Mediterranean Archaeology and Archaeometry, Vol. 14, No 3, pp. 247-257

FURTHER EVIDENCE FOR THE EXISTENCE OF PREHISTORIC CELESTIAL ALIGNMENTS IN WESTERN SCOTLAND: CALENDRICAL ALIGNMENTS ON THE ISLAND OF MULL

T.T. Gough

Independent Scholar, Parkhead Farmhouse, Ballindalloch, Banffshire AB37 9BJ, Scotland
(tt_gough@btinternet.com)

ABSTRACT

There have been some limited studies of the standing stone sites on Mull. Alexander Thom assessed a few sites (Thom 1967, 1971). Clive Ruggles studied the stone rows in northern Mull, determining approximate declinations using only the stones (Ruggles 1985, Martlew and Ruggles 1993, Ruggles 1999, 112ff.). He also catalogued all of the sites and recorded orientations (Ruggles 1984). The present study assessed 29 of 32 standing stone sites on Mull for possible precise alignments using indicated foresight features.

In 1967 Thom published a histogram of some 300 declinations from widely scattered sites (Thom 1967, Fig 8.1). The histogram showed a pattern of peaks that suggested systematic observation of the sun. Thom deduced probable declinations for the peaks.

Eleven sites on Mull could not be measured (due to trees, fallen stones, etc.). Three sites were not visited (two had fallen stones). Five others are probably medieval waymarkers. Four sites gave lunar alignments. The remaining nine sites gave multiple solar alignments which strongly supported Thom's deduced declinations and hence the probable existence of a prehistoric calendar. Mention is made of a recent paper which gives supporting evidence (MacKie 2013).

KEY WORDS: standing stones, foresights, prehistoric calendar

1. INTRODUCTION

In the 1960s and 1970s Alexander Thom published three books and many papers detailing his solar and lunar declination results. Some of the values obtained were approximate ones, from orientations; others were precise ones, from alignments. An orientation is a direction derived only from the structure itself and gives at best a precision of one or two degrees. In an alignment the backsight marks the observing position and also the direction to a usually unambiguous skyline feature, the two together forming the alignment. Such an arrangement, by careful positioning of the backsight, is capable of minute of arc precision – perhaps 100 times more precise than an orientation. The distinction is important.

Thom found many such alignments, mostly in Scotland, which he believed had been intentionally set up. If this was the case, then it implied a much more organised society than that which most archaeologists believed. There was considerable resistance to his ideas, although some were willing to accept them (Atkinson 1975).

Clive Ruggles' criticisms of Thom's alignments (e.g. widely scattered sites and foresights open to subjective choice) effectively determined the methodology of the present investigations:-

- Assess one region at a time;
- All sites in that region included;
- A backsight is a flat-sided stone, pair or short row with an indicated direction; and,
- Within this group, NO selection.

Thom derived a histogram from some 300 declination measurements (Figure 1). He also deduced probable declinations (Table 1).

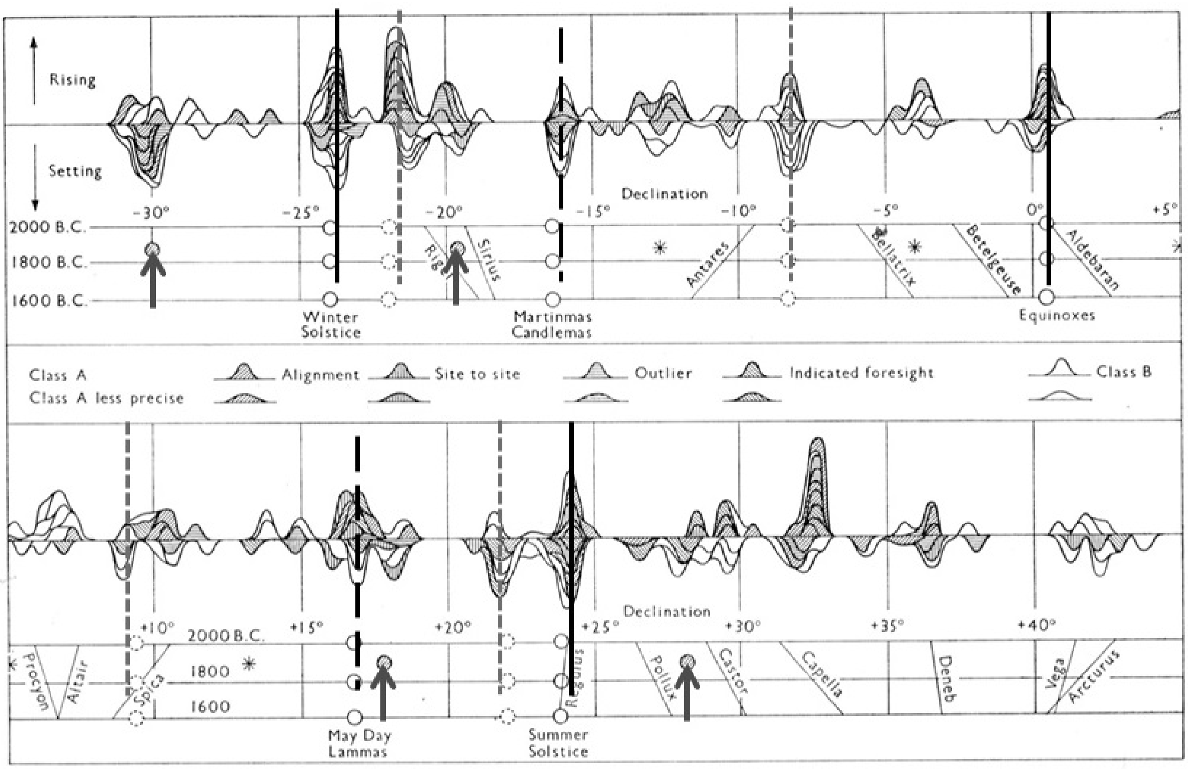

Figure 1. Histogram of observed declinations (Thom 1967, Fig. 8.1).

There is evidence that the year was divided into 16 'epochs' or 'months', each of about 23 days. (Reproduced by permission of Oxford University Press)

Table 9.1. *Calendar declinations* (With Permission of O.U.P. with whom Copyright remains.)

Epoch Number	Days in 'month'	Epoch		δ_R decl. at sunrise	δ_S decl. at sunset	Possible decl. range
		Nominal	Days elapsed at sunrise (t)			
0	23	0	−0·4	+ 0·37	+ 0·56	±0·19
1	23	23	22·56	+ 9·04	+ 9·24	0·17
2	24	46	45·53	+16·55	+16·72	0·14
3	23	70	69·51	+22·03	+22·13	0·07
4	23	93	92·50	+23·91	..	0·00
5	23	116	115·51	+22·09	+21·99	0·07
6	23	139	138·53	+16·80	+16·62	0·14
7	22	161	160·56	+ 9·31	+ 9·09	0·17
8	22	183	182·60	+ 0·51	+ 0·33	0·19
9	22	205	204·62	− 8·40	− 8·57	0·18
10	22	227	226·67	−16·24	−16·35	0·14
11	23	250	249·69	−21·92	−21·98	0·07
12	23	273	272·70	−23·91	..	..
13	23	296	295·70	−21·82	−21·72	0·08
14	23	319	318·68	−16·30	−16·15	0·14
15	23	342	341·64	− 8·52	− 8·37	0·19
16	..	365	364·60	+ 0·28	+ 0·47	

Mean values at both sunrise and sunset are identical and are +0°·44, +9°·16, +16°·67 +22°·06, −8°·46, −16°·26, −21°·86.

Table 1 Calendar declinations (Thom 1967)

Note that the sunrise/sunset declinations differ: The sun has moved. Also note the range, which is largest at the equinoxes.

3. METHOD

A theodolite was used to measure the bearings and altitude of skyline features in the indicated direction to better than 1′ arc. North was determined by the sun method. The azimuths and altitude were drawn on an image of the region and the rising/setting path of the sun/moon for relevant declinations was plotted. Foresights for specific declinations were found in all cases where there was an indicated direction and clear horizons. The foresights found were typically within ±2^0 of the indicated direction, well separated from other features, and are considered to be those used when the alignments were set up. Chance alignments, despite claims to the contrary (Ruggles 1999, 59), have been shown to be uncommon (Gough 2013).

For solar alignments a range of acceptable declinations is inevitable as the sun is, except briefly at the solstices, continuously moving north or south. The sun's rising or setting position on the horizon on any given date will be slightly different the following year. For each horizon feature, a rising/setting range is apparent, but after four years the sun would rise/set outside the range because the sun's declination changes by a quarter of the range each year. A leap year would be required. By using again the beginning of the range, the day adjustment would occur naturally. The range is shown in the table above (Table 1) and in Figure 4 Thom deduced declinations from the histogram which seemed to be close to the ideal for a solar calendar of sixteen months (Thom 1967, 112 and Fig. 9.2). Twenty nine of the 32 sites were visited. Eleven sites could not be measured (fallen stones, trees etc.). Three sites were not visited (two had fallen stones). Probably five waymarkers served to guide medieval pilgrims to the early Christian sites on Iona. The remaining 13 sites all gave an alignment: four lunar and nine solar. Discussion of the four solar sites indicated in Figure 2 follows.

2. STANDING STONE SITES ON MULL

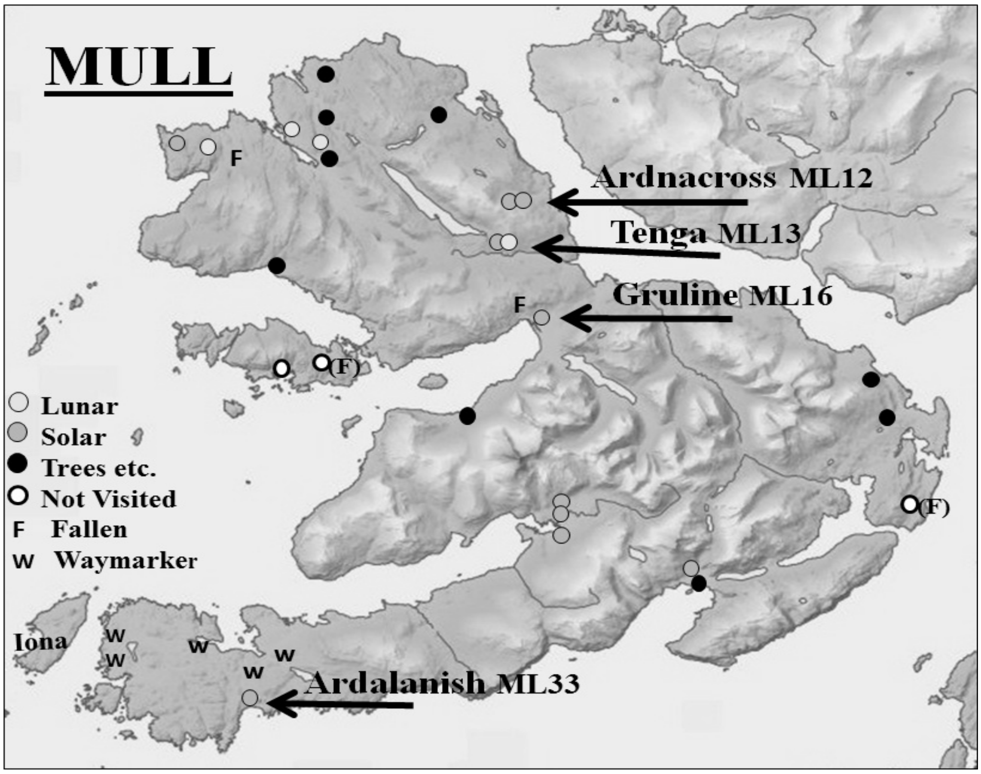

Figure 2 Summary of the results found for Mull. The four sites indicated are discussed below. The site numbering follows that used by Clive Ruggles. (Ruggles 1984)

4. FOUR SOLAR SITES

4.1 Ardalanish ML 33 (NM 378 188)

Two stones about 10m apart, one fallen, and each about 2.5m long (Figures 3 and 4).

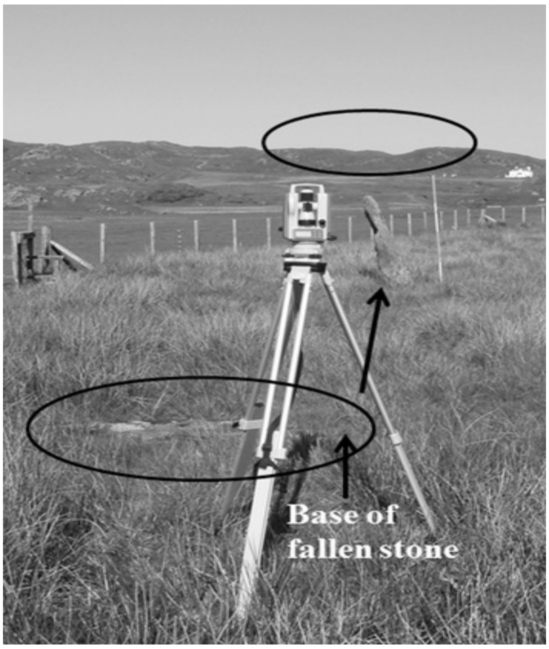

Figure 3 Ardalanish ML33

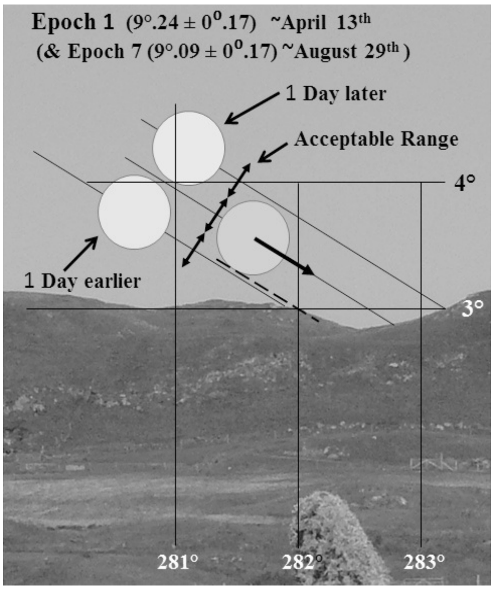

Figure 4 Ardalanish ML33, showing the range over four years

The day of the solstice can in principle be found by observing the sun at a suitable foresight a few days before and after the solstice and then halving the difference (see also Discussion (section 7), below). The next two sites use this method.

Note: *'Halving the Difference'*

4.2 Ardnacross ML12 *(NM 542 491)*

The site is situated on a wide, sloping terrace at moderate elevation. It consists of two rows of three stones and between them the remains of three kerb cairns (Martlew and Ruggles 1993, Ruggles 1999, 112). The two rows are approximately parallel to each other, oriented NNE/SSW, and about 40m apart. They are not opposite but are skew to each other; i.e. perhaps they do not form an avenue. Only one of the six stones is still standing but their bases indicated directions to within a few degrees can be deduced. There is no alignment in the north. In the south there is only one possible foresight – a small but distinct downslope. Each row gives a solar alignment using this feature; one for the upper limb, the other for the lower limb, each 10 days before/after the solstice (Figures 5 and 6).

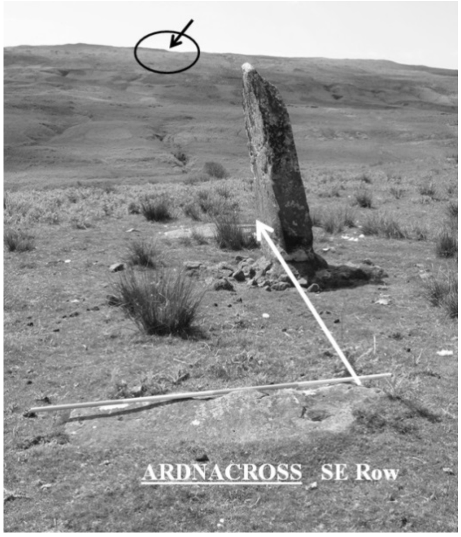

Figure 5 Ardnacross SE Row

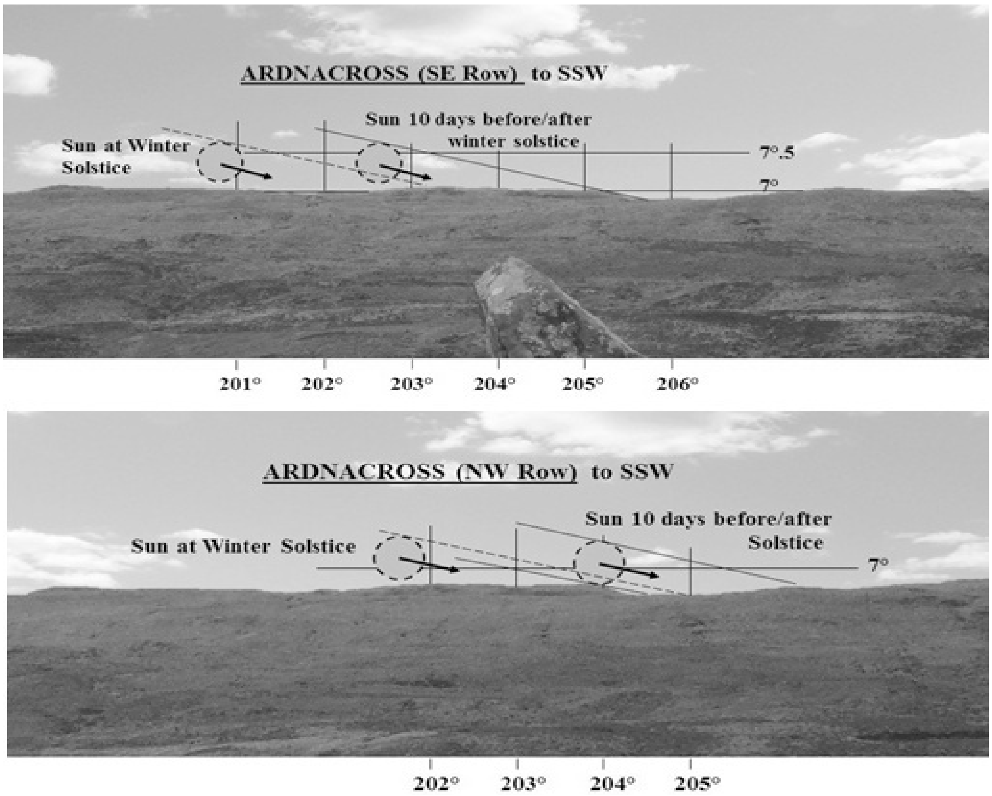

Figure 6 Ardnacross solar alignments 10 days before/after the solstice

4.3 Gruline ML16 *(NM 543 397)*

Gruline is 10km south of Ardnacross. The alignments found are as shown below. Note that the sun's lower limb at the solstice does not clear the skyline at the lefthand bump. But 10 or 11 days before and after the solstice the sun would just have been obscured by the bump. Twenty-three days before and after the solstice (Epochs 3 and 5) the sun would pass just above the bump further up the slope (Figure 7).

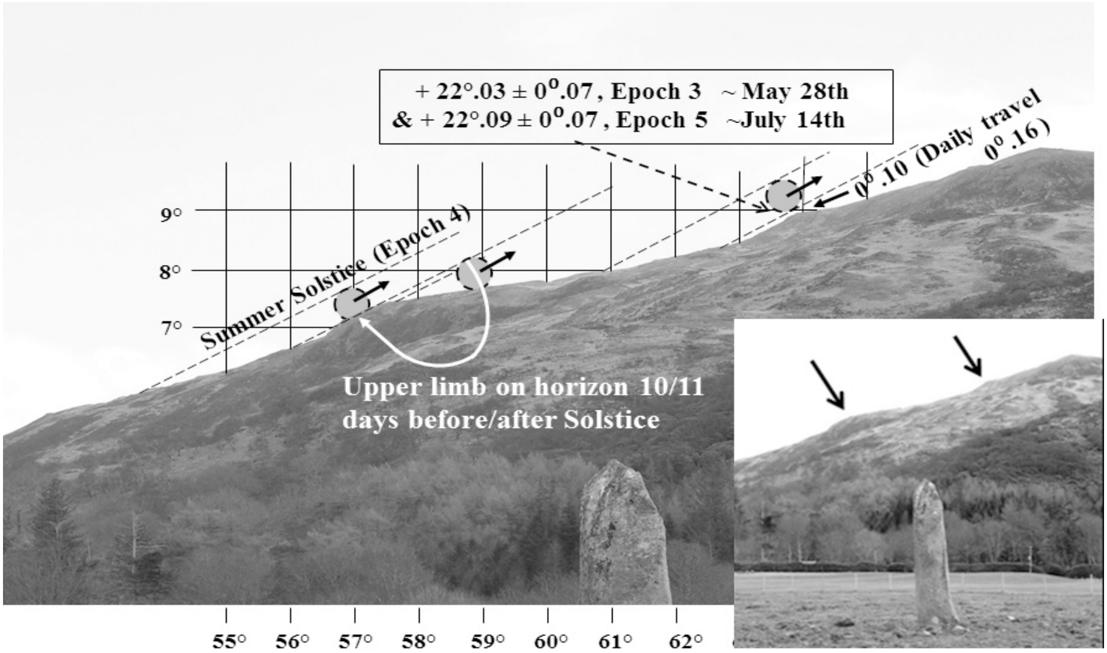

Figure 7 Gruline solar alignments

4.4 Tenga ML13 (NM 504 463)

An unimpressive moorland site consisting of five stones (one fallen), the two tallest being about 1.5m. (The stone designation follows that of The Royal Commission of Ancient and Historic Monuments Scotland (RCAHMS)). There are four alignments, three solar and one lunar. One solar alignment is from the stone pair A (+one fallen) to the other 'large' stone, C. All of the other three alignments are from a small to a larger stone. Opposite directions and all other combinations of pairs yield no alignments. Opinions in the past have favoured the remains of a stone circle (RCAHMS, Ruggles 1984) (Figures 8 and 9).

(The type of alignment A (+fallen) to C, viewing from between a stone pair over a third stone, is found elsewhere.)

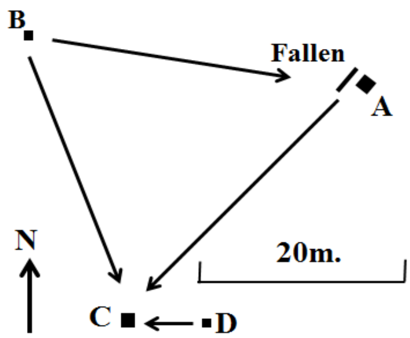

Figure 8 Tenga, Indicated directions

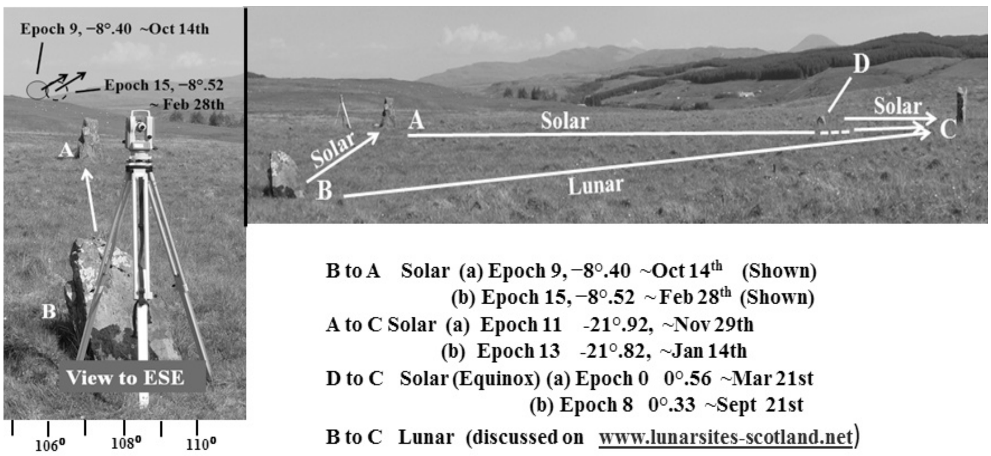

Figure 9 Tenga alignments, with one example

5. RESULTS FOUND FOR ALL CALENDRICAL ALIGNMENTS ON MULL

Sunrise (Map Ref.)		Epoch (Month)		Sunset (Map ref.)
Uluvalt C (ML 25) 5468 2996	+0°.4	0	+0°.6	Tenga (ML 13) 5040 4632
	+9°.0	1	+9°.2	Rossal (ML 27) 5434 2820 Ardalanish(ML 33) 3784 1888
	+16°.6	2	+16°.7	
Gruline (ML 16) 5437 3977	+22°.0	3	+22°.1	
Gruline (ML 16) 5437 3977	+23°.9	4	+23°.9	
Gruline (ML 16) 5437 3977	+22°.1	5	+22°.0	
	+16°.8	6	+16°.6	
	+9°.3	7	+9°.1	Rossal (ML 27) 5434 2820 Ardalanish (ML 33) 3784 1888
Uluvalt C (ML 25) 5468 2996	+0°.5	8	+0°.3	Tenga (ML 13) 5040 4632
Tenga (ML 13) 5040 4632	-8°.4	9	-8°.6	Lochbuie A(ML 28) 6163 2543
	-16°.2	10	-16°.4	Lag (ML 6) 3626 5331
Uluvalt B (ML 25) 5463 3002	-21°.9	11	-22°.0	Tenga (ML 13) 5040 4632
	-23°.9	12	-23°.9	Ardnacross(ML 12) 5422 4915
Uluvalt B (ML 25) 5463 3002	-21°.8	13	-21°.7	Tenga (ML 13) 5040 4632
	-16°.3	14	-16°.2	Lag (ML 6) 3626 5331
Tenga (ML 13) 5040 4632	-8°.5	15	-8.4	Lochbuie A(ML28) 6163 2543
Uluvalt C (ML 25) 5468 2996	+0°.4	16	+0°.5	Tenga (ML 13) 5040 4632

Table 2 Calendrical alignments on Mull

6. POSSIBLE CALENDRICAL ARTIFACTS

6.1 Kerbstone K15, Knowth, Ireland

A recent paper discusses the carved K15 kerbstone at Knowth, Ireland. In the past this has usually been described as being a sundial (Thomas 1988, Ruggles 1999, 129). However, a recent paper explains it as symbolising a solar calendar (MacKie 2013) (Figures 10 and 11).

Figure 10 Kerbstone K15, Knowth. Reproduced with permission of the National Monuments Service Dept of Arts, Heritage and the Gaeltacht, Ireland, with whom the copyright remains

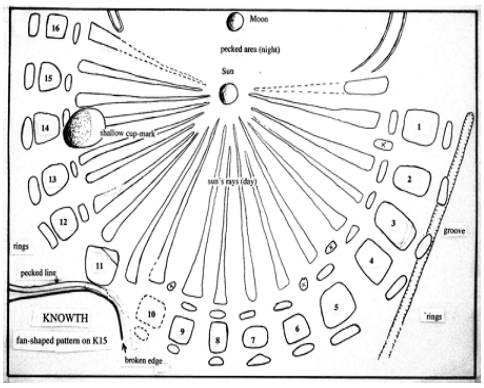

Figure 11 Drawing of K15 by Euan MacKie, reproduced with permission.

Each numbered square represents 21 days. Each short groove above or below the square represents one extra day each. The top right is the vernal equinox. The stone is damaged at the lower left, which leads to some uncertainties. Nonetheless, there is close agreement of the day/epoch between Euan MacKie's interpretation and Thom's (Table 3).

Euan MacKie has written a number of papers related to evidence for a prehistoric solar calendar (MacKie 1988, 1997, 2009).

Epoch	1 2 3 4	5 6 7 8	9 10 11 12	13 14 15 16
Thom (Days)	23 23 **24** 23	23 23 23 **22**	22 22 22 23	23 23 23 23
K15 (Days)	23 23 **23** 23	23 23 23 **23**	23 **21or 22** **22or 21** 23	23 23 23 23

Table 3 Deduced days per Epoch in a solar calendar

6.2 Bush Barrow gold lozenge

The gold lozenge was found when the Bush Barrow near Stonehenge was excavated in 1808. The range and quality of the artefacts found in the grave indicate that the man buried there was of high status. The grave has been dated to 1700 – 1900 BCE. The lozenge is inscribed with fine lines in a regular pattern. It has long been assumed that its purpose was only decorative. However, it is possible that calendrical directions could be encoded within it (Thom et al., 1988). (The gold lozenge is too small and fragile for practical use and so, if it does contain calendrical directions, it is likely to be a copy of a larger more robust field version, probably made of wood.) The deduced epochs to the east are shown in Figure 15.

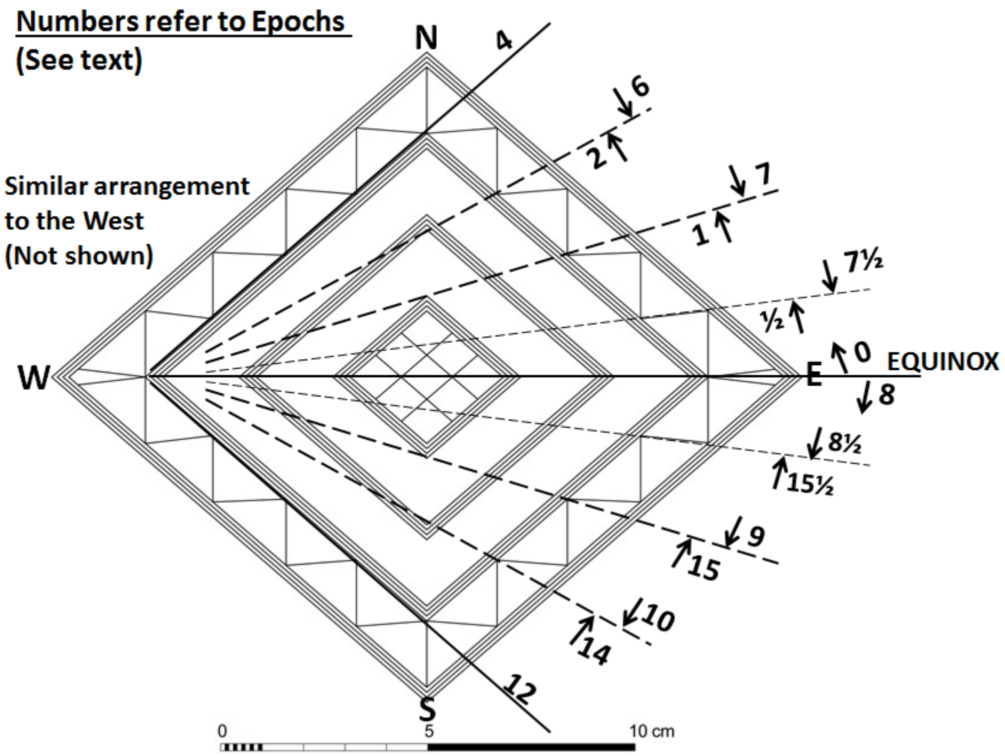

Figure 15. Possible calendrical indications from the gold lozenge

The lozenge has been inscribed with great care and, although small, it was possible to measure accurately the deduced directions. In use, the lozenge would be oriented north/south and levelled. An alidade would presumably be used. Note that the epochs ending in ½ are shown on either side of the equinox and the epochs before and after the solstices are omitted. This allows use of the regular zigzag pattern seen between the outer diamonds. North, although he has reservations about its calendrical properties, has pointed out some lengths are closely related to the megalithic inch (North 1996, 511ff.). The possible calendrical directions are correct to within about ± $0^0.5$. The acute angle at east and west is close to 81^0, which is correct for the angle between the solstices near the latitude of Stonehenge. North also points out (ibid., 517) that crossed lines, zigzags, diamond shapes, etc. are commonly found in prehistory, e.g., on pottery and in stone carvings. It may be that these are ritual representations of lozenges. If so, then they were considered to be important.

Using combinations of the vertices of the three outer diamonds, the lunar standstill directions are also indicated.

7. DISCUSSION

The only fixed times in the solar calendar are the solstices, and knowledge of the day of solstice would be necessary both to set up the calendar and to keep it regulated. This can, in principle and with difficulty, be done by using a very long alignment to determine the actual day of the solstice by observation of the very small movement of the sun near the solstices. Variable refraction would be a potentially serious matter. Ballochroy in Kintyre and Kintraw in Argyll may be of this type. Alternatively, the method of 'halving the difference', whereby the sun is observed at a foresight a few days before and after the solstice, could be used and is much easier (Ruggles 1999, 83; see below).

Clive Ruggles has cited several reasons to doubt the supposed calendrical alignments:

- Foresights for 'halving the difference' could be chance. *(Use of the method of 'halving the difference' is strongly supported by the alignments at Ardnacross and Gruline.)*
- Foresights can be chosen to fit. *(The method used identifies the foresights. The foresights found were typically within ±2 ^{o} of the indicated direction and well separated from other features. They are effectively unambiguous, i.e., there are no other reasonable choices.)*
- Single isolated alignments are quite possibly due to chance. *(Hence groups of stones are assessed. Table 2 above indicates the significant number of alignments found, and with very little duplication. See also Gough 2013 for an assessment of chance.)* (Ruggles 1999, 32, 53, 81)

7.1 Possible origins of a prehistoric calendar

In ancient times the general movements of the sun, moon and stars would have been familiar to everyone. The sun and the changing seasons would have been important, and particularly so as farming became more common. Certain times of the year would have particular importance, e.g., the end of winter, the start of summer, harvest time, and the end of summer. These would appear to be marked by the quarter days. (In England, in more recent times, 'the quarter days' has come to mean the solstices and the equinox. The divisions between them (Candlemass, Whitsunday, etc.) are called the cross-quarter days. This is not the old Celtic usage in Ireland and Scotland, where the subdivisions are the quarter days – as indeed they still are, although the dates have changed. The Celtic usage is adopted here.)

The names and times of the old Celtic quarter days survive: Imbolc (early February), Beltaine (early May), Lughnasadh (early August) and Samhain (early November). Festivals were held at these times. The meaning of the names shows close ties to the cycle of farming:

- Imbolc: Lambs' milk; transition of winter to spring.
- Beltaine: Beginning of summer; sown fields start to sprout.
- Lughnasadh: Wedding of the sun god Lugh to the earth goddess, causing crops to ripen.
- Samhain: Summer's end; preparations for winter.

The early missionaries would have been aware of the importance of these times (and the solstices). It was natural, therefore, to adapt important events of the Christian calendar to them.

A solar calendar that is built around these events and the equinoxes by equal divisions of the year goes far beyond what would be required by early farming communities. Taken overall, the evidence shows that a prehistoric calendar existed, and so the question becomes, how did it evolve? The following must of necessity be highly speculative, for as Euan MacKie has said regarding Thom's deduced calendar: "…what we are constructing is the technology of prehistoric astronomical observation; it tells us nothing about the motives of the alignment designers, or the ideology which guided them, or the social order in which they lived" (MacKie 1997). In attempting a possible explanation it seems necessary to introduce some ideas which may be controversial.

The number and variety of Neolithic monuments in Britain speaks clearly of an able and organised society. It is probable that within this society a chieftainship evolved (Renfrew 1973). Chieftains have a need to maintain their popularity, for which holding regular feasts would be important. It is, perhaps unfortunately, a human trait to wish to control others, whether benevolently or otherwise. A calendar would enable the chieftain to announce exactly when the festival should take place, thereby increasing their importance. An eightfold calendar by division of days would suffice. The counting of days need not be as we envisage it; the divisions could be achieved by use of pebbles or marks on a rope. Whether or not the above approaches the truth, it is clear that at some point a solar calendar evolved, perhaps of eight 'months' initially, later becoming sixteen 'months' (see Conclusions (section 8), below).

One may well ask: "Why in Britain and not apparently elsewhere?" Britain being relatively far north, it would have been noticeable that the sun at the winter solstice was low to the horizon. But probably more important is the fact that the northern latitude causes the length of horizon that the sun traverses between the solstices to be greater than it is further south. This has the effect of increasing the daily horizon movement of the sun and so increasing the separation of the foresights.

Once the basic parameters for a solar calendar were known (i.e., the number of days for each 'month'), alignments for a calendar could be set up in any suitably hilly region. The solstices secure the limits; after that, knowing the months, it is only necessary to find foresights for each epoch on the required day. Unlike lunar alignments, there are frequent opportunities to check the solar alignments. In addition, except at the solstices, a lower precision is required.

Given the precision required for lunar alignments, they can be dated with reasonable confidence. Thus, the root mean square of the differences between the theoretical declinations and the declinations found for the eleven lunar sites in Argyll was less than 1′ of arc (Gough 2013). The rate of change of the obliquity of the ecliptic is about 0′.7 per century, which suggests that the alignments were probably set up within about 100 years of the assumed date of about 1700 BCE (Thom, 1971). This argument applies only weakly to the solar alignments except for the solstices. What we can say is that close observation of the moon and its 'wobble', as found in Argyll, would seem to require an accurate calendar for anticipating succeeding wobble maxima (which occur at intervals of 173 days) during the 18.6-year lunar standstill, and of the standstill period itself. If this is correct, then we can be sure that the latest date for the prehistoric calendar is a little before the time of the lunar alignments. The Knowth kerbstone K15, discussed above, would require a much earlier date if the kerbstone is contemporaneous with the passage grave, which is dated about 3100 BCE. It is possible, however, that the kerbstone is a later addition. If, however, it does date from 3100 BCE (and assuming that it does illustrate the prehistoric calendar), then, although surprising, it does not present serious problems. Other than at the solstices, for which they must cover a range of declinations, calendars are much less sensitive to changes in the obliquity of the ecliptic than are lunar alignments. And, as discussed above, new calendrical alignments could be set up relatively easily by knowing the epochs and using the solstices as guides. The Mull results do not suggest any significant discrepancy, but they may have been set up specifically for the local lunar alignments on Mull and in Argyll and may therefore all be similar in date.

8. CONCLUSIONS

Given the solar alignments found, it seems very likely that the prehistoric calendar as proposed by Thom existed, at least on the island of Mull. The results also serve to confirm that the declinations derived by Thom from the histogram of declinations are essentially correct. Since the histogram was based on measurements from widely scattered sites, the only logical conclusion must be that solar alignments are likely to be common. The most likely reason for this is that the prehistoric calendar was in general use.

(All of the results from Mull and further discussion and analysis is available on the website www.lunarsites-scotland.net.)

REFERENCES

Atkinson, R.J.C. (1975) Megalithic astronomy: a prehistorian's comments. *Journal for the History of Astronomy*, vol.6, part 1, No 15, 42-52

Gough, T.T. (2013) New evidence for precise lunar alignments in Argyll, Scotland in the Early Bronze Age, Sprajc I. and Pehani P.(eds.), *Ancient Cosmologies and Modern Prophets, Proceedings of the 20th Conference of the European Society for Astronomy in Culture, Anthropological Notebooks*, year XlX, supplement, Slovene Anthropological Society, Ljubljana, 157-175

MacKie, E.W. (1988) Investigating the prehistoric solar calendar. *In Records in Stone*, Ruggles C.L.N. (ed.), Cambridge University Press, Cambridge,

MacKie, E.W. (1997) Maeshowe and the winter solstice. *Antiquity*, vol. 71, No 272, 338-359

MacKie, E.W. (2009) The prehistoric solar calendar. *Time and Mind*, vol.4, Issue 1, 6-46

MacKie, E.W. (2013) A Rosetta Stone for the prehistoric solar calendar?: Kerbstone K15 at Knowth, Ireland. *Time and Mind*, vol.6, Issue 2, 211-230

Martlew, R.D. and Ruggles, C.L.N. (1993) The North Mull project(4): excavations at Ardnacross 1989-91. *Journal for the History of Astronomy*, vol. xxiv (*Archaeoastronomy supplement*, no.18), S55-S64

North, J. (1996) *Stonehenge: Neolithic man and the cosmos,* Harper Collins, London

Renfrew, C. (1973) *Before Civilisation*, Cape, London

Ruggles, C.L.N. (1984) *Megalithic Astronomy: a new archaeological and statistical study of 300 western Scottish sites*, BAR British Series 123, London

Ruggles, C.L.N. (1985) The linear settings of Argyll and Mull, *Journal for the History of Astronomy*, vol. xvi (*Archaeoastronomy supplement*, no.9), S105-S132

Ruggles, C.L.N. (1999) *Astronomy in Prehistoric Britain and Ireland*, Yale University Press, New Haven and London

Thom, A. (1967) *Megalithic Sites in Britain*, Oxford University Press, Oxford

Thom, A. (1971) *Megalithic Lunar Observatories,* Oxford University Press, Oxford

Thom, A.S., Kerr, J.M.D. and Burrows, T.R. (1988) The Bush Barrow Gold Lozenge: is it a solar and lunar calendar for Stonehenge? *Antiquity*, vol 62, No 236, 492-502

Thomas, N.L. (1988) *Irish Symbols of 3500 BC*, Mercier Press, Dublin