99.5% of the possible observations (see Figure 6A). The mean value of the 207 observations is 98.3°.

The chi-square statistical method has been chosen for comparing data, as it fits well with the histogram presentation and simply compares the expected values with the ones observed for each bin. Other methods have been considered but, at this stage, rejected. It is also convenient to use the chi-square test due to the fact that it is very simple to scale the model data to fit the observation data — that is, the 207 observations which fit the model are used for the scaling factor. The model produces 3868 full moons for the calculated 200-year period, making the scaling factor 207/3868 for each bin interval.

When investigating the behaviour of the model distribution in comparison with the observed distribution in further detail, the problem is addressed in the following way: first, the observed 207 data points which fit into the test are compared to the complete lunar season pointer model, denoted as model 1 (207) (Figure 6A); second, the observed distribution is compared to a model in which the southernmost full moon is excluded, denoted as model 2 (207) (Figure 6B). The next step is to exclude the 33 granite tombs (group L) from the observed data and then repeat the above-mentioned scheme. This results in model 1 (174) (Figure 6C) and model 2 (174) (Figure 6D).

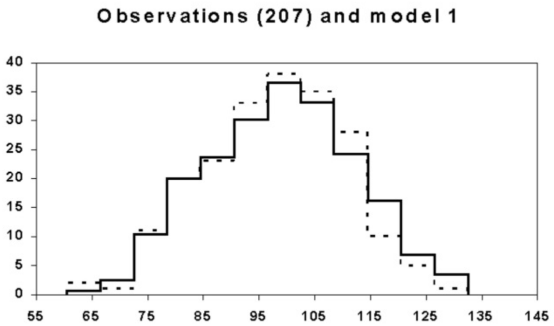

Figure 6A The figure is basically the same as figure 5, but only the 207 observations which fit the model range are used for the test.

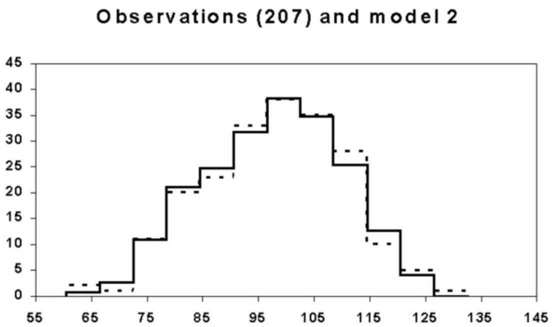

Figure 6B The model (solid line) where the southernmost full moons are excluded compared to the 207 observations.

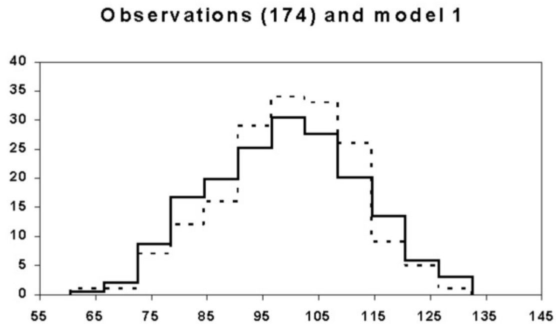

Figure 6C The full lunar season pointer model (solid line) compared to the 174 observations which fit the model range.

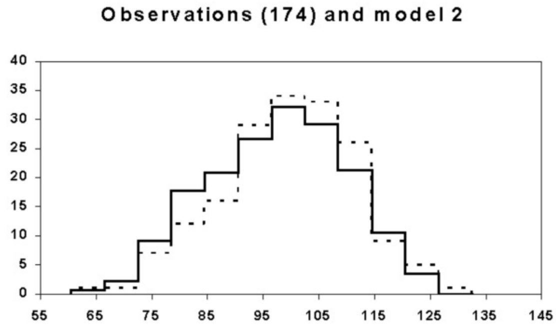

Figure 6D The model (solid line) where the southernmost full moons are excluded compared to the 174 observations.

Results from the four statistical tests are listed in table 2.

5. STATISTICAL RESULTS

It is striking that the mean value (98.9º) of the model 1 (207) distribution is very close to the mean value (98.3º) of the observed distribution, even though it is not conclusive.

Generally, the test with the 207 observations is in better agreement with both proposed models (Model 1 and Model 2) than the test with the 174 observations, but this should be expected due to the azimuth distribution of the 33 granite tombs (see figure 4A).

Model 1 gives, for both observed distributions, a probability value (p) for the overall distributions which is almost the same (see table 2) and so high ($p > 0.5$) that this model cannot be rejected.

Model 2 has a tighter correlation for the main body of the observations (azimuth interval 60.5º - 126.5º), but a very low value for the probability factor for the overall distribution (see table 2).

The obvious explanation for the low probability factor concerning the overall distribution in Model 2 is the missing southernmost full moon.

Model 2 (207) in particular has a remarkably tight correlation; in fact, it equals the 0-hypothesis in the bin interval from 72.5-126.5, i.e., that the observed distribution and the expected distribution are probably originally extracted from the same distribution or has same origin.

A conclusion at this state could therefore be that the lunar season pointer (Model 1) could play a role in explaining the tested distributions. However, the model in which the southernmost full moons have been excluded (Model 2) works better than Model 1, so at least the EFMs and the second full moons should be part of the explanation for the two tested distributions, if an astronomical explanation is sought.

This result is in agreement with some of the lunar models proposed by González and Belmonte (González and Belmonte, 2010) except that they use a moon phase of >99% and do not combine the models. They note that the lunar models they propose are apparently closer in general to their data than the proposed solar models.

Figure 7 Left, a slate plate found in Alentjo in Anta 1 da Herdade da Farisoa, representing an owl, and right, ceramics found at the passage grave, "moon hill", located on the southeastern part of Zealand in Denmark, representing a human face. Note that both artefacts have two stylized eyes and a zigzag pattern.

6. DISCUSSION

The statistical results are in good agreement with the results from the author's investigations of Scandinavian passage graves (Clausen, in press, 2014). The Swedish group of passage graves, especially, behaves like the group of Portuguese and Spanish megalithic monuments used for testing in this paper. The Swedish group of passage tombs also lacks directions for the southernmost full moons.

The Neolithic people who lived in Alentejo and the surroundings belonged to the emerging agrarian culture in Europe. A culture of peasants and farmers needs a kind of calendar to predict the different seasons of the year. A lunar season pointer could be the tool to use for that purpose, not because it can predict the correct time for seeding (for this, the weather can be used), but because it can mark the point in the year at which a ritual in connection with the seeding, for example, a fertility ritual, can be performed.

Curt Roslund (Roslund, 2000) mentions some archaeological artifacts found in connection with the seven stone chamber dolmens in Alentejo. Some of these findings are slate plates with carvings which could be interpreted to represent an owl; these again could represent the moon. A recent study (Rivero and O'Brien, 2014) of the slate plates from the southwestern part of the Iberian Peninsula concludes that these plates represent a core idea. But at this stage, we do not know what that idea is.

Similar carvings are found on ceramics from Scandinavia, which are interpreted as representing a human face (see Figure 7). The similarities between the mentioned artifacts are the two "eyes" surrounded by a ring with radiating lines, and another feature, a zigzag pattern as shown in Figure 7. Figure 8 shows other examples of Danish ceramics which are more similar to the slate plates found in Alentejo and the surrounding area. These ceramic plates have been interpreted as symbolizing the sun. Other similar plates have been interpreted to symbolize both the sun and the moon

(Clausen *et al.*, 2011). In Denmark, white burned flint is often found both inside and outside the passage graves. White burnt flint is, according to some Danish archaeologists, symbolic of the moon. Sometimes the passage graves were also covered with white burnt flint, so they stood out as white domes in the landscape. Perhaps this was meant to symbolize the rising full moon.

Figure 8 A sample of ceramic plates found in Denmark on the island of Bornholm at Risbjerg. Note the similarity with the slate plate from Alentejo (Figure 7).

It would be interesting to investigate whether the West Iberian tombs with identical orientation patterns at different locations (González and Belmonte, 2010), and the Scandinavian area share further common features in addition to the lunar season pointer and perhaps some similar carvings. Are there additional similar features concerning the use of the landscape (Clausen *et al.*, 2011 and Silva, 2013), thus providing an achaeotopographical explanation for the way the passage tombs and dolmens are arranged in small clusters (Roslund, 2000)? And, if so, how was this knowledge exchanged? Does it indicate a kind of link (Roslund, 2000) between the two areas or was it something which developed independently? This would be interesting to investigate further. In this case, a future study should include groups of megalithic monuments south of Scandinavia and north of the Iberian Peninsula with the same orientation pattern.

Another problem concerns the model calculations used, or, more precisely, the selection procedure used for data from the programme output file. Unfortunately, the limits used in the selection procedure, as mentioned earlier, cause a loss of some full moonrises just up to the 96% phase limit. To avoid this situation, the model should be improved by expanding the day limit from plus or minus two days to plus or minus three days around the exact full moon time. Also, the calculation period should be expanded with at least an extra 100-year period. This will be a subject for future investigation.

Finally, weather conditions could play a role when observing the crossovers. The idea of treating the full moon as a several-day event probably solves this problem. If the first crossover moon is missed, a change might be obtained on the following day. This could influence the orientation pattern, but it is covered by the model.

SUMMARY

A model for a "lunar season pointer" has been tested on a sample of 207/174 West Iberian tombs measured by Hoskin and colleagues in 1998 and Roslund in 2000. The result shows that it is possible that Neolithic man in the western part of the Iberian Peninsula in Alentejo and the surrounding area used EFMs, second full moons, and probably the southernmost full moon as a kind of fluent lunar calendar. The same model fits passage graves in Scandinavia and could indicate a possible link between the two areas with their groups of passage graves or tombs. Whether this knowledge was exchanged or developed independently is unknown, but the similar findings at these areas, which are at a great distance from each other, is an indication that a link may well have existed.

It will be the task of a future study to improve the model used to ensure that the selection procedure for the full moons does not miss any full moonrises.

ACKNOWLEDGEMENTS

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Table 1 The output files from the left column give the sun's rising azimuth (Saz), the rising azimuth of the moon (Maz), the date – which is not the exact date but which keeps the phase of the moon to a margin lying within a number of days – and finally, in the last two columns, the crossover conditions. Note that only the October crossover would have been registered by the selection procedure and that azimuths around 97 to 98 degrees (plus or minus a few degrees) are involved both in spring and in autumn (subsection 3.3). Crossover azimuths are marked in bold. Note also that the four crossover events correspond to the rising series A in the spring and B in the autumn.

Saz	Maz	Date	Phase	Maz < Saz Winter full moons	Maz > Saz Summer full moons
98,69	70,35	-2813-03-27	0,97	70,35	
98,20	78,73	-2813-03-28	0,99	78,73	
97,71	87,40	-2813-03-29	1,00	87,40	
97,21	95,99	-2813-03-30	0,97	95,99	0
96,72	104,19	-2813-03-31	0,93	0	**104,19**
84,14	84,11	-2813-04-25	0,95	84,11	0
83,65	92,62	-2813-04-26	0,99	0	**92,62**
83,15	100,90	-2813-04-27	1,00	0	**100,90**
82,65	108,69	-2813-04-28	0,99	0	**108,69**
82,16	115,69	-2813-04-29	0,96	0	**115,69**
76,86	110,50	-2813-09-22	0,98	0	110,50
77,36	103,07	-2813-09-22	1,00	0	103,07
77,87	95,09	-2813-09-23	0,99	0	95,09
78,38	86,82	-2813-09-24	0,97	0	86,82
78,89	78,55	-2813-09-25	0,92	**78,55**	0
92,25	98,56	-2813-10-20	0,96	0	98,56
92,79	90,33	-2813-10-21	0,99	**90,33**	0
93,34	81,91	-2813-10-22	1,00	**81,91**	
93,87	73,64	-2813-10-23	0,98	**73,64**	

Table 2 The statistical results from the four tests. The most notable statistical outcome for each test is marked in bold. Model 2 (207) is remarkable in that it allows assuming the null hypothesis. The three columns in the four test tables are, from the left: the number of used bins in the test (Bins), the azimuth test interval in degrees and, finally, the probability factor p, given as a decimal number between 0 and 1, where 1.00 equals 100 % probability.

Sum model 200 years period					
Model 1: 207 tombs (figure 6A)			Model: 2 207 tombs (figure 6B)		
Bins	Azimuth interval	Probability (p)	Bins	Azimuth interval	Probability (p)
12	60.5 - 132.5	0.56	12	60.5 - 132.5	0.04
11	60.5 - 126.5	0.65	11	60.5 - 126.5	**0.90**
10	66.5 - 126.5	0.84	10	66.5 - 126.5	**0.99**
9	72.5 - 126.5	**0.86**	9	72.5 - 126.5	**1.00**
Model 1: 174 tombs (figure 6C)			Model 2: 174 tombs (figure 6D)		
Bins	Azimuth interval	Probability (p)	Bins	Azimuth interval	Probability (p)
12	60.5 - 132.5	0.54	12	60.5 - 132.5	0.01
11	60.5 - 126.5	**0.57**	11	60.5 - 126.5	**0.70**
10	66.5 - 126.5	0.51	10	66.5 - 126.5	0.64
9	72.5 - 126.5	0.47	9	72.5 - 126.5	0.62

REFERENCES

Blomqvist, L. (1991) *Stenåldersgeometri. Avancerede beräkningar bakom gånggrifterna på Falbygden"*, Västergötland (ISBN 91-970972-4-1).

Chapmann, R. (1990) *Emerging Complexity: The Later Prehistory of South-East Spain, Iberia, and the West Mediterranean*, Cambridge University Press.

Clausen, C., Einicke, O. and Kjaergaard, P. (2008) *The orientation of Danish passage graves*. Acta Archaeologica 79, 216–229.

Clausen, C., Einicke, O. and Kjaergaard, P. (2011) *The orientation of Danish passage graves on the islands of Samsø and Zealand.* Journal for the History of Astronomy xlii, 339–351.

Clausen, C., *Scandinavian passage graves and the 'lunar season pointer'*, Acta Archaeologica, in press (2014).

Clausen, C., *Danish Passage Graves, 'Spring/Summer/Fall Full Moons' and Lunar Standstills*, in proceedings of SEAC 2011 conference, in press (2013).

Da Silva, C. M. (2004) *The spring full moon.* Journal for the History of Astronomy xxxv, 475–478.

S.J. De Laet, Dani, A.H., Lorenzo, J.L. and Nunoo, R.B. (1994) *History of humanity, Volume I, Prehistory and the beginnings of civilization*, Routledge (ISBN 9231028103, 9789231028106).

González Garcia, A.C. and Belmonte, J.A. (2010) *Statistical analysis of megalithic tomb orientations in the Iberian Peninsula and neighbouring regions*, Journal for the History of Astronomy xli, 225–238.

Hoskin, M., Churchill College, Cambridge, and colleagues (1998) *Studies in Iberian archaeoastronomy: (5) orentations of megalithic tombs of northern and western Iberia**, Archaeoastronomy no. 23 in the Journal for the History of Astronomy xxix, S39-S88.
http://adsabs.harvard.edu/full/1998JHAS...29...39H

Hård, B. and Roslund, C. (1991) *Passage graves and the passage of the moon*. Acta archaeologica Lundensia, viii, 35–43

Roslund, C. (2000) *Portuguese passage graves in the light of the Easter moon*, Journal of Swedish Antiquarian Research, Fornvännen 2000 (95), s. [1]-12 : ill., diagr.
http://samla.raa.se/xmlui/bitstream/handle/raa/2974/2000_001.pdf?sequence=1

Rivero, D.G. and O'Brien, M.J. (2014) *Phylogenetic analysis shows that Neolithic slate plaques from the southwestern Iberian Peninsula are not genealogical recording systems*, PLOS ONE
http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0088296

Silva, F. and Pimenta, F. (2012) *The crossover of the sun and the moon*, Journal for the History of Astronomy, 43(2), 191–208.

Silva, F. (2013) *Landscape and astronomy in megalithic Portugal: the Carregal do Sal nucleus and Star Mountain Range*, PIA, Volume 22, 99–114.
www.pia-journal.co.uk/article/download/pia.405/488