# POSSIBLE TALLY STONES AT MNAJDRA, MALTA

FRANK VENTURA, University of Malta,
GIORGIA FODERÀ SERIO, Palermo Astronomical Observatory, and
MICHAEL HOSKIN, Churchill College, Cambridge

In a recent paper[1] we investigated the orientations of the remarkable temple complexes of Malta and Gozo, which date from the period 3600–2500 B.C. Our approach was minimalist, in the sense that we accepted only those axes that were clearly axes of symmetry, and which were directed towards an entrance with a view of the terrain external to the temple. We identified 15 such axes, and we found that (for whatever reason) the orientations of the axes were far from random. Indeed, with one exception, they faced in a southerly direction, between 125.5° and 204° azimuth.

The exception is Temple I at Mnajdra, Malta, which is one of three contiguous structures (Figure 1). The most northerly of these temples, Temple III, is the smallest and the oldest; it belongs to the Ggantija phase and dates from the third quarter of the fourth millennium.[2] Temple I is the

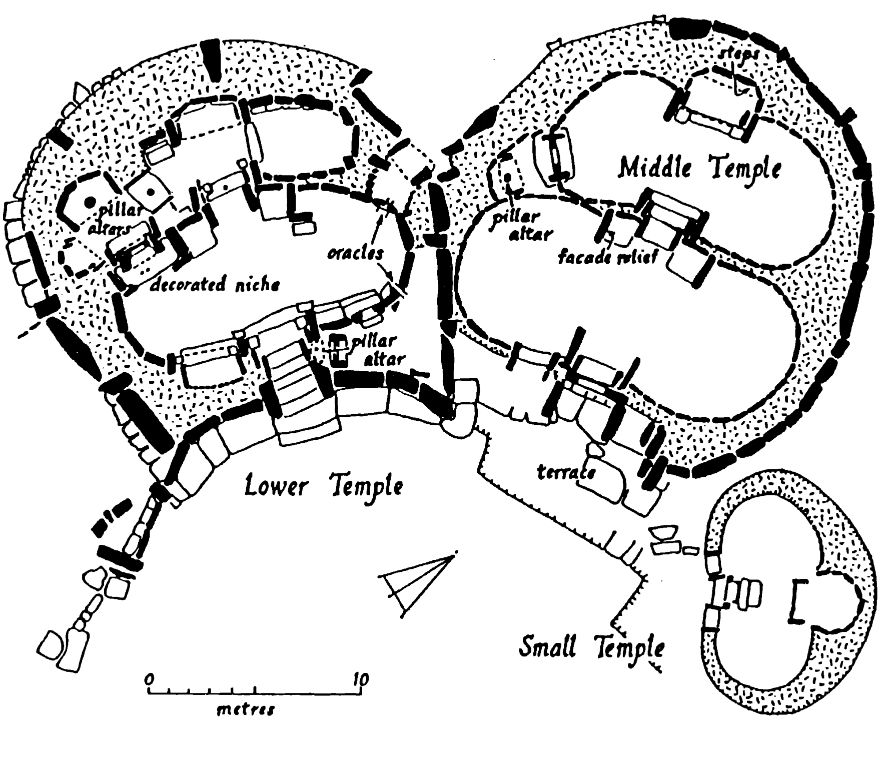


FIG. 1. Plan of the Mnajdra temple complex (from Trump, Malta (ref. 2), 101, courtesy of Dr Trump). To the upper left is Temple I, whose easterly orientation gave rise to this investigation, while to the bottom right is Temple III. The tally stones flank the entrance to the tiny inner chamber of Temple III. An aerial view of Mnajdra was published as Fig. 3 of our previous article (ref. 1).

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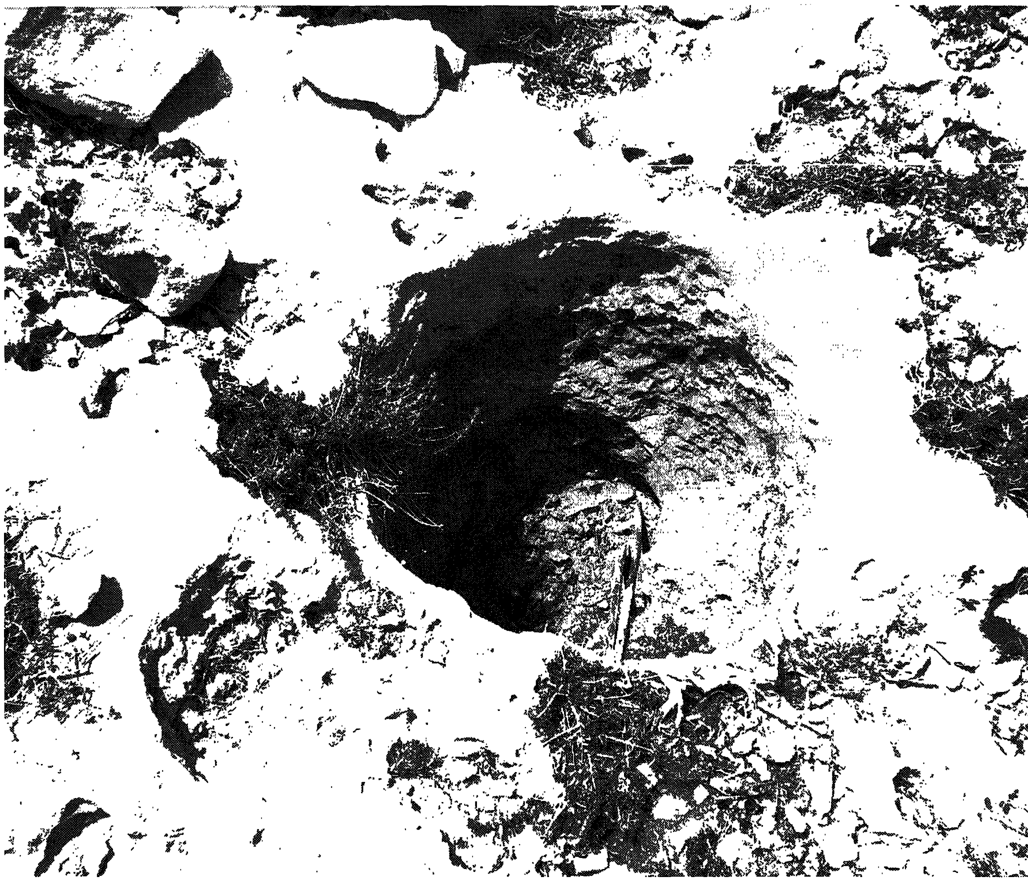

FIG. 2. The possible post-hole seen from Mnajdra I on the skyline in the direction of the winter solstice sunrise (photograph by Michael Hoskin).

most southerly, and dates from early in the Tarxien phase, that is, around the beginning of the third millennium. Temple II, which does not concern us here, was later inserted between Temples I and III.

Temple I faces in an easterly direction, and its orientation had been carefully measured in the investigation of temple orientations carried out in the winter of 1979–80 by Ventura in collaboration with George Agius.[3] In their measurement they followed their usual procedure: they identified the best straight line passing through the mid-points between (i) the uprights forming the entrance, (ii) the inner doorway, and (iii) the altar niche or lobed chamber at the back. They then placed a theodolite on the extension of this centre line to the ground in front of the temple entrance, and used the sun to measure both the forward and backward azimuths. They also measured the altitude of the skyline in the forward direction. The axis of Temple I had azimuth $92\frac{1}{2}°$, and the altitude of the skyline was 4°; as the latitude of the temple is 35.83°N, the orientation of the axis corresponds almost exactly to declination 0°.

This suggested that the temple may have been oriented in the direction midway between that of the winter solstice sunrise and that of the summer solstice sunrise (a direction which for brevity we shall term that of 'equinox sunrise'); but if so, how? One possibility considered by Ventura and Agius was that the builders had erected poles to record certain sunrise positions and had used these to derive the direction of equinox sunrise. In particular, the builders may have erected poles to mark the solstices and then bisected the angle between them. Accordingly, in 1981, Ventura and Agius organized a search for possible postholes.[4] First, by means of an agreed system of signals, a group using a theodolite placed in the centreline in front of the temple entrance directed another group on the opposite slope whose task was to mark points on the ground on either side of the equinox position, points that were exactly on the skyline and sufficiently spread in azimuth to include the summer and the winter solstice positions. A 10-metre band of terrain joining these points was then carefully surveyed for any made-man features that could have acted as outliers for observers at the temple site. Finally, the

FIG. 3. View from behind the inner chamber of Mnajdra III. The pillar slabs are in the foreground, with the main entrance to Mnajdra III beyond. Beyond, to the right, is a corner of Mnajdra I. (Photograph by Frank Ventura.)

FIG. 4. The west pillar (photograph by Salvatore Serio)

azimuths and altitudes of various features were measured and correlated with positions of the centre of the sun's disk on various days during the year at the period of temple construction.

The most interesting find was a circular hole (Figure 2) — possibly, but by no means certainly, man-made, and of course impossible to date — of some 35cm in diameter and similar depth, exactly on the skyline when viewed from Mnajdra I. Calculations showed that at the winter solstice at the time of temple construction, when the whole disk of the rising sun stood on the skyline, its southern limb would have appeared to touch a post fixed in the hole. The post could therefore have acted as an outlier accurately marking

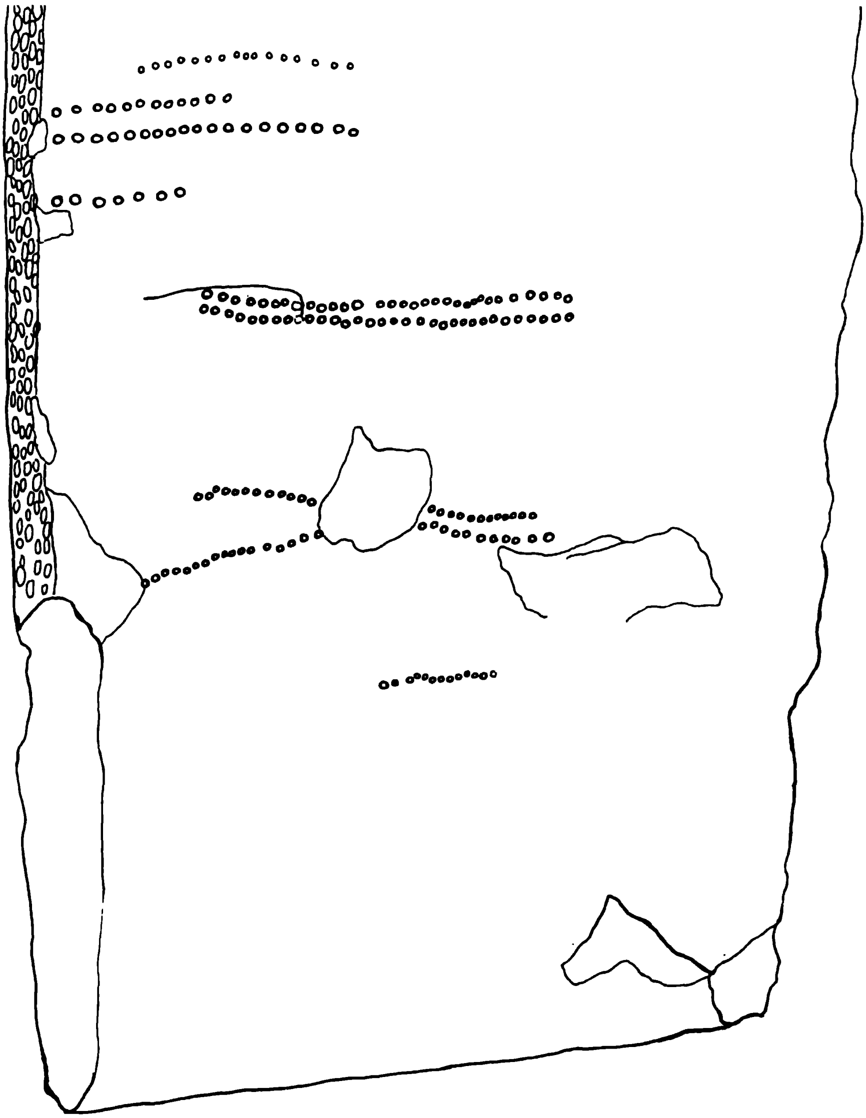

FIG. 5. Sketch of the holes drilled in the west pillar.

the extreme southernmost position reached by the sun's limb at the winter solstice at the time of temple construction.

Several attempts were made in 1981 and later to find a corresponding hole marking the position of the summer solstice. No such hole was found, though it should be noted that systematic observations were thwarted by the landowners who partly cultivate the land and partly use it for hunting and bird trapping. A hole was indeed found, somewhat smaller and probably man-made, but as seen from Mnajdra I it lies somewhat more than 3° south of the summer solstice sunrise.

This then was the situation prior to the campaign in 1991 by Ventura, Foderà Serio and Hoskin. They broadened the enquiry in two ways: first, by

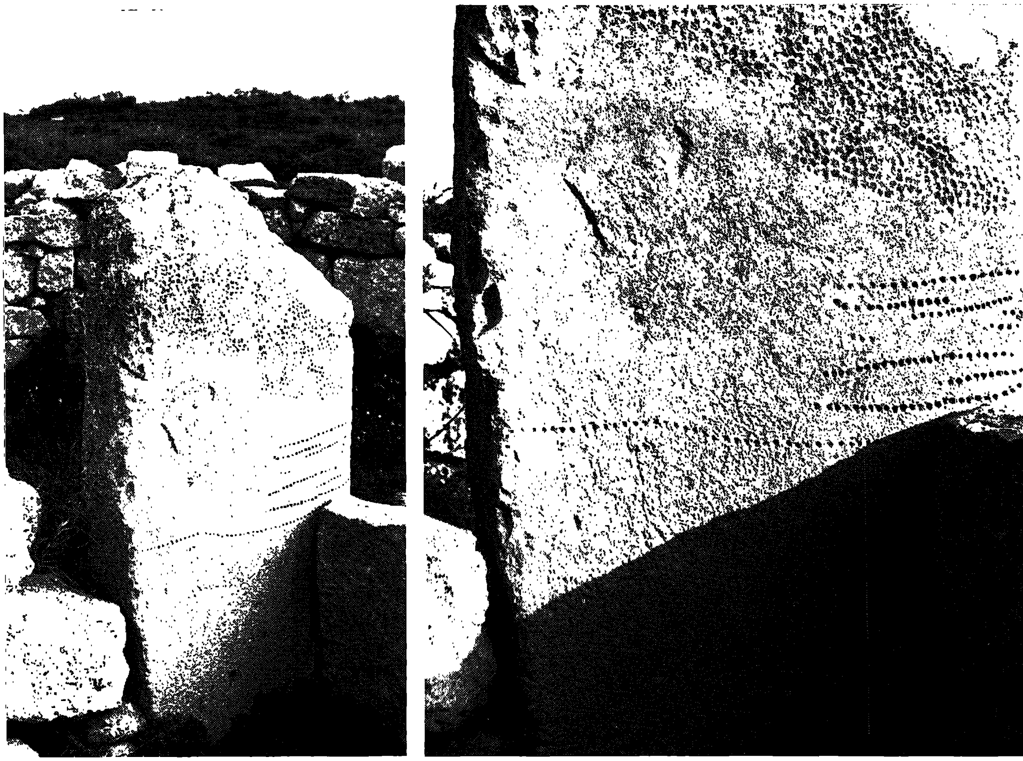

FIG. 6. The east pillar (photographs by Frank Ventura).

considering the possibility that Mnajdra I was oriented not to the equinox sunrise but to the rising of the Pleiades, whose declination was around 0° when Mnajdra I was built; and second, by taking into account the additional evidence contained in the rows of drilled holes on the two pillar slabs (Figure 3) that flank the entrance to the inner chamber of Mnajdra III, the oldest temple on the site. These holes are very different from the stone decoration consisting of close-packed shallow pits on the narrow outer faces of both pillars and on the upper part of the east pillar. The west pillar, which Ashby found fallen early in the present century and which he re-erected,[5] today measures 1.50m high, 0.66–0.69m deep, and 0.28m thick; the eastern one is 1.46–1.50m high, 0.73–0.76m deep, and 0.25–0.26m thick.

The west pillar (Figure 4) has some damage to a limited area of the inner face which interferes with the rows of holes in some places. The top three rows (Figure 5) are made respectively of 12, 19 and 7 deeply incised holes; above them are 16 faint dots each about 5mm wide. The fourth and fifth rows are rather wavy but they run fairly parallel to each other. In two places the face is eroded and so there is some uncertainty in the count. Thus the fourth row clearly contains 30, but possibly 31 holes, while the fifth row contains 31, or possibly 32 holes. The next two rows are the most problematic since damage to the stone surface blots out the middle section of both rows and possibly the left-hand part of the seventh row. In the case of the middle sections, a careful estimate of the number of holes in the gap was

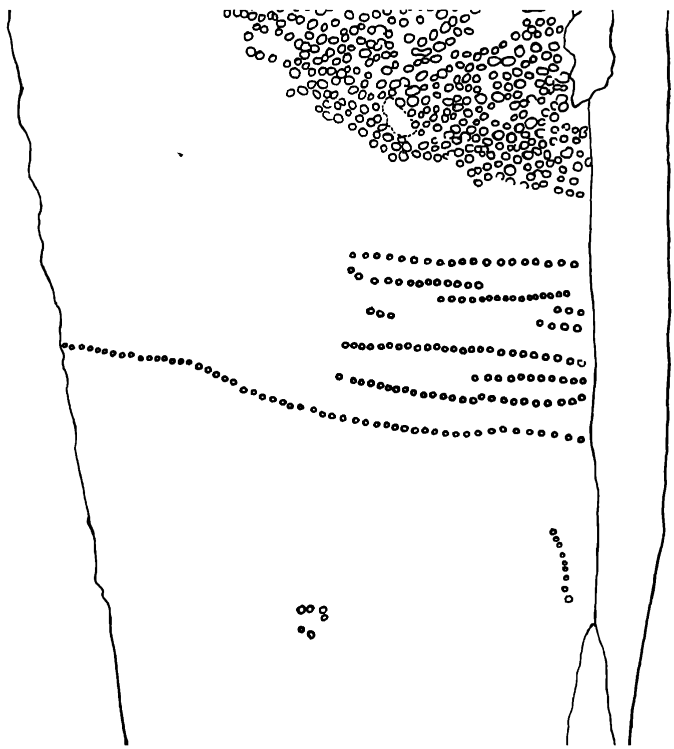

FIG. 7. Sketch of the holes drilled in the east pillar.

obtained by measuring the length of the gap and comparing it to the undamaged part of each row. The sixth row thus consists of two parts with 12 holes each, separated by a gap which could have contained 11 holes, for a total of 35 holes. The seventh row has a part with 17 holes, a gap which could have contained 9 holes, and another part with 11 holes, bringing the total to 37 holes. The last row consists of 12 or 13 narrower holes.

The east pillar (Figure 6) is *in situ*. The upper part of its inner face still carries the pitted decoration which is characteristic of the Ggantija phase. Its middle part contains nine horizontal rows of deeply incised holes and a column of slightly shallower holes. In this case the record is generally very clear with an uncertainty of only 2 holes. The first three rows (Figure 7) contain 19, 13 and 16 holes respectively. The fourth row has 3 holes and the fifth row consists of 4 holes, a long empty space, and 3 holes on the same level. The sixth row has 24 holes, but possibly it could have had 25. The seventh row has 11 and the eighth 25 holes. The ninth row runs from one edge of the slab to the other and it contains 53 holes. The column, part of which can be seen behind a smaller standing stone, contains 8, possibly 9 holes. (We might mention that away from the rows, in a lower part of the pillar, is a curious pattern of six smaller holes arranged in a roughly circular fashion, and it is not impossible that this represents the Pleiades; certainly it is quite different from the rows of holes.)

Comparing the clarity, layout and uniformity of the rows on the two pillars, one gets the impression that the record of the east pillar may be a 'fair copy' of that on the west stone. Certainly the rows convey the strong impression of being a tally — but a tally of what? The east pillar has 179 definite holes, and it may be that either 1 or 2 holes have been lost due to erosion, so that the total could have been as high as 181. In the case of the (somewhat damaged) west pillar, there are also 179 definite holes but there may have been as many as 23 more, giving a maximum of 202 holes.

In the light of this new evidence, we consider the possibilities, first, that the temple was constructed to face midway between the solstices, and second, that it faced the rising of the Pleiades.

As already mentioned, Ventura and Agius originally entertained the possibility that the equinox sunrise was determined by geometry: that the builders may have measured the positions of sunrise at the solstices and bisected the angle. This however seems unlikely, first because no summer solstice pole-hole has been found, and second because at this early date one would not expect to find either the concept of the bisection of an angle, or its effective implementation on the ground.

However, the equinox sunrise may have been determined arithmetically rather than by geometry. The tally on the east pillar (and perhaps that on the west also) is very close to the number of days in half a year, and therefore to double the number of days in a quarter of a year. In theory, once the number of days in the year was known (say, by repeated observations of the arrival of the sun at the winter solstice pole), it would be possible to determine the equinox by noting the winter solstice in a given year and then counting off the number of days in the ensuing quarter of a year. But there is a problem. Near the equinoxes the position of sunrise moves very rapidly along the horizon; by contrast, for several days around the solstices the position of sunrise is constant to within a very few minutes of arc. Hence it is easy to mistake the actual solstice by several days, and such an error would lead to a substantial error in the calculated direction of the equinox. In fact, such a calculation would be better attempted with the possible post-hole that lies at some 3° from the summer solstice; for if the number of days that the sun spent north of this hole were counted and halved, the actual day of the solstice could be determined with greater accuracy.

We therefore do not rule out the possibility that Mnajdra I was constructed to face the equinox sunrise, but we think it unlikely on present evidence.

The second possible astronomical motivation is that the temple faced the rising point of the Pleiades. The exceptional — indeed, unique — importance of the Pleiades to early peoples in both the Old World and the New World is well known,[6] and there is no reason why the same should not have been true of Malta in the Temple Period. If Mnajdra I faced the Pleiades, there is no problem in explaining the accuracy of the orientation. What then of the tally marks? These, it should be noted, are *permanently* incised, in stones that were very prominent (and presumably highly significant) components of temple construction. Permanent incision suggests permanent, rather than

TABLE 1.

| Star | $m_v$ | RA ° | Dec ° | Az ° | Heliacal Rising $k=0.20$ | $k=0.25$ |
|---|---|---|---|---|---|---|
| Pleiades | (2.0) | 350.25 | -0.41 | 91 | day 96 | 100 |
| Hyades | (3.5) | (0) | (-5) | | 125 | 128 |
| a Aur | 0.09 | 1.81 | 25.91 | 57 | 71 | 74 |
| a Tau | 0.85 | 2.93 | -5.04 | 96 | 113 | 116 |
| c Ori | 1.64 | 17.84 | -11.21 | 104 | 144 | 147 |
| b Ori | 0.15 | 20.61 | -25.78 | 122 | 155 | 158 |
| e Ori | 1.70 | 23.28 | -17.30 | 112 | 156 | 159 |
| a Ori | 0/1.30V | 24.46 | -7.58 | 99 | 142/147 | 144/149 |
| f Ori | 1.78 | 24.67 | -17.57 | 112 | 158 | 160 |
| a Gem | 1.58D | 35.44 | 24.68 | 59 | 133 | 136 |
| b Gem | 1.16 | 40.32 | 22.67 | 62 | 139 | 142 |
| b CMa | 1.97 | 42.07 | -27.88 | 125 | 186 | 188 |
| a UMa | 1.80 | 41.14 | 69.16 | | circumpolar | |
| a CMa | -1.58 | 46.64 | -22.52 | 118 | 176 | 177 |
| a CMi | 0.37 | 49.21 | 2.98 | 86 | 162 | 164 |
| e CMa | 1.78 | 56.64 | -33.56 | 133 | 204 | 207 |
| a Leo | 1.36 | 80.21 | 23.88 | 60 | 182 | 184 |
| e Car | 1.74 | 97.29 | -49.22 | 159 | 264 | 267 |
| c Cru | 1.60 | 132.49 | -31.57 | 130 | 264 | 267 |
| a Cru | 0.76D | 133.70 | -37.85 | 139 | 270 | 272 |
| b Cru | 1.50 | 135.85 | -33.97 | 136 | 269 | 272 |
| a Vir | 1.00 | 136.84 | 15.07 | 71 | 234 | 235 |
| b Cen | 0.86 | 147.26 | -33.67 | 133 | 277 | 279 |
| a Boo | -0.06 | 152.43 | 48.59 | 22 | 212 | 214 |
| a Cen | 0.06D | 157.87 | -35.68 | 136 | 286 | 288 |
| a Sco | 0.9/1.2V | 179.03 | -3.88 | 95 | 281/281 | 282/283 |
| a Aql | 0.80 | 236.99 | 9.90 | 78 | 320 | 322 |
| a Lyr | 0.04 | 238.01 | 44.07 | 31 | 291 | 293 |
| a PsA | 1.29 | 262.40 | -44.23 | 149 | 34 | 37 |
| a Cyg | 1.26 | 268.30 | 36.25 | 43 | 327 | 330 |

D: double star; V: variable. RA and dec for 3000 B.C. taken from Gerald S. Hawkins and Shoshana K. Rosenthal, *5,000- and 10,000-year star catalogs* (Smithsonian Contributions to Astrophysics, x/2; Washington, D.C., 1967); azimuth of rising point calculated for zero horizon altitude; $m_v$ taken from Hans Vehrenberg and Dieter Blank, *Handbook of the constellations*, 4th edn (Düsseldorf, 1981). For the Pleiades and the Hyades, estimates were made of their overall brightness, and for the Hyades, of the RA and dec of the centre of the star group at 3000 B.C.; these estimated values are in parentheses. Heliacal risings were calculated with the computer program by B. E. Schaefer, "Predicting heliacal risings and settings", *Sky & telescope*, lxx (1985), 261–3.

once-only, use. If, as seems likely, the tally is a tally of days, then the rows may well indicate the count of days from one event — presumably a festival — to the next. We explored the possibility that individual rows, or groups of adjacent rows, represent the number of days from one heliacal event of the Pleiades to the next. This line of enquiry however led to no definite conclusion, because the dates of heliacal events at a given place may vary considerably from year to year. Dr Bradley Schaefer, who has made a special study of this problem, kindly computed the most likely date for the heliacal rising of the Pleiades in Malta in the Temple Period; but he points out[7] that a small change in air pressure alone could be responsible for altering the date by as much as eight days. Unfortunately, this means that we can never have the information concerning heliacal events at the time the holes were incised that we would need in order to check the hypothesis that herein lies the clue to the tally. Furthermore, since there are just four heliacal events of the Pleiades, we would need to postulate other reasons why the intervals between these events were further subdivided.

However, it is well known that in the calendrics and time-reckoning of ancient Egypt, *successive* heliacal risings played a fundamental role, as indeed they did in the agricultural year used by Greek farmers of Hesiod's day;[8] and so we next investigated the intervals separating the heliacal risings of individual stars of magnitude 2 or brighter, and also the Pleiades, as seen from Malta in the Temple Period. The dates of heliacal risings given in Table 1 are calculated for the latitude of Mnajdra, a star limiting magnitude of 6.0, and extinction factors of 0.20 and 0.25 mag/air mass, which correspond to good nights at a dry sea-level site and in a humid climate respectively. Also included in the table is an estimate of the heliacal rising of the Hyades star cluster, which Hesiod mentions in his Farmer's Year and Homer recognizes among the most significant stars and constellations.[9] The reason for this inclusion will become clear later.

With these data at hand, it is possible to suggest a sequence of heliacal risings at intervals that correspond to the number of drilled holes in each row of the east pillar. The sequence started with an observation of the heliacal rise of the Pleiades, which on a good dry night occurred on 6 April (day 96; vernal equinox taken as 21 March). Nineteen days later, on 25 April (day 115), the heliacal rise of Aldebaran (a Tau) was observed and the interval between the first and second observation was recorded as a row of drilled holes. According to this reasoning, the next notable heliacal rise occurred thirteen days later, on 8 May (day 128). But this date does not correspond to the heliacal rising of a bright star. However, it ties in with the estimated heliacal rising of the Hyades. The observations continued sixteen days later with the heliacal rise of a Ori on 24 May (day 144), followed by c Ori on 27 May (day 147) and seven days (4+3 holes) later by b Ori and the stars of the belt of Orion. Each time, the interval between one event and another was recorded as a series of holes in separate rows on the stone pillar. The next heliacal rise of importance came 24 days later when Sirius (a CMa) rose on 27 June (day 178), close enough to the summer solstice that the connection between the two events could have been noticed by the observers. Eleven days later, on 8 July (day 189), b CMa joined Sirius in the pre-dawn sky, and the heliacal rising of Arcturus (a Boo) was noted on 2 August (day 214), after an interval of 25 days. A long period of 53 days then passed before the next notable heliacal rising, which was that of c Cru on 24 September (day 267). This event must have been of particular importance because the star marked the rising of the Crux-Centaurus group, which as we showed in our previous paper may well have been of special interest to the temple builders,

TABLE 2.

| Interval (days) | Observed day | Observed date | Star/Group | Calculated Day $k=0.20$ | Calculated Day $k=0.25$ |
|---|---|---|---|---|---|
| | 96 | 6 Apr | Pleiades | 96 | 100 |
| 19 | | | | | |
| | 115 | 25 Apr | a Tau | 113 | 116 |
| 13 | | | | | |
| | 128 | 8 May | Hyades | 125 | 128 |
| 16 | | | | | |
| | 144 | 24 May | a Ori | 142/147 | 144/149 |
| 3 | | | | | |
| | 147 | 27 May | c Ori | 144 | 147 |
| 4+3 | | | | | |
| | 154 | 3 Jun | b Ori | 155 | 158 |
| 24 | | | | | |
| | 178 | 27 Jun | a CMa | 176 | 177 |
| 11 | | | | | |
| | 189 | 8 Jul | b CMa | 186 | 188 |
| 25 | | | | | |
| | 214 | 2 Aug | a Boo | 212 | 214 |
| 53 | | | | | |
| | 267 | 24 Sep | c Cru | 264 | 267 |
| 8 or 9 | | | | | |
| | 275/276 | 2/3 Oct | b Cen | 277 | 279 |

and also because it occurred so close to the equinox. The record of drilled holes stops at this point, which could also correspond to the end of the sequence of heliacal risings. However, the column of 8 (or possibly 9) smaller holes on another part of the stone could correspond to the heliacal rising of b Cen, which was observed on 2 or 3 October (day 275 or 276). Table 2 shows the number of holes in each row of the tally (which we interpret as the intervals between heliacal risings), the dates of the presumed observations as derived from the tally, and the calculated dates of observation. Considering that we have no information concerning atmospheric conditions at the time of temple building, and the difficulties of calculating exact dates of heliacal risings, the correspondence between the presumed dates of observation and the calculated dates is remarkable.

With the importance of the Pleiades thus established, it is then understandable that the builders oriented their new temple — Mnajdra I — to face this unique group of stars.

Of course, with the present knowledge it is impossible to prove that this is a correct interpretation of the tally. It can be shown, however, that the congruence between the tally and the intervals from one heliacal rise to another is unlikely to be a chance occurrence, even though it is not possible to use standard probability analysis given the complexity of the hypothesis. This can be done in two ways: first, by checking the tally intervals against the comparable sequence of days of heliacal settings of the stars in Table 1; second, by scrambling the order of tally intervals and each time checking the new sequence against the calculated dates of heliacal risings. The two tests have been applied and they produce congruences or quasi-congruences of a far inferior quality to the one noted above. In the case of the first test, although the statistics of risings and settings are the same, it has not been possible to find congruences that explain many of the tally intervals. This is as expected if the hypothesis is correct, since the temple faces away from the heliacal settings. The second test produces calendars of heliacal risings that miss out some tally intervals, even when a tolerance of one day from the calculated dates is allowed. In other words, the application of these two simple tests does not produce a congruence of the same quality as the one noted already. This result suggests that the tally refers to a unique set of events and that the sequence in Table 2 is the most likely explanation in terms of heliacal risings.

In conclusion, therefore, we think it very likely that the holes are a tally, probably of the days of a regular and significant sequence of events that occurred annually. We admit to a conviction that these events included the heliacal risings of the Pleiades and of other stars or asterisms; but we are some way from proving this. We think however, that the existence of a tally at so early a date — around 3000 B.C. — is a matter of no little interest, and if our suspicions are well founded, then heliacal risings were being carefully monitored in Malta well before similar phenomena were being studied in Egypt. But this would not be surprising: after all, massive temple complexes that exist to this day were being constructed in Malta long before their counterparts in Egypt.

## *Acknowledgements*

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6. See for example Anthony F. Aveni, *Skywatchers of ancient Mexico* (Austin, 1980), 30–35. D. R. Dicks, in *Early Greek astronomy to Aristotle* (London, 1970), remarks that the Pleiades star-group "has been used by various people all over the world to mark the passage of time and the seasons of the year" (p. 36).

7. Private communication to Hoskin, 15 March 1992. Using a value of $k = 0.3$ mag/air mass, and taking the Pleiades to have the same visibility as a 2.0 magnitude star and the faintest star visible in a dark zenith to have 6.0 magnitude, Dr Schaefer's best estimate for the heliacal rise of the Pleiades in 3000 B.C. is 14 April and for the heliacal setting 20 February, where 21 March is the vernal equinox. But if $k = 0.2$ (or if one were dealing with a star of 1.0 magnitude), then Dr Schaefer obtains 6 April in place of 14 April.
8. On the calendar in Hesiod's *Works and days*, see the discussion in Dicks, *op. cit.* (ref. 6), 34-38. When "rosyfingered dawn gazes on Arcturus", for example, the grapes should be cut (*Works and days*, 609-11).
9. Hesiod mentions that when, towards the end of October, "the Pleiades and the Hyades and the might of Orion set", the farmer's year is ended and so the farmer must again think of ploughing (*Works and days*, 615). At the time of Homer, the Hyades were also recognized among the most significant stars. We find in *Iliad*, xviii, 483 that when Hephaistos made the shield of Achilles, "he wrought thereon Earth and Heaven and Sea, and the unwearied sun and the full moon and all the signs wherewith the Heaven is crowned, the Pleiades and the Hyades and the might of Orion and the Bear which also men call the Wain ...". We thank Dr Maria Papathanassiou for these references.