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A Calanais myth and an alignment of the east stone-row with both the rising of the Pleiades and crossovers of Venus at sunrise on the summer solstices

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ABSTRACT

A myth asserts that at sunrise on the summer solstice ‘something’ came to the Calanais Stones’ central ring heralded by the cuckoo’s call. This paper investigates which of the three celestial objects easily visible at sunrise, the Sun, Moon and Venus, might be referred to. The stones have no obvious orientation with the Sun and, while a ‘window’ of the midsummer full-moons could be seen over the stone ring, complex lunar orbits preclude any precise alignments including the lunar standstill positions. Several widespread European goddesses of fertility and sovereignty were associated with both Venus and the cuckoo, astronomically symbolised by the Pleiades in northern Europe. The east-row of the Calanais Stones is aligned with crossover events of Venus. Three crossover events occurred during the period of the east-row construction suggested by radiocarbon dating. The azimuth of the rising Pleiades coincided with the Venus crossover of 1677 and 1674 BC. The ‘something’ was ‘bright, shining, holy’ in Brittonic, gwên, while Gwener is the planet Venus. The appearance of the Sun and Venus at sunrise on the summer solstice might represent a divine wedding. This is believed to be the first European prehistoric monument demonstrated to be purposely aligned with Venus.

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Introduction

General introduction

This paper examines which celestial objects and any associated monument orientations might be referred to in an astronomic myth associated with the Calanais Stones on the Isle of Lewis and what these findings may reveal about contemporary society and beliefs. Myths are associated with supernatural beings while legends are concerned with the exploits of mortals. The myth asserts that at sunrise on the summer solstice ‘something’ came to the stones walking down the great avenue to the central ring.
heralded by the cuckoo’s call (Swire, 1966, p. 25). Otta Swire’s (1898–1973) statement is the only version of the myth known to the author. She was told the myth by her mother, who, as a girl in the latter half of the nineteenth century, heard it from an unnamed elderly member of the Scottish Society of Antiquaries who, in turn, had heard it from an old crofter on Lewis when he was a boy (Swire, 1966, p. 24). Assuming her recollections are accurate, the myth has a provenance on the Isle of Lewis early in the nineteenth century.

Relating megalithic monuments to myths can make both astronomers and archaeologists uneasy; however, it should be considered (Kelley & Milone, 2005, p. viii) as it has been acknowledged by some archaeologists that myths were as important as the landscape in the planning of monuments or settlements (Bradley, 1998, p. 108). Studies in ethnology suggest that monuments themselves, especially religious ones, often represent the cosmos and many actions in myths are best interpreted as astronomical (Grigsby, 2019, p. 41).

There is no direct evidence that this particular myth was extant three millennia ago. However, during the last sixty years the opinion regarding the validity of folklore representing original functions or rituals associated with monuments has changed from the categorical statement that we will never find in folktales an accurate memory of a particular stage of culture (Eliade, 1958) to archaeologists should be wary of rejecting mythological and folkloric accounts or oral history (Gavin-Schwartz & Holtorf, 1999) and then to a recent empirical assessment that concluded the methods and theory from population genetics can be usefully applied to characterise the population structure and variation in cultural packages such as folktales (Ross et al., 2013). These methods have demonstrated that some astronomical myths are Palaeolithic in origin (d’Huy, 2013) while various Indo-European folktales have been demonstrated to have a Bronze Age origin (Graça da Silva, & Tehrani, 2016). Oral traditions do contain much consistently reported, verifiable information. This has been widely recognised by anthropologists but not by all archaeologists (Whitely, 2002, p. 412), although the convergence between folktales and the archaeological material record has been demonstrated (Silva, 2015).

Local folktales can provide details of the original intention of astronomic orientations of ritual Neolithic and Bronze Age sites in Britain and Ireland. An example of a possible five-millennial survival of folktales connecting a Neolithic monument’s association with the Sun is associated with the passage-mound of Newgrange. Radiocarbon dating places the construction of Newgrange between 3320 and 2910 BC (Carey, 1990). The passage contains no materials from the Beaker settlement which occupied the site some centuries later indicating it was sealed shortly after it was finished (O’Kelly, 1982) rendering any further direct observations of the Sun shining into the chamber on the winter solstice impossible, but it was remembered in a local folktale. While the entrance to Newgrange was re-discovered in 1699, the roof-box, through which the Sun shines into the chamber, was blocked by the collapsed mound until excavated between 1962 and 1975 by O’Kelly (Ruggles, 1999, p. 17) and the solar alignment was verified in 1967 (O’Kelly, 1982, p. 123). It is possible that the recorded medieval myths of a chief Irish deity, the Dagda, the supposed constructor and occupier of Newgrange, making the Sun stand still are also related to the stand-still positions of the Sun on the solstices. Indeed, the mound’s excavator, O’Kelly (1982, p. 48), discussing the origins of Irish folklore recorded in early medieval
literature wondered: ‘should one begin to think of this not as a window on the Iron Age but as one on the Late Neolithic?’

The sky is widely regarded as important to prehistoric peoples not only for calendric purposes but as a component of myth (Grigsby, 2019, p. 38). Celestial objects were conceived as supernatural beings, ancestors or heroes, with whom people claimed relationships through descent, mythological narratives, political alliances or power relationships (Iwaniszewski, 2011, p. 31). Despite this, archaeological investigations generally ignore both the sky (Henty, 2016) and archaeoastronomy (Ruggles, 1999, p. vii). As the orientation of monuments is usually towards a horizon, cultural astronomers have concentrated on horizon azimuths, principally of solar and lunar phenomena. This focus might have dissuaded researchers from considering alignments of non-horizon aspects of an object’s position at specific times. To make accurate comparative observations of non-horizon events three constants are required: location, date and time. Obvious difficulties arose determining accurate calendric dates and times in antiquity. However, sunrise on the summer solstice at Calanais accurately fixes a location with both a date and a time.

**Methodical approach**

The primary method in archaeoastronomy for claimed alignments is the statistical analysis of large data sets (Henty, 2016). Reliance on such an approach is not suitable for single sites and, it is argued, precludes any interpretive ability (Sims, 2012). However, a method, referred to as skyscape archaeology (Henty, 2016; Silva, 2014), has recently been developed which considers the role and importance of ‘additional artefactual evidence, the site or sites’ location within a particular ritual landscape, related ethnographic evidence and relative dating’ (Henty, 2016, p. 685). It also takes into account the oral tradition of folktales. This broader approach to cultural astronomy effectively combines archaeoastronomy and archaeology (Henty, 2016).

**Definitions**

It is necessary to define some astronomic terms relevant to this paper. They are adapted from a number of sources, principally Higginbottom and Clay (2016a). The celestial sphere is an imaginary concept of the heavens concentric with the Earth. All celestial objects can be visualised as projected upon the inside surface of this sphere. The rotation of the Earth gives the illusion that the celestial sphere revolves around the Earth with an axis orientated towards the Pole Star in the northern hemisphere. The location of a celestial object on the sphere is specified using two coordinates: right ascension and declination that loosely correspond with geographical longitude and latitude respectively. Declination is defined as the angle northwards from the celestial sphere’s equator and consequently has a negative value when south of the celestial equator. An object at a specified declination will trace out a trajectory in the sky as the Earth revolves. The object will appear to rise and set if that path intersects with the horizon. The azimuth, or bearing, measured in degrees clockwise round from geographic (true) north, of the rising or setting point is always the same for a star at a given declination for an observer at a particular location, with minor variations attributable to atmospheric conditions and
precession (see below). Celestial objects also reduce in magnitude (brightness) at low elevation angles. This atmospheric extinction is due to absorption and scattering of light by the atmosphere which is maximised near the horizon (Ruggles, 1999, p. 52). The altitude below which an object will not be seen is its extinction angle. The altitude of the horizon will also determine when an object is first or last seen – an object will rise later and set earlier behind mountains than on a plain. The rising or setting azimuth of an object can be calculated from its declination if the latitude of the location and the horizon altitude are known and can be used to determine if a monument is orientated to that object (the term ‘alignment’ is used if the orientation is deemed intentional). Equally, latitude, azimuth and horizon altitude can be used to calculate an object’s declination. This calculation can be undertaken using the freeware programme GETDEC (https://www3.cliveruggles.com/index.php/tools/declination-calculator).

The declinations of galaxies and stars, including the stellar cluster of the Pleiades, are comparatively stable but they do change due to precession, which can be visualised as the Earth spinning like a gyroscope. As it spins the axis of rotation moves in a circle, compared to the background stars, with a period of 26,000 years; hence, the point at which an object rises on the horizon will gradually change; however, the declinations of the objects in the Solar System change comparatively quickly. The Sun’s apparent annual path on the celestial sphere is its ecliptic, so called because lunar and solar eclipses can only occur when the Moon crosses it. Deciding which object might have been the primary focus of a monument’s orientation and if it is an intentional alignment is problematic as there may be many objects orientated over the course of a year and, due to precession, different stars could orientate with that same monument over time.

The objects visible at sunrise

The myth states that the ‘something’ is visible ‘at sunrise’; hence, we are restricted to the objects that might be visible at this time of day. With the exception of transient phenomena like comets, only the three brightest natural objects in the sky can easily be seen with the naked eye at sunrise: the Sun, the Moon and Venus. Jupiter and Mars have been reported to be rarely seen but with difficulty and only under excellent atmospheric conditions (Sessions, 2008); however, unlike Venus, their extremes do not seem to be significant events that might have been targeted by alignments (Šprajc, 2015, p. 508).

The cuckoo was celestially symbolised by the Pleiades (see below). They rise before the Sun on the summer solstice and are seen before dawn but are not visible at sunrise. However, they could represent the heralding of the arrival of the ‘something’ that rises after them. Orientations of Calanais with the Pleiades have previously been proposed (Burl, 1983; Somerville, 1912); hence, the position of the Pleiades before dawn on the summer solstice is also considered in this paper.

The Sun

While the various rising and setting positions of the Sun throughout the year are important in many cultures, it is the extreme rising and setting azimuths on the horizon that are usually considered the most significant (Belmonte, 2015, p. 485). The Sun reaches these ‘standstill’ positions for a few days before moving back along the horizon. The summer and winter solstices are relatively easy to determine, as for three days before and after a
solstice no change in the Sun’s rising and setting positions can be detected by the unaided human eye (Sims et al., 2016, p. 3). Thus the Sun has four horizon rising and setting standstill positions (Figure 1).

The Moon
The Moon’s orbit has many irregularities resulting in difficulty establishing precise lunar alignments (González-García, 2015, p. 494). There are four horizon rising and setting standstill positions that occur over the 18.6-year lunar node cycle, its major and minor standstills (Figure 1), although the Moon rising or setting at its standstill limits at any point in its lunar phase is a difficult and rare event to witness (González-García, 2015, p. 494). The orbital planes of moons generally align with their planet’s equatorial plane but the Moon’s orbital plane is close to the ecliptic, with a 5° orbital inclination (tilt), resulting in the most southerly rising and setting full-moon positions occurring in midsummer and the most northerly in midwinter, in the northern hemisphere.

Venus
The orbital behaviour of the planets appears erratic when compared with lunar and solar-cycles. Only the extreme rising and setting points appear to be possibly significant alignment targets (Šprajc, 2015, p. 508). Venus seems to be the only planet whose extremes exhibit easily observable patterns and long-term periodicity (Šprajc, 2015, p. 508); however, the range in declination of Venus is similar to that of the Sun and the Moon which increases the difficulty in isolating Venus alignments (Ruggles, 1999, p. 149). Equally, not all orientations between the solstitial and the major lunar standstill limits (see Figure 1) are necessarily lunar, they could be connected to Venus (González-García, 2015, p. 495). Considering the importance Venus played in the world-view

Figure 1. Orientations of solar and lunar rising and setting maxima at Calanais (latitude 58°) assuming a horizon altitude of 0°
and religion of many cultures (Hugh-Jones, 1979; Krupp, 1993; Malmström, 1997; Zuidema, 1982) any measurable periodicity in its orbit would have been of interest.

Venus has an eight-year orbital cycle. This cycle was one of the two primary components of the Mayan calendar (McCluskey, 1983). The cycle might also have been known in Eurasian antiquity; for example, in Mesopotamia an eight-pointed star was the symbol of the third millennium BC Sumerian goddess Inanna and her Phoenician descendent Astarte (Black & Green, 1992), both of which personified Venus. Eight Earth years take 2,921.94 days while thirteen Venus years take 2,919.6 days (Sprajc, 2015, p. 509); hence, after eight years Venus is an additional two days and eight hours further along in its orbit. Nevertheless, to a viewer using naked-eye observations, Venus, for all intents and purposes, is at the same position on the celestial sphere every eight years. Consequently, when viewed from a fixed location on the same annual date, say midsummer’s morning before sunrise, Venus rises on almost the same azimuth. It follows then, at sunrise Venus will be in almost exactly the same position in the sky as it was at midsummer’s morning sunrise eight years previously.

In the intervening years of the eight-year cycle Venus will also appear twice at midsummer sunrise but at different positions on the celestial sphere. This is easiest explained diagrammatically. In Figure 2(a) an observer will see Venus as the morning star at the start of a cycle (year 0). Exactly a year later (year 1) Venus will have travelled 13/8 or 1.625 orbits and is visible as the evening star. By year 2 it has travelled 3.25 orbits and is now behind the Sun and will not be seen (superior conjunction). Year 3 it has travelled 4.875 orbits and is visible on midsummer’s morning but at a different position to year 0. By year 4 it is seen again as an evening star. On year 5 it’s visible on midsummer’s morning after travelling 8.125 orbits but at a different position to years 0 and 3. At year 6 the planet appears positioned too close to the Sun to be seen (inferior conjunction) et cetera. For an observer at a fixed location at sunrise on midsummer’s mornings the three Venus appearances in that eight year cycle shown in Figure 2(a) would appear as shown in Figure 2(b). As Venus is two days and eight hours further in its orbit every eight years, the year 3 Venus will move almost imperceptibly towards the southern standstill position. Years 5 and 0 will move towards the Sun. The year 5 Venus will not be visible as it gets close to the Sun and the year 6 Venus will appear. At some point year 0 and year 3 will have the same azimuth but will be at different altitudes. This is a crossover event. As the eight-year cycles continue, the year 3 Venus will reach the position now occupied by year 0 and its position will be occupied by the year 6 Venus. Years 3 and 6 will have the next crossover event. The interval between crossovers is 251 years, a cycle named the Great Venus Round by McCluskey (1983) who demonstrated that it was also probably known to the Maya.

Reported orientations of monuments with Venus in Europe are both limited and inconclusive. Buildings dated to the first millennium BC in southern Iberia were orientated with the northern rising and southern setting points of the Moon at its major standstill, sunrise on the summer solstices and the sunset on the winter solstices. However, one or both of the solar or lunar orientations might have been orientations towards Venus rising at its maximum northerly extreme and/or setting at maximum southerly extreme (Esteban & Escacena Carrasco, 2012, 2013). It may be argued that the buildings were intentionally built with luni-solar orientations but were also used and interpreted with the Venus element as it was clear to the users that the positions of both the
Moon and Venus did overlap at some points. However, these buildings were not erected by a wholly indigenous European culture: the sites had evidence of influence by Phoenician colonisation including a bronze figurine of Astarte, a descendent of Inanna and also associated with Venus (van der Toorn et al., 1999). There do not appear to be any reported monumental orientations with the position of Venus at a crossover or at sunrise on any date.

Figure 2. (a) Diagrammatic representation of the orbits of Venus and the Earth looking down towards the Sun’s North Pole. Both planets orbit and revolve anti-clockwise from this perspective. The positions of Venus are shown during an eight-year cycle when viewed at midsummer. (b) The same appearances of Venus when viewed from a fixed position on Earth at sunrise. Venus is 70% of the Earth’s distance from the Sun and has a 3.4° orbital inclination from the ecliptic.
The Pleiades

The statement that ‘something’ was heralded by the cuckoo’s call is considered here. The common cuckoo (Cuculus canorus Linnaeus, 1758) has long been associated with the Pleiades in northern and central Europe ( Méchin, 2000, p. 23). Both were regarded as markers of cosmic time ( Méchin, 2000, p. 28; Sparavigna, 2008). This function of the Pleiades possibly extending back to the Solutrean Palaeolithic in Europe of 21,000 BP ( Rappenglück, 1999). German proverbs indicate why the Pleiades were markers of cosmic time and their association with the cuckoo and might have arisen: ‘the cuckoo stops singing when the Seven Stars (Pleiades) appear’ ( W ander, 1870, p. 1701) and ‘the cuckoo and the Pleiades are not supported together’ ( Bächold-Stäubli & Hoffmann-Krayer, 1932, p. 709). Across Europe the cuckoo traditionally arrives in late spring and stops singing to depart to the Otherworld on Midsummer’s Eve ( Nance, 2019a). The German proverbs suggest that these were the respective dates of the heliacal setting, when last seen after sunset, and the heliacal rising, when they first re-appear in the eastern sky just before sunrise, at these latitudes. There are more extant myths in Europe associated with the common cuckoo and the raven than with any other birds ( Ingersoll, 1923, p. 154). Méchin (2000) details several of them and concluded that: ‘some myths which link the cuckoo to the Pleiades show that, although we cannot rediscover all the symbolic importance, it is the cornerstone of the way people saw the seasonal flow in the Old European societies’ ( Méchin, 2000, p. 23).

The azimuth of the rising Pleiades has gradually been moving north over the last four millennia due to precession. They are not seen below an altitude of 4.4° which is the extinction angle of the Pleiades’ brightest star, Alcyone ( North, 1996, p. 51).

Monuments supposedly orientated to the Pleiades are few. Several enclosures and timber circles in Austria are thought to have an orientation of their entrances on the rising Pleiades. These include a multiple-ditched enclosure in use around 4700 BC ( Gibson, 2005, p. 87). It has been suggested that several Neolithic long barrows in southern England might have been constructed to allow the setting of the Pleiades to be observed ( North, 1996, p. 67). Similarly, for Iron Age monuments, the entrance of a large Irish post-enclosure at Lismullin was thought to be aligned with the rising Pleiades from late summer to the onset of winter ( O’Connell, 2009). This interpretation has been challenged: the eastern alignment of the avenue might have been associated with the rising sun rather than the appearance of the Pleiades in the autumnal night sky ( MacDonald, 2012). Whether the Pleiades were the intended alignment target for any of these monuments is unproven.

The Calanais stones

The Calanais Stones are located on the Isle of Lewis, Outer Hebrides, on a promontory overlooking Loch Roag (Figure 3). They are within a ritual landscape containing other inter-visible monuments including at least eleven stone rings, single standing stones and stone rows ( Ashmore, 2016, p. 52). Most of the monument was covered by peat between 1000 and 500 BC to a depth of 1.5 metres which was cleared in 1857. A detailed survey based on the National Grid was undertaken by Tait (1978) followed by a resistivity survey and subsequent excavation between 1979 and 1981 by Ashmore.
The stones were erected into an approximately cruciform pattern with a twelve metre diameter stone ring containing a five metre tall central monolith, an adjoining stone avenue to the north and three stone rows: south, almost directly west and approximately east-north-east (Figure 4). These components were not erected together or over a
Figure 4. Plan of the Calanais stones showing some supposed solar and lunar horizon orientations (from Hawkins, 1965). The stone numbering is after Somerville (1912). The positions are not as accurate as Tait’s, 1978 map (Ashmore, 2016). The cairn has been superimposed.
comparatively short period. The central monolith and ring were probably set-up between 2900 and 2600 cal BC (Ashmore, 2016, p. 6). It is not known when the rows were erected but stone rows in Scotland have so far been dated to the late Bronze Age (Higginbottom & Clay, 2016b, p. 2) indicating that the avenue and the radial rows are probably Bronze Age additions (Higginbottom et al., 2015, p. 595) and the rows’ stones could have been set individually at various times (Ashmore, 2016, p. 9). A chambered cairn was added within the ring and to the east of the central stone. It is quoted that this was between 2500 and 1700 BC as it was assumed that a burial that was found a couple of metres southeast of the passage entrance is contemporary with the cairn. The burial contained an all-over corded beaker and barbed and tanged arrowheads (Ashmore, 2016, p. 64). The east row consists of five stones and is 23 metres in length. The first four out from the ring are numbered 30–33. The fifth outermost stone, 33A, had fallen and was hidden when Somerville numbered the stones in 1912 but was located in 1977 and subsequently re-erected in 1982 (Ashmore, 2016, p. 51). The row is thought to have been erected at some time between 2560 and 1690 cal BC (Ashmore, 2016, p. 50; see Discussion).

**Astronomical orientations**

The hypothesis that the Calanais Stones serve an astronomic purpose is an old one. In 1726 Toland thought the ring represented the zodiac while the rows represented the four principal winds and the 19 stones of the avenue represented the 19-year Metonic cycle (Huddleston, 1814, p. 136). He also linked Calanais to Diodorus Siculus’s legend of the Temple of Apollo (Huddleston, 1814, pp. 188–191). The Calanais Stones are thought to have orientations with the horizon rising-and-setting points of the Sun and the Moon (Hawkins, 1965; Ponting, 1988, p. 424; Figure 4). While Thom (1967) thought the small enclosure to the east of the ring was an ellipse with one axis orientated to the winter solstitial sun and the other to the rising midsummer sun.

Lockyer (1906) and Somerville (1912) proposed that the avenue was orientated north towards Capella rising about 1720 or 1800 BC respectively, but, along with other proposed stellar alignments, this does not stand up to scrutiny (Ruggles, 1999, p. 136). Hawkins (1965) suggested that it was orientated southward on the setting midsummer moon at its major standstill. Curtis and Curtis (2009, p. 28) proposed that the northern end of the avenue was used to observe the Moon setting into the ring at its major standstill. The west row was thought orientated towards sunset on the temporal equinoxes (Somerville, 1912; Hawkins, 1965; Ashmore 2016). Stones 31–33 of the east row were proposed as foresights marking the range of the midwinter moon when viewed from stone 35 (Hawkins, 1965, p. 129; Figure 4).

Somerville (1912, p. 30) quoted a measured declination of the east row of 6° 43’ N (6.7°). With a horizon altitude of 0.9° (Ruggles, 1999, p. 207) this equates, using GETDEC, to an azimuth of 77.9°. Ruggles (1999, p. 207) measured azimuths between 78.8° and 79.6° and on Tait’s map it measures 78.0°. For the purposes of this study, this range of orientations (azimuths) falling between these extreme values of 77.9 and 79.6° will be used.

The east row was thought to be orientated with the rising Pleiades about 1700 BC (Somerville, 1912, p. 30; Burl, 1983, p. 179) and also with the rising stars Spica in 1270 BC, Hamal in 1130 BC, Aldebaran in 800 BC (Somerville, 1912) and Altair in 1760 BC (Thom, 1967). However, there is no ethnohistorical evidence of an intentional alignment with any of them, with the exception of the Pleiades’ association with the cuckoo,
and none are visible at sunrise which strongly suggests they cannot be the ‘something’ of the myth.

**Method**

The freeware planetarium programme *SkyChart/Cartes du Ciel* version 4.0 was utilised for calculations. Using the co-ordinates of the circle at Calanais (58° 11’ 49.20” N, 6° 44’ 42.00” W) to define an observatory, the night sky at that location can be viewed back to 3000 BC. By clicking on a celestial object, information is displayed including declination, current azimuth and altitude, and its rising-and-setting times with azimuths.

The altitudes and azimuths of the Moon were calculated using *SkyChart/Cartes du Ciel* for sunrise on the summer solstices during the century 1700–1600 BC to determine the variation in the Moon’s positions. The azimuths of the rising Pleiades at eight-year intervals and the altitudes and azimuths of Venus were calculated for sunrise on the summer solstices in the period 2400–1600 BC. The Google Earth ruler and profile functions were used to calculate horizon altitudes (see Discussion regarding the accuracy of these methods).

The Julian calendar was replaced in Britain by the Gregorian in 1582 to correct inherent errors. Astronomers use the Julian for dates prior to 1582. *Cartes du Ciel* also follow this convention; hence, the dates of prehistoric summer solstices do not correspond to the current Gregorian date of 21 June. The Julian dates of the summer solstices were determined for the years 3000 BC to 500 BC by finding the dates of the minimum solar azimuths (between 37.2 and 37.8°) at Calanais.

**Results**

**Solar and lunar orientations at Calanais**

When viewed from the circle of Calanais the azimuth of the calculated first light of the rising sun on the solstices remained between 37.2 and 37.8° throughout the period 2400–

![Figure 5. Azimuth and altitude of the Moon at sunrise on the summer solstices between 1800 and 1700 BC at Calanais. ‘Full’ moons are those greater than 90% illuminated.](image-url)
1600 BC. The Moon varied in phase and in its position relative to the ecliptic (Figure 5). The phases of the Moon closest to the Sun would not have been seen and would have progressed from a slim crescent to full moons in the south to south-south-east.

**Venus and Pleiades azimuths at Calanais**

Venus was potentially visible on the summer solstice sunrise on 2224 BC, with an altitude of 5° and 17% illuminated with an apparent magnitude (brightness) of −4.5. It corresponds with the theoretical year 3 in Figure 2. It was, barring obstructions by the Moon, atmospheric effects *et cetera*, then seen on the summer solstice sunrises every eight years until about 1536 BC but had moved on in its apparent orbit by two days and eight hours each time (Figure 6). Venus moved east and reached a southern limit with an azimuth of 82.1°, declination 13.5°, at what would have appeared to have been a standstill position, it then moved back towards the Sun. In that first eight-year period Venus was also visible on the summer solstices of 2222 (year 0) and 2227 BC (year 5) but at different azimuths and altitudes as they were at different positions in their apparent orbits. Plotting the azimuth of Venus at midsummer sunrise against time these different ‘orbits’ of Venus are apparent (Figure 7). They have a crossover azimuth between 77.5 and 78.0°.

In 2400 BC Alcyone of the Pleiades was first seen from the circle of Calanais 4.4° above the horizon at an azimuth of 86° (Figure 7) but gradually moved north with time due to precession. The rising Pleiades had the same azimuth as a crossover of Venus occurring in 1677 and 1674 BC (Figure 8). The difference in these Venus altitudes was 3.3°. For comparison, a little finger at held at arm’s length covers approximately 1°.
Figure 7. Venus summer solstice sunrise azimuths and Alcyone (Pleiades) rising azimuths for the period 2400–1600 BC at Calanais. The dark grey horizontal band represents the range of azimuths of the east row measured by others. The light grey diagonal band represents the azimuth of rising Alcyone with an extinction angle of 4.4 ±0.25°. The data appears stepped due to corrections to the changing date of the Julian summer solstice.

Discussion

SkyChart/Cartes du Ciel

SkyChart version 4.0 uses the NASA Jet Propulsion Laboratory, Solar System Dynamics Group’s HORIZONS software (https://www.ap-i.net/skychart/en/start) to calculate ephemerides (trajectories) for solar system objects (https://ssd.jpl.nasa.gov/?horizons). NASA’s website states the ephemerides are ‘highly accurate’ but does not state the degree of precision. The software calculates sunrise as the point where the upper limb of the refracted Sun reaches the horizon – first light (https://ssd.jpl.nasa.gov/?horizons_doc#definitions).

The precession calculation is based on algorithms developed by Vondrák et al. (2013) giving an accuracy comparable to International Astronomical Union 2006 precession model around the central epoch J2000.0, the currently used standard equinox and epoch, which is January 1, 2000 at 12:00 Terrestrial Time: the prefix ‘J’ indicates a Julian epoch. The accuracy is within a few arcseconds throughout the historical period and a few tenths of a degree at the ends of the ±200 millennial time-span: acceptable accuracy for the purposes of this study.
The Google Earth ruler tool uses true north for its reference (Romain 2019, p. 158). The accuracy of the images used by Google Earth is heavily dependent upon the accuracy of the orientation data plus the quality of the Digital Elevation Model (DEM) used (Pulighe et al., 2016, p. 17; Potere, 2008). Elevation accuracy of Google Earth was determined with a mean absolute error of 1.32 metres in a number of locations in the US when compared with GPS benchmarks (Wang et al., 2017).

**Solar orientation**

There are no rows orientated towards the rising sun on the summer solstice at Calanais. The summer solstice could have been used as a calendric marker fixing the date for comparative observations of other celestial bodies.

**Lunar orientation**

When the Moon sets at the solstitial sunrise it is in, or close to, its full moon phase, being opposite the Sun and fully illuminated. However, the Moon doesn’t always set.

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**Figure 8.** Venus summer solstice sunrise azimuths and Alcyone (Pleiades) rising azimuths between 1710 and 1650 BC at Calanais. The dark grey horizontal band represents the range of azimuths of the east row measured by others. The light grey diagonal band represents the azimuth of rising Alcyone with an extinction angle of 4.4 ±0.25°. Venus is depicted with an angular diameter of approximately 50°.
on the solstice and can be at any point in its 29.5-day synodic month at the solstice sunrise. It was over 90% illuminated on only seven summer solstices between 1800 and 1700 BC. The two stone rows of the avenue are orientated approximately 9° east of true north when viewed from the circle (Ashmore, 2016, p. 1055). The maximum lunar standstill northern rising azimuth at Calanais is approximately 23° and the maximum lunar standstill southerly setting is 203°, presumably from inside the circle (Ashmore, 2016, p. 1062). Hence, the Moon does not rise or set down the grand avenue even at its extremes which are part of the 18.61-year lunar-node cycle. This cycle is not synchronised with the solar cycle; therefore, it has no direct correlation with the summer solstices. Even if structures were built hundreds of years before or after the century of 1700–1600 BC, the change in the Moon’s apparent position due to changes in the obliquity of the orbit happens so slowly and is so small in the short term that the resulting differences in rising and setting azimuths would not be noticeable to the naked eye (Romain W, 2019).

**Venus orientations**

The azimuths of the Venus crossovers are less than 0.25° below the range of measured values for the east row (Figure 8). This could be due to inaccuracies in measurements made by the erectors. However, JPL’s Horizons software used by Cartes du Ciel calculates sunrise as the time when the first light of the Sun is first seen: this is the current astronomical definition of sunrise. There is no evidence that this was considered to be sunrise by the builders of the east row. If sunrise was considered to be when the whole of the solar disc was visible then, as the Sun’s apparent diameter is 0.53°, the azimuths of Venus would be increased by the same amount and the crossover values would be in the measured range of east row azimuths.

To determine if Venus would be visible after the Sun had risen fully, on the morning of 8 July 2020 when Venus was 25% illuminated with a magnitude of −4.6, Venus only became indistinguishable twenty-five minutes after astronomical sunrise when the centre of the Sun’s disc had an altitude of 3.1°. In addition to confirming the visibility of Venus the observation appears to negate the possibility that the east row was aligned with the subjective position of the last sighting of Venus on midsummer morning.

The orientation of the crossovers of Venus with the east row suggests it could be the ‘something’. Swire (1966, p. 25) proposed that the name of the ‘something’ was: ‘probably pre-Gaelic and from a root common to all the British group of languages [Old Brittonic] that translated as ‘the Shining, or Pure or White One’ and probably had once been the epithet of a god’. Welsh, Cornish and Breton are derived from Brittonic and the adjective *gwen* is ‘shining, white, blessed, holy’ (Thomas, 1976, p. 1770). In all four languages *Gwener* is the planet Venus: ‘the Shining, or Pure or White One’.

The orientation of other monuments with Venus crossovers may be uncommon. In a study of 189 western Scottish monuments, 20 of 23 rows of three or more stones were orientated in the northern and southern quarters, suggesting lunar orientations (Ruggles, 1999, p. 75). The three ‘anomalies’ were in the Outer Hebrides, the Calanais east and west rows and a row on the island of North Uist. The apparent lack of other rows orientating on this declination suggests that either the crossover was not deemed
important by other culturally-connected societies, it was only focused upon by observers in the Outer Hebrides or similar alignments have been overlooked.

**The east row**

The east row was probably erected at some time between 2560 and 1690 cal BC (Ashmore, 2016, p. 952). These data were obtained from both pollen analysis and radiocarbon dating from around stone 30 during re-instatement. Pollen samples were not dated directly but compared to previously radiocarbon dated pollen columns at Leobag, 600 metres to the south-east. One sample resembled another at Leobag dated to a period which ended between 2560 and 2200 cal BC providing a *terminus post quem* for erection of the stone. A date between 1940 and 1690 cal BC (Ashmore, 2016, p. 962) was obtained from a piece of heather charcoal in an overlying layer. The $2\sigma$ radiocarbon date represent a 95% confidence level indicating the true date may be outside this range. In addition, the origin of the heather is uncertain and it is thought it might have originated from clearing out the chambered cairn (https://canmore.org.uk/c14sample/AA-24957) which would have occurred at an unknown interval prior to the stone being erected. The dating evidence does not allow a precise date for the erection of the east row, which might have occurred in stages. There are three crossover events in the period 2560 to 1674, which one was initially commemorated by the erection of the row is undetermined. The rising Pleiades could only have preceded the Shining One down the ‘avenue’ during the crossover of 1674 and 1677 as it would have risen further east before then. It was an event that will not occur again for several millennia. While there are later crossovers they lie outside the dating evidence and the Pleiades rising azimuth would have been increasingly further north. Conversely, the myth states that the Shining One is heralded by the cuckoo’s call. The Pleiades always precede the rising of Venus on midsummer’s morning

**Non-horizon events**

Non-horizon celestial events are obviously more difficult to monitor than horizon events. In addition to the required constants of location, date and time, the mechanics of marking the positions of objects in the night sky with any degree of precision are difficult. Mechanisms to accomplish this are not proposed here. Monuments aligned with the rising and setting Sun not only at its standstill positions but on the temporal equinoxes and cross quarter-days might also have used the Sun as a calendric marker. For example, the west row of Calanais aligns with the temporal equinoxes ‘of that, there can be no doubt whatever’ (Somerville, 1912, p. 29) and the alignment was considered good enough for calendric purposes in the third or second millennium BC (Ashmore, 2016, p. 57). Venus is visible as the evening star on the spring, but not autumn, temporal equinoxes as part of an eight-year cycle. It reaches a final position above the row at sunset every 251 years. Eight years later it cannot be seen as it is too close to the Sun. Hence, the west row may be orientated to the temporal spring-equinox setting Sun as a marker for the solstitial heliacal-setting of Venus when, according to the German proverbs quoted above, the cuckoo appears. While there is no extant
ethnohistorical evidence to support this hypothesis: ‘the absence of ethnohistory of prehistoric sites does not preclude learning something about intent’ (Malville, 2015: xiii).

Orientations of monuments might also have been intended to indicate celestial events below the horizon. The other Outer Hebridean stone row ‘anomaly’ is the west-northwest row of Blashaval on North Uist (Ruggles, 1999, p. 75). It is orientated to the setting point of Venus one and a half hours after its solstitial heliacal position at sunset, not on the horizon but at the base of a hill. This suggests that a cult of Venus was established in the Outer Hebrides in the early Bronze Age, a hypothesis that has some support from a study of the orientation of free-standing stones in western Scotland. The study demonstrated that in the Hebrides the hypothesis of sub-cultural differences is supported by different orientation directions between regions (Higginsbottom et al., 2000).

The cuckoo

The cuckoo was one of the three species of fairy or sacred/enchanted birds in the Hebrides (Goodrich-Freer, 1902, p. 35; Maclean, 1937, p. 113). It was thought they spent the winter months in fairy bower: the ‘Otherworld’ (Maclean, 1937, p. 113). Common cuckoos are brood-parasites, laying their eggs in other birds’ nests, leading to misconceptions of their life cycle: no females, nests or identifiable eggs. It was assumed the male birds mated with the host females (Gubernatis, 1872, p. 231); hence, ‘The cuckoo is the bird of wedlock and fecundity that is why he has ten wives given him’ (Grimm, 1883, p. 1489). It is the bringer of spring and symbolised male fertility across much of its summer range from Denmark (Armstrong, 1958) to China (Lai, 1998). The bird was also associated with both natural and agricultural fertility and abundance (Nance, 2019a). Due to its conceived libido, virility and fertility the bird was associated with several widespread European goddesses of fertility who were probably also associated with mead and the planet Venus (Nance, 2019a).

The goddess

Neither the Sun, the Moon nor any known European gods were associated with the cuckoo. Several widespread, significant European fertility goddesses were associated with the cuckoo including Freyja-Frigg (Guerber, 1895), Hera (Powell, 1995), the Latin Juno and Laima, a goddess of the Balts (Gimbutas, 1989, p. 97). At least two of them, Freyja-Frigg and Hera (Powell, 1995), possibly the Latin Juno, were associated with both the cuckoo and the planet Venus as the morning star and are described as the ‘Queen of Heaven’ (Grant, 1960; Guerber, 1895). Hera, but not the later Aphrodite, was recorded in Mycenaean linear B tablets dating from 1450 to 1150 BC (O’Brien, 1993, p. 114) and was not domesticated and absorbed into Olympic myth and pantheon until the seventh century BC (O’Brien, 1993, p. 6) indicating she had a pre-Greek origin (Burkert, 1972; Beekes, 2009, p. 524) and that Zeus replaced Hera’s original solar partner. This also suggests that Aphrodite was not absorbed into the Hellenic pantheon until after the twelfth century BC.

Several other Iron Age European goddesses are depicted with the cuckoo, previously unrecognised, on a number of European Iron-Age artefacts including the Gundestrup
cauldron and the Galliche phalera (Nance, 2019a). In addition to an association with the
cuckoo and Venus the goddesses were also variously linked with mead, sovereignty, fer-
tility, abundance and sex and thought to have evolved from an early Bronze Age ancestor
(Nance, 2019a). If so, then a variant of that goddess would have been known within the
Beaker Culture and would have existed in Britain during the Bronze Age further support-
ing the findings that Venus was the ‘Shining One’.

A descendent of this goddess appears be the Irish fertility and sovereignty goddess
Áine. Not only is her name suggestive: ‘brightness, glow, joy, radiance; splendour,
glory, fame’ (MacKillop, 1998), but fire and ‘blessing of the land’ rituals associated
with her were still observed at the hill named after her in County Limerick on Midsum-
mer’s Eve in 1879 (Meehan, 2002). The two churches at her site in Limerick are dedicated
to Saint John, whose saint’s day is Midsummer’s Day suggesting he replaced the solar
deity, and the Church of Our Lady of Knockainey, where, as part of the interpretatio
Christiana, the goddess was probably syncretised into a Marian cult.

The goddess might also have been syncretised as local founding saints in Britain and
conveniently allowed to die off. ‘Great shining, white, blessed, holy’ is composed of mawr
and gwen which lenities (softens) to mawrwen. There are a number of early British Saints
named Morwyn or her cognate Morwenna (Baring-Gould, 1914, p. 263). They all have
their saint’s days between 5 and 8 July (Table 1). Although the summer solstice occurs
between the 20 and 22 June in the Northern Hemisphere, it was celebrated on 24 June
in the Middle Ages in the British Isles as the feast of Saint John the Baptist which
began the night before on Saint John’s Eve. When the Julian calendar was replaced in
Britain by the Gregorian in 1582, eleven days were added and 24 June of became 5
July, an indication that the saints Morwenna feast day was originally the solstice but
by 1582 the association of the saint with the solstice was forgotten and the date had
become fixed, although Saint John the Baptist’s day remained on the solstice. A Saint
Morwenna is a founding parish saint of the Cornish village of Morwenstow (Old
English stów ‘holy place’). The parish church is dedicated to both Saint Morwenna
and Saint John the Baptist.

A Venus deity appears to have been introduced into Europe several times. Inanna, a
hypersexual goddess of fertility, love, war and political power (Marcovich, 1996) associ-
ated with the planet Venus, is thought, on linguistic evidence, to have been taken to
Mesopotamia by an early population that brought farming from the northern Zagros
Mountains in the sixth millennium (Kramer, 1963, p. 40): she is descended from a
Neolithic ancestor. While the cuckoo breeds in the Zagros Mountains and further

Table 1. Saints’ days of Morwenna and cognates.

<table>
<thead>
<tr>
<th>Saint</th>
<th>Position</th>
<th>Date</th>
<th>Feast Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modwenna also known as Merryn*, Medana***</td>
<td>Abbess of Burton-on-Trent</td>
<td>Sixth century</td>
<td>5**-6 July*</td>
</tr>
<tr>
<td>Modwenna</td>
<td>Abbess of Polesworth</td>
<td>Died about 900</td>
<td>5–6 July**</td>
</tr>
<tr>
<td>Modwenna</td>
<td>Abbess of Whitby</td>
<td>Died about 695</td>
<td>5 July**</td>
</tr>
<tr>
<td>Moninna</td>
<td>Abbess of Kilkeavy</td>
<td>Died about 518</td>
<td>6 July**</td>
</tr>
<tr>
<td>Moninne</td>
<td>Abbess of Siabh-Guillin</td>
<td>Died about 518</td>
<td>6 July**</td>
</tr>
<tr>
<td>Morwenna</td>
<td>Cornwall</td>
<td>Sixth century</td>
<td>8 July**</td>
</tr>
<tr>
<td>Merryn</td>
<td>Cornwall</td>
<td>7 July**</td>
<td></td>
</tr>
</tbody>
</table>

*Catholic Online. https://www.catholic.org/saints/
**Celtic and Old English Saints http://celticsaints.org
*** Saint Patrick Catholic Church http://www.saintpatrickdc.org
north, it does not breed in Mesopotamia or the Levant (Payne et al., 2005) and was replaced by a bird it resembled and is still confused with, the Eurasian collared dove (*Streptopelia decaocto* Frivaldszky, 1838) which occurs in Mesopotamia (Baptista et al., 1997). The ancestral deity, still associated with cuckoo, could have spread with the Neolithic farmers across Europe, with a later descendent introduced by Bronze Age cultures. Similarly, Inanna’s descendent, Astarte, was introduced throughout the Mediterranean by the Phoenicians in the first millennium BC and texts indicate she was merged with an equivalent Etruscan goddess, Uni (Esteban & Pellín, 2016), indicating a pre-Indo-European goddess possibly associated with Venus. Aphrodite, another of Inanna’s descendants, was absorbed into the Greek pantheon from Cyprus and Hera’s association with Venus was lost (Pseudo-Hyginus *Astronomica* 2.42; Grant, 1960).

The deities associated with the cuckoo were goddesses in triplicate (Nance, 2019a). This suggests an origin with the three appearances of Venus as the morning star in an eight-year cycle representing growth, maturity and decline. Hera, for example, was celebrated by three festivals in Symphalia in Arcadia as the girl, the adult woman and the widowed or divorced woman (Farnell, 1896, p. 190).

**Meaning and intent**

The retained oral history indicates that the appearance of the deified Venus on midsummer morning and the alignment of the east row with the crossover were significant. As a goddess of fertility, the deified Venus must herself have been fertile (Frazer, 1922, p. 13) and had a consort. The Celtic god Belenus is thought to derive from *bhel*, ‘to shine’, indicating a solar deity (Koch, 2006). Images of Belenus sometimes show him accompanied by a female, thought to be Belisama, the ‘brightest one’ (Koch, 2006). These might have been some epithets of the deified Sun and Venus in Britain. Belenus was known in Welsh literature as Beli Mawr, ‘great shining one’. ‘Great, white, shining, holy’ would be gwener mawr which lenites to gwenerfawr where *f* is pronounced *v* in modern Welsh, Guinevere, while some have similarly suggested the name might be derived from Gwynt-fawr ‘Gwenhwy the Great’. The original Welsh form of the name is thought by others to be Gwen-hwyfar, translating as ‘white phantom’ (Schrijver, 1995, pp. 249–250). However, the Guinevere of Arthurian legend is a married queen but promiscuous with a number of lovers and champions, more in keeping with the hypersexual goddesses that personified Venus.

The orientations of the Phoenician temples in Iberia suggested the possibility of double rituals with Baal and Astarte representing the Sun and Venus (Escacena Carrasco, 2010, p. 111) who were also considered to be in a divine marriage (Escacena Carrasco, 2015, p. 1797). The eighth century BC Phoenicians of the Levant and the seventeenth century BC Hebrideans are obviously separated both temporally and spatially. However, the concept of the appearance of Venus with the Sun at its strongest on the summer solstice representing a *hieros gamos*, the ‘wedding’ of a divine couple, may be an ancient one. Such an event has been described, also involving the cuckoo: ‘A seated figure of the goddess [Hera] shows a cuckoo on her staff, and a bas-relief representing the wedding procession of Zeus and Hera has a cuckoo perched on Zeus’s sceptre; so that this bird has got mixed up with the most sacred of all weddings’ (Grimm, 1883,
If this is an astronomical myth then the Pleiades, Venus and the Sun are represented in this *hieros gamos*. From personal observations the ‘sacred time’ of the *hieros gamos* would be visible for about twenty minutes after full sunrise. For completeness, the Sun is not always represented as male in European pre-Christian religions. For example, the Sun is personified in both the Icelandic Poetic Edda and the Prose Edda as Sunni, the sister of the personified male Moon, Máni. However, these sources of northern paganism have been described as ‘comparatively late, fragmentary and of uncertain reliability’ (Ellis-Davidson H, 1964, p. 9).

In Finland the cuckoo was believed to fertilise the earth with his song (Crawford, 1910, p. 20) suggesting that without him there could be no spring. This is reflected in a second myth of Calanais that asserts that the earliest cuckoo to arrive each year on Lewis sings first on the Calanais central stone (Swire, 1966, p. 25). Similar myths are associated with the Gowk (Old English ‘cuckoo’) Stone at Lisdivin, Northern Ireland (Rutherford, 1953) and the parish saint’s stone cross at Nevern, Wales. These and other cuckoo-stones appear to have been *axes mundi* where the vegetation was thought to first regenerate in spring (Nance, 2019b).

Other cuckoo-stones and many other cuckoo place-names are associated (statistically significant) with similar common features when compared to a randomly selected sample of standing stones and random locations respectively, indicating they were associated with the bird in some sense since the stones were erected and survived both language and cultural transitions (Nance, 2019b). A cuckoo place-name sub-set of fields named ‘cuckoo-pen’ in southern England also had similar natural and cultural features in common (Field, 1913; Rawes, 1978) and were thought to be remnant sacred groves (Field, 1993); associated with a pagan seasonal ritual (Rawes, 1978), specifically the widespread legend of the pent cuckoo (Field, 1913; Rawes, 1978) where the village wise-men try to pen or bank-in the cuckoo to save the summer but the bird always flies away. Locations named after the cuckoo in southern Germany and Switzerland are associated with comparable legends (Grimm, 1883, p. 440). This ritual is related to a widespread European folk-belief that the summer solstice was the date the cuckoo stopped singing and departed: if the cuckoo calls later than Saint John’s Day (the summer solstice) it means no good (Grimm, 1883, p. 1888). It was recognised in Gaelic verse: ‘on Saint John’s Day the cuckoo goes to her winter home’ (Macdonald, 1926, p. 123). In Russia Midsummer’s Day is referred to as the ‘funeral of the cuckoo’ (Méchin, 2000, p. 26) while on Romania it is *amutirea cucului*, ‘the silence of the cuckoo’ (Ghinoiu, 1995, p. 463). Hence, the ‘song of the cuckoo’ in the myth would have been its last call of the year before it was thought to go to the ‘Otherworld’ (Gubernatis, 1872, p. 235) prior to migration being understood. The summer solstice would be the most probable date to ‘pen the cuckoo’ and prolong the summer. Perhaps the ritual of ‘penning the cuckoo’ was undertaken at Calanais and the row erected to guide the celestial cuckoos of the Pleiades and the ‘Shining One’ to the ring of stones, the cairn or the earlier timber enclosures, to stay and prolong the summer or to ensure their presence to sing from the central stone, incorporated into the cairn, and bring the following spring.

A possible significance of the crossover is that as one Venus was declining, another took over the ascendency, a possible consequence being the transfer of rituals from one Venus to another in the same eight-year cycle.
Conclusions

The main findings from this analysis are that the east row of the Calanais stones is orientated to crossover events of Venus that occur on the summer solstice approximately every 251 years. The rising Alcyone of the Pleiades would have been seen at its earliest on the same azimuth of the crossover of 1674 and 1677 BC under optimum atmospheric conditions. The event appears to have been remembered in an astronomic myth associated with the Calanais Stones where the ‘shining one’ refers to Venus and the Pleiades symbolise the cuckoo. The deified Venus associated with the cuckoo was represented across Europe and appears to have been part of the Bronze Age pantheon. The Neolithic people might have had a version of the same goddess. The occurrence of Venus at sunrise on the summer solstice probably represents a divine ‘wedding’ of the Sun and Venus while Midsummers Eve is the most probable date for the ritual of ‘penning the cuckoo’. This ritual might have been undertaken at Calanais with the row ‘guiding’ the celestial cuckoos and/or the deified Venus to the chambered cairn to prolong the summer or to spend the winter to ensure the bird sang from the central stone and brought the spring the following year.

These findings are significant because the orientations of monuments are usually assumed to be associated with the rising and setting horizon positions of celestial objects. This study widens the range of significant orientations. At Calanais the rising sun on the solstice was used as a calendric marker to fix a date and time for observations of Venus suggesting that it might have been used similarly when setting on equinoxes. The search for monument alignments should not be restricted to celestial events connected with the horizon including rising and setting azimuths and standstill positions. Alignments with events connected with sunrise and sunset are known: heliacal rising and setting as examples. Crossover events can now be added to this list.

Orientations of monuments appear to be viewing ‘windows’ rather than of high precision. The 1.7° range of measurements of the east row azimuth by others using modern surveying techniques emphasises this point.

The study strongly suggests that oral history records celestial events and can persist over long periods through language transitions and is a valuable resource.

Further work could include examining orientations of monuments for alignments with Venus crossovers. Several single stones and two stone-row possibilities are listed in Table 3.2 of Ruggles (1999). Similar crossover events also occur with Venus as the evening star. In addition, determining if equinoctial and cross quarter-day orientations were calendric markers for other observations may prove fruitful.

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