Professor Challenger and his Lost Neolithic World

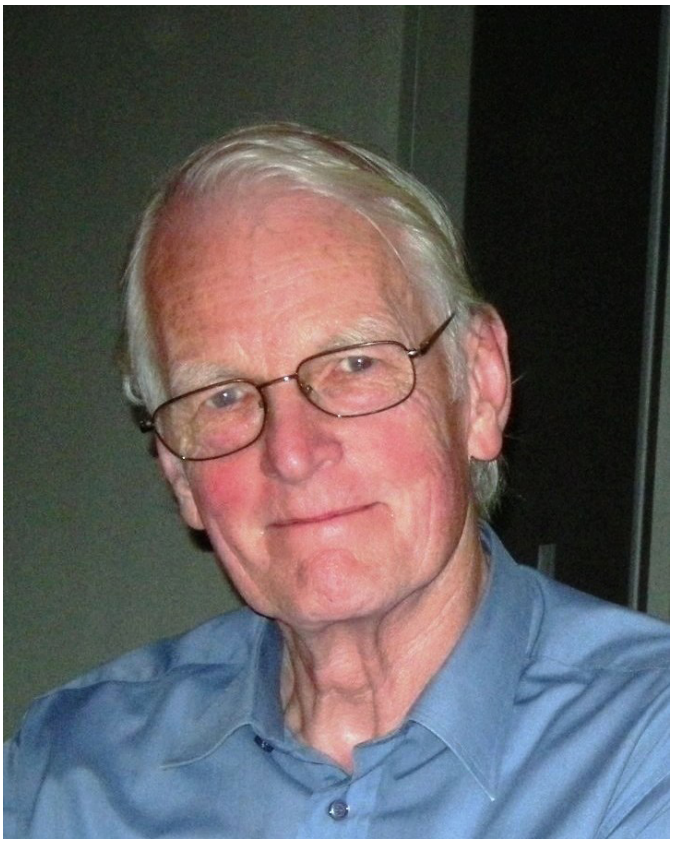
The compelling story of Alexander Thom and British archaeoastronomy

Euan W. MacKie



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Dr Euan W. MacKie (1936-2020), was a British archaeologist who graduated with a degree in Archaeology and Anthropology from St John's College, Cambridge in 1959. As a member of the Cambridge Expedition team in 1959-60, he spent six months in British Honduras excavating the Mayan site of Xunantunich. He was then employed briefly at the British Museum Department of Ethnography, before becoming Curator and Keeper of Archaeology and Anthropology at the Hunterian Museum at the University of Glasgow where he later obtained his PhD. Dr MacKie published books, reports and multiple academic papers on an extensive range of subjects. Through regular excavations, fieldwork and research, he developed his principal research areas: the brochs and vitrified forts of the Scottish Iron Age, and archaeoastronomy - the investigation of the astronomical knowledge of prehistoric cultures. He was a Fellow of the Society of Antiquaries of London and of the Society of Antiquaries of Scotland, and served as President of Glasgow Archaeological Society. In retirement he became an Honorary Research Fellow at the Hunterian Museum and from 2007 was an Honorary Research Associate at the National Museums of Scotland. In 2018 he was the recipient of the Presidential Award from Glasgow Archaeological Society.

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(Figure 4.4, p. 73 - an example of a potential indicated alignment)

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Foreword

Writing Professor Challenger combined two great passions of my father's life: immersing himself in the reconstruction of the Neolithic mind and constructively challenging consensus in his professional domain. Given these preferences, the attraction to both Professor Thom's work and Conan Doyle's eponymous character make perfect sense. The book is semi-autobiographical in style charting Dad's investigation of Thom's theories across a number of key Neolithic sites from Kintraw to Stonehenge and finally Orkney. It also maps his own perspective of the changing reception to Thom's ideas by the archaeological profession from initial curiosity and acceptance to increasing scepticism. This healthy and necessary diversion of views energised Dad well into his retirement to continue researching in the area, conducting painstaking field investigations from which to inductively infer the astronomical abilities of the Neolithic 'priesthood'. The first six chapters are historical summaries of the various strands of evidence from key Neolithic sites across the UK and Ireland with the compelling evidence of the Ness of Brodgar added as an appendix. The final chapter was Dad's endeavour at adding some contemporary references and brought a more optimistic tone to the acceptance of Thom's ideas. Unfortunately ill-health prevented him from editing this final chapter so we have done this for him to enable publication.

Dr Doug MacKie

1.7.20

Preface

In 1912 Sir Arthur Conan Doyle published his novel *The Lost World* which was a story about the discovery in the Amazon jungle of South America of an isolated lost world, on top of a high plateau with cliff edges, in which dinosaurs and pterodactyls still lived. The explorer was the British Professor George E Challenger but, when returning through the jungle from the first expedition, he lost in the river the vital piece of evidence which proved what he had found. Back in Britain he announced what he had discovered but all his scientific colleagues thought his story was utterly fantastic and that he was lying and they denounced him. The only solution was to return to the Lost World with some friends and colleagues who were prepared to be taken to see the dinosaurs. This was a success and restored his reputation.

There is a similar story in British archaeology in the latter part of the 20th century. The equivalent there to Professor Challenger is Professor Alexander Thom who published a book in 1967 called *Megalithic Sites in Britain* which was the result of many years of fieldwork on Neolithic standing stones and stone circles. He deduced from this mass of evidence that the builders of these sites had highly sophisticated knowledge of astronomy and geometry, and also used a standardised measuring system. At first many archaeologists – including me – were very interested in his ideas and several took part in second expeditions to the Neolithic lost world and searched for more information to test Thom's ideas. The Royal Society held a conference to discuss the new ideas and published papers by the participants, including the author's (MacKie 1974).

As years went by however some British archaeologists became increasingly sceptical about Thom's ideas, probably because their major implication was that a skilled professional priesthood existed in Neolithic times. Also such people would have to learn basic astronomy and geometry in order to understand Thom's evidence, which might have seemed rather a burden. However Clive Ruggles, who is qualified in this area, gave them a reason not to believe Thom by claiming to have disproved most of his deductions about individual sites. Chapter 4 contains an analysis of Ruggles 'disproof' which was of apparently such a convincing nature that it persuaded many of the archaeological profession which specialized in this period of prehistory. Ruggles became president of the Prehistoric Society and organized a conference on Thom's work to which the author was not invited.

Alas, Professor Thom is no longer with us so I – being retired and over 80 – have adopted the role of Professor Challenger in this controversy. The scientific method of testing his hypotheses was adopted – starting in 1971 – by carefully examining five sites and checking whether they had the qualities that Thom had deduced. They all had, but the hostility of many colleagues to these conclusions became more intense. The tragedy is that the supporting evidence is completely ignored by some even though debate – and not the 'theory first' approach – is the key to high quality research. Some of the younger generation now study standing stone alignments through computers, and a few through fieldwork, but few seem to accept that a sophisticated priesthood could have existed in Neolithic times (see Chapter 7 for details). The evidence from Orkney (Chapter 3) has now begun to change this for many archaeologists.

However the similarity of this story with Conan Doyle's The Lost World has suddenly become greater because a mass of independent archaeological evidence from Orkney has emerged over the last few years which favours a Neolithic society with a priesthood (Chapter 3). There are also increasingly clear signs that this remarkable northern Neolithic culture had a big effect on – or was affected by – the evolution of Stonehenge (Chap. 5); this remarkable standard archaeological evidence should eventually make the work of Professor Alexander Thom more acceptable. Also in recent years more and more archaeologists have investigated British archaeoastronomy but there seems to be not too much assertion of a Neolithic priesthood (see Chapter 7 for details).

At its core this controversy is about the way that evidence is perceived and the willingness to abandon the preconceptions of 'theory first' approaches in the light of new evidence. Professor Atkinson (1975) was one of the first to change his mind; he found the new evidence highly plausible and explained it thus. 'I myself have gone through the latter process' [a deductive rejection of Thom's work] 'but I have come to the conclusion that to reject Thom's thesis because it does not conform to the model of prehistory on which I was brought up involves also the acceptance of improbabilities of an even higher order. I am prepared, in other words, to believe that my model of European prehistory is wrong, rather than the results presented by Thom are due to nothing but chance.'

My own interest in Thom's research developed in 1970 when I met Professor Thom down in Argyllshire where he was being filmed by a TV group about his ideas about standing stones and stone circles. He explained how the long midwinter sunset alignment of the Kintraw standing stone was invisible beside the stone itself and had to be watched from some way up the steep hill behind the stone. I excavated the place he identified and found an artificial level rubble platform. This seemed to me to prove that he was right and encouraged further successful excavation tests of his hypotheses. This did not prove Thom's discovery to his hostile opponents. However my hope is that the more recent reseaarch described herein will be more successful in persuading the reader of the merits of Thom's hypotheses.

E. W. Mackie

Chapter 1
The origins of the controversy

It is necessary at the beginning of this work to explain how what has been a particular controversy in British archaeology began. In two books (1967 and 1971), and in a number of papers going back many years[1] the late Professor Alexander Thom offered prehistorians a detailed new interpretation of the origin and function of Neolithic standing stones and stone circles, and some new insights into the astronomical, mathematical and geometrical skills possessed by their builders. Although suggestions were not lacking (before this potential major revolution) that the Neolithic and Early Bronze Age inhabitants of Britain, or a few of them, practised quite sophisticated astronomy, it was Thom who did systematic fieldwork in many places. However these earlier views were based on a large number of assumptions derived from individual sites like Stonehenge in southern England and Callanish in the Outer Hebrides.[2] Thom was the first to have systematically surveyed large numbers of standing stone sites, to have looked for possible astronomical alignments in them and to have founded his theories on a mass of data drawn from many sites instead of a few.

1.1 Thom's hypotheses

Thom's hypotheses fell into three groups. The first is that the erectors of stone circles practised sophisticated geometry in laying out their circles and arcs – having knowledge for example of Pythagorean triangles – and used a precise and invariable unit of length in doing it. This is the 'megalithic yard', equal to 0.829m (2.72 feet) and strikingly similar to the modern Iberian *vara* of between 0.843 and 0.838m (2.766 and 2.7495 feet).[3]

The second theory concerns the cup-and-ring rock carvings of south-west Scotland (and can presumably be extended to those of other regions). Thom suggested that these were drawn out with the same elaborate geometry as in the stone circles and rings and were based on a unit of length independently deduced from the carvings. This turned out to be 1/40th of the megalithic yard, that is 20.5mm (0.808 inches).[4]

The third major theory suggested that many standing stones and stone circles were intended as the backsights of long and accurate alignments to notches and peaks on the horizon which were intended to mark accurately the rising and setting points of various celestial bodies at significant times.[5] The solar sites among these are particularly important and were presumably designed to make possible the keeping of an accurate calendar by pinpointing the days when the Sun was at its extreme (midwinter and midsummer solstices) and central (equinoctial) positions on the horizon. Another major part of this astronomical theory is that many other alignments were constructed to record the more complicated motions of the Moon, and that this was done in order to predict eclipses.[6]

In the many decades which have passed since Thom's work was published and made an impact on archaeology, I have tried to test his ideas by investigating some long alignments, several not investigated by him. Chapters 2, 3 and 5 deal with the astronomical theory and Chapter 6 describes a remarkable find in Ireland which strongly supports the need of long alignments to construct a calendar. Kintraw is one

[1] See the almost complete list in the Bibliography on pages 145-6
[2] Lockyer 1906
[3] Thom 1967
[4] Thom 1968
[5] Thom 1967
[6] Thom 1971

site in Argyllshire where it was necessary to make a prediction about the viewing point before it was plausible. This is described in detail in Chapter 2

1.2 Methods of approach

When assessing the value of a new and controversial theory – the acceptance of which would require some drastic changes in long established ideas – it is important to be quite clear about the nature of the evidence on which the new hypothesis is based. In the case of Thom's theories it was quickly evident in the late 1960s that it was not proving easy for the archaeological profession to accept his ideas, which would credit elements in the prehistoric British population of the late Neolithic and early Bronze Age periods with skills in practical surveying, advanced geometry and observational astronomy which are far better than any hinted at by the more traditional archaeological evidence.[7]

At that early time so unexpected were Thom's interpretations when set against previous archaeological ideas that it was only fair to ask that the evidence on which they were based be subjected to careful scrutiny and the theories themselves tested where possible. However it would obviously have been wrong to reject those theories because they did not match with the contemporary accepted picture of prehistoric Britain. Our failure to find evidence of sophisticated intellectual activity among the chambered tombs, stone circles and standing stones of about 4000 years ago cannot mean that such evidence does not exist. It need only mean that most of the archaeological profession was not equipped to discover it; in just the same way ordinary people – including astronomers – are not qualified to excavate an ancient site and analyse its stratigraphy.

It is also true however that such new archaeoastronomical theories should have been independently but empirically tested as much as possible. Hypotheses based on statistical studies depend on the quality of the evidence analysed statistically and this set was to be checked independently in the 1980s by Clive Ruggles, who was not an archaeologist but who had similar knowledge to that of Alexander Thom. Chapter 4 discusses this and asks if Ruggles was completely independent in his attitude to Thom's ideas.

What is the crucial evidence? Basically it then consisted of the identification in the field[8] of a large number of long alignments from pointing standing stones to prominent features on the horizon and of the discovery that these sight-lines cluster round significant prehistoric astronomical declinations (meaning positions in the sky) such as those of the Sun at the two solstices (midsummer and midwinter) and at the two equinoxes. The Sun could be rising or setting at these dates so there are eight potentially significant solar points on the horizon. The Moon has four extreme positions so another eight lunar positions could be marked.[9] If one assumes that the alignments are genuine the histogram of their declinations is by itself a highly significant body of evidence since these Sun and Moon alignments only cluster in this way when converted into declinations in the sky. A histogram of their azimuths would show a more random distribution, since the celestial bodies rise and set at an angle to the horizontal horizon. When the horizon is suitably uneven the azimuth of them varies.

Possible tests for the Thom theories

There is a variety of tests which can be applied to both the evidence Thom assembled in the 1950s and 1960s and to the various theories which he devised to explain it all. I think they can best be identified as answers to the following questions. (1) Have the alignments been identified objectively? In other words

[7] Hawkes 1967
[8] In modern times several archaeologists use computers to analyse alignments; this needs to be justified by explaining what the computer programme does
[9] Thom 1967, fig. 8.1

is there a clear indication, at the backsight, by a standing stone or something else, of the exact rising and setting points on the horizon? (2) Are they the most likely ones, or the only ones, to be seen from the site concerned? (3) Does any available archaeological dating of the backsights fit the dates of the indicated solar or lunar declinations? (4) Are there any features which the astronomical interpretation requires to be present which can be checked by fieldwork and excavation? (5) Does the archaeoastronomical theory involve any equipment and techniques which the Neolithic (New Stone Age) technology was unlikely to have been able to produce? (6) Is there a problem with storing the resulting knowledge about solar and lunar movements in societies which do not use a writing system? (7) Finally, is there any independent evidence for the existence in Neolithic Britain of the kind of society which has a class of specialists – like priesthoods – which can remember and pass on knowledge orally, exceptionally well? An answer to the last question is in Chapter 3, about Orkney.

Starting in the 1960s I attempted to test Thom's ideas by surveying and/or excavating various sites, including one remarkable one called the Kintraw standing stone. Here a prediction had to be made by Thom about the position of an observation platform because the distant horizon could not be seen from the field in which the standing stone was set up. This is a classic example of the scientific method and I carried it out, with success. Chapter 2 contains accounts of these experiments, the results of which favoured Thom's ideas. The other result is that these explorations are unpopular with large numbers of concerned archaeologists. A classic example was provided by an ex-colleague (I am retired now) in the Hunterian Museum. Some time in the 1980s I was to speak about my work to the Glasgow Archaeological Society and I discussed this with him beforehand. He ended the discussion after a few minutes by expressing his near universal scepticism. Many others have similar views which are without doubt sincere; yet it is very difficult to engage in rational debate with them. One is reminded of people with strong political views! However as explained in the Preface this situation may now change.

One particular reason for opposing Thom's ideas was held by the followers of Immanuel Velikovsky's theory of a major catastrophe to the Earth in the second millennium BC, which altered the rising and setting phenomena of the Sun and Moon (MacKie 1975). In the same magazine (*Pensee*) there are several other arguments on the subject, two by Velikovsky himself. Some of his followers came to Kintraw when the excavation was taking place and clearly hoped that the prediction of a high observation platform, well above the standing stone, was nonsense!

1.3 Archaeological reaction to Thom's major publications in the 1960s and 1970s

Although it was Gerald Hawkins' 1965 book that first alerted British archaeology to the remarkable potential that detecting ancient astronomical practices has for altering our view of the prehistoric world, the genesis of the modern flowering of archaeoastronomy and ethnoastronomy clearly lies in the work of Alexander Thom in Britain between the 1930s and the 1970s. It was Thom who taught us how to look for, and rigorously assess, the field evidence for sophisticated sky watching, calendar making, surveying, and geometry in prehistoric times. Without this basic insight, and the stimulus to the sound research that resulted, it is doubtful whether this Royal Society conference of 1974[10] and its six predecessors would ever have been held.

Some British archaeologists and prehistorians, however, still found it hard to deal with Thom's work, which was by then rarely considered in publications, and his conclusions were generally thought too weighty for the evidence he assembled. Mike Pitts' book[11] is a good example of this attitude, not because he is exceptionally skeptical, but because he is fairly typical, at least of those who write books about the Neolithic period. He is also typical in exhibiting a fairly basic misunderstanding of the subject, and one

[10] MacKie 1974
[11] Pitts 2000:222–229

that goes far to explain the skepticism mentioned. His chapter devoted to ancient astronomy mounts an assault on a concept that probably no one who specializes in archaeoastronomy believes any more which is that some kind of 'science' was being practised in prehistoric Britain and that accurate long celestial alignments are the crucial evidence that is used to prove this. This belief must have been given a major boost by Alexander Thom's idea that the intricacies of the moon's orbit were being unravelled with the help of such alignments (Thom 1971); it is easy, when reading that book, to conclude that Thom was arguing for some kind of objective research into the moon's movements in prehistoric times. The whole long and often tedious history of attempts to disprove *all* of Thom's ideas almost certainly derives from this view of prehistoric mental activity that was genuinely held – often subconsciously – in the 1960s and 1970s.

The origin of the idea of 'prehistoric science' almost certainly lies in Gerald Hawkins' *Stonehenge Decoded*[12] which, perhaps unwittingly, fostered the idea that this famous site was used as a 'Stone Age computer' to keep the calendar in order and to predict eclipses. I also have to take some of the blame; the title of my book *Science and Society in Prehistoric Britain*[13] obviously perpetuated the myth and was ill-chosen. By contrast, Colin Renfrew's *Before Civilisation* (1973) had a chapter in which he summarized Alexander Thom's basic discoveries but set them firmly within the real world of simple societies – as traces of the religious activities of a professional priesthood of the kind that could be expected to emerge in the chiefdom type of social organization. If everyone – including myself – had paid more attention to Renfrew's scenario, the mutual incomprehension that existed between orthodox British archaeology and archaeoastronomy about forty years ago might not have evolved and the situation now might have been better.

However, the false equation referred to is still widely believed, and British archaeological critics clearly believed that any acceptance of accurate alignments (capable of being used as observing 'instruments' instead of just as rough orientations),[14] as well as the 'megalithic yard' and its associated geometry, would open the door to 'prehistoric science' and to an infinity of further misunderstandings. Even the concept of a professional priesthood, with a specialized knowledge of the movements of celestial bodies, seems to be viewed in the same light, and the purely archaeological evidence for such a priesthood in southern Britain in Neolithic times is usually dismissed impatiently (see the subsequent quotation about my 1977 book). Thus, the underlying reason for the doubts about Thom's accurate long alignment hypothesis seems to have been forgotten, and Clive Ruggles, Gordon Barclay, and Mike Pitts, for example, continue to criticize this and related concepts even though it ought to be generally accepted by now than any astronomical skills present in prehistoric Britain – even up to the level of eclipse prediction, which is debatable to say the least – must be seen as part of a wider religious activity and not as 'scientific' research.

Thus, Pitts' chapter accepted without comment all the hostile assessments of Alexander Thom's work – and of my related archaeological work that supports Thom. Indeed, Pitts explicitly wrote, 'My assessment relies heavily on the fruits of Clive Ruggles' work, which displays unparallelled attention to detail in both its archaeology and astronomy.' His resulting skepticism is therefore understandable since Ruggles' assessments are widely accepted in the world of archaeoastronomy, and his major work on the subject[15] has been much praised. His assessment of Thom's work is described in Chapter 4: I wrote a review of Ruggles' book (in 1984) which discussed a basic difficulty in it but it was in an American journal[16] and probably did not reach British archaeology. This is in Chapter 4. However Clive Ruggles was

[12] Hawkins 1965
[13] MacKie 1977a
[14] MacKie 1997a:340-41
[15] Ruggles 1984
[16] MacKie 1984

quite generous to Alexander Thom. His 1988b book included a mass of papers – included one of mine – which mostly supported Thom's work.

One or two further examples of frequent misunderstandings are found in the chapter cited. First, Pitts refers to the tendency of people who are favourable to archaeoastronomical ideas to quote the intellectually sophisticated Maya as a parallel for what is claimed to have taken place in Neolithic Britain – 'Not least the oft-quoted but ill-informed and out-dated MacKie (1997)'. For a recent perceptive and damning critique of MacKie's ideas, see Ruggles and Barclay'[17] yet I had already, several years earlier, abandoned as misguided the idea of 'prehistoric science' and admitted that the possible parallel drawn with the Maya in 1977 had gone too far.[18]

A study of later relations between British archaeology and Thom's archaeoastronomy is in Chapters 4 and 7.

[17] Pitts 2000, Endnote 497. Ruggles and Barclay 2000
[18] MacKie 1977a: 341, including footnotes 2 and 3

Chapter 2
Early hypothesis-testing in western Scotland

2.1 The Kintraw standing stone

Alexander Thom was taking part in a BBC television programme in about 1970 and the Kintraw standing stone featured in this. I met them all there and heard about the unique possibility of Thom's idea about Kintraw's solstitial function being able to be checked by testing a major prediction by excavation. There are many more details in the paper I wrote about the site in 1974 (see bibliography).

The site is at the inland end of the long sea-loch Craignish where there is a single flat field some height above the water. In this field is the flat-sided standing stone – approximately aligned down the loch (Figures 2.1 and 2.2) – next to a large and a small cairn which were excavated in 1959 and 1960.[1] The small one had been almost destroyed but a hole for a wooden post about 7.5cm in diameter was found in the ground under the centre of the large cairn. Thom discussed this site (1967) and suggested that the menhir was the back-sight of an astronomical alignment looking down the loch and aligned towards Beinn Shiantaidh, one of the Paps of Jura (Figure 2.3). This provided a very clear notch in which the midwinter sunset could have been marked (Figure 2.3, lower). However there was a major viewing problem in that a local ridge 1.6 km in front of the site (and on the other side of part of the loch) prevented one from seeing the Pap of Jura from beside the stone. Thom thought that the observation position must have been on top of the large cairn when it was higher long ago; plenty of modern dry-stone structures are nearby which probably used cairn material. The notch between the two Paps indicated a midwinter sunset at about 1800 BC. Presumably he spotted this distant set of mountains by climbing on top of the large cairn.

However there was a major problem because of the presence of a tree-covered ridge about 1.6 km in front of the stone in the same direction (Figure 2.3, lower); this hides the distant potential fore-sight from anyone standing in the field. It may be true that it is visible from the top of the cairn but this cannot explain how the notch was identified in the first place; it would have been necessary to have made many observations of the notch from either side of the final backsight until the spot from which the extreme sunset was visible in the notch – marking the position in which to erect the standing stone – was identified (Figure 2.3). This could not have been done from the field surface. Thom realised this and explored the steep slope beyond a stream which runs across the north end of the field. He found a long narrow ledge several metres above the field which had evidently been dug out to make a horizontal and crude observation path when the site was being planned. From this ledge or path the Paps of Jura were easily visible (Figure 2.3, lower). At the spot – just in front of the rough path – marked by a line from the notch in the Paps through the standing stone in the field below there was a large prostrate boulder which seemed to mark the observation point. Later this supposition was confirmed by the observation of a small standing stone a few yards further up the steep hill (Figure 2.7).

In the autumn of 1969 I discussed the Kintraw site with Professor Thom and with Dr A.E. Roy. Thom was kind enough to let me read the manuscript of his new 1971 book in which a detailed discussion of the Kintraw site occurs. It was immediately apparent to me that the site was of a rare kind which would be a scientific test of Thom's hypothesis about Kintraw. If that was correct, excavation would almost certainly reveal a carefully laid stone floor behind the boulder from which observations of the midwinter sunset could easily have been made. I agreed to carry out a week's excavation to test this idea in the summers of 1970 and 1971; the full details are in my 1974 paper (see Bibliog.). The excavations

[1] Simpson 1967. Thom 1967: 54

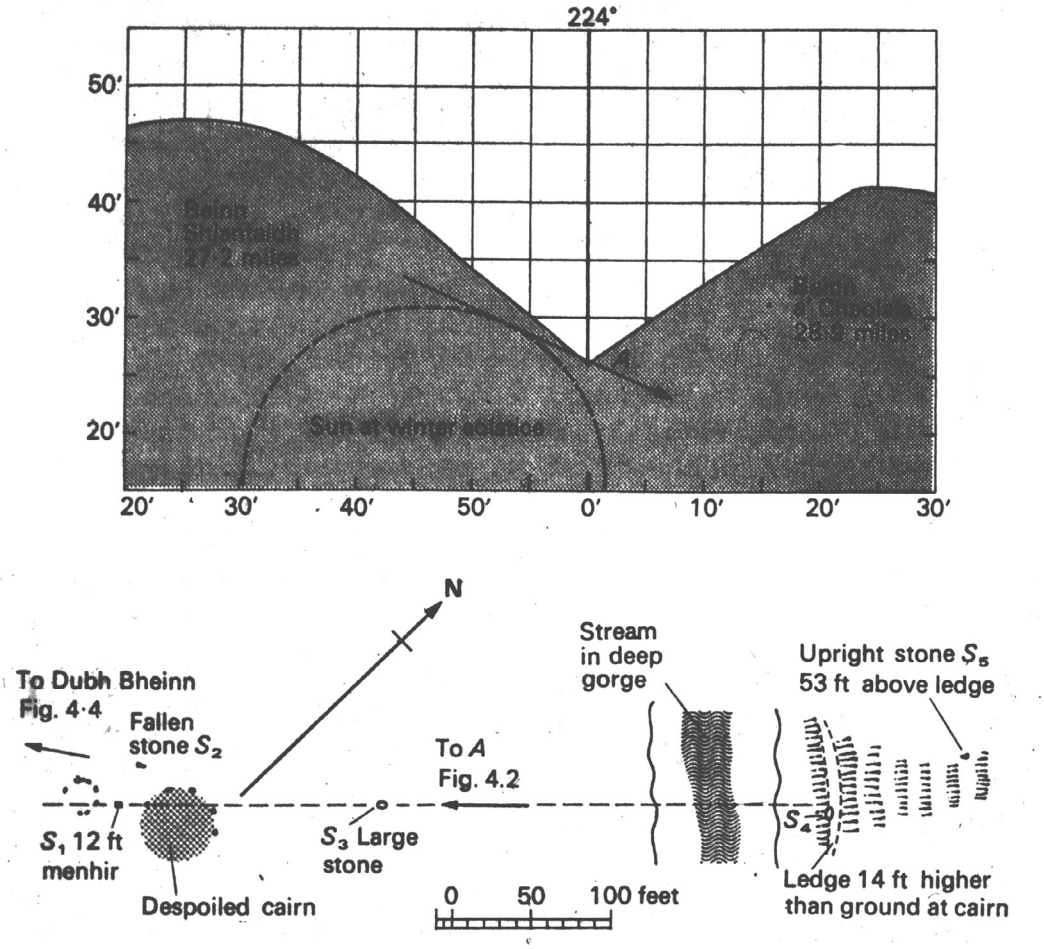


Figure 2.1. Alexander Thom's map of the Kintraw site.

revealed a thick stone floor piled up against the two horizontal boulders and a statistical analysis of the stones confirmed that they were laid by humans. Many years later (about 2012) Douglas Scott refused to believe any of this and referred to Thom's theory as a 'myth' in an on-line journal – *Past Horizons*. I had to explain in the journal in 2014 the real nature of the evidence uncovered by the excavations on the steep slope behind the field containing the standing stone and cairns. This is the text of the on-line paper.

Introduction

Douglas Scott's 2011 paper 'Astronomical observations at Kintraw in Argyll' concludes that Alexander Thom's hypothesis about the site is a myth. This states that the standing stone there marked the observing position for a long and accurate sight-line to a conspicuous notch between two peaks on Jura, which was capable of defining sunset on midwinter's day exactly. This conclusion is based on an examination of archaeological evidence, concerning the burial cairn next to the standing stone, which is not essential for that hypothesis. There is in fact plenty of other information from the site which decisively supports Thom's ideas but it is not considered. This is not unusual; the Royal Commission's account of 1980 fails to mention it either, although it does refer the reader to the relevant publications.[2]

[2] RCAHMS 1988: 64-67 and note 4

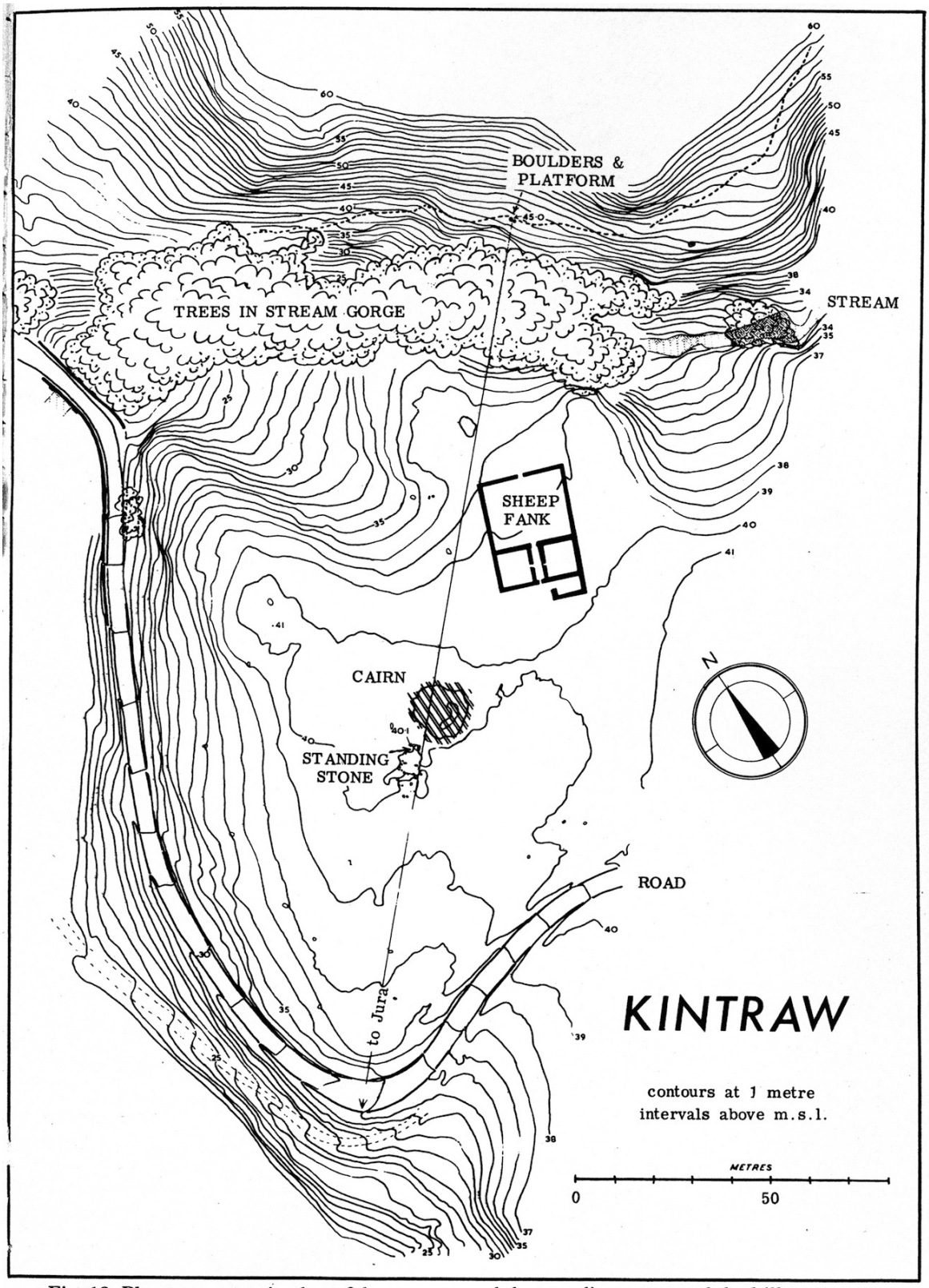


Figure 2.2. Photogrammetric contour plan of the Kintraw site showing the field with the cairns and the standing stone ('menhir'), the stream gorge and the platform with boulders discovered beyond on the hillside. The small standing stone slightly above the platform was omitted. The contours are at 1m intervals above mean sea level and the straight line connects the platform, the standing stone and the distant peak.

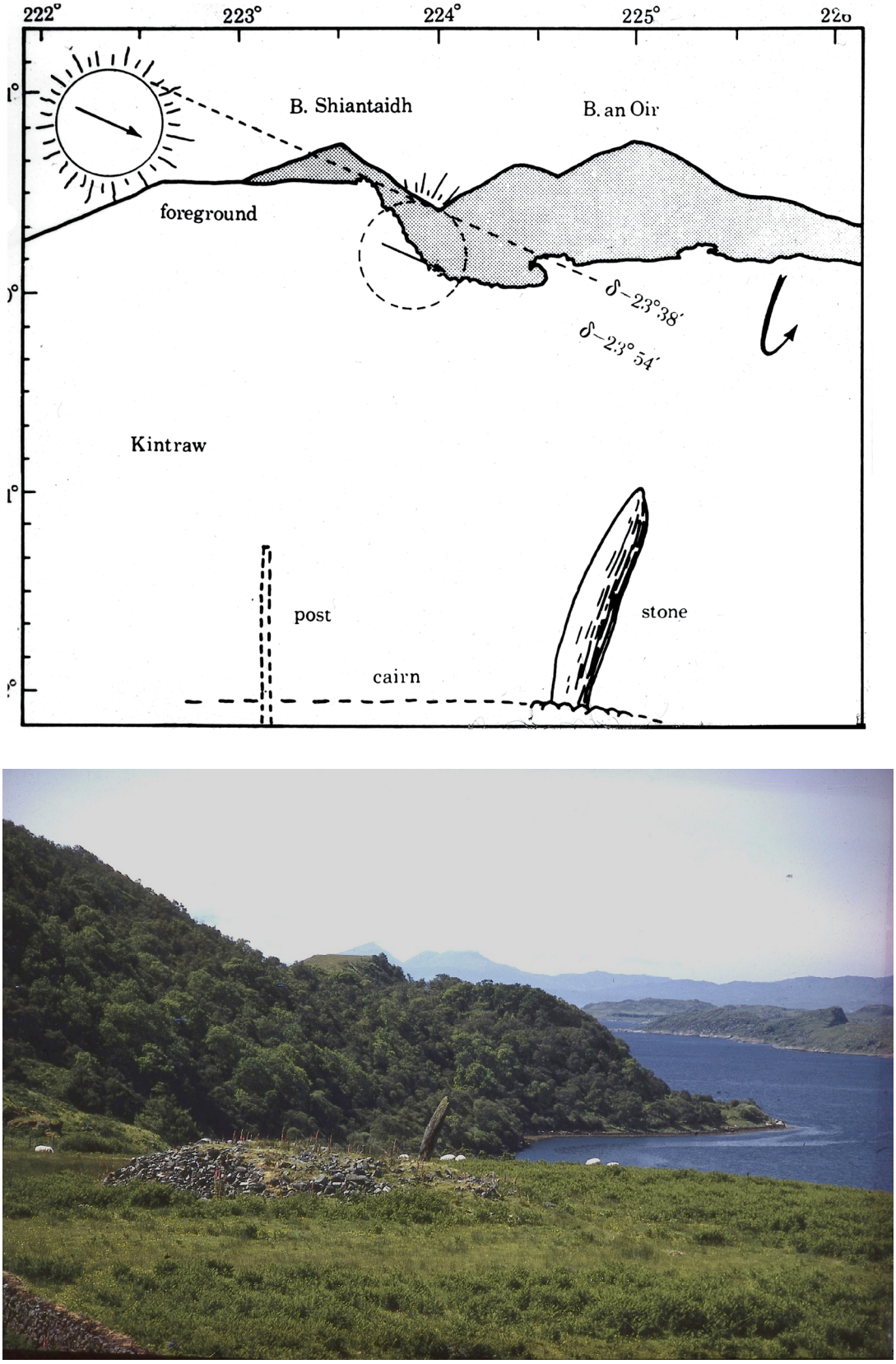


Figure 2.3. Photograph from the hill platform at Kintraw, with the cairns, the standing stone and the two distant horizons all showing. Above it: drawing of the same view.

Thom's original 1954 publication about the potential of the Kintraw standing stone as a 28 mile long, highly accurate midwinter sunset alignment is unlikely to have come to the attention of archaeologists. Right at the beginning he recognised that there was a difficulty with the interpretation; one cannot see the distant foresight (a V-shaped notch between two of the Paps of Jura) from beside the standing stone because of an intervening ridge about a mile away (Figure 2.1). A higher observation point was needed. The first mention of the site in the book explains his reasoning. 'To see the col' (on Jura) ' one must move to the right, where the azimuth of the col is too low to give the solstice, or climb some structure such as the cairn, which is in the correct position. How did the builders know where to place the cairn when they could not see the col from ground level?' One might add, how did they know where to put the standing stone itself? 'The answer, obvious now, is that they first established a position on the steep hillside to the north of the plateau.'[3]

It is important to note that it was Thom himself who suggested that the massive burial cairn next to the standing stone was intended as the primary observing position. The hypothetical location on the steep slope northeast of the cairn and beyond the stream gorge was seen as simply a temporary device to make sure the cairn was built in the right place. Hence Douglas Scott, and others before him, were quite right to challenge this view and to try to show that there was no evidence from the cairn itself to support this idea. Even more important is the inherent assumption that the cairn was contemporary with the standing stone and if Thom's interpretation of its primary purpose was an essential part of his long alignment hypothesis then this would be a major flaw in his argument as this is quite unprovable; it could easily be later or earlier than the stone and therefore have nothing to do with the alignment.

The Kintraw cairns

However Scott has offered some quite plausible hypotheses which imply that the cairn builders arranged orientations – from the central post under the larger cairn – towards mid-summer sunset and sunrise, and also towards midwinter sunset and to the Quarter Day sunsets at the beginning of February and November. Essential evidence to support these ideas is however missing. If these supposedly calendrically significant lines were more than mere ceremonial orientations – like the east-west arrangement of Christian churches – each should point to some conspicuous notch or hill slope on the horizon to give a minimum of accuracy. However drawings of the horizon points concerned are not given. In any case any useful sight-lines must obviously pre-date the cairn, through which they pass. However the 'sight-lines' may not even be that, but ritual lines built into the architecture of the cairns for purely ceremonial purposes.

Scott's argument essentially seems to be that these cairn orientations are all there are to be discovered on the site. He writes 'It seems unlikely that, if the winter solstice sun setting in the notch was important to the cairn builders, they would have placed the cairn in a position where all of the notch could not be seen. Indeed, from the centre of the cairn, as the notch is not indicated by any part of this monument this also means that there would be no need for any observers on the hillside terrace. It seems that by ignoring the actual orientation of the cairns and projecting his Jura notch concept onto the site, Prof. Thom created a myth which many people still believe.'

This implies that the only plausible way of looking at the midsummer sunset notch from the field with the standing stone is to stand on the large cairn. By making this supposition the evidence of the hill platform can be the more easily dismissed without examination. 'During Euan MacKie's excavation of the terrace, no signs of human activity were found, but it was suggested that two boulders and some flat stones were the remains of a paved observation area.' This is not quite fair, so I shall explain again here what actually was found there, even though it was published in detail in 1974.

[3] Thom 1971: 39).

The Kintraw hill platform

Thom discovered a 'large stone', at the right height (14 ft) above the field, on the steep slope beyond the stream gorge and assumed it to be the spot from which the large cairn was positioned; this in turn assumed that the cairn was built to serve as the actual observing point to see over Dun Arnal, the nearby ridge which obscures the notch on Jura from the ground beside the standing stone. However a stone cairn of uneven, heavy rubble is not a comfortable spot on which to stand to make exact observations and moreover – as Scott observed – the line of sight to Jura does not pass over its centre, as one would expect, but near its north-west edge (Figure 2.3). However if the boulder on the hill slope was the primary observing position the cairns would then become irrelevant. One thing that would be needed for such an observing point would be a reasonably firm and level stone floor next to it on which the observers could stand without worrying if they were going to overbalance and fall into the gorge while staring into the distance at Jura. There was no sign of such a floor so my excavations of 1970 and 1971 were designed to find it or disprove its existence.

One of the first discoveries was that the boulder was in fact two massive stones, which appeared to have been arranged to form a small notch in which was a level layer of rubble (Figure 2.5). Figure 2.5 shows the 'boulder platform' at an early stage of the excavations in 1970 and Figure 2.4 is my plan and cross sections of the site as exposed in 1971; it shows almost the maximum extent of the excavations, although there was another long trench running up hill just beyond the left edge of the plan. The plan shows how the pavement is strictly limited in area – being quite wide immediately behind the boulders but extending to the right (south-east) as a narrower path. Similarly the cross section a-b and the longitudinal section c-d show how the stone pavement was much more level than the surface of the earth which had subsequently accumulated on top of it. The south-east limit of the pavement was not reached; this was the direction in which any preliminary observations of sunsets immediately before and after the solstice would have to have been taken. However there is general agreement that one would be lucky to get more than one such because the notch disappears behind the higher part of Dun Arnal very soon after moving to the left of the boulders. This point is considered again later.

Although the fact that no charcoal, pottery or flint implements were found associated with the stone pavement means that there is at present no independent means of dating it, the petrofabric analyses described in the next section leave almost no room for doubt that it was a man-made structure. It seems quite likely that the two boulders were dragged to their present position, and underpinned, before the stone floor was laid.

In 1971 the BBC made an excellent programme called 'Cracking the Stone Age code' for its *Chronicle* series which examined Thom's ideas, and my excavations at Kintraw featured in it. This programme can be viewed at http://www.bbc.co.uk/ archive/chronicle/8604.shtml.

The second boulder

At a distance of 46m upstream from the 'observation boulders' is another fairly massive stone, resting similarly on the edge of what is assumed to be the same natural ledge at the lip of the steep stream gorge. There is a similar flattish area between it and the steeper uphill slope and if the excavated stone layer at the 'observation boulders' is of natural origin then there should be a similar layer at this more south-easterly stone. However there was no trace at all of any such thing; deep red earth containing scattered stones was found to a depth of at least 1.5m (Figure 2.6).

Petrofabric analysis

Because of the absence of any dating material on the platform, or any artefacts, a different kind of analysis was required to test whether the layer of stones behind the boulder was a natural accumulation or laid by

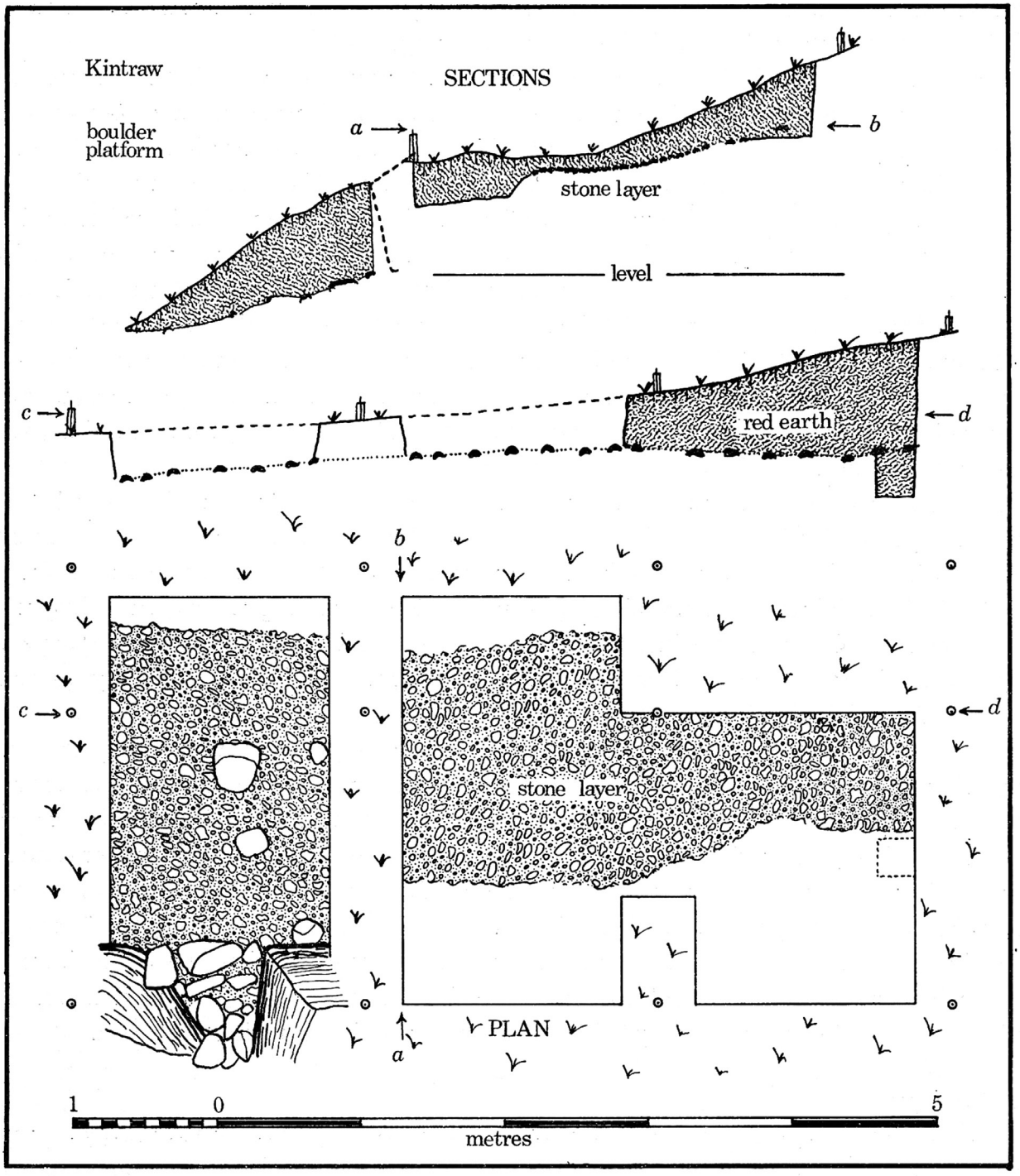


Figure 2.4. Plan and sections of the trenches cut on the boulder platform at Kintraw. The top section (ab) runs uphill, the lower one (cd) runs along the platform.



Figure 2.5. An early stage in the excavations of the high pebble platform held in place by two large boulders on the steep slope beyond the stream north of the field with the Kintraw standing stone and cairns. The photograph and drawing of the distant solstitial foresight in Figure 2.3 were taken from this notch.

man. Such layers of stones do accumulate naturally if soil gradually moves down a slope, for example as scree. The petrofabric analysis was kindly undertaken by Mr J. S. Bibby of the Macaulay Institute of Soil Research in Aberdeen (Bibby in MacKie 1974) (Figure 2.8).

When soil soliflucts (that is, moves naturally) downhill the long axes of any stones in it tend to align themselves among the direction of the slope and this can be measured as a compass bearing; the angle of dip of the long axes depends on the angle of the slope and can be measured with a clinometer. The analytical technique is to measure the orientation and dip of one hundred stones in a deposit and plot the results on a Lambert polar equal area net (fig. 8a). The results from the Kintraw analyses were explained by Bibby (MacKie 1974, 193); the original work should be consulted for more details (the Figure 2.8 referred to below is Figure 2.8 in this internet paper). The results are so important that Bibby's main conclusions are quoted in full.

> '*Two contoured petrofabric diagrams from Kintraw are reproduced in fig. 2.8b and c. The salient features are the wide variation in the dip of the a axis*,' (i.e. compass direction) '*and the relatively low angles of inclination. There is a concentration associated with the slope of the ground surface but it is not a strong one. By contrast, fig. 2.8e is derived from an area of scree and fig. 2.8f is from a stone pavement produced by frost action and since modified by solifluction processes. In the diagram derived from scree there is a marked association both with direction of slope and with its inclination; this trend is even more apparent in the diagram representing the structure within the soliflucted stone pavement. It appears that the process of solifluction, involving mass creep lubricated by melt water, imposes a strong degree of orientation on the constituent particles. The strong degrees of orientation shown by fig. 8e and f are in obvious contrast to the weak orientations shown in fig. 8b and c.*

No information was available concerning patterns produced on fabric diagrams by data drawn from man-made stone pavements. In order to obtain some check, however tentative a visit was made to the Sheep Hill vitrified fort, Milton, Dunbartonshire where a pavement exists that has been identified as man-made by independent evidence.' (MacKie 1976) '*The resulting diagram is shown as fig. 8d which, allowing for the different direction of ground slope, is closely similar to fig. 8b and c. This resemblance is all the more remarkable because of the contrast in parent materials and stone shape between Kintraw and Sheep Hill, the former being dominantly tabular schists and the latter wedge-shaped basalt.*

The evidence from petrofabric analysis indicates that the stone horizon discovered at Kintraw bears little resemblance in structure to superficially similar horizons known to have been formed by the actions of frost-heave or by scree accumulation. Other forms of genesis are rendered unlikely by the peculiar combination of lithological and site conditions obtaining. The available evidence supports the hypothesis that the Kintraw pavement was man-made.'



Figure 2.6. Another boulder lying on the edge of the terrace on the steep slope beyond the stream, a few yards right of the notch (as seen from the standing stone). It was excavated to see if the rubble platform extended that far but it did not.

Presumably Scott had not quite digested the full implications of that report when he wrote 'During Euan MacKie's excavation of the terrace, no signs of human activity were found but it was suggested that two boulders and some flat stones were the remains of a paved observation area' (Scott 2011, on-line).

The 'watch stone'

On Thom's original plan of the site (Figure 2.1) the main standing stone is marked as 'S' and what turned out to be the double boulder-and-notch with the laid pavement behind it is S4. These two, as noted earlier, form a line which points directly at the sunset notch on Jura. At a height of 53 feet above the former is 'S5' – a small standing stone about 1m high, still upright although set into a very steep slope (Figure 2.7); it is slightly to the north-west of the line to Jura. Thom suggested that this stone marked a position from which an observer could give a warning of the imminent midwinter sunset to people on the hill platform below. As can be seen from my drawing of the view from the hill platform (Figure 2.3) the upper limb of the Sun would be seen only momentarily at the base of the notch after disappearing behind Beinn Shiantaidh, and an observer higher up would have been able to say when it was approaching the notch.



Figure 2.7. The small standing stone a few yards above the observation platform. Douglas Scott said that this had accidentally crashed down the slope. It may have done that but then the Neolithic priests and wise men must have put it upright.

This little standing stone is of crucial importance and to my knowledge has never been discussed adequately in a published work after Thom's brief description in 1971; I didn't realise its full significance until about 2008. It certainly should have been mentioned in the Royal Commission's account (RCAHMS 1988). The presence of this clearly man-made feature above the hill platform is highly convincing confirmation of the importance of that platform as a solstice observing point, and surely indicates that it was the primary such point and not just a temporary marker to help position the large cairn. The solidity of the double boulder, the way the two stones form a small notch, and the presence of the laid rubble pavement behind them all confirm this. Douglas Scott wrote somewhere that this small standing stone on the hill side was accidental; it had fallen down the slope. He doesn't explain how it ended neatly upright in a socket in those circumstances!

Discussion

All this evidence surely confirms decisively that the primary astronomical sightline at Kintraw is to the midwinter sunset as Thom claimed. Moreover this is a true long alignment, or practical observing instrument, and not a short ceremonial orientation, and one moreover which was very probably capable – under the right atmospheric conditions – of pinpointing the solstice to the exact day. The back sight was the painstakingly constructed hill platform of which the two boulders were probably manoeuvred into position to form a neat notch (marking the exact observing position) and also serving as a massive revetment for the level rubble pavement which was laid behind and on either side of them. The tall standing stone was simply a ceremonial marker – indicating that this was an important observing site – although it also serves as a pointer towards Jura from the hill platform. This however is hardly necessary as the notch formed by the two Paps of Jura is one of the most striking features on the horizon (Figure 2.3).

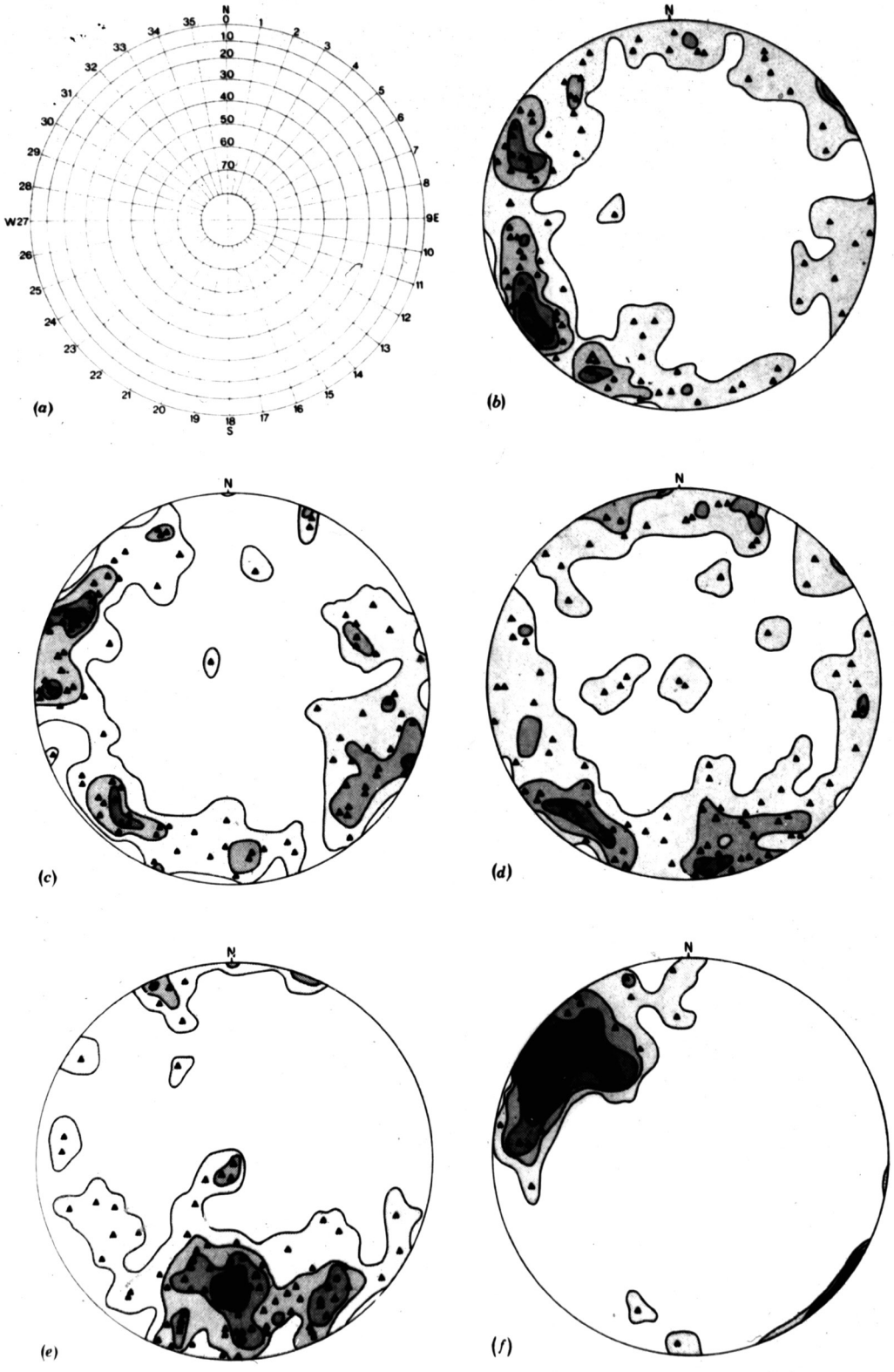


Figure 2.8. Analysis by Bibby of the orientation of fragments of stone in different layers. Nos. b and c are for the raised observation platform at Kintraw, d is of a definitely artificial stone floor at Sheep Hill hillfort and e and f are of layers naturally formed by falling down slopes.

One final issue must be dealt with. It has been claimed that the hill platform cannot be a genuine solstice observing point because there is no way its position could have been established from the natural terrace on the steep hill slope (Patrick 1981: 211); moving only a short distance to the south-east of it causes the Jura notch to disappear behind Dun Arnal, so the necessary preliminary observations of the sunset for several days before the solstice would have been difficult if not impossible. However this pre-supposes that the discoverers and builders of such sites had no pre-existing knowledge of the dates of the solstices, and needed the long alignments to establish them in each place they went to. It is clear now however that the detailed solar calendar inferred by Thom from standing stone alignments was already in existence before 3000 BC; it is marked in great detail on one of the carved kerb stones of the great burial mound at Knowth in Ireland (MacKie 2013). The accurate solstitial and other calendar alignments were presumably to help non-literate societies to keep track of the solar calendar over many years.

Conclusions

The really important thing about Kintraw however is that it provided the first scientific test of Alexander Thom's long alignment hypothesis, a test which the idea has passed with flying colours. Thom effectively predicted that there would be an observing platform on the steep slope north-east of the standing stone and this was duly found by excavation. He did not realise of course that it would be so massive and permanent as to render redundant his idea that the main observing position was on top of the large cairn. This however makes the site even more plausible as an accurate midwinter observatory because – apart from its being an uncomfortable spot on which to stand – the chances of the cairn being of the same age as the standing stone are minimal; if it is the least bit older or younger it has to be irrelevant to the alignment hypothesis.

Kintraw should have an international reputation because of this and it is a real tragedy that its true significance is ignored. The hill platform and the little standing stone above it should be a national monument; instead they are steadily disappearing under vegetation and among ever growing trees. Late in 2016 – 2017 being a special year for archaeological and historical sites for the Scottish Government – I recommended this site for conservation and to be made a tourist attraction to Alex Paterson of the Historic Environment Scotland but got no reply (see Chapter 1 for possible explanations for this). The modern versions of Professor Challenger are still not popular among Scottish archaeologists, many of whom belong to the 'theory first' school (see below) and assume that contradictory evidence is nonsense.

If there was a priesthood in Neolithic times in Scotland (see Chapter 3) these indicated sunset dates would probably have been identified by them as evidence of their gods. They may have been shown to a group of the faithful public, standing on the rubble platform. This idea is confirmed by the features of the main solar alignment at Brainport Bay in Argyllshire (below, p. 26).

2.2 The Cultoon stone circle on Islay

This was a battered-looking stone circle which the Islay Historic Works Group asked me to excavate so that they could turn it into a tourist attraction and fit it with an explanatory notice board. The work took place in 1974 and 1975, and at the start there was no idea that the results would test Thom's ideas in any way. Fortunately it was possible to do so. The circle, consisted of two standing stones and ten prostrate stones forming a rough oval about 45yds by 40yds on a low knoll. The prostrate stones were more or less turf-covered.

The excavation showed that although all the stones had been brought to the site, only two had been erected and in some cases the sockets had not been dug. The site had evidently been abandoned in the middle of construction and those sockets already dug had been allowed to silt up, although one had been deliberately filled, confirming that some change of plan had occurred before the final abandonment.

Radiocarbon dating indicated that peat began to form on the site in the 8th century BC, only after it reached its present condition. Mesolithic flint microliths were found on and in the topsoil of the old land-surface; and larger flints, presumably Neolithic, were found on the land-surface and in the lower levels of the peat, where scrapers and hollow-based points of Bronze Age type were also found. Caches of flint flakes, which I interpreted as votive offerings, were found in the peat next to the standing stones. Apart from Stonehenge this is the only stone circle which has revealed evidence of never having been completed.

The site was visited by the Ordnance Survey on June 16th 1978 and its comments seem to have provided the entry for the sites in the RCAHMS book. On the name board added to the site after my work was finished this circle, occupying a prominent swelling in a low lying area of peat, is generally as described. Twelve stones of notable size now lie recumbent, without apparent regard for orientation or spacing, in a rough oval shape measuring overall 45.0m NE-SW by 35.0m NW-SE. Of the two standing, the northernmost is 1.5m high and the other 1.9m, with those recumbent of a similar size range. Two socket holes are clearly visible, and the excavation appears to have revealed a sinuous stony bank connecting several of the stones around the SW side. The holes dug to receive many of the stones were discovered and are now marked by concrete, but it was clear that several of the stones had never been erected in their sockets, while in other cases there were sockets without adjacent stones. The excavated stone-holes had been allowed to fill up naturally with stones and silt some time before the site was covered by a growth of peat; a sample taken from the base of the peat layer produced a radiocarbon determination of 765 bc+40 (SRR-500). There is little doubt that the original intention was to set up the stones on the perimeter of an ellipse measuring 40.7m by 35.1m, but that the site was abandoned after the erection of only three stones (A, B and H). All the prone monoliths lie immediately on the old ground-surface, not on peat, and this confirms that the site had been abandoned before the onset of peat-growth. The excavator considered that the broad band of small stones and rubble between the stones was the result of the clearance of the central area within the circle.



Figure 2.9a. This photograph was taken in 2017 and shows how difficult it is now to see the hill observation platform from the field of the standing stone because of the vast increase in trees and bushes on the steep slope beyond the stream. Attempts have been made, without success, to persuade Historic Scotland to improve these sites and make them desirable to visit by tourists.

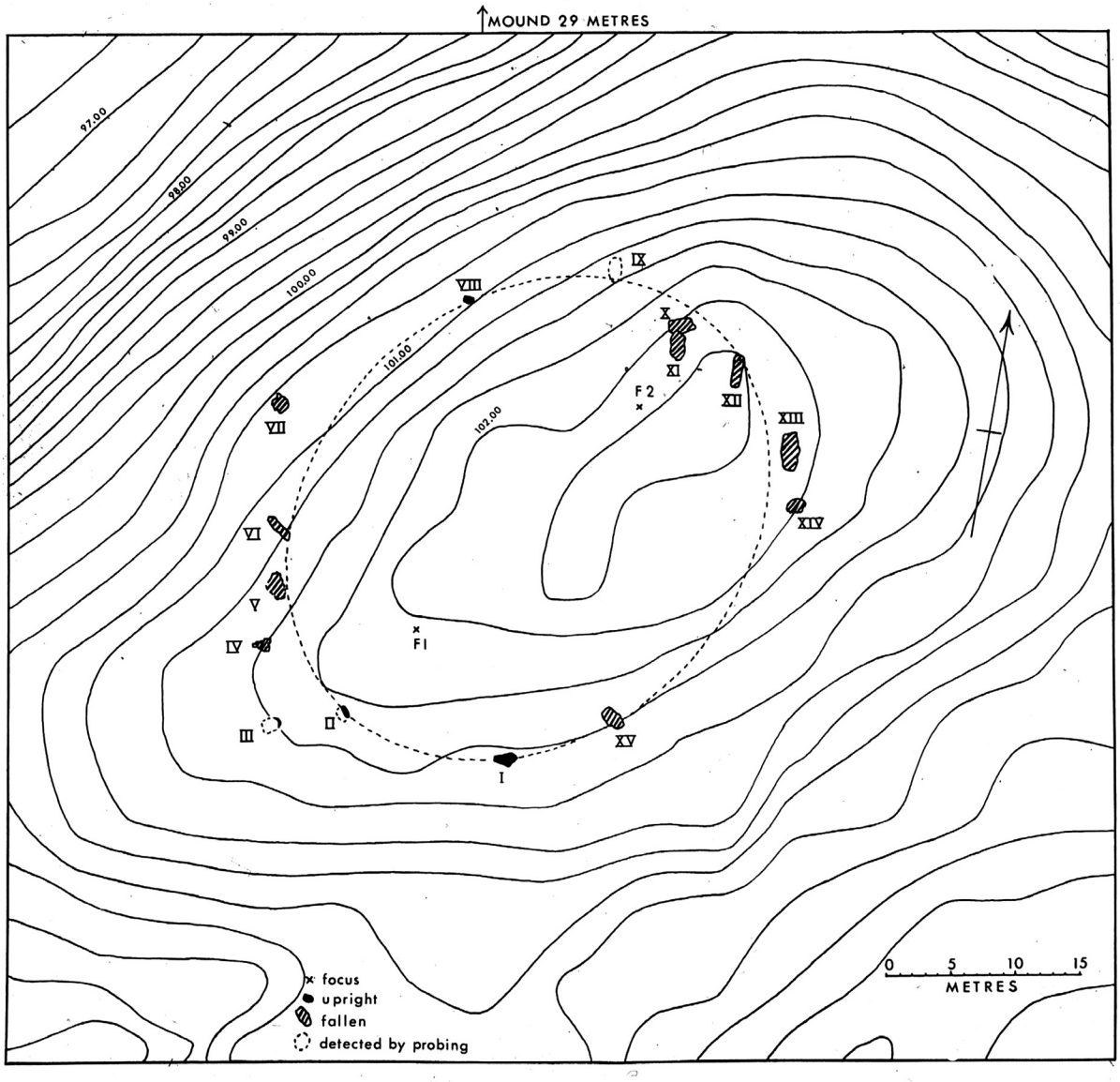


Figure 2.9b. Plan of Cultoon stone circle before excavation started. The three upright stones (I, IV and VIII are marked in black, what appeared at first to be fallen stones are marked with parallel line shading and those found under the turf are marked with dotted lines. The shape of the circle appeared to be approximately elliptical and this was tested later when several stone sockets were found.

That is a summary by the Royal Commission on the Ancient Monuments of Scotland of my work and it accepts that the original design of the unfinished circle was to create an accurate ellipse. However the purpose of the ellipse is not described, perhaps because it confirms Thom's theories! After the size and shape of the ellipse had been discovered I put two ranging poles upright in the two centres (Figure 2.10). At first the air was not clear enough to see the distant horizon of Ireland in the south-west but the first clear day showed that the poles were pointing close to a peak in Ireland (Figure 2.12, top) and this turned out to be a long alignment towards the midsummer sunset. Presumably the Neolithic designers of the circle had orientated it in the same way– by fixing the two poles required to control the marking of an ellipse on the ground so that they pointed to this distant peak. They obviously had some sophisticated knowledge of geometry as well as solar astronomy. Thus the investigation of the unfinished and abandoned Cultoon stone circle had the delightful and unexpected result in confirming Thom's theories.

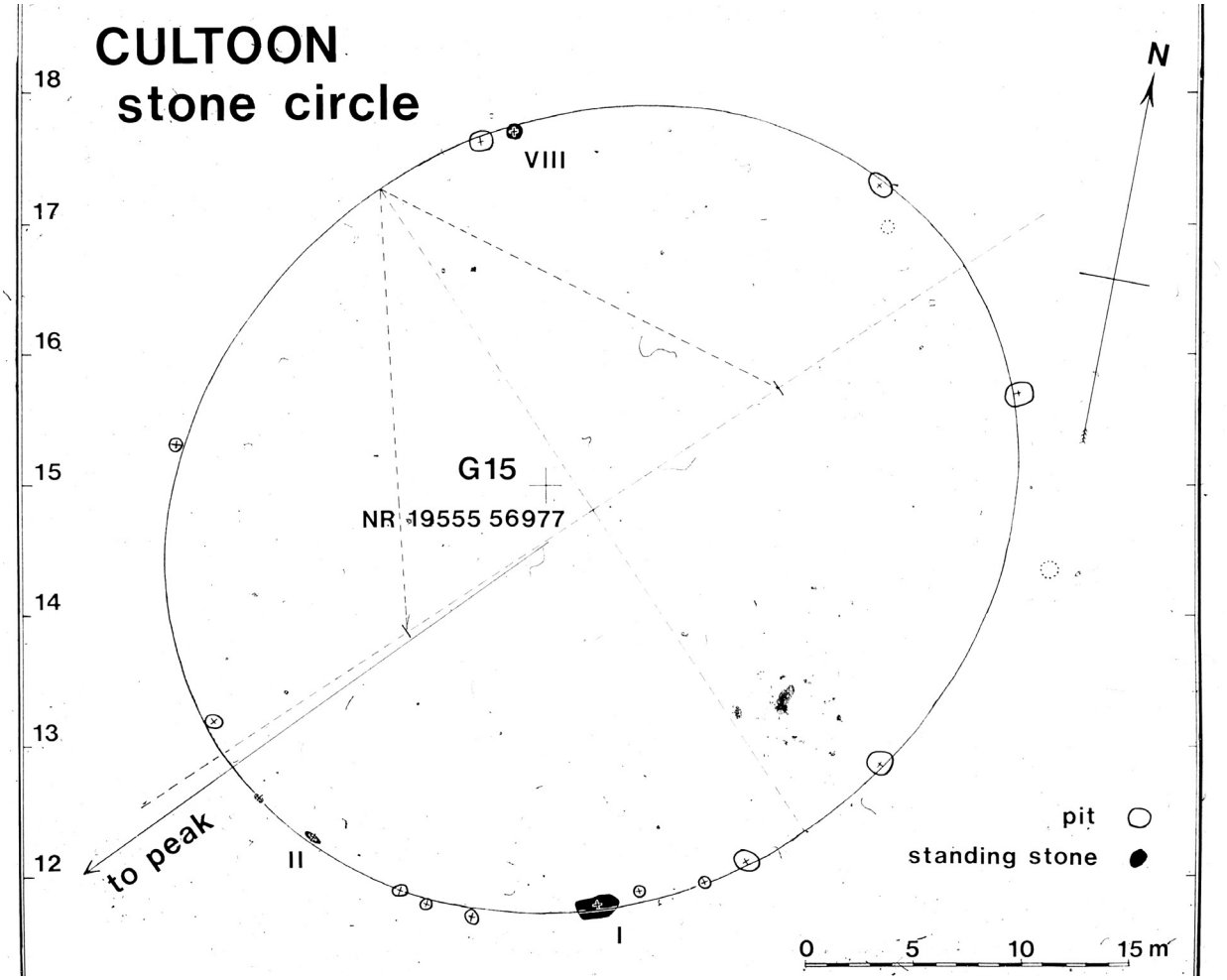


Figure 2.10. Elliptical plan of Cultoon after the stone sockets were discovered.

The Cultoon ellipse measurements

Ratio of two axes of an ellipse with an eccentricity of a half is 1 : 0.866.

	long axis	*short axis*	*eccentricity/ triangle shape*
1. **Computed**	**40.882 m**	**35.374 m**	**0.501** (equilateral)
2. **Ideal 'yard' unit**	**0.8176 m** (/50)	**0.81695 m** (/43.3)	avg. = **0.8173 m**
3. **Meg. yards** (0.829 m)	**50** (= 41.45 m) (plus 57cm)	**43.3** (= 35.90 m) (plus 53cm)	0.50 (equilateral)
4. **Ideal 'foot' unit**	**0.3271m** (/125)	**0.3268m** (/108.25`)	**avg. = 0.3270m**
5. **Doric foot** (0.328 m) on Salamis slab)	**125** (41.00 m) (plus 11.8cm)	**108.25** (35.506 m) (plus 13.2cm)	**0.50** (equilateral)

Figure 2.11. Dimensions of the planned circle at Cultoon, using the few standing stones and the many empty stone sockets.

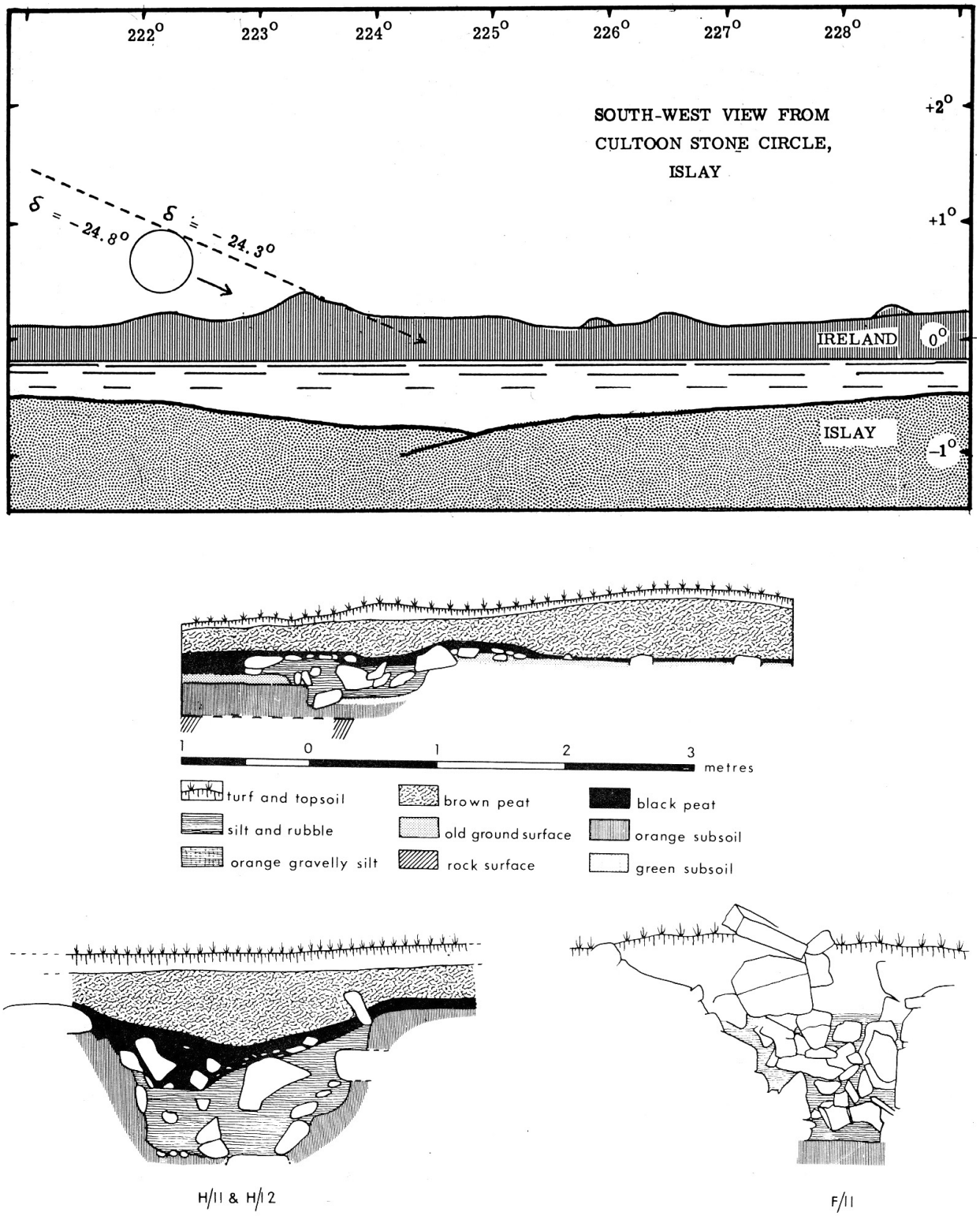


Figure 2.12. Top: drawing of the south-western horizon in Ireland indicated by the long axis of the Cultoon ellipse. Bottom: layers in the stone circle showing how a peat layer, formed about 1000 BC, sealed in the abandoned circle.

Figure 2.12 (lower half) shows the stratigraphy of the deposits in the holes dug for the stones. The holes were obviously abandoned and began to fill up with debris. When the climate changed about 1000 BC peat began to form on this moorland and sealed in the stone-holes.

2.3. The stone circle in North Uist – Sornach Coir Fhinn

The last part of this chapter contains a brief description of a new discovery on North Uist which shows in rather a striking manner that the possibility of accepting the existence of long aligments should not be rejected out of hand. The standing stone sites in the Long Island provided Thom with some of his most intriguing material (Thom 1967: chap. 11).

Introduction

In late August 2001 I was on holiday in the Outer Isles with a friend who had not been there before and decided on impulse to visit a well sign-posted stone circle in North Uist with which I was unfamiliar, having been primarily concerned with brochs on previous visits. This is *Sornach Coir Fhinn*[4] and it stands on a fairly steep slope immediately to the north of Loch Langass (grid ref. NF/843650); Burl says that it 'occupies one of the loveliest situations for a stone circle in the British Isles.'[5] It also has the rare quality of having been built on an artificial platform; the stone ring is set on a level bay cut out of the hillside and the material excavated in this way was spread around the circle as a broad bank (Thom, Thom and Burl 1980, 311). The local tourist board has prepared a path linking the circle with the nearby Barpa Langass chambered cairn (NF 838657) and there is an excellent notice board a short distance from the site, next to the hotel.

Thom described the stone circles and standing stones of the Outer Isles and made some detailed inferences about the way they were interlinked by celestial long alignments. He also made an accurate plan of *Sornach Coir Fhinn.*[6] It seems to be partly built as a true circle with a diameter of 125 ft.[7] but the arc on the southern (downhill) side is flattened; there are possible entrances at the ends of this arc. Though the alignments are not discussed in the text of *Megalithic Sites in Britain* his plan shows that Thom evidently believed that the stone circle was positioned in order to indicate two such from the centre of the ring – one towards standing stones on the summit of Cringaval not far to the west (Thom, Thom and Burl 1980, 310-11). This gives a good calendar declination for sunset on the third 'sixteenth' before and after midwinter.

The other suggested alignment is to the large standing stone next to the excavated chambered cairn at *Leacach an Tigh Cloiche*,[8] known as 'Uneval' or 'Unival' in the literature, but this does not fit easily as a solar calendar marker.[9] Ruggles also surveyed the indicated horizons at both circles and discusses them briefly (MA: 102 and 106, 114, and 116-17: figs 6.11 and 6.12: sites UI33 and UI37). In the case of *Sornach Coir Fhinn* he suggests in addition (since it is visible) a line to the other *circle Sornach a'Phobuill* and, while accepting Thom's line to *Leacach an Tigh Cloiche*, does not mention the one to Cringaval.

One can hardly doubt that the position of *Sornach Coir Fhinn* was carefully chosen; evidently it had to be at a particular place on the slope above Loch Langass and a flat platform was prepared for it. Looking at Thom's plan it seems that another line is clearly indicated by the plan of the stone ring itself; the diameter of the true circle which seems to mark the boundary with the flattened part was

[4] Apparently means 'The heap of heavy stones of the generous Finn'
[5] Thom, Thom and Burl 1980, 311
[6] Thom, Thom and Burl 1980, 310-11: site H/17
[7] Equal to 45.96 Megalithic Yards
[8] 'The (something) house on the stony summit of the hill'
[9] Henshall 1972 [UIST34]: Ruggles 1980, 102, site UIST28

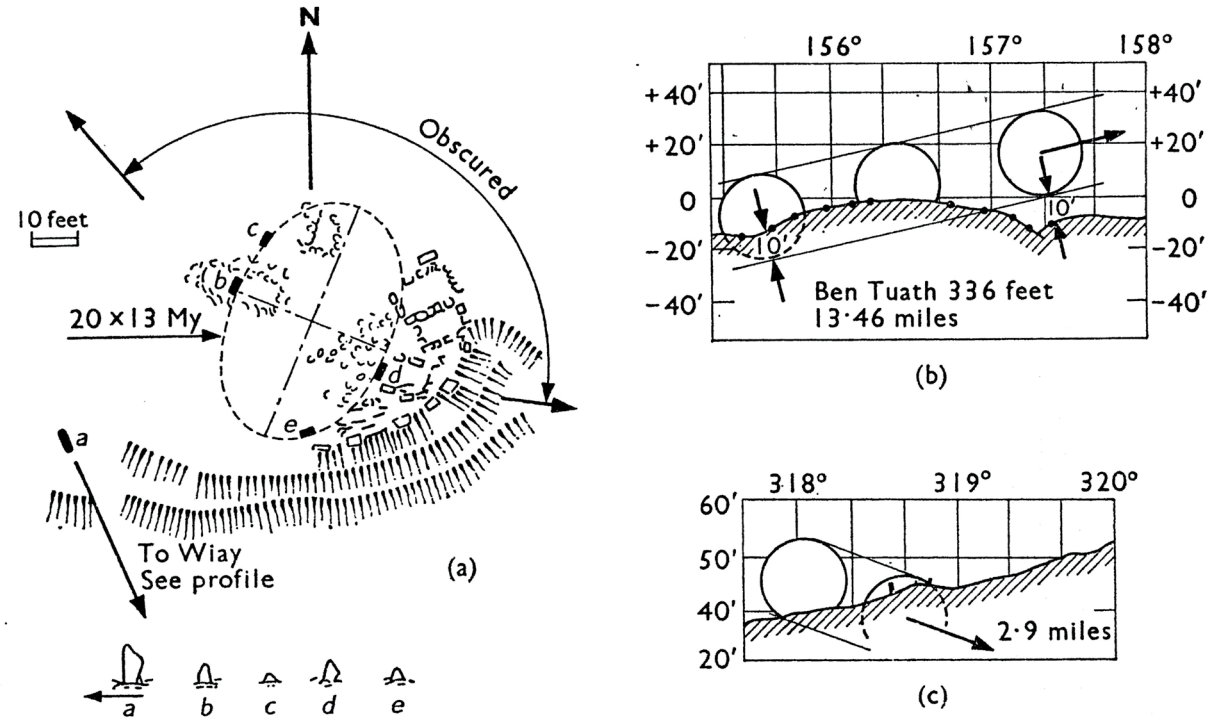


Figure 2.13. (a) Scale sketch of Leacach at Tigh Cloiche; the site is at 260 ft above sea level, on a ridge running down towards the south-west. (b) The Moon rising over Wiay island in the furthest south positionas seen from the site (c) the midsummer Sun setting over the stones of the site and over a local horizon foresight 2.9 miles away.



Figure 2.14. Photograph of the south-west view from the Sornach Coir Finn stone circle; the distant foresight peaks on the island of Skye and just visible to the left of the massive local peak.

marked by eye on the plan in the book and then measured with a protractor; the angle was 117/297°. Ruggles excluded such alignments from his survey *a priori* so could not discuss such a one here even if it were found.

A long alignment discovered

None of this was known to me when I visited the site in August 2001; I had not briefed myself on any of the Neolithic sites in the Long Island before going on holiday, nor taken any relevant books. By chance the weather was fine and the air clear so I looked round the horizon in search of distant peaks to see whether there were any feasible long alignments. Most of the horizon is only a few miles away but there is one group of distant peaks in South Uist, visible to the south so clearly irrelevant as solar markers.

However in the south-east the landscape is particularly striking; the low hills Eaval and South Lee to its left stand out, framing a stretch of local low ground between them. In that gap showed faintly two much more distant flat-topped mountains which I was able to recognise, having spent a month excavating near them in 1965; they are MacLeod's Tables on Skye – *Healabhal Beag* and (to its left) *Healabhal Mhor*, about 27 miles away. Just to the left of the latter, and showing even more dimly (almost vanishing before I left the site), was *Glamaig*, a conical peak also on Skye, just south-west of Raasay island and almost exactly 47 miles away (Figure 2.15).

The azimuth from the stone circle to the top of Glamaig is very close to 122° and it seems reasonable to suggest, first, that the diameter of the true circle which forms the boundary with the flattened part was actually aimed at this remote peak (so that it is a genuine indicated alignment) and that, second, the reason for digging out the platform for the circle at this point on the hillside was to keep the top of *Glamaig* in view, together with whatever other nearer horizon targets, if any, were being aimed at. From the OS map data the declination of the peak proved to be – 16.5°. Thus when the Sun rises with its upper edge at the peak (Figure 2.15) its centre has a declination of – 16.7 - 16.8°, very suitable for marking in prehistoric times the first and last Quarter Days of the year, at the beginnings of February and November respectively.[10]

I have suggested several times (Maeshowe in Chapter 4) that these Neolithic solar calendar dates explain the origin of the much later Celtic feasts – Imbolc in the spring and Samhain in the autumn[11] – which divided the old Celtic year in half. They appear to be very prominently marked at Maeshowe itself (Maes: fig. 5). The idea has been strongly opposed by Ruggles[12] so the chance discovery of a very long potentially very accurate alignment to exactly the same dates is particularly interesting. If long alignments are figments of the author's imagination what are the odds against finding such a precise and significant indicated example, by chance during a brief holiday visit to a randomly chosen stone circle?

Moreover if the argument in Chapter 4 is correct – that Ruggles' fieldwork has not disproved accurate long alignments – then one could predict from the evidence from *Sornach Coir Fhinn* that more examples of clearly indicated Quarter Day alignments will be visible in his own data. This turns out to be the case, and the best examples are probably shown in Figure 1 in Chapter 4.

Discussion

Some useful points emerge from this new discovery at *Sornach Coir Fhinn.* First, how many more such long alignments, visible only in clear weather, await discovery? Thom and Ruggles between them have surveyed more British standing stone sites than anyone else but they rarely comment on the weather at the time of

[10] This is a preliminary computation done from the maps and a photograph; no theodolite or GPS was available at the site
[11] Together with Beltane at the beginning of May and Lunasda at the beginning of August
[12] Ruggles and Burl 1985, 68-9

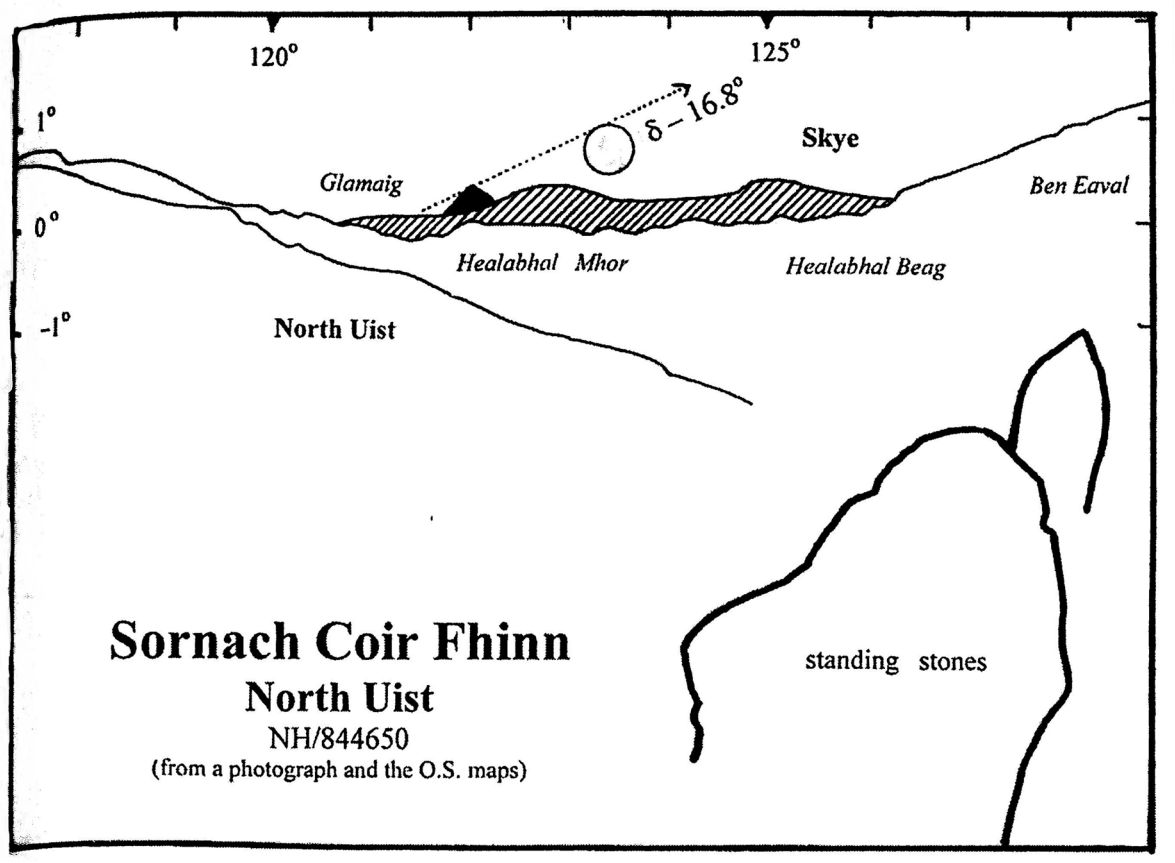


Figure 2.15. A measured drawing of the same view in Figure 2.14 with the estimated sunrise on the distant peak on Skye.

the site visits. Obviously if a distant peak is recorded it must have been clear but it is unlikely to have been equally good when all the sites shown having only near horizons were surveyed.[13]

With present climatic conditions in Scotland it must often be a matter of luck whether a vital distant peak is seen during a short visit[14] and the situation cannot improve much until more archaeologists take an informed interest in this aspect of standing stone sites, visit them systematically in fine weather and carefully record what they see. The basics of this aspect of Neolithic landscape studies should surely be part of every undergraduate archaeology course.

The second point is that investigations of the astronomical qualities of standing stone sites should be a little more flexible. The irreducible requirement must remain of course: to be plausible a celestial alignment must include a direction indicator of some kind in the backsight which points at the horizon foresight. However as with *Sornach Coir Fhinn* the landscape itself could often be giving us important clues about what the circle builders and stone erectors intended. There the distant mountains in Skye, framed between local hills, seemed an obvious potential sunrise foresight and an examination of the site plan showed that this direction was indeed marked. Moreover if plausible indicated alignments

[13] Archie Thom told me that he and his father had visited Maeshowe in Orkney in the early 1980s with the intention of checking for any distant foresights but could see nothing in the south-east except the local horizon; yet the hills of Hoy (later shown to mark solar calendar dates with indicated alignments) are only ten miles away

[14] I found this to be the case during his two weeks of excavation at Kintraw, Argyllshire, in the summers of 1970 and 1971; Beinn Shiantaidh on Jura – the claimed midwinter sunset marker 29 miles away – was rarely seen through the haze during those times even though the weather was usually dry and often sunny

have already been identified at a site it is surely reasonable to accept an additional distant foresight which marks a solar calendar position even if no indicator can now be identified.

Maeshowe again is a good example (Chapter 3); the vital first and last Quarter Day sunset marker, at the right end of Cuilags, is not now specifically marked but other solar calendar dates are and it therefore seems quite arbitrary to ignore the Cuilags line, especially as the tomb itself must have been carefully positioned in the landscape in relation to various sunrises over Hoy (Figure 3.2). The main need is to have a set of clear rules which prevents one from choosing foresights at random, and then claiming them as significant, and to follow these carefully.

It should be possible to draw up such a set with which one could try predicting the existence of long celestial alignments through landscape analysis.[15]

The third point is that the discovery of the rarely visible yet indicated *Glamaig* sight-line surely points again to a better climate and clearer air in Neolithic times. Other rarely seen sight-lines suggest the same, like those to Boreray.

2.4 Brainport Bay, Argyll

(MacKie, Roy and Gladwin (1985a and 1985b))

This is a potentially very important site as it has produced features suggestive of 'astronomy-based' religion as well as the usual features of simple astronomical alignments. It is just above Brainport Bay, just south of the village of Minard and with a clear view to the north-east, facing a short beach on the W shore of Loch Fyne. The possibility of it being an ancient site was recognised by the late Col. Peter Gladwin in the early 1970s; he did some excavation there with members of the Mid Argyll Archaeological Society. Because of what looked like several small quern quarries scattered around the site he contacted me in 1976 and I visited Brainport Bay that summer. It was difficult to make sense of the various rock outcrops and attached artificial paved platforms as a normal ancient domestic site, though flints had been found.

The primary features are what has come to be known as the *Main Alignment* – a series of modified rock outcrops running from close to the beach in a more or less straight NE/SW line over about 100 yards (Figure 2.16). First is the Main (rock) Outcrop with paving on it and attached to its SW end; a curious feature is a small V-shaped notch, seemingly partly artificial – at its SW end; the Lower Platform is on lower ground next to this. Three long stones – looking like fallen small standing stones – were found on various parts of this area in the early excavations; Col. Gladwin put one upright in a socket what he had found just SW of the rock notch.

A few yards to the SW are what became known as the *Observation Boulders*, a pair of large rocks with a gap between which appeared to have been pushed into their present position. Standing between them and looking NE one gets a view of distant mountains near Tyndrum, framed in the rock notch and with the re-erected stone framed in it and looking like the foresight of the sights of a rifle barrel (Figure 2.19). The ground then rises towards the SW and about thirty yards further back is the Back Platform, another rock outcrop with paving added to it. From this one gets a very clear view to the NE up Loch Fyne but the rock notch is too low down to see through. This suggests that – at midsummer sunrise – there was probably an audience on the back platform as well as a trained observer between the two boulders; this implies that Brainport Bay was a ceremonial or religious site as well as an astronomical alignment. There are two other finds – described later – which support this view. Excavating the ground around

[15] see Figure 2.13 (c)

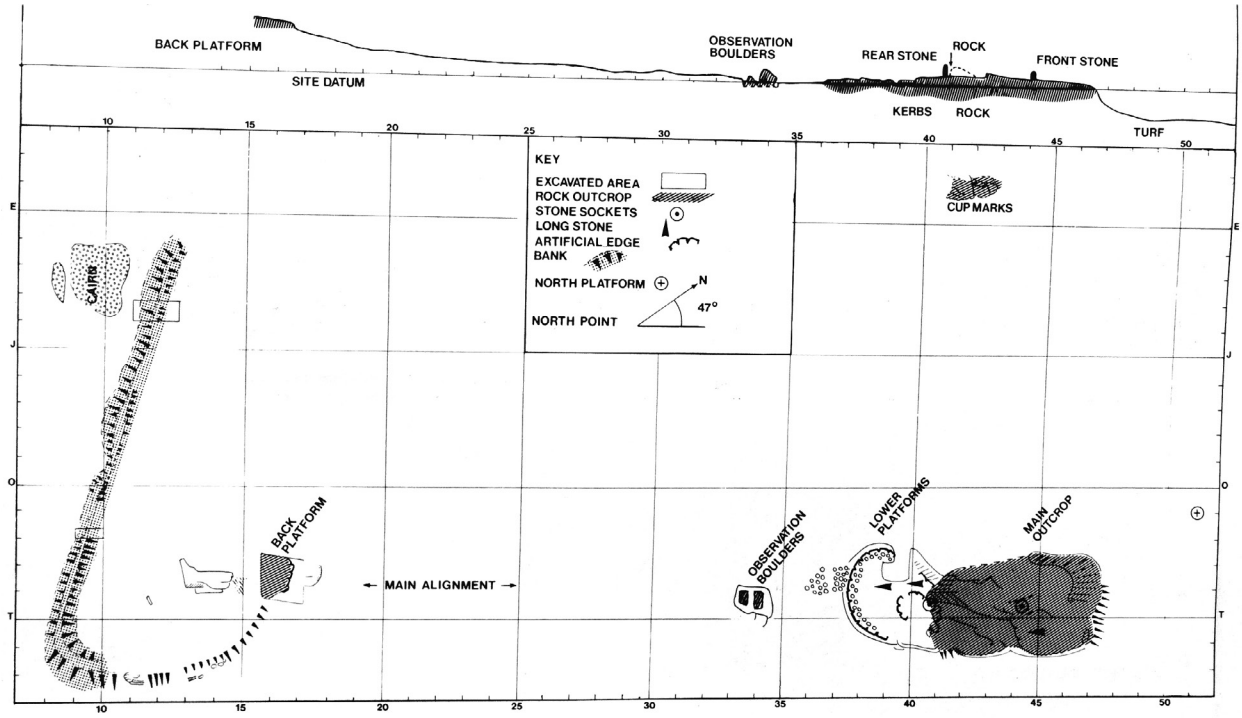


Figure 2.16. Plan of the main alignment at Brainport Bay (taken from MacKie, Gladwin and Roy 1985, fig. 3).



Figure. 2.17. Midsummer sunrise in 1977, seen from the double observation boulder. It shows that the original one of about 1800 BC would have risen slightly to the left (Figure 2.19 below) so that it would have allowed the exact date of midsummer to be discovered by halving the interval – about 18 days – between the two sunrises exactly at the notch. The pile of 33 white pebbles found by Colonel Gladwin on the main outcrop would have been a great help in working this out in a pre-literate society (Figure 2.21). The upper photograph in Figure 2.18 is the same view, more obscure, in 2017.

and next to the Main Alignment produced quite a number of flint flakes and small implements, which are now in the Kilmartin Museum. They confirm that the astronomical alignment to the midsummer sunrise was perhaps organised in the Neolithic period but more probably in the Early Bronze Age at around 1800 BC.

Other features near the Main Alignment are the *cairn* and the *bank*, both about thirty yards further back from the Back Platform. Perhaps 150 yards to the S of these and in the wood is a standing stone which has fallen and now rests on a tree trunk. There may be another broken one next to it. About 100 yards NW of the Main Alignment, the ground rises steeply up to what we call *Oak Bank*, and on top of that is a large fallen standing stone with two curious rock carvings nearby.

In the late 1970s there was a dense plantation of young conifers on various parts of the site, some planted by the Forestry Commission. Members of the local archaeological society, under Colonel Gladwin, removed many of them. Unfortunately after Gladwin's death no further tidiness seems to have been wanted locally and the Main Alignment is getting covered with bushes (Figure 2.18).

Midsummer sunrise

Colonel Gladwin and I discussed the nature of the site and eventually wondered whether it might be a ceremonial rather than a domestic one, and whether the Main Alignment was in fact aimed at the midsummer sunrise. On midsummer day in 1977 I watched and photographed (Figure 2.17) the Sunrise at 4.40 am while standing between the Observation boulders; it appeared behind distant Beinn Dubhcraig and exactly framed in the rock notch. This aroused my interest and I investigated the site on and off the for the next 7 or 8 years, including carrying out a series of small scale excavations in 1981. The fact that the midsummer sun rises in the indicated distant notch now shows that in about1800 BC midsummer sunrise was a short distance further to the left; its date could thus be determined by halving the number of days between the two dates in which the sun did rise in the notch (Figure 2.19). This is probably about 18 days. This closeness of a natural alignment of rock outcrops – slightly adjusted with small standing stones in prehistoric times – is a good explanation for the unique nature of this site, especially the facilities for a religious audience in the excavated sitting place at the SW end of the alignment.

There are two other unusual finds which confirm that Brainport Bay is an uniquely important archaeoastronomical prehistoric site in Britain. Col. Gladwin discovered a neat heap of 33 white pebbles when he was excavating the main outcrop; they had probably been put into a small pit there, perhaps when the site ceased to be used. The pebbles are now in the Kilmartin Museum (Figure 2.21). The other type of artefact was not found but was thought to be rotary querns; several small rock outcrops are close by with clear signs of stone discs having been removed from them. This would have been very appropriate if Col. Gladwin's original idea about the site being a domestic one was correct. However no rotary querns were found during his or my excavations. He did find one disc however (Figure 2.20) which was not a quern because it had no central perforation and was extremely regular and completely circular.

Discussion

The Long natural Alignment at Brainport Bay is a remarkable site. The existing outcrops of rock were obviously chosen for improvement as a summer sunrise detector because they were naturally aligned in that NE direction, where there was a distant hill with a notch in it 28 miles away and just showing over the local horizon beyond Loch Fyne. There were two massive observation boulders a short distance SW of the elongated primary rock outcrop and it looks as if a notch in the latter had been cut in line with them and the distant foresight. Col. Gladwin found three long stones on the Long Alignment and put one back immediately in front of the notch, where he found a socket. A particularly unique feature of the site was a third rock outcrop about 30 yards SW of it which had been adjusted with paving to provide a higher watching point for the sunrises for quite a large audience. This suggests that this may have been a religious site. Two other finds fit in very well with this interpretation.



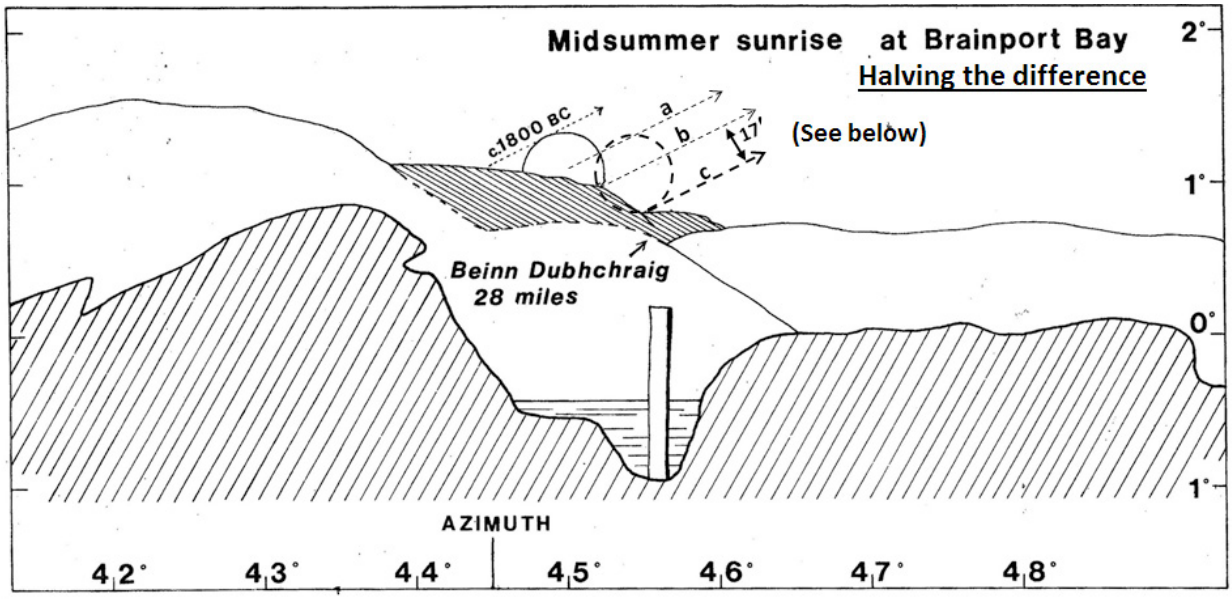
Figure 2.18. These two photographs were taken in April 2017 and show how untidy the site has become. The first one is taken from between the observation boulders and shows how the alignment to the distant horizon of the sunrise is almost obliterated. The second one is a reverse view, towards the higher platform, which is almost completely hidden now under bushes and trees.

When the position of the Sun at the indicated foresight was examined thoroughly, particularly by Thomas Gough (2010), it became clear that in about 1800 BC the extreme midsummer, north-eastern rising point was somewhat to the left of the long alignment to Beinn Dhubchraig (Figure 2.19). Thus the sun would have risen twice exactly at this indicated notch, after moving leftwards to its midsummer position and then back again. The interval between the two risings in line with the alignments was probably about 18 days and the date of the longest day of the year could have been exactly determined by halving this number; the observer would have had to be in the observation point very early in the morning for all those days. Col. Gladwin found a neat cluster of pebbles on the rock of the Long Alignment and they would have been used by a pre-literate society for keeping track of this 18 day interval and dividing it in half.

Thomas Gough's analysis (2010) of the Brainport Bay's most prominent alignment to the midsummer sunrise is as follows. 'In addition to the four sites as above, there is also the site at Brainport (MacKie 1981: 128-137, 1988: 213-224). For the alignment at Brainport near the midsummer solstice it had been assumed that the upper limb was observed (MacKie 1988: 214). This would make the distance between the solstice and the alignment 'notch' about 1 ½ solar diameters ($0^{o}.8$). This is possible, but the points noted above tell us that it is more likely that the *lower* limb was observed. This limb would then be at the alignment point 9 days before/after the solstice, travel less than the sun's diameter and would mean that the sun was visible before the moment of observation.' This seems logically sensible but the only doubt is that if the lower limb of the Sun had to be next to the horizon profile (Figure 2.19); the complete bright, often blinding, disc had to be studied rising up and this might have made an accurate observation difficult to Neolithic men (apparently without dark glasses!).

The small rock outcrops with traces of circular discs being carved out of them were thought at first to have been for rotary querns. However no traces of these were found – which is not too surprising because such querns are mainly from the Iron Age. Col. Gladwin found a stone disc somewhere which had obviously been taken off one of these but it was not a quern. It had no central perforation and its two surfaces were flat and parallel with each other (Figure 2.20). This could be interpreted as a sun disc and this fits in well with the fact that an audience, probably religious, came to the site at midsummer, and would doubtless have liked to have had a symbol of their God. The photograph shows what looks like two straight carved lines on one face, meeting at an angle near the rim. One will have to find the disc to be sure about it but it looks like the same angle as is on the Bush Barrow gold lozenge from Wiltshire, near Stonehenge. This diamond-shaped figure has an angle of about 81 degrees at two corners which represent the angle between the midsummer sunrise and that at midwinter.

There are several other standing stones at Brainport Bay and this carved angle might have been very useful in choosing the positions in which to set them upright. These features are unique to Brainport Bay and surely confirm the interpretation of its nature as a natural alignment adjusted to be close to midsummer and having the facilities for an audience and for counting the days to establish the date of midsummer at that time. It feels like the product of a prehistoric priesthood, probably early Druids who, according to Julius Caesar who – having met a high ranking Druid in Gaul in about 50 BC – heard that they originated in Britain and that new Gallic young recruits went over there to be properly trained (Handford 1951). This also supports the idea that a Neolithic priesthood was the organisation that constructed the numerous long astronomical alignments in the form of standing stones and stone circles. Caesar also discovered, when he invaded Brittany, that the tribes there had a large navy which dominated relations between the tribesmen of northern France and southern England. Their ships also presumably took the Druid recruits back and forth across the English Channel and they might well have gone up the west coast – even to Orkney – to link their modern development with Scotland, especially Orkney where there was the ideal sandstone for sophisticated buildings and standing stones. There is a quotation from Caesar in Chapter 3.



a) Midsummer solstice declination 1800 BC, $23^{o}\ 55'$
b) Lower limb of sun at the solstice, $23^{o}\ 39'$
c) Lower limb rising out of hill intersection, $23^{o}\ 22'$ (See ref.)

The hill intersection is about 17′ before/after the solstice for the lower limb. This equates to 9 days before/after the solstice or 18 days in all. (9 days before/after the solstice the sun's daily change in declination is about 3′.5 of arc. Therefore the days when the sun's lower limb is at 'c' could easily be identified and by 'halving the difference' the day of the solstice found.)

(Ref. MacKie E.W. in Ruggles (ed.) Records in Stone 1988: 214)

Figure 2.19. Diagram showing the horizon, and relevant sunrises, indicated by the natural rock outcrops of the long alignment.



Figure 2.20. The stone disc discovered at Brainport Bay by Col. Gladwin. It cannot be a rotary quern as it lacks a central perforation and also lacks the slightly concave cross section which is essential for these prehistoric querns. The alternative explanation as that it is a model of the sun, which suits the nature of the site very well. Unfortunately I could not get anyone local to tell me where it was after Col. Gladwin died.

The present state of Brainport Bay

In 1996 I wrote a brief paper explaining how Brainport Bay had been accepted as an uniquely important site and how a local archaeological society had taken the responsibility of cleaning and tidying it and putting in notice boards explaining its significance. However the last two photographs here at the end of the sequence for Brainport Bay were taken in April 2017 and show how neglected the site now is. A vast number of trees and bushes have grown since I did my excavation work there and the distant notch of the midsummer sunrise alignment is more or less hidden behind twigs and branches. Likewise the rear platform, which was very clear when I was working there, is barely visible now. It is true that a vast number of branches and twigs are lying around, having been cut down, but whoever started that project did not continue it. One suspects that those who do not accept Aleander Thom's ideas have no interest in preserving such sites as Kintraw and Brainport Bay and keeping them tidy. I wrote to Historic Environment Scotland in 2016 about their importance but received no response. This is discussed further in Chapter 7, but it is clear that the archaeological world does now include a fair number who accept archaeoastronomy and carry out detailed research into it.



Figure 2.21. The deposit of 33 small white pebbles which was found during Colonel Gladwin's excavations on the main rock outcrop element of the long midsummer solar alignment. They are on display in the Kilmartin museum.

Chapter 3
Decisive tests in Orkney and Ireland

3.1. Introduction

Up until the 1970s, enquiries into the astronomical and mathematical knowledge of the standing stone-erectors of prehistoric Britain dealt largely with statistical patterns. Since then, the great passage grave at Newgrange, eastern Ireland, has proved to be engineered to address the midwinter sunrise. It was then time once more to look at another great chamber-tomb with these concerns in mind – Maeshowe in Orkney. After that the extraordinary site of Ness of Brodgar was studied, starting in about 2003. It has been excavated for a number of years now by Nick Card, of the Archaeological Institute at the University of the Highlands and Islands, in Kirkwall. This is discussed in Section 3.5.

Acknowledgements

I thank Noel Fojut and Patrick Ashmore of Historic Scotland Edinburgh, for arranging for access into Maeshowe to do the work in 1994, and the staff at the site for their unfailing co-operation. I am particularly grateful to Frank Zabriskie of Birsay for undertaking the calculations from the theodolite readings I took in September 1994 and for supplementing them with his own observations. He also later checked the position of the west slope of Cuilags for me. All of the aforementioned together with Aubrey Burl, Colin Renfrew, Colin Richards, Graham Ritchie, Archie Roy and the late Archie Thom, read and commented constructively on at least one of the drafts of the text on which this section is based (1997a). I should also thank Patrick Ashmore, Aubrey Burl and Graham Ritchie for supplying some useful references as well as Charles Tait for permission to use his photograph of the midwinter sunset.

3.2. Decisive tests in Orkney

Back in the 1960s, enquiries into the astronomical and mathematical knowledge of the standing stone-erectors of prehistoric Britain dealt largely with statistical patterns. Since then, the great passage grave at Newgrange, eastern Ireland, has proved to be engineered to address the midwinter sunrise. It was time once more to look at another great chamber-tomb. Maeshowe in Orkney just north of the Scottish mainland, with these concerns in mind.

The main point to note in this section is that the modern systematic excavations on the Ness of Brodgar ceremonial village (see below) had not been started then so this study of Maeshowe chambered cairn was done only with its own qualities in mind.

Archaeological background

In the later part of the Neolithic period in Britain, when the distinctive flat-based pottery known as Grooved Ware came into use, the Orkney Islands witnessed the emergence of a culture in which unusually spectacular ceremonial buildings were of prime importance. This was tentatively recognised 40 years ago when the only important Grooved Ware sites known in the north were the stone villages of Skara Brae (Figure 6.5, p. 115) and Rinyo;[1] it was already clear that in the British Isles Grooved Ware is concentrated in two widely separated areas, in the far north and northwest of Scotland on the one

[1] Piggott 1954: 324*ff*

hand and in southern England and East Anglia on the other.[2] Further excavations and many radiocarbon measurements have confirmed the picture.[3]

In Orkney a distinct change is now apparent with the preceding period when round-based Unstan bowls were in use and when stalled cairns – chambered tombs of a different and more modest design – were built. It is now apparent that the passage tombs and their local derivatives form a quite distinct tradition associated with Grooved Ware; moreover it is to the later part of the Grooved Ware phase (which itself seems to overlap with that of the Unstan ware tombs:[4] that the three unusually large Orcadian monuments belong which required an investment of labour several orders of magnitude greater than in earlier times. These are the ditched stone circles of Ring of Brodgar and Stenness and the chambered tomb of Maeshowe, all closely associated in a relatively small area at the south end of the Loch of Harray. The Stenness circle is estimated to have taken some 50,000 man-hours to build and the ring of Brodgar perhaps 80,000 man-hours.[5]

Renfrew has argued persuasively that the later part of the Orcadian Neolithic period saw the emergence of that more centralised political authority which could organise the construction of such large-scale works. The very end of this period saw the construction of the final stone village at Skara Brae; its several C-14 dates, when calibrated, indicate an age of about 2500-2400 BC[6] for this latest phase of a settlement with a long history. Several monuments of a slightly earlier phase have produced high quality pots of the 'Clacton' style which does look like a national form of Grooved Ware – a small vessel shaped like a squat flowerpot decorated with geometrical designs in broad, shallow grooved lines: they include the Stenness circle[7] and the Quanterness chambered cairn in Orkney,[8] the Unival chambered tomb in North Uist (Outer Hebrides)[9] and various sites in Wiltshire and other parts of southern England and East Anglia (Figure 6.5, p. 115).[10]

All the Neolithic Orcadian tombs are built of freshly quarried sandstone slabs carefully and skilfully fitted together and the two stone circles mentioned are formed of similar fresh slabs with pointed tops; the huge upright slabs inside Maeshowe are very similar.[11] An ancient quarry, with levered-off slabs lying near-by, has been identified on Vestra Fjold about 3 km north of Skara Brae.[12] A socially less centralized earlier stage is implied by our modern radiocarbon-based understanding of the development of the Orcadian chambered cairns which shows the simplest monuments to be the earliest.[13] It is also suggested by the existence of simple standing stones formed from more irregular and eroded slabs which must have been found lying on the surface – for example those on the causeway between Loch of Stenness and Loch of Harray at HY/3095 1285.[14]

Back in 1977 the author argued that the Grooved Ware sites in Orkney were a sign of the penetration into the far north of a society dominated by a religious elite with advanced skills in astronomical observation,

[2] Wainwright and Longworth 1971; Longworth *et al.* 1986: figure 20
[3] Renfrew 1979: chapter XII; Clarke and Sharples 1990: 56-7
[4] Renfrew 1979: figure 55
[5] Ralston 1976
[6] Renfrew and Buteux 1990
[7] Ritchie 1976: figure 6, No. 16
[8] Renfrew 1979: figure 33, No. 2
[9] Scott 1950: plate VII; Henshall 1972: 309, No. 14
[10] Piggott 1954: figure 57
[11] Richards 1990: 310; 1992: 447
[12] RCAHMS 1946 (2): no. 727 and figure 397
[13] Renfrew 1979: figure 55
[14] RCAHMS 1946 (2): No 278, figure 396

calendar-making, measuring and surveying; this had already been responsible for the extraordinary late Neolithic earthworks and stone circles on Salisbury Plain.[15]

An extension of this hypothesis saw Skara Brae as a settlement of an elite of 'wise men' or professional priest-astronomers, comparable to those detected by him at the great henge sites of the south like Durrington Walls ;[16] in particular the main drain under the village, and the separate building apparently serving as a combined workshop and cook-house. seem incompatible with a simple peasant settlement.

This view has not found much favour. The book setting it out is rarely referred to and then usually dismissed.[17] Skara Brae and allied sites continue to be interpreted as peasant villages, sometimes with some cautiously expressed doubts about their communities being part of a truly segmented society.[18] Apart from Renfrew,[19] the evidence for intellectual skills in late Neolithic Britain has not been much discussed and recent works on Orkney rarely mention it. Henshall finds the proposed solar alignment in Maeshowe implausible and continues to offer the traditional interpretation of passage tombs,[20] not referring to the possible calendrical significance of the intriguing discoveries at New Grange in Ireland (below). Emphasis on the clear regional styles of Grooved Ware downplays its unifying features,[21] even though the 'Clacton' style makes a plausible national form.

Yet any picture of the Grooved Ware period in Orkney must notice the evidence for unusually elaborate ceremonial activity. Renfrew, thinking that Orkney may have been one of several centres in Britain of 'a remarkably powerful body of religious beliefs, with accompanying ritual observances',[22] also suggests that Grooved Ware may be evidence for widespread travel, even pilgrimages, connected with these centres.[23]

A significant discovery in recent years must be the Grooved Ware village at Barnhouse, close to Orkney's three really large-scale Neolithic structures mentioned earlier.[24] Alongside houses very similar to those of Skara Brae (though standing not more than 30 cm high) two much larger buildings look as though they had a public or ceremonial function. Richards notices similarities between the ground plan of one of these and that of Maeshowe cairn near-by, and sees that the chamber of Maeshowe incorporates into its architecture four massive standing stones like those of near-by Stenness and Brodgar circles. The Barnhouse site, a further element in the striking Grooved Ware complex of domestic, funerary and ceremonial buildings in this small area of the southern part of Orkney Mainland, has, in the author's view, provided a vivid confirmation of his earlier re-interpretation of Skara Brae as a settlement of a religious elite. There seem to be no signs at Barnhouse of a surrounding ditch with an external bank, as at Durrington Walls, Marden and Mount Pleasant, but there appear to be traces of one at Skara Brae.

The religion practised by the Grooved Ware people of Orkney must remain obscure to us, with only tangible archaeological evidence to be relied on. Although debris of certain kinds of ceremonial activity may be uncovered by excavation,[25] its interpretation is speculative without some clue from elsewhere. Such a clue may come from traces of an elaborate and accurate solar calendar quite different to the modern one which are evident in specific and quantifiable aspects of many standing stone sites as well

[15] MacKie 1977: chapter 9
[16] Wainwright 1971
[17] e.g. Whittle 1981: 247
[18] Clarke 1976; Clark and Sharples 1990: esp 69
[19] Renfrew 1973: 120-46
[20] Henshall 1990: esp 113-114
[21] Wainwright and Longworth 1971
[22] Renfrew 1990: 256
[23] MacKie 1994
[24] Richards 1990
[25] Perhaps at Links of Noltland: Clarke and Sharples 1990: 68

as in a few passage-graves [26] and in the geometric designs on the Bush Barrow gold plaque.[27] An exact calendar could have needed long and potentially accurate solar alignments to keep it synchronized with the seasons; many possible examples of these have been found and the genuineness of a few has been tested by excavation [28] (see Chapter 6).

Archaeoastronomy

Tracking celestial bodies accurately with primitive equipment involves – no less than flint knapping – technical problems for which there are a limited number of practical solutions. When the facts fit together in an unequivocal way – as they seem to at Maeshowe – there is the same sense of having crossed over the centuries and, however briefly, of having entered the mind of the architect and designer, just as one grasps how a skilled flint-knapper worked on a core by perfecting the skill oneself. The techniques for plotting the positions of the Sun, Moon, planets and stars in an era before accurate small instruments were available can be reconstructed, and sites suitable for observing them identified. The reality of the solar calendar alignments is shown by independent archaeological and historical evidence which supports also the existence of the sixteen 'month' calendar inferred statistically by Thom.[29] Yet, although this is a valuable new window to the more ceremonial aspects of prehistoric societies, 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 worked.

Orientations and alignments

Celestial sight-lines can be of two distinct kinds.[30] An *orientation* is a clear axis of a structure which can aim in a celestially significant direction; examples include the straight entrance of a Neolithic passage-grave or of an Iron Age Scottish broch, or the long axis of a Christian church or a Maya stone building, or of a non-circular and symmetrical stone ring. Orientated structures with axes that are short and imprecise can perform an observing function only at a fairly low level of accuracy.[31] The nature of the horizon pointed at need not be important here.

By contrast an *alignment* is a long line of sight extending from an artificial structure, the backsight, to a distinct natural mark on the horizon like a notch or a hill slope which is the foresight. To be plausible the structure must have some built-in direction indicator which points to this natural foresight mark – a pair of standing stones, or a stone circle and a single outlier, or a stone which is a single flat slab the long axis of which could be the pointer. Such a long line can be a useful observing *instrument:* a far-off horizon mark can in theory define the date of the rising or setting of a celestial object very precisely.[32] Fundamentally important is that the exact position of the backsight structure must itself have been chosen, after careful observation of the celestial phenomenon concerned, in relation to the horizon mark.

The existence of long alignments marking the solstices [33] has been much disputed.[34] It is uncertain whether the atmospheric distortions which afflict a long alignment near the horizon would ever have

[26] Thom 1967:1972
[27] Thom 1993: Thom *et al* 1988
[28] MacKie 1974:1981: see also Ruggles and Martlew 1993
[29] Thom 1967: chapter 9
[30] MacKie 1974:175; Burl 1987
[31] They might conceivably record directions, as perhaps at Stonehenge: Hawkins and White 1965; but see Heggie 1981: 145-51
[32] Thom 1971: figure 1.1
[33] The sun changes its real position, or declination, very slowly at these times - MacKie 1977: figure 9
[34] Ruggles 1984

permitted accurate observations of solstices, even in the drier climate of Neolithic times;[35] there is a view that the degree of refraction at sea-level would have made them unusable.[36] Yet excavated evidence from two claimed solar sites in Argyllshire strongly favours their genuineness [37] (Chapter 2) and some general arguments against them have been shown to be circular.[38] The logic of the situation implies that, though their accuracy may have been limited, attempts to use long measuring alignments could often have been made by simple societies.

Because extreme claims for 'scientific' activity in Neolithic times have been made,[39] the existence of potentially accurate long alignments is sometimes confused with this, most recently at Newgrange.[40] Even attempts to refute this idea have endorsed the false equation by implication [41] as perhaps has the whole prolonged controversy about the existence or otherwise of 'megalithic astronomy'. Research has revealed similar long alignments attributable to American Indian societies in pre-European times,[42] and there has never been any suggestion that 'Stone Age scientists' existed among these peoples. The author now prefers therefore, when discussing possible alignments, to use the more neutral adjective 'celestial', as 'astronomical' brings to mind an ancient practice of astronomy in the modern sense of the term.[43]

Solstitial sunrises and sunsets

I understand that the directions at which the sun rises and sets at the summer and winter solstices – as seen from any given site and from a specific location – have changed since 5000 years ago (Figure 3.2) because of a slow change in the direction of Earth's axis in relation to the fixed stars. At present this is tilted 23°27' away from a line perpendicular to the plane of Earth's orbit but it was apparently at a slightly greater angle in prehistoric times, about 23°56' in 2000 BC and 24°01' in 2700 BC. Thus, as Figure 3.2 makes clear, the Sun in those early times set at midwinter and rose at midsummer to the *left* of its present position, and rose at midwinter and set at midsummer slight to its *right;* in all four cases the position was a little further away from the equinoctial sunrises and sunsets, 21 March and 21 September. This difference lessens as one approaches the equator and the Sun's daily path gets more vertical in relation to the horizon. At the time of the building of Maeshowe, which we think to have been at about 2700 BC, sunset at midwinter was about a solar diameter of declination below its present position. In Orkney at latitude 59° North the Sun would have touched a level horizon about three diameters to the left of where it does now (see Figure 3.2).

That drawing also shows why, when considered in terms of a long alignment, sunset at winter solstice is different from that at midsummer. At both times it sets towards the right and at a shallow angle – about 19° in Orkney. From the observer's viewpoint this makes it possible to choose a distant foresight peak the right-hand slope of which has an angle about the same as that of the Sun's descent; thus the position of the upper edge of the disc can be pinpointed. Until midsummer the Sun's real position on the horizon is changing gradually towards the right; theoretically therefore it is possible to arrange a long

[35] Lamb 1974; Sinclair and Sofaer 1993
[36] Schaefer and Liller 1990
[37] MacKie 1974: 178*ff;* 1981: 128*ff*
[38] MacKie 1986
[39] The claim for 'Neolithic science' was first made by Hawkins and White: 1965 with their concept of Stonehenge being a Stone Age computer. A. Thom: 1971: chapter 5 made a more sophisticated claim, based primarily on the evidence he thought he could see in the standing stone alignments for the tracking of the finer lunar cycles, phenomena which could have had no useful purpose in ancient times except to help with eclipse prediction (see Heggie: 1981: 170-79; Schaeffer 1993: 163-4)
[40] Powell 1994
[41] Moir 1981: 223-4
[42] McCluskey 1982; 1993
[43] The author accepts some of the blame for equating ancient celestial observation with scientific knowledge; his 1977 book was entitled *Science and society in prehistoric Britain.* Heggie's book (1981) implies the same.

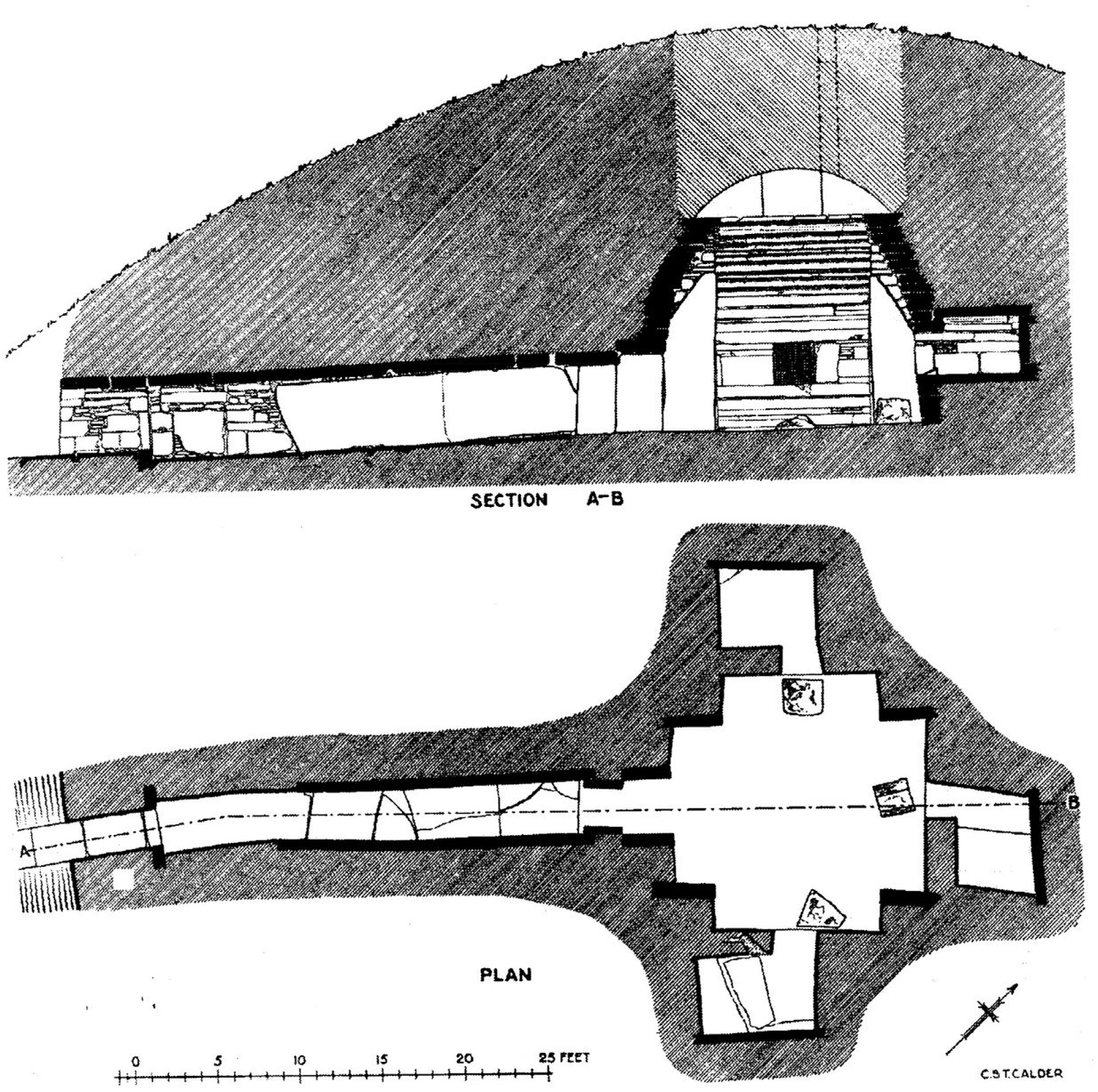


Figure 3.1. Plan and elevation of the burial chamber and entrance passage of the Maeshowe chambered Neolithic cairn. It is reproduced with the kind permission of the Royal Commission on the Ancient and Historical monuments of Scotland. (Crown Copyright reserved).

alignment – perhaps Ballochroy in Kintyre, Scotland [44] - so that the right edge of the Sun on the longest day, and *only* on that day, just peeps into view at the right slope of the foresight peak.

Before midwinter, though the Sun is still setting along a shallow angle towards the right, its actual setting position has been moving daily to the *left* or south until the centre of its disc reaches its maximum southerly declination of -23°27' (at present); it is difficult to arrange a long alignment so that the edge of the Sun just flashed into view at the right edge of a peak on the shortest day since the disc has been *more* in view on the previous evening. At a long alignment like Kintraw in Argyllshire the solstice might have been defined, by trial and error, as the one day when the Sun just failed to appear at the right slope of Beinn Shiantaidh.

[44] Thom 1967: figure 12.2; MacKie 1974: figure 2; 1977: figure 10

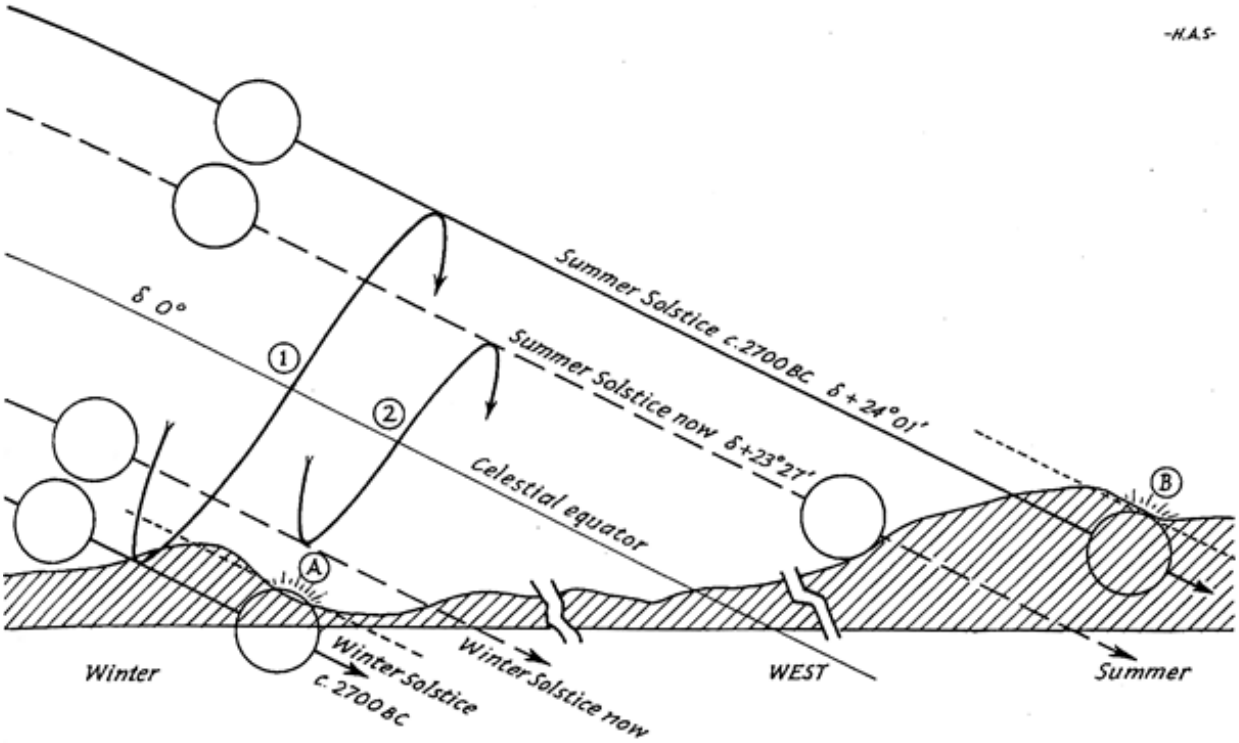


Figure 3.2. Diagram showing the solstitial sunsets now and at about 2700 BC ; the distance between the winter and summer solstice positions is not to scale (shown by the little gaps in the horizon); the solar discs and the setting lines immediately next to them are. The arrows labelled (1) and (2) indicate the Sun's declination changes at the two dates. Position A shows how a foresight notch for a winter solstice alignment is 16 minutes nearer the declination of 0 degrees than the declination of the centre of the solar disc, while B shows how it is 16 minutes further away at the summer solstice.

This contrast involves another distinction between midsummer and midwinter alignments which helps to demonstrate the genuineness of some. The right slope of Beinn Shiantaidh has a declination of -23° 38' as seen from the Kintraw stone (Figure 2.3); the alignment would thus mark the midwinter Sun when mostly hidden behind the peak.[45] The centre of the solar disc, with an apparent diameter of 32', would then be a semidiameter lower in the sky at -23°54', the prehistoric solstitial declination for about 1800 BC.[46] At the summer solstice the foresight slope – of Corra Beinn as seen from Ballochroy for example – should, by contrast, have a declination of +24°10' when the centre of the disc is at the equivalent position north of the celestial equator. Thus the declinations of the foresight slopes themselves should differ by 32' on midwinter and midsummer alignments, as they do at Kintraw and Ballochroy.

3.3. Newgrange, Ireland

Newgrange, the great passage tomb in Eastern Ireland [47] has been interpreted plausibly as clearly orientated towards the midwinter sunrise.[48] The construction of the vast mound has been well dated to the late 4th millennium BC by radio-carbon. The two dates were 4415 ±40 and 4426 ±45 b.p..[49] There seems to have been a massive stone door blocking the outer end of the main passage[50] and a rectangular

[45] MacKie 1974: figure 4; 1977: figure 14b
[46] Thom 1967: figure 8.1 and 17-20
[47] O'Kelly 1982
[48] Patrick 1974; Ray 1989
[49] GrN 5463 and 5462-C. O'Kelly 1972
[50] Lynch 1973: 148

opening with a decorated lintel – the 'letterbox' – is carefully built above the outermost passage lintel. The surrounding partial stone circle seems not to have been part of the original design and was evidently added in the mid 3rd millennium BC, at the time of Beaker activity at the site,[51] and contemporary with intense activity at Grooved Ware sites like Skara Brae and Barnhouse in Orkney.[52]

The 'letterbox' proved to be so designed that at dawn on 21 December the Sun shines through it and, for a few minutes, also through a gap between the first and second passage lintels; as the floor of the passage rises steadily towards the corbelled chamber, the beam of light strikes the rear wall of the rear side chamber almost at floor level and lights up carvings thereon.[53] Despite this discovery the 'letterbox' is still interpreted occasionally as an opening for the living to communicate with the souls of the dead.[54]

Contrary to Powell (1994), there is no suggestion, and never has been, that Newgrange contains a useful solar alignment with 'scientific capability'; the horizon, fairly level and close, contains no natural features capable of serving as a sunrise foresight; the size of the light apertures means that the spectacle was, and still is, seen for several days on either side of the solstice. Rarely mentioned but potentially significant is the outlying standing stone about 200m in front of the entrance which appears to prolong the line of the entrance passage (and possibly the axis of the whole mound) and to indicate from it the point of midwinter sunrise. Presumably the entrance passage is capable of defining the alignment a bit more, by being arranged so that the midwinter sun, when rising, shines right down into the tomb chamber. The existence of an accurate calendar, based on such alignments, is proved by a complex diagram on one of the kerb stones of the cairn. This and its meaning is described in detail in Chapter 6.

3.4. Maeshowe chambered cairn, Orkney

Bearing Newgrange and the other sites in mind, could Maeshowe have been built as some kind of solar temple/observatory as well as a collective tomb? The entrance passage pointing south-west suggests a connection with the shortest day of the year.

Architectural details

Maeshowe (Figure 3.1) – is architecturally the most sophisticated of a group of Orkney passage-graves which are themselves outstanding among this whole class of Neolithic monuments; it consists of an apparently free-standing square, corbelled chamber in the middle of a round mound of earth, reached by a long passage facing southwest; this is all surrounded by a shallow, rock-cut ditch.[55] The remains of the corbelled dome, square in plan, continue the sides of the chamber upwards by interlocking the long quarried slabs. The four corners are visible, curving inwards, as far as the original roof is preserved.[56] Each of the four corner 'buttresses' is faced with a huge upright slab with a pointed top, very like the many upright stones in the near-by circles of Stenness and Ring of Brodgar; the plan of the chamber is that of a short-armed cross (Figure 3.1).

These four uprights were standing *before* the chamber, the adjacent sides having been built against them. They would have formed an approximate square with the flat slabs aligned northeast-southwest; the lines formed by the two aligned pairs actually converge slightly towards the southwest. By contrast the drystone masonry parts of the corner pillars interlock with the sides of the chamber, confirming

[51] Sweetman 1984
[52] Grogan 1991 for list of all Irish dates
[53] Patrick 1974
[54] Lynch 1973: 148-9; Henshall 1990: 113
[55] RCAHMS 1946(2): 306-13, figs 381-2 and plates 383-6; Henshall 1963: 219; Burl 1981a: 124-6: Davidson and Henshall 1989: 45-51, 142-6; Ashmore 1990. The grid reference of the centre of the mound, taken from the 1:10,000 OS map, is HY/31821 12775 and its latitude is 58°59'50' north.
[56] Stuart 1864: plate XVIIl; Ashmore 1990: 11

that these were built with the tomb. The architecture (apart from relative weathering, if any) offers no evidence as to whether the four uprights were erected several centuries before the chamber or only a few weeks or days. The quality of the drystone masonry is outstanding.[57]

In three sides of the main chamber are small raised side-chambers reached by small square openings above floor level; the roof of each is a single huge, flat slab. In the fourth side is the long entrance passage facing south-west; the inner two-thirds of its roof and sides are formed by three enormous slabs of quarried sandstone some 5.49 m (18 ft) long. There are also rebates for a door, not including a sillstone (which may well be modern) below, 1.80 m (5.9 ft) in from the outer end, in front of the megalithic section. The passage outside these checks has a slightly higher floor than that within and is 0.7 m wide; the latter is 1.05 m wide and 1.35 m high; the roofs of the sections are now at the same eight. Just within this door frame and on the left (northwest) side, a large loose stone slab is set within a carefully built lintelled recess ;[58] the stone was found by Ferrer lying in the passage.[59] It appears to be a door which with some effort could have been swung round against the door frame, but only from the inside; the stone is only 2.5 cm narrower than the adjacent passage. A gap of about 35 cm (13 ins) would remain between the top of the slab and the lintel, or 45 cm from the roof of the passage within, when the door slab was in place. If the outer part of the passage was originally lower (below) the door would have blocked it completely.

Like Newgrange, Maeshowe was opened and emptied long ago (there are many inscriptions in Norse runes on the walls).[60] The only direct indication of its age is the oldest two radiocarbon measurements for the base of the peat in the surrounding rock-cut ditch; these gave ages of 3970±70b.p. and 4135±65b.p.[61] equivalent to *c.* 2800–2500 BC:[62] they presumably mark a period some time after the building of the monument, when peat had started to accumulate in the ditch. More recent excavations revealed an apparently earlier structure on the site; the outer end of the floor or a passage at a lower level appeared in front of the present one and apparently aligned slightly differently; underneath it was a drain.[63] It is therefore unclear to which period the surrounding rock-cut ditch and its C^{14} dates belong; these features may relate to this possible earlier monument, which might have consisted of the four standing stones now part of the main chamber. An alternative explanation for the lower paving is suggested below.

Another discovery during the 1991 excavations was a large socket for a slab-like standing stone on the opposite side of the mound from the entrance, on the platform within the surrounding ditch. Maeshowe or its predecessor might have been surrounded by a circle of standing stones.

The midwinter sunset at Maeshowe

The claim that the setting Sun shines down the tunnel-like entrance passage of Maeshowe on the shortest day was first made in 1893 [64] and was considered sceptically by Lockyer a few years later ;[65] the topic appears not to have been taken up again for many years,[66] though local people seem to have been coming to see the phenomenon for a long time. Modern photographs seem to have established this beyond doubt,[67] on a postcard which was on sale in Orkney (Figure 3.3). It is clear that the Sun is not shining down the *centre* of the passage but along its northwest side (the left as one looks in). Yet 5000 years ago the solstitial Sun

[57] Davidson and Henshall 1989: plate 19; Henshall 1990: plates 8, 5.2 and 5.3
[58] Henshall 1963: 220; Davidson and Henshall 1989: plate 20 and 85
[59] Stuart 1864: 250
[60] Farrer 1862; RCAHMS 1946(2): figures 387-9: Ashmore 1990
[61] Q- 1482 and SRR 505
[62] Renfrew 1979: 206
[63] Richards 1992: 448 and figure
[64] Spence 1893: 407
[65] 1906: 123-32
[66] Brown 1975: 12; Burl 1981a: 124-6
[67] Ashmore 1990: 7, bottom



Figure 3.3. Photograph showing the light from midwinter sunset shining down the passage, taken at 14.55 on 21 December. (Copyright © Charles Tait, Kelton, St Ola, Orkney).

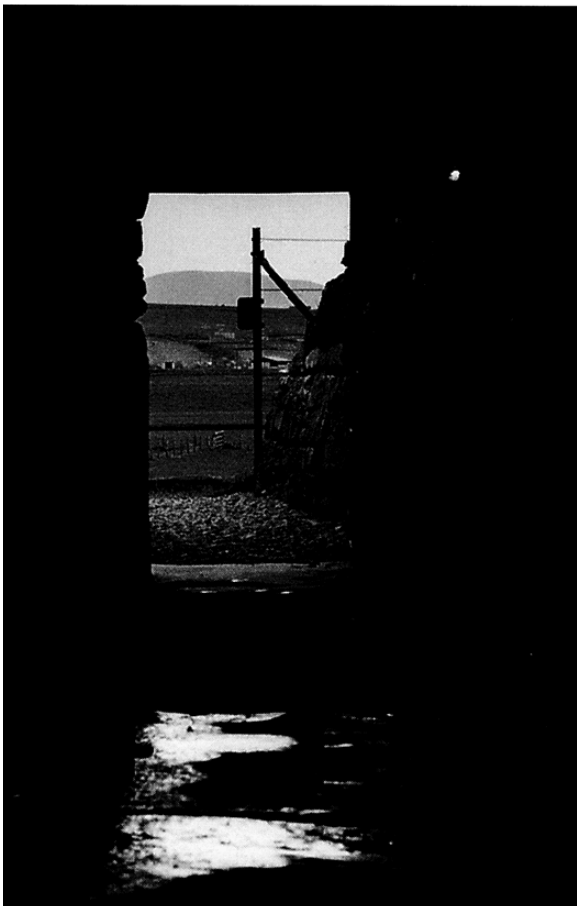


Figure 3.4. Photograph taken by the author, looking out from the Maeshow chamber. Ward Hill on Hoy is visible.

would have set about three solar dimensions further south and sent a beam of light down the passage even more off-centre towards the northwest than today. The discussion continues below.

Does the sunset on 21 December really shine down the passage and into the chamber now? Did it do so when the monument was built, bearing in mind the different obliquity of the ecliptic which prevailed at that time, and the probability that the outer part of the passage is not as it was originally (below)? If it did so, was this contrived by the builders or did it come about by chance? Any large, open, 11 m long squarish tunnel could have been orientated to admit the light from the Sun on and near the horizon for many days in succession. Bearing in mind the important distinction between *orientations* and *alignments* another question arises; is there a horizon foresight to mark the prehistoric midwinter sunset exactly for someone either inside Maeshowe or standing immediately in front of its entrance?

Because the position of sunset moves daily to the left on the horizon as 21 December approaches, at present the Sun shines into the chamber on several evenings leading up to the winter solstice, after the sunset position emerges from behind the left slope of Ward Hill (Figure 3.7). On these days a spectacular ritual involving this light could have been performed. When the tomb was built, and if the passage was as high as at present, there could have been more such evenings, but could this have happened on 21 December itself in *c.* 2700 BC?

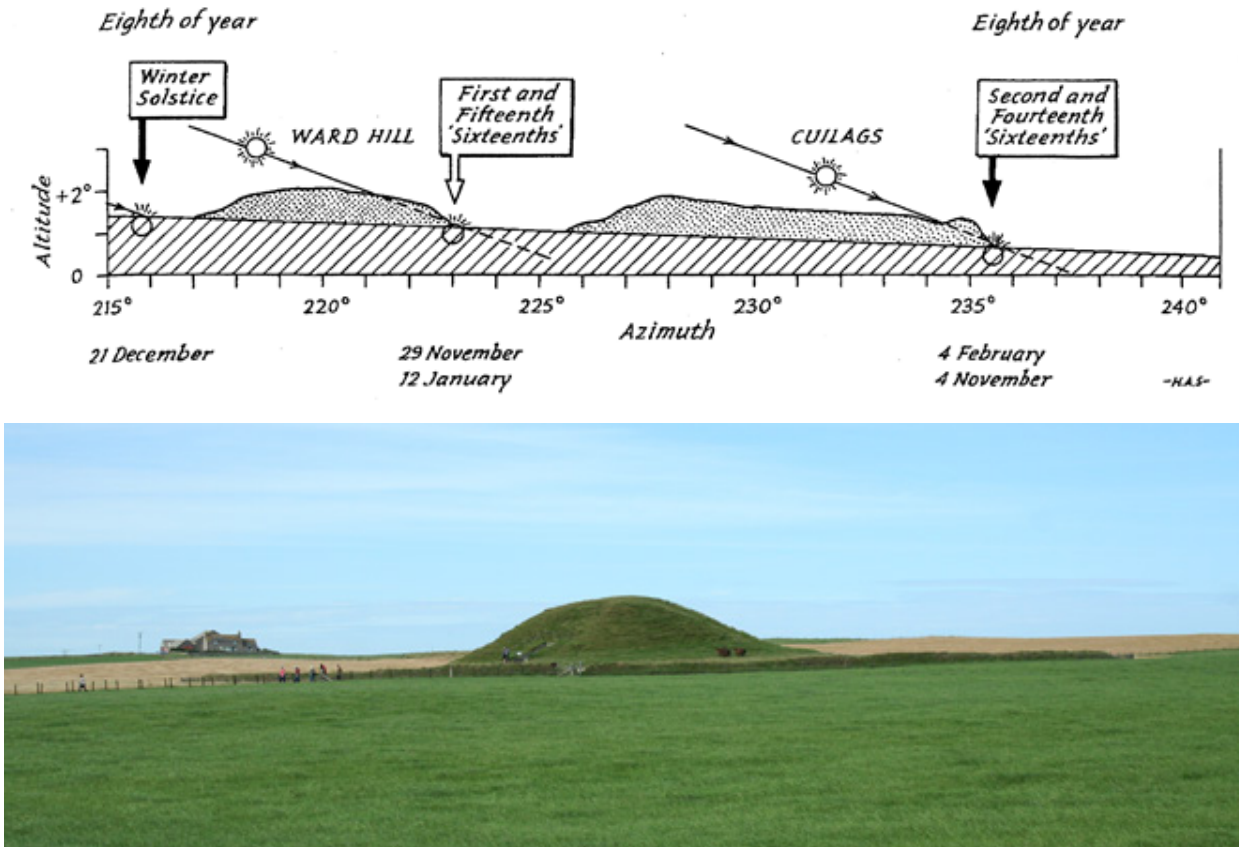


Figure 3.5. Top: Scale drawing of the south-west horizon seen from Maeshowe, showing both Ward Hill and Cuilags. The significant calendar sunsets are marked. Bottom: a general view of the Maeshowe cairn looking roughly towards the north. The doorway is just visible on the left side.

Thus is one lead to several hypotheses, of which two are pursued here (the idea that the southwest direction of the passage was fixed for a reason unconnected with the sky is not one, since by its nature it is very hard to test).

The first and simplest is that the building was orientated towards the midwinter sunset for purely ceremonial reasons – presumably connected with a solar religion – rather as a Christian church is orientated east-west. There need be no requirement for the solstitial sunset to shine into the chamber, and the horizon might not even be visible from inside. It is hard to deal with this hypothesis, either to sustain or to disprove it, with the evidence to hand.

A second hypothesis follows from the parallel with Newgrange; the requirements of a solar religion could have obliged its builders to construct the passage on a pre-established sight line so that the Sun *did* shine into the chamber on the shortest day. In that case the passage would be clearly orientated with the solar phenomenon in mind, and the southwest horizon – with the appropriate celestial declination – should be visible from inside the tomb chamber (Figure 3.6a). The profile of that horizon, however, need not have been important; an almost level one could have served, as it did at Newgrange.

A third hypothesis is that Maeshowe, unlike Newgrange, might in addition have had a useful working alignment with the capacity to detect midwinter's day itself; the tomb would then have been built in a spot where it could serve as the backsight for a long alignment towards some distant mountain peak or horizon notch. For this to be effective as a solstice indicator one could expect a foresight at

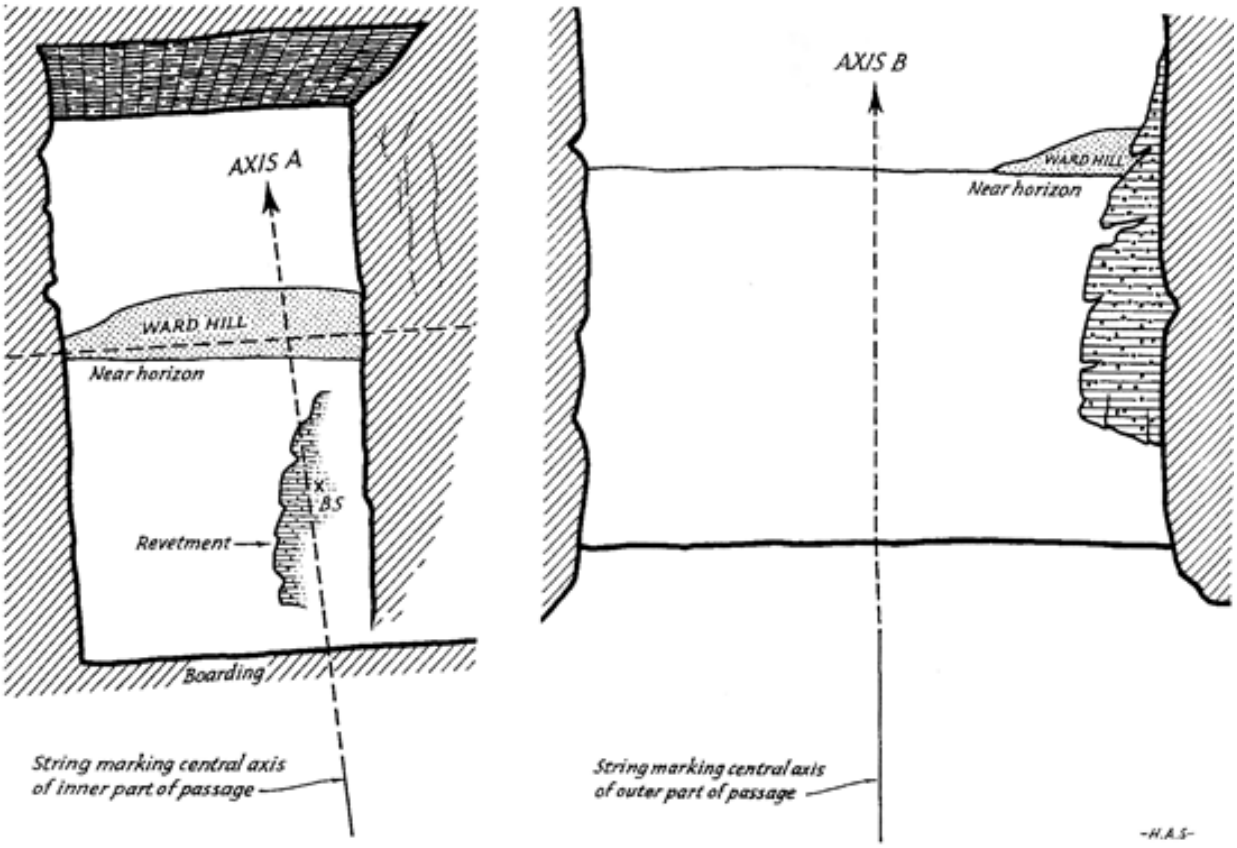


Figure 3.6a. The definition of Axis A (left) along the centre-line of the main (inner) part of the passage. Traced from a photograph o a string laid along two measured centre points of the passage. BS marks position of Barnhouse Stone. The definition of Axis B (right) along the centre-line of the short, outer part of the passage. Traced from a photograph of a string laid along two measured centre points of the passage. In both drawings the dotted line suggests where the original lower roof of the outer passage might have been.



Figure 3.6b. View from Maeshowe to the south-west horizon, showing the potential midwinter long alignment on the island of Hoy (see Figure 3.7).

least 10 miles away.[68] Practical observations would be more convenient when taken from in front of the entrance, as if at a standing stone, rather than from inside the chamber. Such a structure could also have had a ceremonial orientation built into it, as with the second hypothesis.

As we have seen, the backsight of a claimed celestial alignment must have some inbuilt indication of the direction of the chosen foresight; otherwise one would be free to select any hill slope or notch that fitted one's theory. The carefully made and symmetrical entrance passage, incapable itself of providing a useful alignment, could mark a point on the horizon by means of its centre-line. As first noticed by Spence in the late nineteenth century,[69] the Barnhouse standing stone is clearly visible *c.* 800 m distant in front of the passage, though below the near horizon (Figure 3.7); it points to a spot towards the right end of the flattish summit of Ward Hill on Hoy. The line has an azimuth of about 221° and could be evidence of an indicated alignment towards the right slope.

Fresh work at Maeshowe

In June 1993 a preliminary reconnaissance established that the southwest horizon seen from Maeshowe is quite dramatic (Figure 3.5 (top) and Figure 3.6b). Two conspicuous mountains on Hoy island – Ward

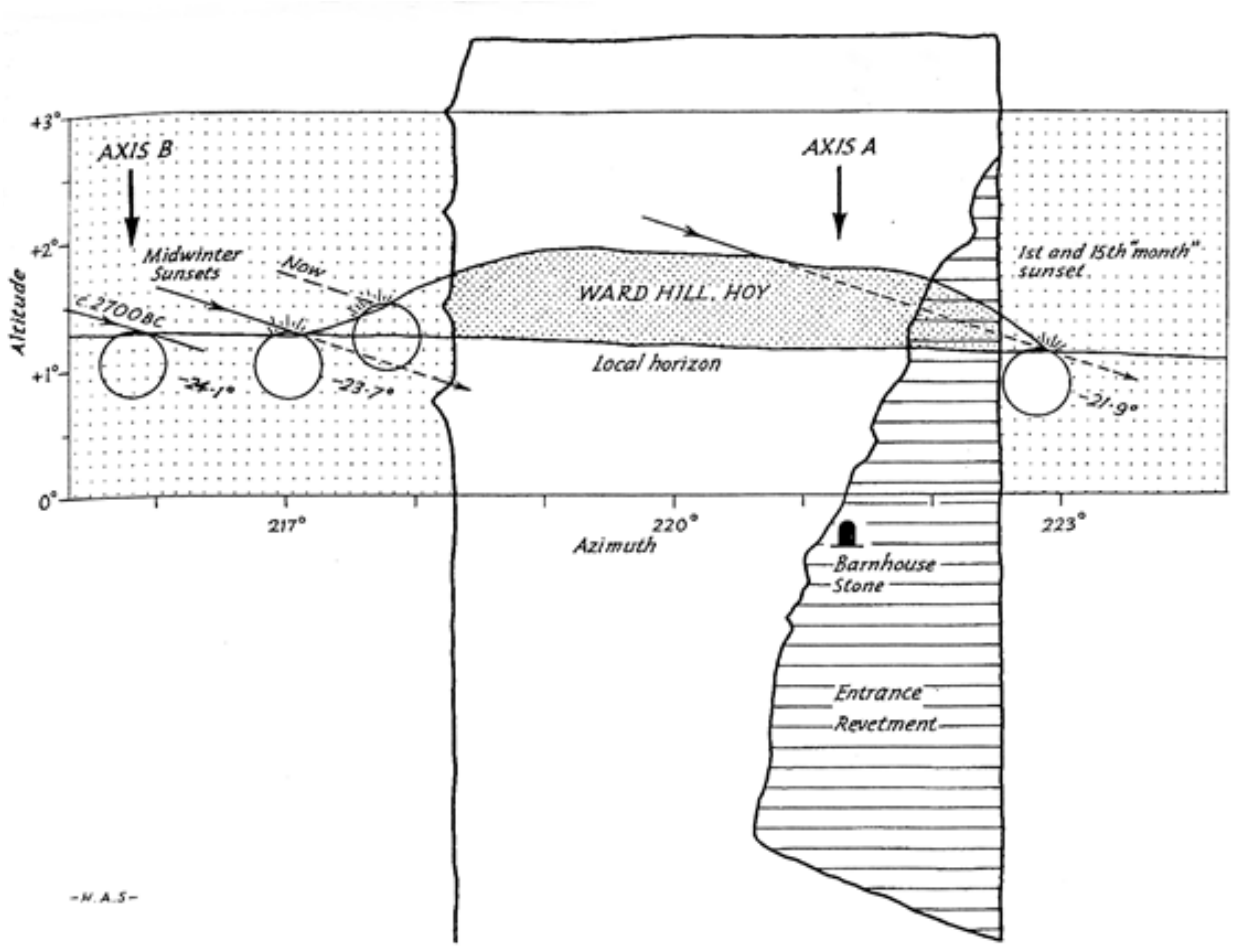


Figure 3.7. Alignments to the south-west horizon marked by the axes of the two parts of the entrance passage. The dotted line indicates the view from some distance down the passage. The Barnhouse stone is just hidden by a modern revetment.

[68] MacKie 1977: table 6b
[69] Spence 1893: 407

Hill and Cuilags – rise above the gently sloping but even local horizon, the only breaks in that horizon for a considerable distance in either direction. Photographs from inside the tomb chamber show that the central part of the long summit of Ward Hill can be seen from a position not far above the floor – a conspicuous hill pointed at by the passage. The Barnhouse standing stone, *c.* 800 m from the mound, does stand almost directly in line with the passage (Figure 3.7).

In September 1994 this southwest horizon profile was drawn with a theodolite mounted immediately in front of the entrance (Figure 3.7), and the azimuths were determined with timed observations of the Sun's position. Professor Frank Zabriskie kindly reduced the observations and, finding some discrepancies, made checks of his own at the site with a Wild theodolite. The azimuths and declinations, shown in the Figure 3.7 and obtained from the two most consistent of the author's three sets of 'Sun shoots', are thought to be accurate; in all cases refraction has been taken into account.[70] The figures agree with those obtained from a similar horizon profile drawn from the 1:10,000 O.S. map. The bases of the left and right slopes of Ward Hill form the only two obvious notches for long alignments (excluding for the moment the two similar notches formed by Cuilags a short distance to the right – below). The left notch (not really suitable for the setting solar disc) has a declination of -23°25.2' and the right notch -21°37.8'.

Photographs taken from just inside the Maeshowe chamber show how much of the horizon is visible from within the tomb (Figure 3.4). The visible segment of landscape – framed by the outer end of the passage (Figures 3.5, 3.6a and 3.7) - varies slightly according to where one is in relation to its inner end. The viewpoint has to be low down – within about 2 ft of the floor – for the summit of Ward Hill to be visible. The right-hand notch is invisible from anywhere inside the building; the left-hand one can just be seen if one stands behind the left or northwest inner corner of the passage. From this position the Barnhouse stone is just obscured by the modern revetment of the mount material immediately outside the entrance, which obtrudes slightly into the field of view for a reason about to be explained (Figure 3.7).

The entrance passage is composed of two straight sections – a short outer one and a longer inner one; according to the site plan prepared by the RCAHMS they are angled at about 8° to each other, the outer one pointing further south (Figure 3.1). If because of its symmetrical construction the passage is thought likely to indicate a precise point on the horizon, then there could be two such points. Bent passages are not uncommon in passage tombs; there are several in Orkney[71] and the angled passage grave of Gavr'inis in Brittany has been interpreted as having astronomical significance.[72]

By stretching a string between two large pebbles along the middle of each section (the floor being of impenetrable stone slabs) it is easy to determine fairly exactly where the two centre-lines are pointing (Figures 3.5 (above), 3.6a and 3.7). In this exercise, also carried out in September 1994, the centre point of the beginning and end of each section was defined with a tape and the taut string adjusted to them. The two passage axes were thereby found to be set with the short outer section pointing about 5.6° further south than the inner one.

In this way the centre-line of the main, inner section of the entrance passage – 'Axis A' – was found to have an azimuth of very close to 221.4°, indicating a point towards the western end of the flattish summit of Ward Hill (Figure 3.7). As near as can be determined it also passes *exactly* through the Barnhouse standing stone; this coincidence surely confirms that the outlying stone was part of this geometrical axis.

[70] Thom 1967: 25-6
[71] 197 RCAHMS 1946.
[72] Deconche *et al.* 1979: 8

A further indication that a northeast-southwest line was important may be provided by another structure close by; a short cist, empty but presumably of early Bronze Age date, was found in 1915 about 95 m northeast of the mound. The site, marked by a small cross on the 1:10,000 map with a grid reference of HY/3192 1289, is very close to the line of Axis A. This could of course mean that Axis A was also intended to point to the northeast, somewhere near the midsummer sunrise position (although the horizon in that direction is fairly featureless).

If Axis A does indicate an important sunset, it is probably that which occurs behind the west end of Ward Hill – in particular when the Sun sets so that its upper edge momentarily re-appears at the base of the slope (Figures 3.6a and 3.7). The midwinter Sun sets at an angle of about 19° in Orkney so that on this date (as well as on one or two others before it in late autumn and after it in late winter) it completely disappears for a short time, giving a 'double sunset' effect. The base of the west slope is quite steep; at about 13.8 km (8.57 miles) it is not very distant but, giving a good angle with the local horizon, it should be capable of defining a particular date exactly. The line indicated by the Axis, passing through the Barnhouse stone, seems to point slightly to the right of the place on the long summit where the Sun disappears on this particular day in autumn and again in the spring. When its upper edge is at the base of the slope, the centre of the Sun has a declination of 16' less than that of the notch, that is 21°54'.

The shorter, outer part of the entrance also has a clearly definable centre-line – Axis B – which strikes the flat local horizon at an azimuth of about 215.8°, a short distance left or south of Ward Hill (Figure 3.6a, right). This makes an orientation to a point slightly to the left of the modern midwinter sunset – nearer to its prehistoric equivalents in the 3rd millennium BC.

The azimuths of the two straight sections of the Maeshowe entrance passage both point close to conspicuous notches on an otherwise flat horizon with one passing through an outlying standing stone; this certainly suggests that the two axes of the building were deliberately directed at two settings of some celestial body. This is only likely to have been the Sun.

Modern reconstruction of the outer part of the passage

Unfortunately the rebuilding of the outer part of the passage, which undoubtedly took place after the explorations of 1861, may have radically altered the original design.[73] Was the roof of the outer part of the passage once lower – which would affect how much of the horizon could be seen from inside the chamber in Neolithic times? Is the skewed orientation of the outer passage also a modern construct – which would affect the orientation of Axis B?

The level of the flagged floor outside the door-checks may have recently been raised by about 0.2 m. Gibb's elevation, drawn after the 1961 explorations shows it at the same level as the inner floor; now there is a step up at the checks (his fig. 2, in Stuart 1964). Petrie's own drawing shows the same level floor (his fig. 11). There was a lot of debris on the floor of the passage, even the roofed part, when it was entered; the step may have been missed by the first excavators. Yet Gibb shows the main passage floor made of huge slabs of varying length, which he marks as continuing for at least 12 ft beyond the door-checks, and this suggests it was exposed. Moreover none of the plans from the 1860s shows the present sill stone crossing the passage floor at the door-checks. The only way to know the original arrangement would be to re-excavate part of the floor immediately inside the modern gate.

[73] Davidson and Henshall 1989: 145-6

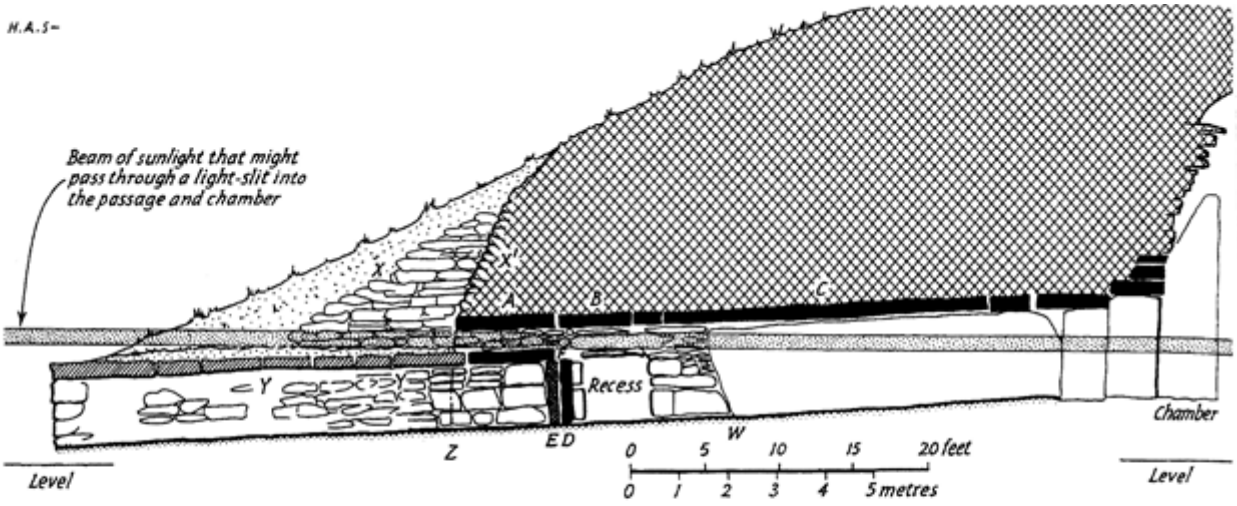


Figure 3.8. Reconstruction of the northwest elevation of the enterance passage of Maeshowe as it may have been in c. 2700 BC. The door-checks are at E and D shows the door slab shut agaisnt them. A, B and C are the existing lintels of the inner part of the passage while F is that at a lower level as marked by Petrie (1861: fig. 1) and lengthened according to his notebook information; W is the slab floor drawn by Gibb (Farrer 1862: fig. 1), extending in front of the door-frame; Z is the present position of the wall at the end of the passage and Y is the assumed vanished row of lintels at the same level as F. If there was a light box above lintel F there would presumably have been an open channel, with revetted sides (X) leading to it through the mound material and a layer of turf over the outer lintels; there should also have been a stone revetment for the mound material over the outermost upper lintel (X[1]).

A clue may be available from Richards' recent excavations a little further out; a row of paving stones continues approximately the line of the outer part of the passage for about 4 m at a lower level (1992: 448). Considering the 19th century drawings these stones may be not the remains of an earlier structure, but part of the original outer passage, beyond its present restored end. However the excavator believes it to be the remains of an earlier structure because it lies below the clay layer on which the mound stands.

More important here is the original height of the outer passage; Gibb shows the roof outside the door-checks considerably lower than that inside but today all the lintels are at the same height (Figure 3.8 from Stuart 1864). The four lintels drawn by Gibb (in Stuart 1964), shown immediately in front of the door-checks, seem to have been about 0.9 m above the original floor level there (whatever its height) whereas the inner part of the passage is 1.35 m high. His drawing suggests that the row of higher lintels continued outwards above the four lower lintels and over the door-checks, although the shading suggests that the masonry below the former is solid down to the latter. Petrie's drawing (1861), both clearer and more obviously diagrammatic, shows three massive lintels at the higher level roofing the inner part of the passage and extending in front of the door. The innermost, C, is clearly the single 19 ft (5.6 m) long slab, B is a large one about 5 ft (1.5 m) long which extends the roof up to the door-checks; A, about 6.5 ft (2 m) long, extends that distance in front of them. This is the point where the present roofed passage terminates at the revetted outer face of the mound and the iron gate. Petrie [74] stated that 'The passage has been traced to the margin of the base of the tumulus, and runs inwards in the direction of E.N.E. It is 2 ft 4 in. wide at its mouth (at E), and appears to have been the same in height, but the covering stones for about 15 feet were wanting. It then increases in dimension to 3 feet 3 inches in width, and 4 feet 4 inches in height, and continues so far for 26 feet, when it is again narrowed by two upright stones...'

[74] 1861: 354

Petrie also shows a single lintel at a lower level immediately in front of the checks, below lintel A referred to and with a gap of about 18 ins between them. This lower stone, about 2 ft long in his drawing, his notebook records as 5 ft 6 ins (1.68 m) and 0.7 m above the floor (Davidson and Henshall 1989).

At present the lintelled passage ends a short distance in front of the door-checks at what seems the built wall of the outer edge of the mound (Figure 3.8). This seems not to be the same as the revetted outer face of the stone cairn containing the chamber which was exposed, at two points nearer the centre of the mount, by V.G. Childe (Childe 1956; Davidson and Henshall 1989: 142, fig. 201) (but see below). Gibb's elevations clearly show the sizes and shapes of the regular sandstone blocks forming the passage sides; his drawing of this stonework matches that of C.S.T. Calder for the Royal Commission quite well, at least in the lower parts. These elevations show the walls of the passage – formed of carefully fitted blocks and slabs – extending well beyond where the end of the built passage is now (and beyond where the lintels were then); they show no signs of any straight joining.

The lower part of the end wall may in fact be ancient. Both Gibb's and Stuart's plans show that the stone cairn enclosing the central chamber has an extension northwest which encloses the passage as far as the present end wall. The sloping, rubble-faced walls, which now restrict the approach to the site gate through the outer part of the mound, certainly are modern; they have evidently replaced some fine Neolithic masonry. It is quite probable that the lintelled passage once extended some distance beyond its present end.

It does seem that Petrie's lintels A and B (at the highest level) were in their original positions. At the start of the excavation, he says: 'The covering stones (A and B, see ground plan and section) were soon reached and lifted in the presence of Mr. Farrer and myself.'

The outer part of the passage, originally probably somewhat longer, had lost most of its lintels and was filled with debris in 1861. Yet Petrie sets its roof at the height of the level of the single lower lintel he marks in position in front of the door-checks; something evidently made him think this lintel was a guide to the height of the roof of all of the outer part of the passage. Although the contemporary drawings are not entirely consistent, there does seem to have been some kind of double roof for a short distance in front of the door checks which was evidently not replaced.

Was the outer part of the passage in 1861 bent as it is now, or in line with the inner part? Both Petrie and Gibb show the whole passage dead straight although the opportunities for detecting a bend of about 6° at that time of first exploration were perhaps not numerous; yet any bend would have been more obvious in a passage exposed for a total length of about 56 ft. As it seems unlikely that the sides of the passage – which were traced, as noted, for some 6.4 – 7.0 m in front of the door-checks – were later completely rebuilt on a new line, it is assumed with reasonable confidence that the passage was indeed built as it appears now, two dead straight sections at a slight angle to one another. If the paving exposed by Richards is part of the original floor this is probably confirmed.

Discussion

Aspects of the siting and architecture of Maeshowe are clearer after these investigations, but one remains puzzling. The clearest element must be Axis A, a classic Thomian long solar alignment. Yet this primary and obvious axis is directed some distance to the right of the prehistoric midwinter sunset point, as Spence observed in 1893 (Figures 3.6a and 3.7). At present the marked sunset occurs about 22 days before and after midwinter and fits the 16-'month' solar calendar inferred statistically by Thom from scores of standing stone alignments. There the 365.24-day year is subdivided into halves (fixed by the solstices), quarters and eighths to give 16 divisions of either 22 or 23 days with one of 24.[75]

[75] Thom 1967: 109*ff*

In about 2700 BC the 'ideal' declination for the setting Sun on the first 'sixteenth' before midwinter was -22.08° and on that after it -21.82° (Modified from Thom 1967: table 9.1). All these calendar markers (except those for the solstices) presumably served two separate dates six months apart, the declinations for which are slightly different. Thom suggests an 'ideal' declination which would serve for both; many of the suitable alignments are very close to this ideal figure. As noted the Sun with its upper edge at the right notch has a declination of -21.9°; it would have set here just over 23 days before and after the solstice.

There is increasing evidence – both historical and from the analysis of standing stones and stone circle alignments all over Britain – that this sixteen 'month' Neolithic solar calendar was a reality with the four most important points in it – the 'quarter days' half way between the solstices and equinoxes (McCluskey 1989) – incorporated in the ancient Celtic calendar and surviving to modern times in Scotland (MacKie 1988: table 2). This point is pursued below. Slightly later independent evidence for this prehistoric calendar arises from a re-interpretation of the golden lozenge-shaped plaque from Bush Barrow in Wiltshire (Thom, Ker and Burrows 1988; Thom 1993).

Axis B, today defined by the equally straight and symmetrical outer part of the entrance passage, has an azimuth of about 215.8°, or 5.6° to the left of Axis A. About 1.2° to the left of the left notch of Ward Hill it may be deliberately aimed at the ancient solstitial sunset, at the point where the disc was about to vanish below the flat local horizon. The coincidence with the compound setting position of about 2700 BC seems significant.

Doubts about the original shape of the passage, in both plan and elevation, allow one only to conjecture about its relation to the prehistoric midwinter sunset and whether this shone down the passage into the chamber. As the modern post-card shows, the sun today shines down the left (northwest) wall of the passage (Figure 3.3), and only a narrow squat beam can penetrate the chamber (Ashmore 1990: 7, bottom), constricted as it is by the outermost lintel of the passage and by the left (northwest) inset slab at the inner end. The prehistoric solstitial sunset, further to the left of Ward Hill, would reach in even less, and the probable longer and lower roof over the outer part of the passage is another obstacle; it would have hidden the horizon from the chamber altogether.

Despite this discouraging preliminary impression there are other facts and possibilities that imply that the illumination of the Maeshowe chamber at sunset on the shortest day was intended. The door slab seems designed to leave a narrow slit open above itself when it was shut (Burl 1981b: 247): but see Lynch 1973: 148-9 and Henshall 1990: 113-14 for another interpretation. Also the tomb was built on a spot from which the few sunsets up to and after midwinter occur on a low, level horizon; if that on the shortest day occurred over Ward Hill, for example, the illumination phenomenon would have been harder to arrange.

The clear possibility of an overlap at the door-checks between the higher roof of the inner passage and the lower outermost lintels, together with the 'letterbox' arrangement at Newgrange, suggest another solution; there could have been a gap in the mound materials over the lower part of the passage, its lintels only just below the surface, leading to a narrow horizontal slit between the upper and lower roof just above the door-checks. Then the setting Sun for several days around 21 December could have shone into the closed building, almost exactly as it does at Newgrange. Figure 3.8 shows a suggested reconstruction to this design.

A multiple calendar site?

Having explored the two directions indicated by the entrance passage, and discovered a link with the 16-'month' solar calendar immediately around midwinter, is there any more to be learnt from the site in its setting in the landscape?

A second major solar alignment?

Two hills on Hoy are conspicuously visible from Maeshowe, the second being Cuilags; these are the only prominent horizon marks in the south-west visible from the site (Figure 3.6b). No standing stone is known which points at Cuilags, an admitted essential to proving an alignment there. The right end of this hill forms a steep slope at the end of another long, flattish summit with a marked bump, almost a separate summit, just before the end of the ridge. Thus when the upper edge of the setting Sun reappears to flash momentarily at the base of the slope it has already set behind a substantial thickness of hill (Figure 3.7). The declination of the Sun with its edge at the base of the slope is -17.3°, or -16.9° at the bulge higher up.

If the existence of an indicated calendar alignment to Ward Hill makes more plausible the intention similarly to use the right slope of Cuilags, despite the apparent absence of a direction indicator, the second and fourteenth 'sixteenths' of the year – 45 days before and after midwinter – are an obvious target. The 'ideal' declination for this date at about 1800 BC is -16.35°, or -16.43° when adjusted to c. 2700 BC (Thom 1967, Table 9.1). There was once a standing stone at Kethesgeo, just over a kilometre southwest of Maeshowe and about 7° to the right of the Barnhouse stone as seen from the cairn (NGR HY/3035 1136). It had disappeared by the end of the 19th century but a stake still marked its position some years later (RCAHMS 1946: site no. 910). It is possible that this stone was an indicator of the alignment at the right end of Cuilags although at present it seems to have pointed at a spot closer to the left end.

A few sites are known which seem to have been positioned to make use of two or three long solar alignments using the same backsight. From the standing stones near Watten, a clear view southwest is to be had across the plain of Caithness towards several peaks in Sutherland; these stand behind an almost level horizon, as at Maeshowe (Thom 1967: 115 and Figure 9.3). Three of these peaks could have marked sunsets on the sixteenth intervals in the old solar calendar. Another site is at Brainport Bay in Argyll where a standing stone (now fallen) seems to have been so situated that two conspicuous horizon notches – in the west and southwest respectively – could have marked the sunset at equinoxes and at winter solstice (MacKie 1981 and 1988: RCAHMS 1988, no. 364).

Further conclusions

The restored state of Maeshowe and the uncertainty about its original form prevent a more than tentative account of a full scheme. Yet the celestial positions of the two conspicuous right hill slopes visible from Maeshowe *are* both close to those predicted by the Thom calendar hypothesis. The tomb itself – or any earlier structure which it replaced – could have been built at the one place in the landscape where use can be made of these horizon features as alignments.

This hypothesis of the builders needing two clear solar calendrical alignments at one site explains why the prehistoric midwinter sunset occurred against no foresight but on the local flat horizon just to the left of Ward Hill. This setting position, determined by the other two alignments and by local topography, would have been quite arbitrary in relation to the horizon.

The unique sophistication of the Maeshowe architecture is matched to a unique setting within the landscape – tied to the one place where long alignments to sunset on the first and second sixteenth before and after midwinter are available to the most conspicuous natural foresights on the southern Mainland of Orkney. This argument becomes stronger if a special light slit was built over the door (Figure 3.8).

The specific reason for constructing the passage so that the light from the sunsets nearest to midwinter shone into the chamber remains unclear. The bent passage inhibits the light now, and at 2700 BC could

have prevented any illumination of the chamber at all, especially if the outer part was longer and lower. A slit over the door, however, would have allowed light to shine down the inner passage alone and could have overcome some of the problems. However, the fact that the light shines into the chamber more easily on several evenings before and after midwinter than on the shortest day may be one of the more significant facts revealed here.

Late survival of the solar calendar?

Thom was the first to point out that the dates of those 'eighths' of the year in his prehistoric solar calendar, which fell between the solstices and equinoxes, were close to the modern festivals of Candlemas (early February), May day, Lammas (early August) and Martinmas (early November) (1967: 107 ff and fig. 9.2). These 'Quarter Days' are still important legally in Scotland and also seem to coincide closely with the old Celtic festivals of Beltane, Imbolc, Lunasda and Samhuinn (Burl 1983 p. 34 ff: Darvill 1987, pp 189-90: MacKie 1988, 225 ff.). McCluskey (1989) has analysed the historical evidence for the pagan origins of those modern Christian festivals which fall on, or close to, the modern Quarter Days. He also considered which version of the eighths of the year – as defined by the Thom solar calendar, by the 'geometric' model and by a combination of the two – corresponded most closely with the known dates of these festivals near the time of the Christianization of the British Isles; on the whole the Thom model seems most consistent with the historical evidence.



Figure 3.9. View from the top of Maeshowe cairn towards the Ness of Brodgar – a peninsula which used to be isolated between two lochs before the causeway for a modern road was built. The Ness of Brodgar site is among the cottages on the left and the Ring of Brodgar stone circle is on the right, just before the peninsula slopes down to a lower level.

It has been pointed out that, not only are the diagonals of the Station Stone rectangle at Stonehenge more plausibly orientated towards the 'Quarter day' sunrises and sunsets than towards the Moon, but that these lines are also indicated in a number of important standing stone sites in Brittany (Thatcher 1976, Burl 1997) (Chapter 5).

The possibility that elements of the Neolithic solar calendar and its accompanying festivals have survived into modern times could have far-reaching implications.

3.5. Ness of Brodgar (ceremonial centre)[76]

A new excavation began in about 2003, not very far from the Maeshowe tomb. Ness of Brodgar seems a remarkable site which provides convincing confirmation that a professional priesthood existed in Neolithic times and explains the ingenious astronomical and geometrical qualities of stone circles and standing stones all over Britain. Of course there are some archaeologists who still don't accept this view (more details in Chapter 7). Unfortunately Rosie Kinchen, who wrote the original article in the *Sunday Times*, which convincingly supports Alexander Thom's ideas, did not make this point. Records of new work at the site is recorded on the web site 'www.nessof brodgar.co.uk.'

There is now a recent publication by Historic Scotland (Pickering and Foster) which discusses all these sites, including Maeshowe, the Stones of Stenness, the Ness of Brodgar, the Ring of Brodgar and monuments around it, and Skara Brae. It contains many impressive illustrations, including many finds, and then a discussion about Neolithic Orkney. The conclusions are cautious; for example on p. 51 it says 'We can never know how these early people viewed the world, but they are likely to have been sensitive to the passing of the seasons; the cycles of the Moon and Sun may have been particularly important.. Aspects of these beliefs are apparent in their architecture.' Clearly the idea of Neolithic priest-astronomers like the Druids is not acceptable. There are no bibliographical references in the booklet so the readers are expected to believe that the authors believe they are right.

However Nick Card – the director of the excavations -- has written a booklet called *The Ness of Brodgar: digging deeper* (2017). On p. 34 the author writes 'Who were the people of the Ness? With each passing year we add new chapters to the story of the Ness'..... 'Our work so far tells us that we are dealing with intelligent and highly creative people; sophisticated, spiritual, gregarious and competitive.' ..... 'There was a time when ideas, material and people circulated over great distances, when stories were carried across the water and around the hearths of scattered communities. And the Ness lay at the heart of this world. Back then the the area drew people in to honour the dead and to celebrate with feasts, to renew old ties and to forge new bonds. People travelled from near and far to attend important ceremonies. And when they came together, many things were possible; the settling of feuds, competitions of renown, the exchange of goods, gifts and gossip. And all of this woven around key moments of ceremony, through a sense of the spiritual that could be traced in the land and the sky.' This is an intriguing recent publication; even though it does not mention a priesthood it deduces numerous activities which fit with the existence of one.

The archaeological team (led by Nick Card) have discovered what they may regard as a Stone Age temple complex on the peninsula which contains Britain's earliest wall paintings and which they believe could be as significant as Stonehenge. They have (by 2012) excavated fourteen buildings but this is believed to be only about 10% of the complex, which may take generations to investigate.

Using thermal geophysics technology to survey underground, the experts have discovered buildings spanning an area the size of five football pitches. It is believed the earliest parts of the site pre-date

[76] 'Temple Discovery rewrites Stone Age'. Rosie Kinchen's article in *The Sunday Times* of Jan. 1st 2012

the stone circles at Stonehenge by about 800 years and are likely to have been built for ritual purposes. Until now, archaeologists believed Stonehenge – more than 500 miles to the south in Wiltshire – was the centre of Neolithic culture in Britain. The scale, age and complexity of the discoveries in Orkney are leading some to challenge this view.

The Ness of Brodgar site is a neck of land (between two lochs) between the Ring of Brodgar stone circle and the standing stones of Stenness, which are now beyond the causeway which takes the modern road across to the peninsula. There was no proof that its raised terrain was anything other than a natural phenomenon until full excavations began in 2008. The archaeologists have uncovered a prehistoric wall around the edge of the site, built from more than 10,000 tons of quarried rock. It is likely to have been 10 ft high and even some of the remains are more than 5 ft tall.

Samples of charcoal taken from beneath the wall show that it was built around 3200 BC, a century into the life of the site and at about the same time as the nearby tomb mound of Maeshowe, and Skara Brae, a stone village that was previously Europe's most complete Neolithic settlement, uncovered by a storm in 1850. It is now a UNESCO world heritage site.

Nick Card, senior manager at the Orkney Research Centre for Archaeology, who is overseeing the dig said; 'It's a huge discovery, in terms of scale and complexity, and there really is nothing else quite like it.' In the documentary 'A History of Ancient Britain', which was screened on BBC2, the presenter Neil Oliver follows archaeologists as they try to understand why Stone Age people built such a large group of structures. In one of the 14 structures uncovered Card's team found three doors and three hearths. One massive building is 75 ft long and 60 ft wide, with sides 4 ft thick in places. In another – known as 'structure eight' – stone slabs protrude from the walls to create enclosed spaces. A number of artefacts incuding a whalebone macehead, a whale's tooth and a small stone spatula have been found inside.

These findings offer insights into Neolithic life but are in contrast to the more domestic items such as a bone pin, necklace, and stone cupboards with shelves, found in the houses at Skara Brae. In a conversation in 2013 Card said: ' At first we thought it was a settlement, but the scale and complexity of the buildings within makes you think along the lines of a temple precinct.'

The walls in many of the structures have been carved and painted using pigment from rocks. In some red zig-zags can be seen – thought to be some of the earliest eamples of Neolithic artwork. The archaeologists also uncovered four stone mace heads, thought to be signs of status as well as weapons. All were broken in two in exactly the same place, which the experts claim suggests they may have been used in ceremonies. The temple complex is a more sophisticated site than some Neolithic stone circle sites in Britain. 'It is something you would normally associate with the Classical world' said Card. 'A temple precinct would have taken an awful lot of planning and mobilisation of manpower.' This, according to experts, suggests Stone Age Britons lived in a structured society.

Alison Sheridan, former head of early prehistory at National Museums Scotland, said on the BBC2 programme 'Orkney's Stone-Age Temple' 'It makes it more likely that we're dealing with a theocracy, where power was based on ability to communicate with the gods.' Julian Richards, an archaeologist and author of several books on Stonehenge, said: 'The indication is that building was taking place at a time when Stonehenge was, relatively speaking, insignificant.' The preservation of the buildings and artefacts on the Orkney site is also rare. The walls still stand several feet high in some places and there are traces of paint.

A figurine made from baked clay – now named the 'Brodgar boy' – was discovered in one of the structures. Only one other similar representation of the human form from the period has previously been found in northern Europe. Richards said 'We have tended to think we knew how things were in the Neolithic period, then something like this happens and it turns that on its head. It is going to take a very long time to fully understand the site'.

Discoveries of possible links between Orkney and Wiltshire – suggesting religious links between the distant areas – are described at the end of Chapter 6 on Stonehenge.

Structure 12

This is the building in the south-west corner of the excavated area – rectangular in plan but with rounded corners and with its long axis aligned (judging from the plan) approximately on 20 degrees (Figure 3.10). The internal plan is more rectangular and is divided up by three short stone piers projecting from each of the long side walls. The quality of the masonry is extremely high but the building seems to have suffered damage at some stage while it was in use, and extensive repairs and rebuilding took place. This later masonry concealed some of the original features, including the unusually situated doorway, which is in the middle of the northern end. It is aligned approximately at 280 degrees and is the narrow space between the short cross wall and the most northern internal pier on the western side. However by moving slightly to the right, one can see the part that is probably pointed at by the passage, and this is the right slope of a hill which might well define the setting of the Sun or Moon. The GPS grid reference of the standing stone close to the passage is HY/29404 13362.

My compass bearing along this passage read 292 deg. which is about 288.5 from grid north. As far as I can tell from the contours on the 1 inch OS map (and allowing for the possibility that the prismatic compass is not spot on) this hill with a fairly steep northern slope should be Cringla Fold the summit of which is at HY/238 142. This becomes more likely when one notices another, shallower descending slope just to its north, which seems match the photograph in Fig. 2. As a check, using the two grid references one gets a grid north bearing from Ness of Brodgar to Cringla Fold summit of 282.1 deg., which is equal to a true north bearing of about 281.0 deg. The bearing seems about right since the summit is to the left of the relevant slope. The altitude from the contours (assuming Ness of B at 5m above sea level) is 1 deg. 13' (I couldn't mount my theodolite at the dig, and had omitted to bring the Indian clinometer). A declination for this peak would be interesting and perhaps significant? The following year I thought I would try and get more precise data, but this did not succeed.

Traces of at least fourteen major buildings have been uncovered by the ongoing excavation at this site, and four of these are sufficiently well preserved for the orientation of their doorways to be determined and analysed. This was attempted on Aug. 14th 2013.

The information was not so easy to obtain as at Barnhouse, partly because excavations are on-going, but also because the actual design and alignment of the passageways was not always clear and had to be explained to me (I had no portable site plan at that stage). Finally the simple plans of the buildings which are available on one of the notice boards on site did not always show the entrances which had been demonstrated to me. There is an additional difficulty in that no N point is marked on the plan. There is in fact a better site plan on-line which I have photographed on my computer screen and use here.[77] The more accurate information on it has allowed me to refine some of the data.

In this section, and because many of the pictures of ruined Neolithic buildings look similar to anyone not thoroughly familiar with the site, I am identifying the photographs by their camera numbers, e.g.

[77] http://www.orkneyjar.com/archaeology/nessofbrodgar/excavation-background-2/plan-of-structures-on-site/

[990]. It is always possible to tell which are my ranging poles because they are painted in feet. To make the prismatic compass bearings as accurate as possible I took the reverse bearing each time, without first working out what it should be.

Structure 12 presented some problems when I came to interpret my photographs against the available plan. In Nick Card's latest booklet there is a vertical photograph of Structure 12 on page 29 which is more realistic. This booklet contains many clear photographs of several structures and many more of the artefacts which were discovered on the site. Under the section of 'The Big Questions' it says 'How was the Ness used? Was it occupied continuously or was it a place where people came at special times to do special things? And who lived there? Many of the structures on the site are impressive statements in stone. This may indicate that they were the preserve of the powerful, but it is unlikely that this was fixed. So we need to know how the use of the site changed over time, linking this to the wider changes we see

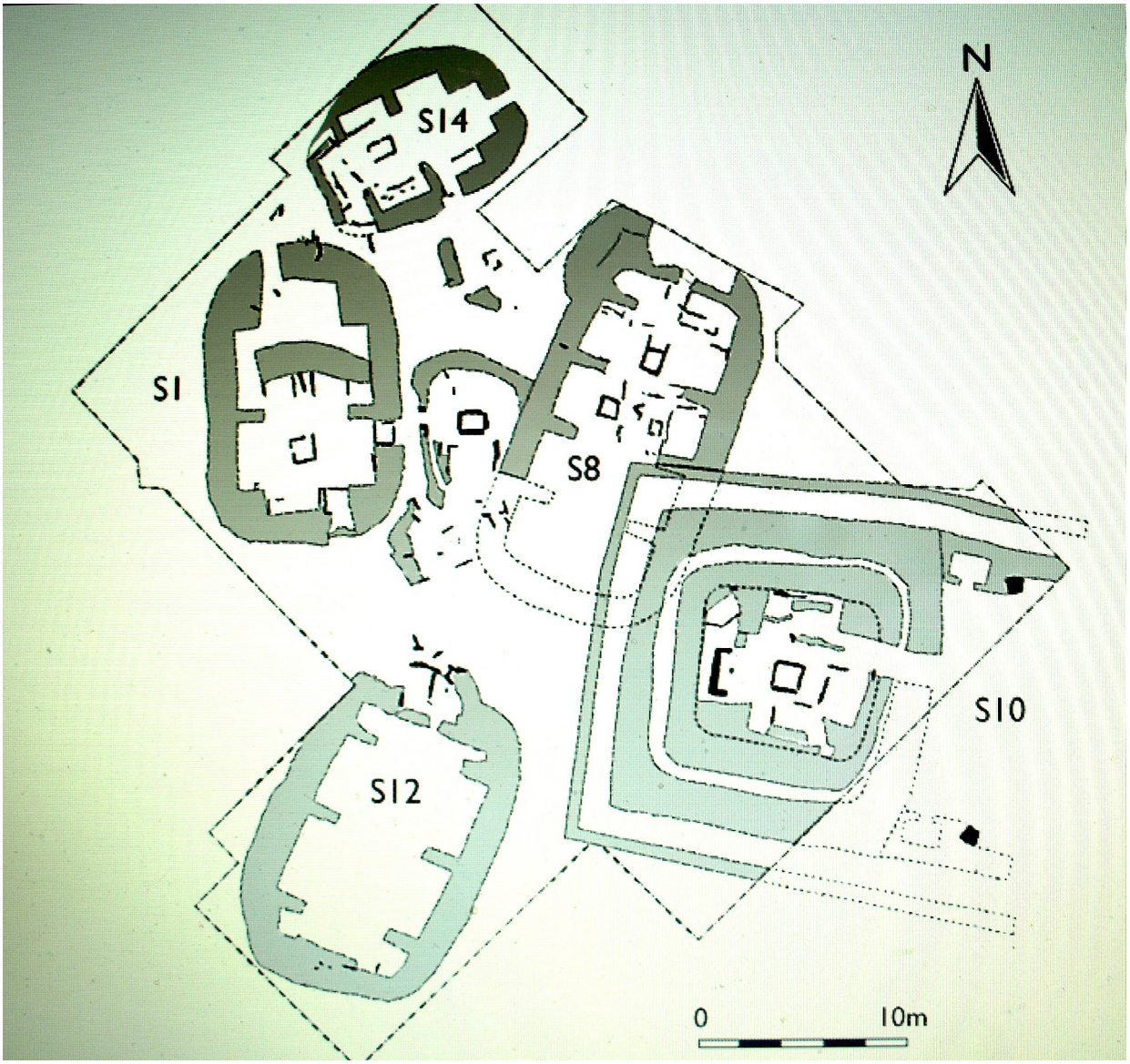


Figure 3.10. Plan of six of the most complete buildings at the Ness of Brodgar – with north point and scale – taken from the web site mentioned in the text and photographed on the computer screen.

over the region. Questions of scale also matter. The Ness was central to life in Orkney, but how wide was its reach? The Grooved Ware of Orkney inspired the making of similar vessels across Britain and Ireland. Stone artefacts from the site also include materials from Cumbria and from the west coast of Scotland, proof that objects, people and ideas were all on the move. That means that the story of the Ness can never be just local. Then, as now, the people of Orkney were caught up in wider worlds. We need to ask how that was possible and what it meant, back then.'

The next two pages are titled 'Finding out more' and these comments follow. 'As excavation work progresses archaeological science is helping build a clearer picture of the buildings, what happened inside them and of the lives of the people who built them.' These conclusions seem to support the idea that the Ness of Brodgar was a priestly settlement and that there may be some accurate long astronomical alignments, particularly to the peaks on the island of Hoy to the south. Some of these are shown below. The links between the artefacts and the other parts of Britain seem to support my conclusions from Julius Caesar's evidence on pages 64-5.

Structure 8

This is a building similar in general design to No. 1 below but which probably had four dividing piers against each long wall, forming five bays. Its long axis is aligned about N by NE / SW by S. There is *only one entrance passage* (grid ref. HY/30302 12851) the orientation of which was not immediately clear because it was filled with earth in plastic bags; it had to be indicated to me and from the plan should point at about 10° TN.



Figure 3.11. View of the alignment of the only doorway into Structure 8. The horizontal pole was placed along the estimated alignment. Orientation 14º MN: altitude + 0° 50'.

In fact it points to a flat zone between two shallow hill summits on the other side of the loch, on a bearing of 14° MN [998]; the 'reverse bearing' is 195**°** MN. The line indicated by my ranging poles may be irrelevant because of the closeness of the door alignment to true north, unless it marks some extreme lunar rising position. This is disappointing because the building is long, straight and has only one doorway in the narrow end at the N. The altitude of the almost level horizon is + 0° 50'.

Structure 14

This is a relatively small, compact rectangular building with the usual stalled plan and – judging from the site plan – the long axis of which is aligned about NE/SW; there is a hearth in the centre. There are two doorways, the one in the narrow NE end being aligned on about 50° TN; the second one – in the SE long sides – is also apparently primary and is orientated somewhat to the S of SE, on about 145° TN judging from the plan.

1. The *NE entrance* in fact has a bearing of 59° MN (reverse is 238° MN) and it points across the loch towards an even, shallow hilltop with an altitude of + 1° 45' [1004]. Its grid reference is HY/30291 12858 (Photo 1004).

2. The *doorway in the SE long side* of Structure 14 has an orientation of 145° MN (reverse bearing 320°) and indicates a flattish hilltop with an altitude of +3° 0' **(**its grid reference was omitted but it hardly



Figure 3.12. View outwards from the centre of Structure 14 (hearth in foreground) through the doorway in the NE short side; the foreshortened pole lying flat marks the position of the actual passage. The orientation is 59° and the altitude of the indicated horizon is + 1° 45'.



Figure 3.13. View through the SE doorway of Structure 14, showing the indicated distant hill top, now invisible from the doorway itself. Orientation 145º MN, altitude + 3º 0'.

matters). The photograph was taken slightly to the left of the line of the axis in order to see past the nearby building.

Structure 1

This looks like a more massively built house, with a large partition wall inside looking later than the original piers, which project from the centre of each long wall. The plan suggests that there are three doorways – one at the W end of the short N wall, one near the E end of the short S wall, and one near the S end of the long E wall. Only two were indicated to me, namely the N entrance in one short end wall – which appears to be orientated close to due N – and the S entrance in the other short end wall, which seems to be orientated towards about 170°/175° TN.

The north doorway [1010] (grid ref. HY/30282 12848): this entrance appears to face almost due N and across the loch. This passage is actually orientated on an azimuth of 345° MN (reversed 165°) and is aimed at the shallow summit of a low hill, now concealed behind a modern shed. The photograph shows the left end of the hill and its altitude – measured from slightly left of the line – is + 0° 30'. The grid reference is HY/30282 12848. The fact that the passage points not far W from due N suggests that there may be no astronomical significance in its direction.

The south doorway [1012]: it was not possible to place a pole in the remains of this passage which is lined up – across the remains of Structure 12 – approximately at the centre of a long low hill far away across the loch in the SE and on a azimuth of 158° MN to its highest point; the altitude of the hill is + 2° 40'.



Figure 3.14. View of the alignment of the N doorway of Structure 1, pointing on 345º MN to a small hill with a distinctive 'summit on the summit'; this has an altitude of + 0º 30'.



Figure 3.15. View outwards through the S entrance of Structure 1: this is the opening with the excavator crouched in it and it was therefore not convenient to place a pole in it. The orientation of the passage is on 158º MN and the long low hill has a maximum altitude of + 2º 50'.

The line looks about 7° to the left of that of the reverse of the N entrance (NGR omitted). It may be questioned whether anything could be actually seen of the SE horizon if Structure 12 was intact when no 1 was in use.

3.6. A 'Beltane line'?

During our stay in Orkney in August 2013 our host at Quoybow showed me a copy of *Orkney and Shetland Folklore* for 1908, in which is an article called 'Orkney Bonfires' by Magnus Spence. He recalls that in 'pagan times' bonfires were regularly lit to commemorate the four great pagan festivals – 'Yule, Beltane, Midsummer ('Johnsmas') and Hallowmass'. In terms of the prehistoric solar calendar these are four of the 'eighths' of the year which the alignments seem to define particularly clearly, namely midwinter (Dec. 21st), Beltane (May 2nd), midsummer (June 21st) and Samhuinn (Nov. 2nd). The other four are the two *equinoxes* (March 21st and Sept. 21st) as well as *Imbolc* (Feb. 2nd) and the variously-spelt *Lunasda* (Aug. 2nd).

He says that fifty years earlier (in about 1860) most parishes lit these bonfires but by 1908 the custom had almost entirely died out; 'the only bonfires in Orkney during the memory of the oldest inhabitants were the Johnsmas bonfires', that is on midsummer's day. Spence believed that evidence for Beltane fires was to be found; 'The Beltane alignment of Barnstone, Watchstone and centre of the large circle' (i.e. the Ring of Brodgar) 'pointing clearly to sunset during the Beltane feast, is undoubted; and again the alignment of the Barnstone, through the centre of Maeshowe, with walls of chamber and sides of passage parallel to this and pointing to the rising sun on Midsummer morning, is evidence of a prehistoric period when both feasts were religiously observed.' He evidently was not aware that a line to the sunset on May 2nd (Beltane) could also point, in the opposite direction, to sunrise on the harvest festival on Aug. 2nd (Lunasda).

The possibility that the centre of the Ring of Brodgar, the Watch stone and the Barnhouse stone fell on a single line had not occurred to me, but a check of my chart of the sites being studied showed that it was so. A check on the ground with binoculars confirmed this; from the Barnstone the Watchstone is seen to be in line with the Brodgar stones, and a position on the SE arc of the latter (the centre of the Ring is invisible from the stones) shows the two standing stones to be exactly in line at one point.

The calculated grid bearing of the Watch stone from the Barnhouse stone is 212° 32' GN and that of the estimated centre of the Ring of Brodgar from the same spot is 212° 48' GN. Whether the quarter of a degree discrepancy is due to the exact centre of the Ring not having been established yet, or whether it means that the line connects exactly with one of the stones on the perimeter of the Ring but not the centre, is uncertain but the photograph below suggests the answer. Unfortunately my photographs SE from the Ring did not pick up the standing stones clearly as I didn't have my camera's mirror telescope with me, but the binoculars made all clear. The view from the Barnhouse stone is clearer (below).

These photographs are not very satisfactory, being much magnified segments of the originals. I hoped to take better ones on a subsequent visit with the mirror telescope attachment which I did not think to bring on this visit.

The NW alignment is shown in the photograph above and the line seems to pass through a truncated standing stone on the right side of the Ring; the exact grid reference of this is not yet available. The alignment to the Watch stone is 212° 32' GN (by calculation) and the indicated point on the horizon beyond is a shallow notch in a shallow hill slope with an altitude of + 0° 25'.

The SE alignment (photograph below) indicates a prominent hill slope suitable for marking fairly exactly the rising point of a celestial body, presumably the Sun. The line to the invisible Barnhouse



Figure 3.16. Much magnified view of the Watch stone (more or less at the centre of the picture) seen from the Barnhouse stone; it lines up with the right side of the Ring of Brodgar. It looks as if it is sitting in a field instead of on the causeway, but that must be an effect of foreshortening; the Stones of Stenness are just out of the picture to the left. Orientation 212º 32 Grid North (by calculation), altitude of indicated hill slope + 0º 25'.



Figure 3.17. View from SE side of the Ring of Brodgar to the Watch stone (just visible above the left end of the water, near the centre) and the Barnhouse stone beyond. The latter is not visible here but its position was confirmed as exactly behind the Watch stone with binoculars. Grid orientation to Barnhouse stone 147º 12', altitude of indicated hill slope + 0º 45'.

stone has an orientation of 147º 12' GN and the altitude of the indicated part of the slope is + 0° 45'. The Barnhouse stone is not visible in the photograph but can be seen clearly with binoculars. I omitted to take a GPS reading of the Ring of Brodgar stone concerned.

In 2017 I obtained a copy of the new book 'Digging Deeper' co-authored by Nick Card. There is a section called *Who were the people of the Ness*? 'With each passing year we add new chapters to the story of the Ness. ..... Our work tells us that we are dealing with an intelligent and highly creative people; sophisticated, spiritual, gregarious and competitive. In physical terms they were much like us, and their origins were probably as mixed as ours. Descendants of Mesolithic people' (hunter-gatherers) ' who colonised Scotland by travelling along the coasts; folk who came to the archipelago at the start of the Neolithic, and others who flowed in and out from then on. There's another reason why we need to think of people in the plural. This was a time when ideas, materials and people circulated over great distances, when stories were carried across the water and around the hearths of scattered communities. And the Ness lay at the heart of this world. Back then, the area drew people in to honour the dead and to celebrate with feasts, to renew old ties and forge new bonds. People travelled from near and far to attend important ceremonies, and when they came together many things were possible; the settling of feuds, competitions for renown, the exchange of goods, gifts and gossip. And all of this woven around key moments of ceremony, through a sense of the spiritual that could be traced in the land and the sky. .....'

This suggests to me that a priesthood, with some wise men assistants, arranged for the building of the main structures at the Ness of Brodgar and organised the ceremonies and the astronomical alignments. In many of these buildings a mass of flat, probably roof tiles were found on the floor, which is a remarkable style of roof for that period, and seems to support the idea that a powerful elite had arranged the Ness of Brodgar settlement

3.7. Julius Caesar's evidence

About two thousand years later Julius Caesar was conquering Gaul and he found out two things which could be relevant to the Neolithic period in Britain.

This is a quote from Caesar's 'The Conquest of Gaul', translated by S.A. Handford (1951: 31-33). (The underlined sentence could have significance for the British Druids' probable Neolithic ancestors).

'The two privileged classes are the Druids and the Knights. The Druids officiate at the worship of the gods, regulate public and private sacrifices, and give rulings on all religious questions. Large numbers of young men flock to them for instructions, and they are held in great honour by the people. They act as judges in practically all disputes, whether between tribes or between individuals; when any crime is committed, or a murder takes place, or a dispute arises about an inheritance or a boundary, it is they who adjudicate the matters and appoint the compensation to be paid and received by the parties concerned. Any individual or tribe failing to accept their award is banned from taking part in sacrifice – the heaviest punishment that can be inflicted on a Gaul. Those who are laid under such a ban are regarded as impious criminals. Everyone shuns them and avoids going near or speaking to them, for fear of taking some harm by contact with what is unclean; if they appear as plaintiffs, justice is denied them, and they are excluded from a share in any honour. All the Druids are under one head, whom they hold in the highest respect. On his death, if any one of the rest is of outstanding merit, he succeeds to the vacant place; if several have equal claims, the Druids usually decide the election by voting, though sometimes they actually fight it out. On a fixed date in each year they hold a session in a consecrated spot in the country of the Carnutes, which is supposed to be the centre of Gaul. Those who are involved in disputes assemble there from all parts, and accept the Druids' judgements and awards. The Druidic

doctrine is believed to have been found existing in Britain and thence imported into Gaul; even today those who want to make a profound study of it generally go to Britain for the purpose.

The Druids are exempt from military service and do not pay taxes like other citizens. These important privileges are naturally attractive; many present themselves of their own accord to become students of Druidism, and others are sent by their parents or relatives. It is said that these pupils have to memorize a great number of verses – so many that some of them spend twenty years at their studies. The Druids believe that their religion forbids them to commit their teachings to writing, although for most other purposes, such as public and private accounts, the Gauls use the Greek alphabet. But I imagine that this rule was originally established for other reasons – because they did not want their doctrine to become public property, and in order to prevent their pupils from relying on the written word and neglecting to train their memories; for it is usually found that when people have the help of texts, they are less diligent in learning by heart, and let their memories rust. A lesson which they take particular pains to inculcate is that the soul does not perish, but after death passes from one body to another; they think that this is the best incentive to bravery, because it teaches men to disregard the terrors of death. They also hold long discussions about the heavenly bodies and their movements, the size of the universe and of the earth, the physical constitution of the world, and the power and properties of the gods; and they instruct the young men in all these subjects.'

Caesar's army and navy eventually advanced to Brittany and he said that there was a remarkable local navy there, with boats well adapted to the sea weather. Unfortunately the Roman navy apparently destroyed it! The native ships provided access to Gaul and Britain and the young men who went over to Britain, to be taught by the Druids there, doubtless went that way. Again one wonders whether the ancestors of these native ships existed in Neolithic times, thus making the connections between Orkney and Wiltshire fairly simple – much better than walking or horse-riding. In any case there had to be boats to cross over to Orkney from Caithness, and back again. Caesar's revelation of these features in Gaul in the 50s BC (Druids and a navy) may well make the theory of a Neolithic priesthood in Britain, and the archaeological links between Orkney and southern England, much more plausible.

3.8. The Survey of the Ring of Brodgar (Figure 3.18)

This site was surveyed by Alexander Thom before 1980 (Thom and Burl 1980: 328). Burl's description of the site is as follows. 'This magnificent circle-henge stands on a low-lying neck of land at 10, O.D. between the lochs of Harray and Stenness. It is 4 miles NE of Stromness. The ring of stones stands on a plateau sloping down to the E surrounded by a rock-cut ditch 30 ft. (9 m) wide and 6 ft. (1.8 m) deep. There are wide entrances at the NW and SE but there is now no trace of an outer bank. Inside the ditch a circle of tall sandstone slabs was erected, the stones perhaps coming from an outcrop half a mile to the N at Bookan. There may originally have been up to 60 of them. They are all spectacular slabs, the tallest 18 ft. 6 ins. (5.6m) high, but today many have gone and the most impressive are between NW and SE.'

'450 ft. (137m) to the SE, on a low circular platform, is a squat monolith known as the Comet Stone. The stumps of two others stand near it, perhaps the remains of a Cove such as once existed inside the standing stones of Stenness.'

'A stone axe and flint leaf-shaped arrowheads have been found inside the Ring of Brodgar which is surrounded by round cairns which are presumably of the Bronze Age and later than the erection of the circle-henge.'

Alexander Thom's survey was as follows. 'The mean circle diameter was determined by steel tape measurements from the centre. We measured to the four corners of each stone and the mean of these

gave the radius to the stones. The mean diameter was 340.02 ± 0.6 ft. Assuming this to be 50 mr ' (megalithic rods) ' we obtain 1 mr is 6.800 ± 0.012 ft. but there are two stones in the NE quadrant which lie inside the ring. Omitting these were to find the diameter to be 340.66 ± 0.44 ft, making the rod 6.813 ± 0.009 ft. The corresponding values of the megalithic yard are 2.720 ft and 2.725 ft.

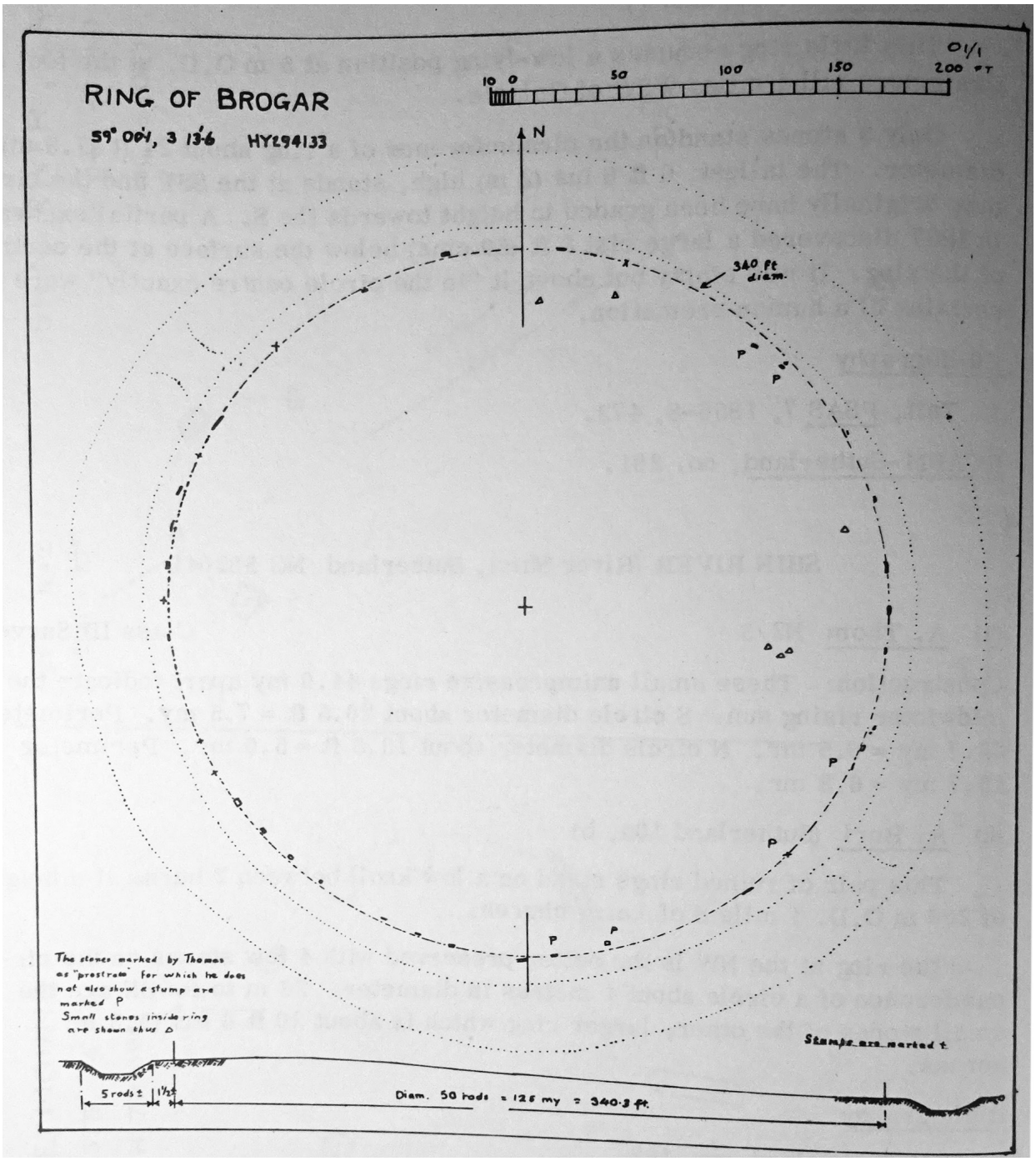


Figure 3.18. Alexander Thom's survey of the Ring of Brodgar stone circle (Thom and Burl 1980: 328).

The reason for using a circle diameter of 125 my (megalithic yards) is that this gives a perimeter of 392.7 my which is very nearly an integral number of megalithic rods.

The Brodgar site is the most perfect example of a megalithic lunar observatory that we have left in Britain. The ring and the ditch were probably placed on this little hill at first because from here there are 4 foresights marking the approximate position of the rising/setting Moon at the major and minor standstills. Perhaps about a thousand years later the accurate observatory was built from cairn of earth built with such accuracy that we can today date the observatory by the slowly changing obliquity of the ecliptic to about 1600 BC (see Thom 1978, Chapter 10).

It is remarkable that by that time the builders were not using stone, in fact there is only one place where a slab and two small stones were used and this was at the Comet stone. Large mounds were built so that watchers could be placed on the top to warn the people below of the impending rising of the Moon. These are in the exact position necessary.'

It is a pity that this book contains only plans and no accurate drawings of astronomical alignments. There is also a possibility that the Ring of Brodgar and the Ness of Brodgar priestly settlement are in line. In 2017 I went up to Orkney to find this out but the Ring of Brodgar was enclosed by numerous fences and notices told one not to go inside the circle. However the recent existence, in the 19th century, of bonfire celebrations in Orkney marking the eighths of the solar year, possibly implies that the priesthood and wise men of the Ness of Brodgar studied solar alignments and worked out how to divide the year systematically. I hope to do work on this when the fences are removed from the Ring. The clear foresights of the island of Hoy should be visible, though Thom and Burl apparently did not notice them. From their plan of the circle there appears to be no indication of an alignment, but if the Hoy horizon is visible from there, Neolithic wise men would surely have placed the stone circle in that position?

Chapter 4
Research into Alexander Thom's fieldwork

4.1. Background and the work of Alexander Thom

In the 1960s the generally accepted view of British Neolithic society (in about the 4th and 3rd millennia BC) was that it was essentially agricultural, rural and primitive, although there are clear signs that powerful people occasionally emerged to organize the construction of major monuments like Stonehenge and Avebury. Professor Richard Atkinson at one point (when writing a hostile review of Gerald Hawkins' new 1965 book on Stonehenge) even referred to these people as 'howling barbarians'. The main problem was that Hawkins had studied only one stone circle site among many hundreds

From 1967 however, with the publication of his *Megalithic Sites in Britain*, the work of Alexander Thom (a retired professor of Engineering at Oxford) became widely known to archaeologists. Over many years he had conducted accurate surveys of scores of standing stone sites and had concluded from the extensive and diverse evidence that their builders possessed some highly sophisticated knowledge. First, they understood geometry and designed some stone circles to incorporate shapes like accurate ellipses, usually based on a 'perfect' Pythagorean triangle. Second, they used a standard unit of length – the 'megalithic yard' of 0.829m – to lay out the sites. Third, and most significant of all, they had developed long and therefore potentially highly accurate astronomical alignments – the observation points marked with standing stones – and with them had apparently understood the fine details of the movements of the Sun and Moon. The degree of understanding of the Moon's complex movements was astonishing and, understandably perhaps, completely implausible to many archaeologists unfamiliar with this aspect of astronomy. The crucial point about these '*alignments*' is that, while the observing point or back-sight is marked by a standing stone, the foresight is a distant and obvious horizon mark (either a notch, or a hill slope lined up with the path of the rising or setting celestial object) which can be many miles away. These distant foresights are capable, allowing for refraction, of marking a position in the sky extremely accurately, to within a few minutes of arc. By contrast all Gerald Hawkins' claimed sight-lines at Stonehenge were short, of limited accuracy and are better termed '*orientations*'.

4.2. Early reaction from British archaeology

At first these ideas were treated as plausible hypotheses by some archaeologists, even though there was little to support them in the traditional evidence they handled. Professor Atkinson (1975) was one of the first to change his mind; he found the new evidence highly plausible and explained it thus. 'I myself have gone through the latter process' [a deductive rejection of Thom's work] 'but I have come to the conclusion that to reject Thom's thesis because it does not conform to the model of prehistory on which I was brought up involves also the acceptance of improbabilities of an even higher order. I am prepared, in other words, to believe that my model of European prehistory is wrong, rather than the results presented by Thom are due to nothing but chance.'

Colin Renfrew and I even wrote books trying to incorporate Thom's new evidence into a new view of British Neolithic society. This maintained that the form of society known as a Chiefdom must have existed then, and that this included a professional priesthood which – despite presumably being non-literate – was capable of acquiring and accumulating the knowledge that Thom had uncovered. This idea is completely plausible because Julius Caesar's description of the Druids of Gaul and Britain from about 50 BC (while he was conquering France) makes it clear that new members of that priesthood (which he heard had originated in Britain) had no written records to read and had to learn the mass of knowledge

from their instructors and keep it intact in their memories. This sometimes involved a learning period of about twenty years! They usually went to Britain for that purpose.

4.3. Testing the Thom hypotheses

As explained in Chapter 1, I also undertook some tests of Thom's ideas on archaeological sites and found that most were decisively in his favour. The most important, and eventually notorious, of these tests was at the Kintraw standing stone in Argyll where an observation platform on the slope behind the stone was predicted by Thom on the assumption that the standing stone was the backsight for a miles-long alignment to a distant notch on Jura marking the midwinter sunset. This was hidden behind the local horizon from beside the stone. I found this platform in exactly the right position by excavation (Chapter 2). Attempts have been made ever since by a few archaeologists to find faults in the evidence.

The evidence from Kintraw was first published in the *Phil. Trans. Royal Soc.* in MacKie 1974, and it also featured in a BBC *Chronicle* programme on Thom in 1970. This, and the tests carried out at three other sites (including Cultoon stone circle, Islay, which is particularly important as it tested all three of Thom's hypotheses), were described in several later publications including an issue of *Time and Mind* in 2013. But since then – for a number of years – it proved increasingly impossible to publish papers about this data in archaeological journals as the tide of opinion gradually swung firmly away from Thom's views. Many in the profession thought then that any ideas based on Thom's work must be mistaken. The result was that many modern students of the simple version of British archaeoastronomy now in favour (below) cannot accept the existence of accurate long astronomical alignments even when they are apparently clear, as for example at Ballochroy and Kintraw. The failure to recognise the evidence is a major defect in modern British archaeology, resembling a dogmatic ideology; evidence which would support Thom's views is occasionally simply dismissed. However many archaeologists do now (in the 21st century) conduct archaeoastronomical research.

4.4. Reaction against Thom

Even back in the 1970s many colleagues remained sceptical of Thom's ideas and opposition to them increased, encouraged by the then editor of *Antiquity*, the Cambridge Professor Glyn Daniel. Eventually, in the late 1970s, Clive Ruggles – who has similar skills in mathematics and surveying to those of Thom – decided to carry out a different test on Thom's work (1984). Quite reasonably he argued that a large proportion of the sites on which Thom's ideas were based should be re-surveyed to make sure that there were no unconsciously biased selections of evidence and to that end he embarked on re-surveying about 300 of them in western Scotland. His conclusions were critical of Thom and were immensely influential, being seized upon by most archaeologists because they appeared to disprove decisively and authoritatively Thom's most ambitious hypothesis – that accurate astronomical *alignments* existed in prehistoric times. He became a sort of champion to the profession and was eventually elected president of the Prehistoric Society. During his tenure of this office he organized a conference on British archaeoastronomy to which the author was not invited – rather symbolic of the attitude of some of my profession to Thom's work: he must be censored, not debated. This is why I think the time has come to try to publicise this irrational 'theory first' attitude.

Yet Ruggles seemed to be objective and fair at the time. After Alexander Thom died he edited a book in which several archaeologists – including me – were able to publish ideas and evidence which favoured Thom's interpretations (Ruggles 1988b).

However Thom's original idea of long, accurate alignments could be quite controversial because, if true, it must imply a much higher level of intellectual skill in Neolithic Britain than there was, and is still

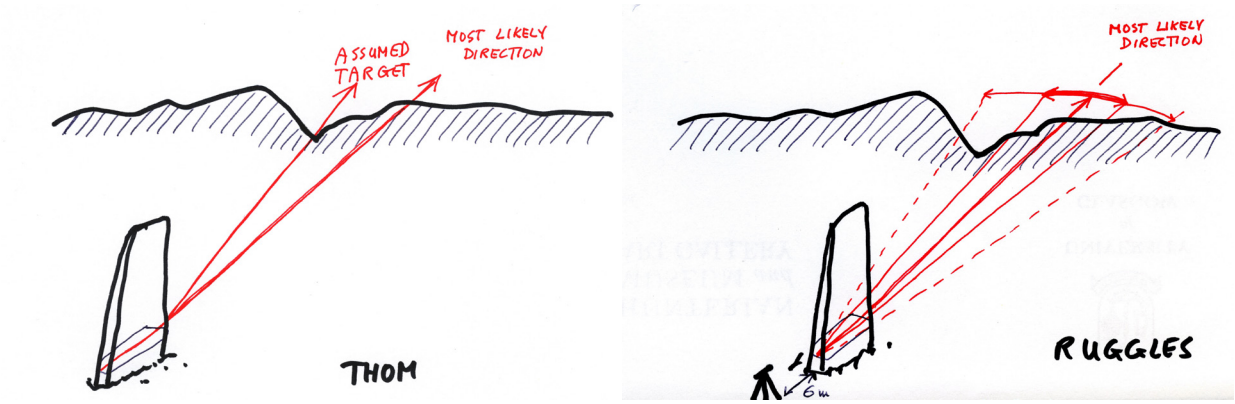


Figure 4.1. Two diagrams to illustrate the different approaches to analyzing prehistoric astronomical alignments of Clive Ruggles (right) and Alexander Thom (left). The site is an imaginary one with a clear distant foresight.

to some extent, acceptable using the standard archaeological evidence. Also very few archaeologists used to understand Thom's evidence. Now however, thanks to Ruggles' work, it seems to be generally accepted that only approximate simple, astronomical orientations existed in prehistoric Britain. These are relatively short lines between artificial markers and are incapable of defining a celestial position better than to about half a degree. In Chapter 3, 'Decisive tests in Orkney', the evidence from Ness of Brodgar is remarkably supportive of the idea, based on Thom's work, of a Neolithic priesthood.

Naturally I read his report in 1984 with great interest because it was claimed as an important additional and objective test of Thom's ideas; Ruggles had evidently checked Thom's data through new field surveys, and with the resulting new statistical analyses. However it seemed that he had in this way disproved Thom's concept of accurate alignments and I clearly needed to know the details of this exercise. My own tests on individual sites through excavation had fairly clearly shown Thom to have been correct in two out of his three basic hypotheses (my tests were inconclusive on the subject of the 'megalithic yard', except for that on the Cultoon circle), so clearly one of us had to be wrong. I was asked to review the work so went through it in great detail (1984). I was eventually convinced that Ruggles was trying to be rational because, four years later, he edited his 1988 book – *Records in stone: papers in memory of Alexander Thom* – and asked me for a contribution (MacKie 1988).

Before proceeding it will be helpful to say a bit more about the nature of astronomical *alignments* (described earlier) and the important difference between them and *orientations*. The latter are simply in-built directions in a prehistoric structure which are rarely capable of marking a precise position on the celestial sphere (the east-west orientation of Christian churches is a modern example). *Alignments*, as explained earlier, have a prominent foresight on the horizon and are potentially much more accurate (Figure 4.1, left). Yet the crucial element needed in its back-sight (usually a standing stone), before it can be regarded as potentially genuine, is that it must have some built-in indication of the direction of the distant foresight; otherwise one could stand beside a standing stone and select the foresight which fitted one's theory best. Usually the direction indicator is provided by the stone itself being approximately slab-shaped, at least one flattish side of which is *orientated* towards the horizon foresight. Occasionally there may be two stones providing a more exact line; otherwise the line may be formed by the centre of a stone circle by and either that of another circle or an outlying stone. A summary of my conclusions follows.

There is one very important point about alignments which, as far as I know, has not been mentioned before and which occurred to me while writing this chapter. In Neolithic times all the wise men who

were instructed about them must have been able to see and remember the indicated horizon notch or slope, provided that the standing stone backsight – or pair of backsights – indicated the foresight fairly closely and provided that the landscape around the foresight notch or peak was very memorable. Each site's horizon foresight – and surrounding landscape – is almost certainly unique and intelligent men should have had no trouble in remembering them, and what solar or lunar phenomenon was marked there. The Ballinaby stone on Islay is a classical example of this (Figure 4.5). This means that approximate alignments are perfectly adequate and that Ruggles' assumption (below) – that they had to be very precise (Figure 4.1) – was not necessary.

4.5. Clive Ruggles test of the long alignment hypothesis

Essentially Ruggles analysed each one of his samples of Thom's potential long alignments in a manner apparently designed to make sure that conclusions about the sites were entirely objective. He wished to make sure that no alignments had been unconsciously selected by Thom because they fitted any pre-existing theories. This was done by making the basic assumption that, to begin with, only the standing stone at the observing position (the back-sight) should be studied for signs of an indicated direction; the details of the horizons pointed at by the stones should be ignored at first so that the orientations by themselves had to yield any significant astronomical patterns within them (Figure 4.1, right). In other words he systematically measured the *orientation* of each standing stone site without reference to the horizon pointed at. Presumably only then would the existence of long alignments be plausible to him. As noted above this is an unreasonable conclusion and has to rely on the assumption that the Neolithic astronomer-priests were not very bright and would be confused by his version of the imaginary site in Figure 4.1. This is shown very clearly in Figure 4.7; the simple peak is projecting above the sea horizon and the various alternatives of the foresight suggested by his drawing are obviously untenable. They are all level sea horizons, apart from the extreme right end of the 'possible' foresights which is above a low local piece of land. A Neolithic wise man or astronomer-priest would know that the island was the foresight for sunsets on two Quarter days (see caption for Figure 4.7).

Ruggles' theodolite was mounted about two metres behind the stone, at a point which seemed to be on the line indicated by it (Figure 4.1, right). The horizon was then drawn or photographed and the part which clearly was pointed at was marked with a thick primary arc to show the most likely target zone; a broader, thinner secondary arc marking the maximum indicated zone. The width of the arcs obviously depended on the flatness of at least one side of the stone. Figure 4.6 shows two example of his surveys. Gartacharra stone (top one) shows interestingly that the narrow 'most likely' band of indicated directions points more or less exactly at a conspicuous notch 26km away, formed by two peaks on Jura. The declination of this notch (not specifically indicated) appears to be close to the same two Quarter Days marked by St. Kilda in ure 4.7. The bottom drawing appears to be incomplete and is said to show the direction indicated by Cultoon on Islay. However it is not at all clear how Ruggles established the direction arcs at this site as the direction indicator (to the SW) is the long axis of an elliptical stone circle which was only established by surveying a mass of excavated stone-holes and three standing stones and by analyzing them for the goodness of their fit to a true elliptical shape.

What Ruggles achieved with his new surveys is relevant for Thom's argument about long alignments. He has shown, independently and mostly objectively, that the built-in direction-indicators, *or orientations*, of standing stone sites are genuine and he has quantified their accuracy. Moreover his own analyses of the indicated rough orientations showed clearly that some cluster convincingly around preferred targets in a similar way as Thom's more accurate ones did (Figure 4.3). These include a cluster around – 30 deg. which certainly do. This is the zone of the extreme southerly positions of the Moon and Ruggles accepts that Neolithic man was particularly interested in the Moon's movements. However, and unsurprisingly, many of the orientations between declinations 0 deg. and – 35 deg. do *not* fall into such peaks but appeared to be

scattered at random. Ruggles is therefore more skeptical about prehistoric interest in the Sun's movements, and in particular he doubts the genuineness of the solar calendar. Obviously this is what happens when evidence for precise alignments – distant horizon peaks and slopes – is deliberately excluded from the analysis. However the method he adopted for analyzing Thom's sites sounds quite plausible, as it defines the accuracy of the back-sight. We have to accept though that the Neolithic wise men knew that the conspicuous notch or peak on a distant horizon, roughly indicated by the orientation, was the accurate foresight. Figure 4.5 provides a classic example. Another important point is that the Neolithic observers had no telescopes or theodolites so defining the indicated angles of the backsight and using them to scan the horizon would have to have been done with the naked eye. Naturally an indicated prominent distant peak or notch would have been the one, and would have been mostly obvious.

The logical conclusion is obviously that there is a limit to what can be deduced from the rough orientations of the stones themselves. Yet if even these do show fairly clearly that there was a prehistoric interest in some astronomical phenomena, then it is surely inevitable that long alignments were used to achieve much greater accuracy. It is clearly impossible to track the fine movements of the Moon – fluctuating monthly as it does between its northern and southern 'standstills' over a period of 18.6 years, and with another small, about 173 day, period fluctuation of the four standstills themselves – by tracking these movement simply by looking along the rough sides of standing stones. Yet Ruggles histogram (Figure 4.3) shows that this is what was almost certainly happening so it is difficult to avoid the conclusion that long alignments were used.

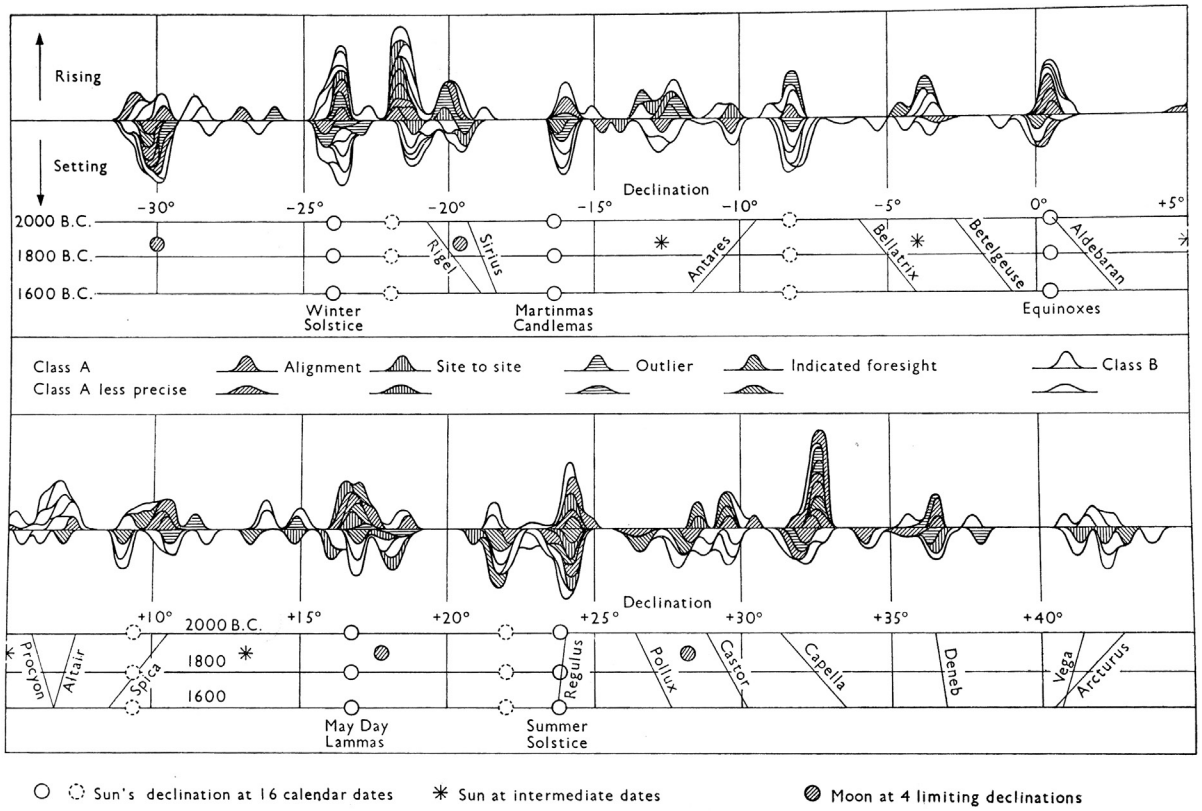


Figure 4.2. Alexander Thom's histogram of the astronomical positions (declinations) indicated by the long alignments he surveyed. The very fact that these fall into many distinct, often sharp peaks shows that the correlation between indicated alignments and celestial phenomena is genuine. Ruggles' claim that these correlations are not genuine is surely unfair; the fact that there are a few peaks with no obvious targets shows that Thom included everything, even the few that probably occurred by chance. For example the multiple peak at about a declination at just above – 40 deg. looks like one of those.

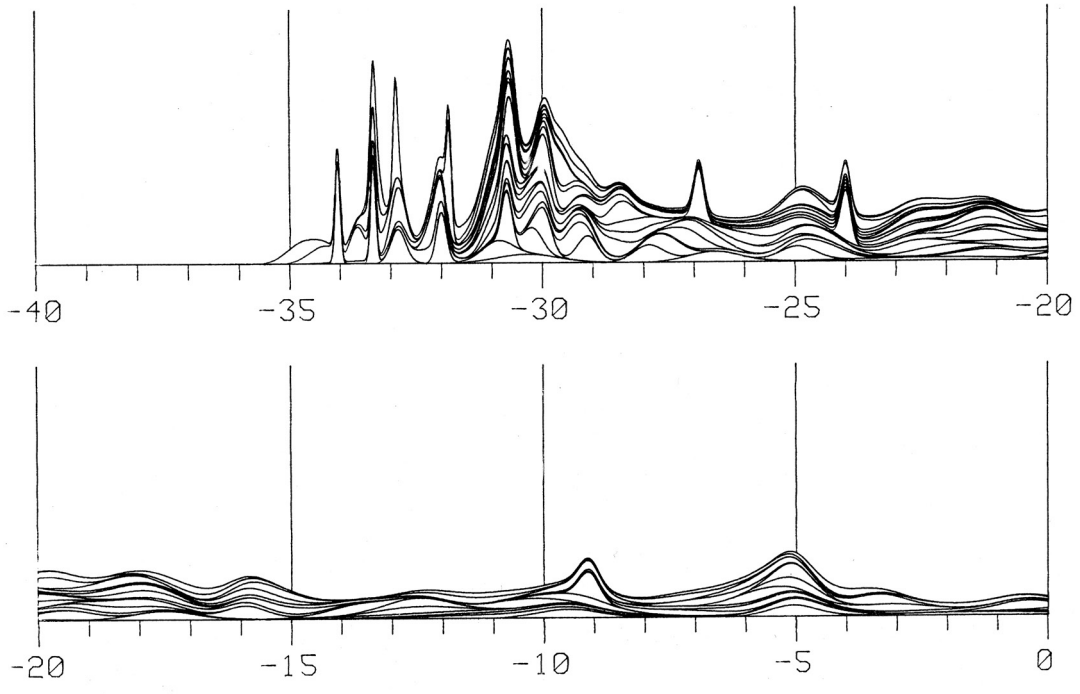


Figure 4.3. Clive Ruggles' histogram of the indicated orientations revealed by his own surveys of about 300 sites in western Scotland. The range is in the minus declinations only and suggests a striking interest in the complex movements of the Moon; the solar calendar is much less obvious (Ruggles 1984, fig. 12.17 (top): 292).

Yet this was not Ruggles conclusion. He made the fundamental assumption – quite unjustified by the evidence – that measuring the stone orientations was the best you could do to define the astronomical target zone intended by the Neolithic stone erectors. It didn't matter if there was a conspicuous horizon notch just outside the primary arc as is shown in Figure 4.1: it was ignored. All indicated targets thus automatically became crudely defined and the evidence for accurate long alignments was assumed to have been disproved. But the 'disproof' depended on a primary assumption that they could not exist! My pointing this out in the review in the American journal was, unsurprisingly not taken up by British archaeology. Archaeo-astronomy in Britain thenceforth took the 'disproof' of long alignments as absolute truth and went down a different path, which did not threaten the existing interpretation of Neolithic society.

4.6. Further points about orientations and alignments

Thom's method was of course to confine himself to analyzing sites with built-in direction indicators but he assumed that the Neolithic observers could have made use of distant horizon marks to achieve much greater accuracy. Thus if a stone slab pointed approximately towards a conspicuous notch it was assumed to be the target (Figure 4.1, left). This is perfectly reasonable because – as Ruggles pointed out – it is impossible to point a stone slab in exactly the right direction (unless it is made from Orkney sandstone for example) so a notch is unlikely to be indicated exactly except by a much longer sight-line (Figure 4.2). Provided that it can be shown statistically that indicated alignments consistently point towards astronomically significant horizon marks then it can be assumed that they were used (Figure 4.3). As noted the intelligent Neolithic observers must have known that distant horizon marks, roughly pointed at, are the key astronomical foresights.

The whole point surely is that modern students cannot expect to be led to discover exactly how a four thousand year old site was planned and what it was intended for. The line between the circle centres on Machrie Moor (Figure 4.4) makes this point. The centres of the circles are not marked with standing stones but may have had wooden pegs in them. Even if they didn't an apprentice Neolithic astronomer–priest would soon have grasped where the two circles were in fact pointing and would easily have remembered the contours of the indicated notch and slope, and what rising object they marked. It is the pattern of the landscape and its indicated horizons that is of crucial importance – not whether one can tell where exactly a standing stone is pointing, which one rarely can. Ballinaby, Islay, is one major exception; the flat standing stone does point very closely to a distant peak on the horizon which for some reason is not mentioned/analysed in Ruggles' survey (Figure 4.5).

4.7. Evidence for anti-Thom prejudice

The sceptical attitude one encounters when long alignments have to be disproved is pervasive. A clear example is the on-line paper from 2011 by Douglas Scott denouncing Thom's long alignment to midwinter sunset theory at Kintraw standing stone as a 'myth'. He systematically avoids or discounts all



Figure 4.4. an example of a potential indicated alignment (not examined by Thom) on Machrie Moor, Arran, inspected by the author in October 2014. The line being tested for astronomical significance runs between the centres of stone circles nos. 4 and 2, the latter 127m away in the distance (the ranging pole at the centre of the latter is accidentally concealed by the near pole). This line points north-east, almost exactly at the notch at the base of a slope suitable for a sunrise or moonrise. The azimuth of the notch is 62.59 deg. (calculated from GPS grid references) and its altitude (measured with a clinometer) is 4 deg. 10' (Latitude 55 deg., 32' N). My calculation of the declination on a mechanical declination calculator gave a figure of c. + 18.5 deg. which suggests the Minor Standstill moonrise in the north-east. The indicated slope seems very convincing. See also Figure 4.5.



Figure 4.5. The Ballinaby standing stone, Islay. This classic example of a very neat and symmetrical standing stone – with its clear long axis pointing almost exactly at a setting horizon slope – was omitted by Ruggles from his fieldwork even though he visited other sites on Islay.

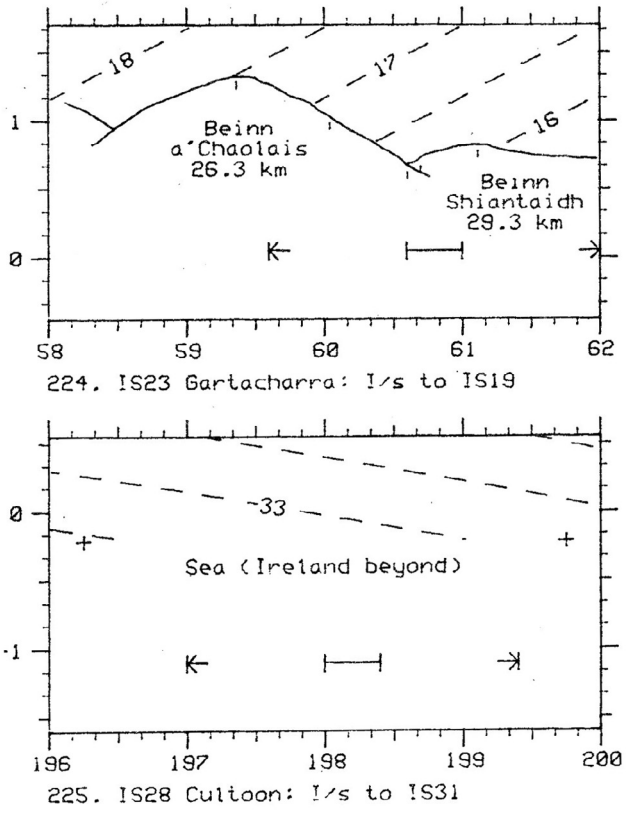


Figure 4.6. Two examples of Ruggles' analyses of standing stone sites in Islay, Argyll: above is the view from the Gartacharra stone and, below, from the Cultoon stone circle. Apparently Ireland was invisible when he was there.

the evidence to the contrary. One example is his interpretation of the small standing stone a few yards higher up the steep slope than the predicted observation platform. This was claimed to have fallen down the hill and ended up upright by chance. The stone would have to have tumbled down a long way and have ended up diving one end into a pre-existing socket. I responded to his first assertion (about the observation platform) in the on-line 'PASTHORIZONS' magazine in 2014. Carrying out a Google search for 'Kintraw MacKie' will easily find it.

4.8. What kind of astronomical alignments would Neolithic wise men invent?

The plausibility of accurate astronomical alignments, devised by Neolithic astronomer-priests and their trained assistants, surely determines what modern archaeological interpretations are plausible. For such wise men – who had no modern instruments like telescopes and theodolites, and could not write things down on paper -- the only available accurate instrument to study the movements of celestial objects was the carefully marked long alignment. This, as explained, is a conspicuous peak or notch in a distant horizon which can mark the rising of setting of the Sun and Moon if observed from a specific spot. There are vast numbers of these horizon features in Scotland. The observation point, when established, was marked usually by a standing stone with a flat surface, or by a pair of cruder ones, or by the centre of a stone circle with an outlying stone, or occasionally by a sophisticated elliptical stone circle with its long axis pointing at the distant peak or notch. In the latter case there must have been some visible indicators of the position of this axis. The crucial point is that wise Neolithic observers would have been told which conspicuous horizon foresight was indicated by the site concerned and would not forget it, because the backsight was fairly accurately aimed at it and because they knew what type of conspicuous distant foresight was indicated.

This practical conclusion for our ingenious ancestors of the third millennium BC means that analyzing the sites now by measuring the range of possible directions they point at – by measuring the crudity of the pointer – is completely irrelevant. The Neolithic wise men would not have been told that the indicator was vague because it was obvious which peak or notch it pointed at. And the position of the rising or setting of the Sun or Moon would have confirmed that this was a deliberately arranged site.

Ruggles' 1984 book has a mass of horizon drawings but vast numbers of them show a relatively smooth horizon which must be irrelevant, since there is not conspicuous peak or notch – fundamentally necessary to an accurate Neolithic astronomical instrument. Quite a number of others do not have a horizon at all. These should all be compared with Alexander Thom's drawings of them, if he studied all these smooth horizon sites. Figure 4.7 gives an example of the sharp contrast between Thom's and Ruggles' interpretation of a standing stone at Benbecula in the outer Hebrides. Thom believed that a distant island – projecting above the sea horizon – was the foresight but Ruggles' survey method stated that the stone could point simply at the sea horizon on either side of the island. It seems entirely logical that the 84km distant Boreray island was the natural foresight for the Neolithic wise men.

One further plausible suggestion can be made, about the motivation of studying the movements of the Sun and Moon in such detail by a Neolithic priesthood. The title of my first book on the subject (*Science and Society in Prehistoric Britain,* 1977) was a mistake. Objective scientific studies in Britain began only a few centuries ago and religion dominated our lives far back into the past. In Neolithic times it seems sensible to suggest that the priesthood of that time was anxious to examine the activities of their gods, particularly the movement of celestial objects in the sky which probably reflected their activities.

4.9. Ruggles' and Barclay's criticism of the author's views

Clive Ruggles and Gordon Barclay (2000) are clearly not persuaded, first, by the author's arguments for the hierarchical structure of late Neolithic society in Britain or, second, by the evidence he has

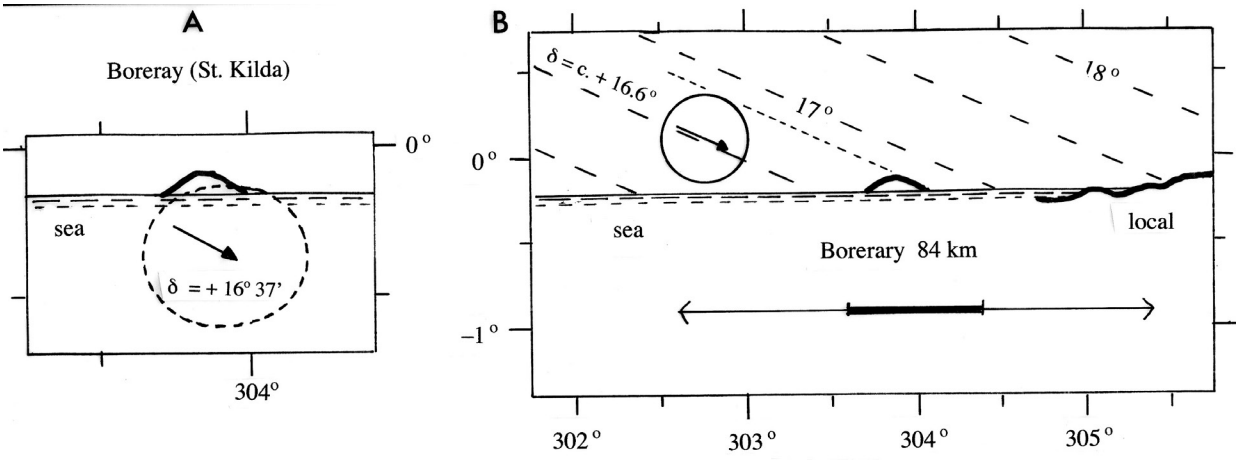


Figure 4.7. Two drawings of the horizon indicated by the standing stone at Rueval in Benbecula, Outer Hebrides. On the left is Thom's version which shows the peak of the island of Boreray (St. Kilda) many miles away across the sea in the north-west. The alignment could scarcely be more precise as there is only one possible foresight – 84 km away – and it marks sunset on the two Quarter Days in the solar calendar, at the beginning of May 1st and of August. On the right is Ruggles' version of the same alignment. His methodology required that he marked the largest and smallest arcs of the horizon indicated by the stone and paid no attention to the fact that the island peak is an obvious distant foresight in the middle of the smallest arc. The idea that the Neolithic wise men or astronomer priests could not have been told by experts on the site which was the foresight here is unreasonable.

collected for the genuineness of the long celestial alignments postulated by Alexander Thom. Although their 'reply' was primarily provoked by his article in the same journal on the Orkney chambered tomb Maeshowe (MacKie 1997), the main focus of their criticism is broader — on the present author's book which was written over forty years ago.

In brief, two main arguments were put forward there. The first is that the archaeological evidence for the late Neolithic period could by itself be re-interpreted to give a picture of some kind of hierarchical organisation in which a professional priesthood played a prominent part; sites like Durrington Walls and Woodhenge were — in this new scenario — the obvious residences and training centres of this élite. The second argument was based on the work of Alexander Thom (1967 and Thom and Thom 1978) whose discoveries (made mainly from exact measurement) about the geometrical and astronomical qualities of the standing stone sites seemed to provide clear evidence for the intellectual capabilities of the priesthood concerned. To this evidence was added that from several fieldwork tests of Thom's ideas carried out at standing stone sites by the author. The rest of this chapter discusses Clive Ruggles' and Gordon Barclay's criticism of my views.

The author is pleased that both Barclay and Ruggles have taken the trouble to respond in some detail to his ideas. In a case like this, when one is in a minority among one's colleagues, it is much easier to evolve one's thinking — and to abandon untenable ideas while holding on to those that still seem good — when they are openly challenged in this way. One hopes that the critics will feel the same way about this riposte. The whole point is that such debates should involve the scientific method – analyzing all the relevant evidence and, when possible, testing hypotheses based on it. One must not behave like members of the 'theory first' school of archaeology.

It seems more useful to begin by going back to some basic principles of archaeological research. For example both Ruggles and Barclay seem very positive and confident in their refutations of the author's views, but in view of the fragmentary and incomplete nature of the relevant evidence can such confidence really be justified? Another obvious question is whether the protagonists in this dispute are taking account of all the relevant evidence or are they sometimes tempted to emphasise only that which supports their respective cases? A detailed discussion of the nature of archaeological evidence is in a paper by this author (on Academia.ed; it can be downloaded). Some if it is discussed here.

The argument from analogy

It can be argued that, when dealing with mute archaeological evidence, there is a limit to what can be directly inferred from it (MacKie 1977: 7–12; Hodder 1982). When seeking clues among this evidence which illuminate the intangibles of vanished prehistoric ways of life – language, belief, social organisation and so on – there can be no direct answers; whether one realises it or not one has to draw analogies with recent simple societies which have an approximately similar technology and economy, or with the alleged universalities of human behaviour. To go beyond describing past technologies and economies, and the environments in which these flourished, our discipline has to become a branch of anthropology, in the broadest sense of the word, and to use the vast amount of evidence about living, functioning simple societies that anthropology has assembled.

A primary aspect of the whole argument concerns what kind of analogy is most appropriate to explain the late Neolithic evidence. In addition to matters of archaeological detail (referred to again below) Barclay objects to the author's view that late Neolithic society in Britain was hierarchical and priest-dominated, and particularly to the analogy he tentatively drew with the Classic Maya civilisation of Central America. Although this is asserted to be essential to the whole argument this is not the case, though the author concedes that the Maya analogy was probably stressed too strongly. The book concerned was after all written over 40 years ago and to argue then for any kind of hierarchical society was daring; the Maya were invoked simply to show that a technologically Neolithic people did not necessarily have to be simple intellectually.

The obvious fundamental differences – like the absence of writing and of elaborate life-like stone carving in late Neolithic Britain – were stressed (MacKie 1977: 208–11) but might have been overlooked. What should not have been overlooked was the analogy drawn with a priestly caste much closer to hand – the orders of Druids which existed among the pre-Roman Iron Age tribes of Britain and Gaul. Here, it was suggested, was exactly the kind of non-literate priesthood – divided into a number of specialities (including those skilled in astronomy and cosmology) and living in the same area two millennia later – which could fit the Neolithic evidence. Particularly interesting in this context is Caesar's information, first, that the most learned orders were in Britain where the Druids were thought to have originated and, second, that the influence of these 'wise men' was supra-tribal – they were entirely above local loyalties and sometimes acted as arbiters in inter-tribal disputes (MacKie 1977a: 226-28: Piggott 1968) (see pp. 63-4 in Chapter 3 for a detailed quotation from Caesar).

However one must begin with essentials. To read Barclay's comments one would think that no-one except this author had ever suggested that a priesthood may have existed in Britain in the 3rd millennium BC. Yet it was Colin Renfrew, three years before the book in question, who first drew attention to the need to explain Neolithic Britain in terms of an analogy with the kind of societies known to anthropology as chiefdoms (1973: chapter 11). The primary purpose of *Before Civilisation* was of course to re-assess European prehistory in the light of the fact that radiocarbon dating was completely undermining the old view that advanced learning and technology had spread out from the Near Eastern civilisations into Europe; in that context it suddenly seemed reasonable to accept that by late Neolithic times

chiefdoms were emerging in southern England and that the new order is likely to have included, not just a mechanism (under a chief) for collecting and re-distributing surpluses of economic goods, but also a class of professional priests with esoteric knowledge.

Although controversial to many archaeologists the basic findings of Alexander Thom, then recently published, seemed to fit well into this scenario and it was difficult to disagree with Renfrew's hint that opposition to it was based upon an essential unwillingness to accept that Neolithic 'barbarians' could have developed anything of the sort. In other words – and following the old-fashioned view – they would still have needed to be taught by more advanced cultures in the Mediterranean in the traditional diffusionist picture of ex oriente lux.

Renfrew also took up Geoffrey Wainwright's point that there were good analogies for the huge roundhouses at Durrington Walls in other parts of the world – notably among the chiefdoms of the agricultural Indian tribes of the south-east USA in the 18th and 19th centuries For example according to William Bartram's observations, each Cherokee 'town' (really a large village) then had about 200 people, supervised by a council of chiefs at the head of which was the local mico or ruler. The two other high officials of the council were the war chief and the chief priest. A large round wooden thatched house dominated the centre of each village and served not only for council meetings but as a storehouse and re-distributive centre. Bartram provides a plan of this structure which is remarkably similar to the large round-houses of the late Neolithic henge monuments (Renfrew 1973: fig. 53; Bartram 1980; Hoffman 1996: 294-96).

Some decades later, in the early 1840s, Major E.A. Hitchcock described Tuckeebatchee Town, a similar settlement of the Creek Indians in Florida (Foreman 1934). By this time the square of the 'market' was formed of four rectangular houses but there was a round-house, or 'warm house', behind this containing the sacred fire. (Foreman 1934: figure facing p. 114). Hitchcock also learned from 'Tuckee-batchee Micco', the chief who was in charge of the roundhouse and the sacred implements of worship, something of the way that surpluses of corn and labour were used. There was also an individual called the 'prophet' of Tuckeebatchee who sounds like a chief priest.

Thus a picture can be built up of southern Britain in the 3rd millennium BC in which the local societies had advanced somehow beyond the level of the relatively simple tribal groupings of earlier Neolithic times, which had presumably been organised in basically egalitarian, familistic units without much social or economic specialisation (Service 1968: chapter 4). The new order saw the emergence of larger units, each dominated by a major chief capable of centralising authority, collecting surpluses of food for large public works, or sometimes for warfare, and thus in general encouraging the appearance of specialist occupations like skilled craftsmen, warriors and priests.

Indeed a major feature of chiefdoms according to Ellman Service (1968: chapter 5) was the elaboration of religious and ceremonial activity. In addition to the village shamans of the old tribal culture – mainly concerned with local life-cycle rituals and achieving their positions by personal qualities and reputations – there emerged a professional priesthood occupying a permanent position in society. 'Chieftainship and priesthood in fact seem to arise together as twin forms of authority' and the offices often descend in the same family lines. The emergence of such a priesthood would very probably result in the elaboration of religious ritual and the accumulation of esoteric knowledge. Renfrew pointed out that the unsuspected qualities of British stone circles then being unravelled by A. Thom fitted in well with the belief that these ceremonial sites appeared in later Neolithic times side by side with the new chiefdoms with their professional priesthoods.

It has long been clear to the author that he did not sufficiently acknowledge the debt which his book owed to *Before Civilisation*. He thought at the time that he had worked out the new picture of late Neolithic society as the text of his own work was being written; indeed he articulated this – and particularly the idea that Durrington Walls was an inhabited sacred site – earlier at a conference in 1975 (MacKie 1976). However Geoffery Wainwright had already written his excavation report on Durrington Walls in which the large roundhouses there were compared with those of the 18th century Creek Indian chiefdoms (Wainwright and Longworth 1971: 232–3) and Renfrew's book had constructed a broader scenario (1973: chapter 11). The author's book argued for a greater role for a more sophisticated priesthood but probably pushed the analogy with the Maya too far. At that time he had not really taken on board the fact that professional priesthoods were commonly associated with chiefdoms and was still too much in thrall to the idea that some kind of primitive 'science' was practised in Neolithic Britain.

Yet one must ask whether the quarrel which Barclay, and those who think like him, has with that book is not just with the Maya analogy but with the whole concept of a radically new form of society emerging in late Neolithic Britain as first postulated by Renfrew? Indeed does this school of thought even accept that, fully to understand what was going on five thousand years ago, analogies with recent simple societies have to be drawn? For enlightenment we must look briefly at some of the specific points Barclay has made.

4.10. Archaeological evidence for chiefdoms

The scale of the building projects

The evidence for the emergence of chiefdoms in the third millennium BC is very varied and is quite independent of Alexander Thom's inferences. Indeed a much lower level of skill in sky watching could fit the scenario just as well. Thus it is important to distinguish the various sub-hypotheses which form parts of the general ideas being debated here.

The first and most incontrovertible evidence that something had changed in late Neolithic society – at least in southern England and in Orkney – comes from the sheer size of the new monuments built then and the much greater manpower that must have been empoyed to build them. This is an old idea, first quantified by Richard Atkinson (1974) in relation to Durrington Walls, Avebury, Silbury Hill and other sites and summarised by the author (MacKie 1977: 136 ff). Atkinson drew a vivid comparison with the much lesser numbers of man hours required to build the earlier monuments like long barrows and causewayed camps, commenting that, in terms of the likely resources of Neolithic society, buildings like Silbury Hill and Avebury required an effort comparable to the then ongoing Apollo space programme in the 20th century USA.

Something similar, though not on quite such a vast scale, evidently happened in Orkney at about the same time and the author alluded to it (1997, 338-40). Renfrew conducted excavations on several Orcadian Neolithic sites in the 1970s specifically to investigate this problem and set out the case clearly, suggesting that again a more centralised authority emerged in late Neolithic times and organised the building of the larger monuments which were set up then (1979). The man hours involved in constructing some of these had already been estimated by Ralston (1979). Richards has offered a more speculative explanation of the motivation behind all this building activity (1996).

Thus it seems improbable that Barclay's objections can relate to the general idea of the rise of chiefdoms in at least two parts of the British Isles in late Neolithic times (though he never refers to the concept) but rather to some of the detailed evidence which can be interpreted as supporting this idea, and more particularly to that supporting the idea of a learned professional priesthood at that time. A brief examination of some of the specific objections may help.

Inhabited ceremonial centres?

Barclay objects strongly to the idea that the great timber circles at Durrington Walls (and by inference at neighbouring Woodhenge and also at Mount Pleasant and Marden) could ever have been roofed roundhouses. If they were not then of course one major prop for the author's hypothesis – that we can identify the inhabited 'colleges' and training centres of the priesthood – is knocked away. First we can surely all agree that some, perhaps most, of the great timber circles may have been open air temples. The Sanctuary is an obvious possible case in which wooden circular settings were succeeded by a stone ring; thus interpreting the site as an open air temple throughout its history is not unreasonable (Musson 1971: but see below). The post settings inside the unexcavated Stanton Drew stone circle could well be another (David 1998).

The question is however – were they all like this? The argument is about the function of such settings in the small number of quite different sites – namely three of the four giant henge monuments in southern England (excluding Avebury), and in the smaller Woodhenge adjacent to one of them (Durrington Walls). Excavation has revealed all of these to be different in one important way – in that unusually large quantities of what could be domestic rubbish were uncovered – namely animal bones, ashes, flints and potsherds. The vast majority of the rest of the excavated Neolithic circular sites have revealed very few finds.

Barclay implies that the author ignored vital evidence about the likely purpose of the Durrington Walls timber circles, supplied by the architect C.R. Musson (1971), but neglects to mention the views of Geoffrey Wainwright, the excavator of the site, who was the first to advance the 'inhabited roundhouse' hypothesis. He of course had to take into account not just the views of his architect adviser but also all the other diverse archaeological evidence he found in and around the 'Southern Circle' (Wainwright and Longworth 1971: 231–34). These views were all set out again later (Wainwright 1989: chapters 5 and 6) but none of this is referred to by Barclay.

As Barclay notes, Musson himself 'concluded that the patterns of posts at Durrington Walls, Woodhenge and The Sanctuary allowed equally well for unroofed as well as roofed interpretations' (Ruggles and Barclay 2000: 64); yet he did not claim what Barclay implies – that they disproved the roofed interpretation. These conclusions took account only of the post-holes, not of the other archaeological evidence. Likewise later commentators like Barrett – whom Barclay cites as pointing out again the significance of Musson's conclusions – also concentrated only on the evidence from the size and patterns of the post-holes and took little account of the debris in and around the rings (Barrett 1994: 20–4); his is essentially an exercise in deductive re-interpretation. The same applies to Wood who doesn't even bother to explain why he is being deductive and offers an extensive discussion of these 'tree henges' based entirely on the assumption that they are open to the sky. In the section on Durrington Walls he fails to mention Wainwright's interpretation of a roofed rotunda and ignores the archaeological evidence for that entirely (1996: 361–73).[1]

One potentially important fragment of evidence about possible roofing has been ignored in most discussions about Neolithic timber circles; it was recognised by John Evans in shells of small riverine molluscs which were excavated earlier at The Sanctuary on Overton Hill, close to Avebury (Musson 1971: 371, footnote 2). Although proper stratigraphical information for the shell samples is lacking the presence of three freshwater species – far from the nearest pond or river – is most easily explained by supposing that they travelled in the bundles of reeds brought in to thatch a series of roundhouses constructed at that site. Reed matting is another possibility although even that would surely imply a roofed structure of some kind.

[1] Unfortunately I have not been able to identify this publication

There is no need to pretend that the evidence about whether this sub-group of Neolithic timber circles were inhabited thatched roundhouses, or not, is unequivocal. It is not. However if one is trying to come to a sensible conclusion it is surely necessary to review all the evidence available, and not just the parts which suit one's case – for example that from the patterns of the post-holes. Analysis of the latter could certainly set limits to the permissible inferences; the key post rings might be too slim to support a thatched building of the dimensions concerned, or the structure might be too large to have been roofed. However if there are no disproofs of this kind, then other data – like the presence of hearths inside and domestic-looking debris round about – has to be taken into account and may well suggest that roofed structures are the likeliest explanation, as the excavator of Durrington Walls thought.

Sometimes it is useful to stand back and look at the general picture. Durrington Walls is one of the largest potentially inhabited ceremonial sites known (one could surely call it a small town like Tuckeebatchee if the entire interior was covered with roundhouses, as it might well have been – Wainwright and Longworth 1971: 234). Moreover it is only 1.8 miles N of Stonehenge which is architecturally the most sophisticated stone circle, with the most complex history, in prehistoric Europe. Is it not likely that the greatest late Neolithic 'monastery/college' would have been close to the greatest circular temple of the age? It may be that scepticism about inhabited Neolithic roundhouses is sometimes based on intellectual inertia. It has been stated for so long in textbooks that only open air circular temples existed in Britain in the third millennium BC that the idea seems like an obvious truth. Very similar Iron Age roundhouses have, by contrast, always been interpreted as inhabited dwellings.

Grooved Ware and regional Neolithic cultures

The author readily admitted when this was first written that time may well not have dealt kindly with his idea of an 'expansion to Orkney' of a sophisticated Grooved Ware culture from southern England (MacKie 1977: chapter 9). That chapter title was a child of its time and, like the unrealistic idea of some kind of 'science' being practised in prehistoric times – now gladly abandoned (MacKie 1997: 341, footnote 3) – may well no longer be tenable. The author has no difficulty in abandoning hypotheses which have had their day when the evidence demands it. Doubtless too the radiocarbon dates can no longer bear the exact synchronisms suggested forty years ago, though no-one would surely deny that there is a broad chronological correlation between the end of the late Neolithic and the start of the Beaker period throughout the British Isles. However the author did not know then what a remarkable site would be found at Ness of Brodgar a few years later (Chapter 3). Now the archaeological evidence is overwhelmingly in favour of a Neolithic priesthood in Orkney and of some clear links with the Stonehenge area of southern England (Chapter 5).

Likewise it cannot be doubted that important regional cultures existed in the Neolithic period and can be defined by different kinds of stone circles and local pottery styles (Ruggles and Barclay 2000: fig. 1). No-one has ever been rash enough to claim a nation-wide unity of all aspects of Neolithic archaeology! Indeed the flawed reasoning that has to be emphasised here is that which allows Barclay tacitly to assume that the existence of a clear regional Neolithic culture – for example among the Recumbent stone circles of Aberdeenshire (Ruggles and Barclay 2000: fig. 1) – disproves the possibility of a nation-wide element. This is logically indefensible.

The point surely was then that some national elements do seem to exist across this regional diversity even before we consider the less tangible and more controversial examples – like the 'megalithic yard' and the celestial alignments. The idea of the circular sacred site itself (stone circle and the henge monument) is an obvious case in point; sites like Ring of Brodgar and Stenness in Orkney – each a classic stone circle surrounded by a ditch with a causeway – are essentially the same kind of ditched temples as Stonehenge itself and Arbor Low (in Derbyshire) far to the south; Burl's excellent book provides

numerous other examples of structurally similar sites spread over wide areas (1976). It seems strange to have to point out such basic facts, and likewise to have to mention that some kind of social mechanism must have existed to produce this widespread ceremonial uniformity.

Certain forms of Grooved Ware provide another example of a nation-wide material culture and a study of this pottery has provided a mass of new information (Cleal and MacSween (ed.) 1999). As Barclay says the distribution of the various styles of this pottery no longer show concentrations in the south and the extreme north as it still suggested in 1977; for example there is now plenty in northern England (Manby 1999, presumably in Cleal and MacSween 1999: illustration 6.1) and a significant quantity in eastern Scotland (Cowie and MacSween 1999: illustration 5.2). The over-simple interpretations put forward on the basis of the evidence of the early 1970s will of course have to be abandoned. However that is not really the point. Some of this pottery can still be interpreted as forming a national tradition, especially the flower-pot shaped vessel with finely grooved ornament originally named the Clacton style (Wainwright and Longworth 1971: 236 and fig. 97). This material has been found associated with important ceremonial sites as far apart as the Hebrides, Orkney and southern and eastern England (Cleal and MacSween (ed.) 1999). A new example from Orkney of this type has recently been published; hitherto unrecognised it comes from Skara Brae (Shepherd 2000: fig. 12.19), linking that site firmly with the great circular ceremonial centres. Another one came from the Stenness stone circle a few miles away (Ritchie 1976: fig. 6, no. 16). There seems to be general agreement that Grooved Ware was important ritually.

In any case there must surely be some explanation for the relative uniformity of the first flat-based pottery in Neolithic times throughout the large areas of the British Isles in which it appears. Even leaving aside the more esoteric evidence for intellectual abilities at the time, if we assume that chiefdoms probably existed at least in Orkney and southern England, is it not perfectly reasonable to suppose that the chiefs and priests of the two areas had at the very least occasional contact with one another and took gifts with them? A new idea about this occurred to the author fairly recently. There is a piece of historical evidence which may support this idea. When Julius Caesar was conquering Gaul in the 50's BC he invaded Brittany and found a massive local tribal navy which dominated links between Gaul and Britain. They were very efficient ships and it must surely be possible that they went up the coasts to Orkney. The archaeological evidence just reviewed makes it possible that these ships existed in Neolithic times and made links between Orkney and southern England much easier.

Orkney Neolithic houses types

Barclay rejects the author's view that the 'Skara Brae' type settlements in Orkney could be the residences of a priestly élite (Ruggles and Barclay 2000: 63); however he wrote elsewhere earlier, in rather vague terms, that these settlements were 'buildings of complex domestic, and perhaps ceremonial and religious function, constructed and used by a sophisticated society' as if this has always been understood by orthodox archaeologists and as if the author was defending some out-of-date view from the 1960s (Barclay 1997: 139).

This is more than a little unfair. It is the 'orthodox' view of the Orcadian villages he quotes (e.g. Parker Pearson and Richards 1994; Richards 1992) which has changed dramatically and which has moved, without much acknowledgement, several giant strides towards the author's 1977 ideas. It has to be remembered that it was not until David Clarke re-excavated the site in 1972–73, and found barley grains associated with an earlier occupation of similar houses (dated to about 3100 cal BC), that it was even realised that the Skara Brae community consisted of farmers (Clarke 1976). Up to that time the standard view was still that presented by Childe many years earlier (1940: 84–8) and later analysed in greater detail by Piggott (1954: 321–36). This was that it was an integrated cluster of houses of primitive herdsmen who lived in squalor under their own midden material. The author's view as set out in 1977

– that the village was the residence of an élite – seemed far more extreme then than it did when I wrote this. However the excavations of the Ness of Brodgar since then have made the idea of religious settlements far more plausible (see Chapter 3).

One counter argument was then that the number of known late Neolithic settlements in Orkney is increasing and that, since they are all of the Skara Brae type, they must be the standard dwellings of the population (Ruggles and Barclay 2000: 63). Skara Brae itself is the best preserved such site and all its various architectural features which suggest it was something unusual – such as a main drain under the village and an apparent cook-house and workshop serving the whole community – have already been discussed and need not be repeated (MacKie 1977: 184–203).

Yet the crucial question to ask surely is whether we can be certain that we have identified any stone dwellings of the ordinary farming population anywhere in the country at any period from the Neolithic to the Iron Age and beyond. Always worth remembering in this context is the complete absence of such dwellings from the recent archaeological record of the Scottish highlands before the middle of the 18th century. For example first hand accounts of the highland population near Inverness in the 1720s indicate that even the smallest single-storey stone cottages were occupied by the clan gentry. Ordinary people, even innkeepers, lived in flimsy structures of wood and thatch which would leave hardly any trace (Burt 1754). Samuel Johnson made similar observations in Skye in the 1770s (1985) and the author has discussed all of this in the context of the modernisation during the 18th century of single-storey cottages in northern Argyllshire (MacKie 1997b: 263–65). It is also the case that explanatory hypotheses are not necessarily the best available just because they have been unquestioned for decades. An example is the belief that the stone 'dressers' in the Skara Brae huts are imitations of wooden furniture. This is not proof that the buildings were domestic but derives from the assumption that they were; after all no such Neolithic wooden furniture has yet been found! Alternatively we could see those huts – each with its opposed pair of what look like single box beds – in a slightly different way, for example as the cells of something like a monastic settlement, each occupied by two priests (or a priest and a novice). In this case the 'dresser' could seem equally plausible as a safe place to keep delicate ritual and surveying equipment, or even as an altar. The exploration of the Ness of Brodgar village, which is very clearly a religious settlement, makes all these ideas about Skara Brae much more probable.

The Skara Brae form of settlement at Barnhouse, not far from Maeshowe and the Stones of Stenness, was discovered and excavated by Colin Richards during the 1980s, and one of the more remarkable finds was that this site included, in addition to the standard small dwellings, two very large and presumably public buildings (Richards 1990: 1996). This seemed to the author to go a long way towards confirming his diagnosis that these sites were the residences of élite groups of some kind. Barclay however accuses the author of taking no account of the excavator's belief that the larger of the two big buildings belonged to the end of the site's history, or even after its abandonment.

This really is misleading. The other, better preserved large building was part of the main village and it looks like a monumental version of the small dwellings, with a massive central hearth. The excavator himself drew attention to the striking resemblance between its plan and that of the nearby Maeshowe chambered tomb and suggested a ceremonial function (Richards 1990). One accepts that the exact type of society which did all this is still not really clear, and that more than one view is possible, but we surely cannot doubt that there was also a strong ceremonial connection with some nearby chambered tombs, as is shown for example in the similarity between the bone pins from Quoyness and those from Skara Brae (Piggott 1954: fig. 55). As noted, the discovery of flowerpot-shaped 'Clacton' Grooved ware vessels at Stenness and Skara Brae also reinforces the link between these stone settlements and the stone circles.

In assessing the possible meaning of the new evidence from Neolithic times that he and others had excavated in Orkney in the 1970s and 1980s Renfrew suggested that in the late Neolithic period Orkney may have been one of several centres in Britain 'of a remarkably powerful body of religious beliefs, with accompanying ritual observances', and that Grooved ware may well be evidence of widespread travel – even pilgrimages – connected with these centres (Renfrew (ed.) 1990a: 256). Presumably this is the picture that Barclay was supporting in the quotation given earlier, although he seems to have been excluding both the possibility of any 'intellectual' activities and the existence of professional priesthoods (which are never mentioned).

4.11. The skills of the priesthood

Introduction

We have seen that – using only the evidence from 'traditional' archaeological investigation, though helped with the judicious use of analogy – a perfectly good case has long been made out for the chiefdom form of society existing in certain parts of late Neolithic Britain, presumably evolving from earlier in that period. As already described such recent chiefdoms which have been directly studied are usually found to have a professional priesthood of some kind. However what seems to stir up vehement opposition in this context is the attribution to this hypothetical Neolithic priesthood of the kind of intellectual skills suggested by the discoveries of Alexander Thom, and it is to this topic – discussed by Clive Ruggles extensively in his book (Ruggles 1999) – that we must now turn. This hostile position is far less plausible now when many probably religious sites in Orkney are known. Stonehenge and some nearby sites in southern England also now combine quite well with Thom's work (Chapter 5).

Space does not permit yet more detailed discussions of the individual sites the author has examined, and sometimes excavated with the aim of testing Thom's ideas, and the diverse results from which have been uniformly rejected by Ruggles. Brief comments on these criticisms will be made later in the hope of showing that the evidence in favour of Thom still stands up. It seems more important to ask why Ruggles finds all this data so completely unconvincing. Could it be because the results are all equivocal, or because Ruggles is sceptical *a priori*, or both?

It has long been clear from his own statements that the larger picture of 'prehistoric astronomy' he has constructed from his own work finds no place for the kind of systematically-deployed, accurate long celestial alignments claimed by Thom. Is this why the new ones which have been identified by the writer, most recently at Midhowe and Howe in Orkney, seem implausible? As we shall see this does seem to be the case and an important section of the second part of this chapter must be devoted to analysing this firmly deductive approach.

It must be fairly well known by now that Alexander Thom claimed that he could detect three different aspects of the intellectual activities of an élite in his surveys of standing stone sites. The first is that a standard unit of length was widely used; he believed that his accurate surveys of scores of stone circles revealed that a high proportion had once been exactly circular and that the diameters of these had been measured out with this megalithic fathom of 5.44 ft (1.658 m), made up of two megalithic yards (MY). The Cultoon stone circle on Islay seems to support this idea, and the one in the next section in Chapter 2.

The second is the idea that those stone rings which were not true circles were actually laid out on geometrical principles as ellipses, flattened circles and egg-shapes. It is claimed that this was done using basic field geometry and surveying — including a knowledge of the properties of right-angled triangles – and of course using the MY to establish the dimensions.

The third idea originated long before Alexander Thom but he refined it by undertaking a nation-wide survey of standing stones and stone circles, noting particularly those parts of the local horizon which seem to be pointed at by straight elements of the 'back-sights' – such as pairs of standing stones, stone circles with outlying stones, elements of the assumed geometry of the circles (such as the long axis of an ellipse) and the straight passages of chambered tombs. Of course such straight lines could have come about for many reasons – not least by chance – but Thom argued that, when these lines were projected to the horizon, they peaked so often around celestial latitudes that there must have been a clear intention of systematically marking the rising and setting points of the Sun, the Moon and some bright stars (1967: chapter 8). If only the terrestrial azimuths of these points are plotted sharp peaks rarely appear. The Cultoon stone circle on Islay is a clear ellipse the long axis of which points at a far away peak in Ireland (Chapter 2).

The point about these long alignments is that, if they indicate the Sun, they are theoretically capable of defining the length of the year exactly, and of subdivisions within it, to make an accurate calendar.

Thom also claimed that the sophisticated lunar alignments could help predict eclipses. However the lunar lines are omitted from the present study because there are potentially so many of them that they are difficult to verify individually. As noted Ruggles has made a special study of these (1981, 1982a and 1983) which the author has yet to consider in detail. By contrast the annual movement of the Sun is much simpler and slower so solar lines should therefore be easier to detect, longer (and hence more accurate) and therefore less controversial. If these turn out to be undoubtedly genuine then clearly they would support the case that the Moon's movements were also tracked.

The essential point to keep in mind is the basic difference between orientations and alignments already explained (MacKie 1997: 340-1). The former can be built anywhere; no useful horizon marks need be involved, and nothing need be concluded about the interests of builders except that such an orientation was ideologically important. Alignments on the other hand involve selecting the position of a back-sight (a standing stone or stone circle) specifically in relation to a distant, prominent horizon foresight so that a celestial body will rise or set at that clear mark on a specific day. Done systematically and on a large scale this surely carries all kinds of implications about the detailed interest of the builders in the sky, in a solar calendar and perhaps also in the complex movements of the Moon. In terms of Neolithic skills and equipment these long, accurate alignments – clearly pointed at by stone structures – are the only ones that should be surveyed and analysed.

However it has been claimed that this mass of Neolithic standing stone sites may still have many astronomically significant lines built into them, but at a much lower level of accuracy – that these may in effect be orientations rather than alignments. In other words the standing stone erectors may have been concerned only with approximate dates of celestial events rather than with marking them exactly and accumulating knowledge about them. Such a discovery would not necessarily disprove the existence of a priesthood (Renfrew 1974: fig. 53) but it would certainly suggest that, outside the major ceremonial centres, there were probably only village shaman figures involved, concerned with marking the seasonal rituals of agriculture and stock breeding and with ancestral funeral rites at the appropriate times. This is the picture which, broadly, Ruggles believes that his own work supports. By contrast undoubtedly genuine, carefully constructed long alignments – together with the sophisticated surveying and geometrical techniques – must surely be indicating to us the existence of, in addition to and not instead of this shaman class, another group of highly skilled astronomer priests which existed on a national basis and which kept some kind of records of their observations. It is this picture which the author believes to be more likely to be correct.

I also feel that the mass of Ruggles' sites shown with vague directions to horizons would not have been functional for Neolithic observers (1984). How could they decide what part of the fairly smooth horizon was indicated when the stone structures, measured and recorded in this way, mostly fail to clearly indicate anything specific? It makes much more sense to assume that long, accurate alignments were is use.

Neolithic metrology

There is no space, or capacity, here for a systematic discussion of Thom's hypotheses about the geometry and measuring system inherent in the layout of the Neolithic stone circles. However the author tested this idea by chance while excavating the Cultoon stone circle on Islay and found that that site clearly supported Thom's theory (Chapter 2). The most thorough re-assessment in an archaeological journal of Thom's own survey data is that of Barnatt and Moir (1984) and their conclusions seem eminently sensible. Their data was confined to genuine stone circles in a reasonably good state of preservation and which were not known to have been extensively reconstructed. Broadly these conclusions are that one sub-set of the data (that collected by Thom up to 1955) gave excellent support to a unit of length of 5.44 ft (2 MY) as did the 21 clearly non-circular sites. On the other hand the 40 well-preserved circles surveyed later, and the 26 sites with 3 or 4 erect stones, gave no support at all to any unit of length. In statistical terms this means that the stone circles as a whole fail to reveal convincing evidence of a megalithic fathom (or yard). Admittedly it is hard to see why circles measured before 1955 should be different; might the explanation be that a standard measuring rod was used, but only in a proportion of the stone circles? A reason for this is suggested below.

Likewise a significant proportion of the rings are irregular in plan and are consistent with having been laid out by eye rather than systematically with pegs and rope. Unless one assumes *a priori* that all stone rings were laid out geometrically with rope, pegs and a megalithic fathom rod – and that serious deviations from the ideal are the result of subsequent damage – this is the most economical hypothesis. It seems that nearly half of the systematically laid out circular rings are concentrated in southern and south-western England. Barnatt and Moir point out that, in the far north, only Ring of Brodgar has shown this highly accurate circular layout (with a 1.5% deviation from the true circle) and wonder whether an affinity with southern England is implied (1984: 212).

Barnatt and Moir also suggest this interesting possibility (1984: 212). 'The distinction drawn between accurately laid out circular sites and those laid out by eye may reflect differences in social structure. The use of a rope and central peg is a simple method of design, but implies a desire to incorporate an accuracy beyond what is visually apparent.' This observation fits well with the notion that the members of any professional priesthood of late Neolithic times would not necessarily have been found all over the country, that its arcane rituals were often copied by local groups, far from its main centres of influence, which did not really understand them. Such a phenomenon is clearly seen in a late Classic burial at Barton Ramie in Belize in which was a stone axe incised with a crude copy of the 'Ahau' glyph of the Maya writing system (Willey 1956, 779).

Cup-and-ring rock carvings

Rarely mentioned in this kind of discussion is the fact that Thom studied the patterns of these late Neolithic and early Bronze Age rock carvings, using numerous rubbings provided by Ronald Morris (Thom and Thom 1978: chapter 5 and references). The carvings of course consist of pecked grooves so the mid-lines of these have to be estimated. However the measured diameters of the concentric rings did indeed fall into distinct groups with peaks about 0.816 ins (20.73mm) apart. This is almost exactly 1/40th of the megalithic yard and there is a pronounced peak at five of these 'megalithic inches' (103.7

mm) (Ibid.: fig. 5.1). Moreover Thom thought he could apply some of the geometrical constructions he detected in the stone circles to the non-circular rock carvings.

Davis has undertaken a study of the dimensions of a group of north English rock carvings in order to test this hypothesis independently (1988). No universal unit of length was found which was sufficiently plausible to pass the statistical test applied, although a quantum of 5 MI was clearly detected at several sites, especially among the motifs known as ringed cups (1988: 413). With the same end in view he also examined the Greenland Farm rock carvings just north of the river Clyde in West Dunbartonshire, which the author had just cleaned and recorded (MacKie and Davis 1991). Thom had never studied this site. The results here were different and the use of multiples of the MI seemed highly probable in the 74 diameters analysed at this two period site. It may be that, as with the stone circles, a plausible explanation of these differing results is that some rock carvings were initially scratched on the rock by highly skilled members of a learned order while others were geometrically unsophisticated copies; both could have been finalised by equally skilled rock carvers.

Two other finds may also be relevant. The first is a group of five cup marks forming a right-angled triangle above Gourock golf course in Renfrewshire; the centres of the cups can form quite accurately two classic superimposed Pythagorean triangles with sides of 3, 4 and 5 and 6, 8 and 10 MI respectively (Thom and Thom 1978: fig. 5.2). The second is a rectangular piece of bone with a square cross-section found in a deposit with Beaker material at Dalmore near Callanish in Lewis; it is marked on adjacent faces with two regular zig-zag patterns, the points of each set meeting at one edge (Ponting 1988: 432 and fig. 19.8). The mean distances between the five 'points' of the two sets of zig-zags at the edge are 5.106 + 0.411 mm and 5.102 + 0.541 mm respectively; four of these units are thus almost exactly one MI (20.75mm).

The large gold lozenge from Bush Barrow

An ideal test for Thom's metrological hypothesis would be a contemporary artefact which bore an accurate design which could be analysed to discover if the craftsman concerned used a unit of length to set it out. The early Bronze Age gold lozenge is mentioned here because it bears what is surely the finest, most delicately and accurately engraved geometrical design known from prehistoric Britain (Taylor 1980; plates 24 and 25: Kinnes et al. 1988) the analysis of which should surely provide a test case for the existence of the megalithic inch. Unfortunately Ruggles dismisses this possible aspect of the lozenge (Ruggles 1999: 139 and fig. 8.10).

A claim has already been made that units of 5 MI appear in the design, and also that the design itself could be a small version of a template for experts laying out calendric alignments (A.S. Thom et al. 1988). Precise measurements of the elements of the geometric pattern were taken by A.S. Thom but are not published as far as the author knows. It seems that North has also taken measurements but the details of these are not published either, although he draws an important distinction between lines which had to be physically measured on the gold during the construction of the geometrical pattern by the engraver and those which did not but appeared automatically because of the design. Among the former 'There are . . . distinct traces of sub-multiples of 1 MY. There are nine compartments to the central rhombus, each itself a rhombus, and each has a side almost exactly one hundredth part of Thom's Megalithic Yard. Furthermore, the shorter sides of the 36 right-angled triangles in the zig-zag all approximate even more closely to exactly two such units.' (North 1996, 511). It is surely time that an impartial group studied the dimensions on the lozenge pattern statistically to find if any unit of length was employed by the master craftsman concerned and, if it was, whether it fits with Thom's system. The Bush barrow lozenge seems at present to be the only high quality direct evidence available for any measuring system employed in Wessex in prehistory. Although it

dates from a few centuries after the late Neolithic period its archaeological context surely implies that its owner was a member of the south English élite of his day.

Ruggles' criticism of Thom

It is clear from his book (Ruggles 1999) and his joint paper with Barclay (Ruggles and Barclay 2000) that Ruggles believes that the new statistical data he himself collected is so overwhelmingly against the idea of long accurate celestial alignments that he has no doubt that any evidence which seems to point to the contrary conclusion – particularly that recovered by the author – can easily be shown to be invalid. The hypothesis of an intellectually skilled élite is therefore made redundant. It seems only fair therefore that in turn Ruggles' own fieldwork, and the conclusions he draws from it, should be logically assessed. The author tried to do this in 1984 but the review appeared in a journal which has little or no impact on British archaeology; most of those interested in the UK have tended to take Ruggles' work at its author's valuation, for example Ashmore (2000). However the author believes that the situation is nothing like as straightforward as this and that it is necessary to repeat here a few of his 1984 criticisms which, in the author's opinion, show that Ruggles does not actually disprove Thom, despite his publication of 1999 (Ruggles 1999). Ruggles' fieldwork techniques were described earlier in this chapter.

Have long alignments been disproved by Ruggles' research?

What about the question – fundamental to the present discussion – of the existence of long, potentially accurate alignments? In his 1984 discussion Ruggles is slightly contradictory about this point. In summarising the main results of the study he says 'We find no evidence of astronomical orientations of a precision greater than about one degree.' (Ruggles 1984a: 304) which seems to rule out all accurate 'observatories'. Similarly, and comparing his own work with that of Thom, he writes ' .... the results of this project .... strongly suggest that any claimed astronomical sight lines of a precision of 0.5^0 and better can be completely explained away as chance occurrences emphasised purely by the process by which they were selected for analysis in the first place.' (Ruggles 1984a: 306).

However a little later it is stated that 'We have not examined our data for very high precision indications using distant horizon features such as notches, on the grounds that there is no motivation from our data at lower precisions to do so.' He goes on to say that anyone can investigate this point themselves from the information presented (Ruggles 1984a: 308). As noted such notches can be spotted in many of the horizon profiles (Figure 4.1). However it is really not possible to agree with Ruggles that his conclusions about the general low precision of the measured orientations make such a search superfluous; as described earlier the methodology used in the survey actually forced such a conclusion on him. The logical conclusion must be something like the following.

The methodology devised by Ruggles to re-examine Thom's claimed standing stone 'observatories' was essential if the problem of bias in the selection of long alignments was to be overcome. However no long alignments could be seen in the data because they were not looked for nor measured as such. One cannot therefore say that they did not exist among the sites examined, although Ruggles' other work on the claimed high precision lunar alignments may have raised grave doubts about accurate Moon observatories (1981, 1982a, 1983).

By contrast, a keen interest in some lunar and solar lines still clearly shows in the data examined in western Scotland, despite the ruling out *a priori* of high precision. Therefore it seems perfectly reasonable to suggest that some of these are likely to have been primary investigation sites, positioned carefully in relation to a distant horizon marker and therefore capable of accurate observation. To establish the genuineness or otherwise of these different approaches – actual archaeological tests at specified sites – are needed (see Section 4 below).

It is fair to add that Ruggles himself has addressed this very question of the potential conflict between the 'statistical' and the 'interpretive' approach to identifying or discarding observing sites, though not in quite the same way as the author (1988). Norris also noted how potentially important was this independent demonstration of a fairly sophisticated interest in the sky in Neolithic times (1988: 273). As noted on elsewhere, a logical assessment of the intelligent Neolithic wise men, or astronomer-priests, means that they always used a distant horizon notch or slope, indicated by some kind of backsight. The idea that Ruggles' analysis of the lack of precision – in relation to a distant slope or notch – of many of these backsight orientions means that long alignments are unlikely is implausible. This would imply that the Neolithic astronomer-priests were unable to remember a dramatic far horizon because the backsight sometimes pointed very slightly to one side of it! Yet most of the distant peaks and notches are very obvious and easily remembered (Figures 4.5 and 4.7).

However Ruggles is sometimes fair in his analysis of my work. In his words 'The story of Kintraw is one of the best known in the entire debate about 'megalithic astronomy' and he gives a good account of the research at the site, and of the resulting controversies, with many helpful photographs and diagrams (Ruggles 1999: 26–9). It is only necessary to mention here that most of the objections in principle to the hill platform being the backsight for a long midwinter sunset alignment depend on pointing to the topographical difficulties which hinder establishing the site from scratch. On the other hand if the organisation which set up Kintraw already had a functioning solar calendar and the date of midwinter was already exactly known, most of these objections become irrelevant. The site would then be an accurate local calendar site designed to keep track of the year for local purposes but integrated into a much wider system (Chapter 6).

It is also pleasant to record that Ruggles finds the long alignment at Cultoon reasonably plausible. 'An important example (of an elliptical ring with a solstitial alignment) is . . . Cultoon . . . whose major axis is aligned upon the midwinter sunset; and it may not be a coincidence that it is also aligned on a distant peak in Ireland.' (Ruggles 1999: 133). During the 1975 excavations this quality was predicted and tested for. During a spell of hazy weather the computed dimensions of the best-fitting ellipse were received over the telephone from Glasgow, and the positions of the two foci were measured out on the ground and marked with ranging poles. When after a day or two the weather cleared the poles were found to be pointing very close to Slieve Snaght in Co. Donegal (Figure 2.12: MacKie 1981: fig. 3.6).

Brainport Bay on Loch Fyne, Argyllshire (p. 26) is a complex site which has been described several times and Ruggles gives a lengthy account of it (Ruggles 1999: 29–34). It has the advantage over Kintraw that the possible solar alignment includes undoubtedly artificial elements, that flint flakes were found in the soil horizon stratigraphically associated with these artificial features and that the earliest C-14 date takes the occupation of the site at least as far back as the late 2nd millennium BC (MacKie 1988: 246 ff). Ruggles dismisses the value of all the work done there as follows. Acknowledging that the fieldwork was guided by the principle of constructing hypotheses, testing them on the ground and then abandoning or modifying them as necessary he nevertheless says '...the problem is that while the archaeological evidence is allowed to modify the specific predictions, for example by adding more alignments, it is never allowed to influence the more fundamental hypothesis that Brainport Bay was a high precision 'calendric' site. Thus, as contradictory data confront each suggested alignment, more are suggested in an attempt to bolster the calendric idea, and the structure of 'supporting' evidence becomes steadily more cumbersome. Yet the increasingly attractive alternative, that the astronomy of the main alignment was of lower precision and all other alignments were fortuitous, is never considered. Instead the idea of archaeological verification has been turned into mere post hoc justification, which in this case becomes less and less viable as the weight of the evidence builds up against the hypothesis being proposed.' (Ruggles 1999: 34)

This is not at all a fair summary of the situation. The account of Brainport Bay by the author explains the methodology of the research (MacKie 1988 and Chapter 2 here). I argued that the 'prediction and test' method as described there is perfectly valid; there was a sense of being led by the refuted predictions to the discovery of the cup-and-line rock carvings on Oak Bank, one of which (after some tree clearance) was found to point directly to a notch suitable for marking the equinoctial sunsets. The plethora of extra alignments which he is supposed to have conjured up in his desire to keep his idiosyncratic interpretation of the site going in fact totals two (in addition to the main alignment). One is the indicated equinoctial notch just mentioned (MacKie 1988: fig. 1) (Figure 2.19) while the other is the midwinter sunset notch on Oak Bank. The latter is admittedly less plausible because it is short; it was discovered by chance and nothing depends on it.

Moreover the author's interpretation of the main alignment – that it was a linear assembly of natural features which pointed by chance close to the midsummer sunrise and was modified by man in ancient times to make it more impressive ritually (MacKie 1988: 229 ff) – is surely exactly that advocated by Ruggles. It seems strange that he could have edited the book mentioned while apparently not picking up this basic point. Equally difficult to understand from someone well versed in practical astronomy is the discussion of the equinoctial line (Ruggles 1999: 33-4). Firstly this is unlikely to be fortuitous as its situation, if not its nature, was predicted and discovered as explained. Also it is unfair to mention as an objection that the second cup-and-line rock carving does not point to any obvious horizon marker without also mentioning that the two cup-marks themselves also point (along the pecked line through the first) to the equinoctial notch in Siaradh Druim, the 'western ridge' (MacKie, Gladwin and Roy 1985: fig. 1).

The comments on the nature of the equinoctial foresight are also surprising (Ruggles 1999: 34). For example Ruggles finds unconvincing the idea that the whole Sun was visible in the notch at the 'megalithic equinox' as shown in the original publication (Ibid). Yet this is inevitable for two reasons, first because the daily movement of the Sun along the horizon at the time of the equinoxes is so rapid, and second because sunrise or sunset at that date cannot recur in the same place two years running because of the extra quarter of a day in each year. Thus in any given equinox notch the Sun's disc must in different years be either in full or in partial view on the established dates in March and September. This is fairly elementary astronomical knowledge.

Ruggles' second objection to the genuineness of the western alignment at Brainport Bay is a general one, and a classic example of the use of deduction to oppose a fragment of concrete evidence. 'Finally there is a deeper problem in relation to supposed alignments upon the equinox which is a concept not necessarily meaningful outside the Western scientific tradition (see Chapter 9 and Astronomy Box 8)' (Ruggles 1999: 34). This Box (Ruggles 1999: 150) clearly explains the point just made about equinoctial sunrises and sunsets in successive years but even there Ruggles mixes up the two concepts of the 'megalithic equinox' and the modern astronomical equinox and implies that they are interlinked. They are not. The former is simply a slightly variable date arrived at by sub-dividing the total days in the year; because of the irregularity of the Earth's orbit, the Sun will arrive at this 'calendar equinox' slightly later than the true (or astronomical) one in spring and slightly earlier than it in the autumn, as Thom explained many years ago (1967: 107 and fig. 9.2).

The latter concept depends on understanding that the Earth hangs in space, that its axis is tilted in relation to the plane of its orbit, and that the Sun therefore twice a year must reach declination 0° as it crosses the celestial equator against the background of the fixed stars. As far as the author is aware not even the most zealous advocate of prehistoric wisdom has maintained that Neolithic man in Britain knew all that!

One piece of evidence from Brainport Bay has been re-assessed. During the first phase of excavations at the site, in the mid 1970s, Peter Gladwin and members of the mid Argyll Archaeological Society found a

cache of 33 quartz pebbles buried in a shallow pit on the main alignment. Many such pebbles had been found scattered around all over the site but the vast majority of these were broken (Gladwin 1985: 28, appendix III). The cache is of smooth, whole pebbles which 'were packed tightly together as though they had formerly been contained in a bag' (Gladwin 1985: 14). A fine colour photograph of the group has been published (Butter 1999: 17, plate) and it is now in the Kilmartin House Museum, Argyll, with the rest of the finds (Figure 2.21).

When he was shown the cache in the late 1970s the author could not think of any calendric significance for the number 33. The possibility that the distant horizon notch pointed at by the long alignment marked a period of time before and after the summer solstice sunrise in c. 2000 BC – giving advance warning of the longest day as well as being able to define it exactly by the 'splitting the difference' method – was considered, but this interval is about 16 days.

Recently the author read Heath's account of the 33 year solar cycle and its possible mythological connections (Heath 1998: 227-29). It is such a simple concept that it seems surprising that it is not better known in the archaeo-astronomical literature. It depends on the fact that the year is just under 365.25 days in length (actually 365.242199) and that after 33 years this cycle repeats almost exactly (to within just under 11 minutes). By contrast when eight normal leap years have been inserted into the calendar of 365 days (that is, after 32 years), this adjusted calendar will still be running almost exactly six hours ahead of the real year. To any society accustomed to checking its calendar against horizon notches this would surely be obvious.

With a good clear equinox notch to hand it might just be possible (because of the rapid daily changes in declination mentioned earlier) for naked eye observers (no doubt with smoke arranged to rise up between them and the Sun at sunset) to detect the fact that after 33 years the disc has returned exactly to the notch. Only a long term practical experiment could verify this. Yet it seems unlikely to be a coincidence that an obviously important cache of 33 white pebbles was hidden on the main alignment with a plausible equinoctial alignment close by.

Maeshowe and Howe in Orkney

There seems no good reason to enter into a further debate about the alignments suggested by the author at these sites. The reasons for suggesting them were set out in detail, together with possible difficulties, in the papers concerned and Ruggles' comments add little to what was said then (MacKie 1997; 1998). All such suggestions are intended to be tests of the basic Thom alignment hypothesis – in other words if there is something in the idea then it should be possible to interpret many major late Neolithic structures as having significant solar calendar lines incorporated in their design. However one of Ruggles' counter arguments cannot be ignored – his objection to Axis A at Maeshowe.

He accepts that this is a classic Thomian long alignment in which a straight line – formed by the longer inner part of the tomb passage, and by the Barnhouse standing stone 400m in front – points towards a spot on the summit of Ward Hill on Hoy; here the Sun sets one sixteenth of the year before and after midwinter (Ruggles and Barclay 2000: 70). However a cloud of doubt is then thrown over it by implying that this alignment points 1.5° (actually more like 1.7°) to the left of the clear notch (between the base of the right slope of Ward Hill and the almost level local horizon) where sunset on the 'sixteenth' finally takes place, so it is really not very accurate at all.

As the author's drawing makes clear (Figure 3.5) (MacKie 1997: fig. 9) the rounded shape of the right end of Ward Hill means that the Sun can set twice here for several days twice a year – disappearing behind the flattish summit and then reappearing for a short time at the base of the right slope. Thus when it

comes into view and sets again, as a brief flash, with its upper edge at the base of the slope – presumably on the 'sixteenth' date being indicated – it had already set a few minutes earlier on the summit ridge to the left, the point indicated by 'Axis A'. As far as the position in the sky is concerned it does not matter which of these two azimuths the Maeshowe alignment points at; they have the same declination.

Conclusions

Reconstructing late Neolithic society, and the activities of any élites of that time, is evidently not simply a matter of refuting or confirming this or that piece of specific evidence; it also requires the drawing together of a great variety of evidence (some of it not too familiar to archaeologists), as well as the recognition that the use of analogy, involving the findings of anthropology and ethnography, is a vital step in the process. It also involves recognising that archaeological and statistical data are rarely unequivocal and that coming to a firm conclusion over its meaning often involves balancing various probabilities. However, much of the evidence for the intellectual skills current in Neolithic times is quantifiable and has to be understood and accommodated. In the author's view, when one takes all this into account, the general argument for the existence of chiefdoms with professional priesthoods in late Neolithic times is soundly based on traditional evidence. It is the level of expertise of those priestly classes in arcane intellectual activities that is still debatable, as also of course is the wider significance of those activities. The new discoveries on Orkney have made the existence of a Neolithic priesthood far more likely (Chapter 4).

4.12. Modern and ancient alignments and orientations

There is one further conclusion which is important. How accurately do modern archaeoastronomical studies – using cameras, computers, theodolites and mathematical instruments – reflect the activities of Neolithic wise men who presumably wanted to find out how their gods operate things in the sky? The first conclusion is that the results of these skilful modern fieldwork observations cannot reflect precisely the conclusions of the wise men, who could only use their eyes. But they could count the numbers of days between risings and settings by using neat pebbles, like the group of 33 found at Brainport Bay (Figure 2.21). They could also mark the direction of the foresight with wooden sticks. One can assume that flat standing stones were erected at an important place to point at a distant foresight connected with the Sun's or the Moon's rising or setting at what turned out to be an important date – would be aligned as accurately as possible to the distant peak or notch. The wise men would know the target and remember it, following its (occasionally approximate) indication. Any modern studies which claim that most backsight stones have a variety of approximate indictions clearly do not refute prehistoric alignments. The Neolithic wise men would surely have identified the distant notch or peak and would remember its appearance. Thus even if the backsight was only roughly aligned at it they – being skilful and intelligent investigators – would recognize what it was pointing at at once. One key point is that modern fieldwork on archaeoastronomy (starting with Alexander Thom) shows – if carefully carried out – that the Neolithic wise men were concentrating hard on identifying celestial risings and settings.

Chapter 5
The probable astronomy and geometry of Stonehenge[1]

The authoritative work by Ruggles (1997) on whether there were significant astronomical and calendrical alignments built into Stonehenge in the third millennium BC concluded that the evidence for accurate alignments is minimal and that there is none for sophisticated astronomical practices, nor for any kind of calendar. Whether sophisticated geometry was used in designing the site is not discussed. I will review the relevant evidence – previously discussed by Hawkins, Thom and Atkinson – in the light of both Atkinson's accurate on-site surveys in 1978 and Hawkins' photogrammetric survey. It will be argued that these data allow us to infer that important lunar and solar alignments were built into the rectangular formation of the Station Stones, and into the main axis of the site. Moreover, geometrical constructions – and the use of at least one standard length unit – have been postulated for the Station Stones and the sarsen circle; these ideas too are investigated. It seems that these two aspects of prehistoric intellectual skills – astronomy and the calendar, and geometry – are closely interwoven at this site, and that this emerging picture has broad implications for our understanding of Neolithic society. The main problem is that the horizon around Stonehenge is fairly smooth and doesn't have any obvious peaks and notches.

This chapter enquires whether Stonehenge – one of the most famous prehistoric sacred sites in Europe – was built in a more sophisticated way, and for more sophisticated purposes, than those usually suggested in archaeological textbooks. Was it laid out according to advanced geometrical principles and with the aid of skilled surveying? Were sight lines built into it which pointed at the risings and settings of the sun and moon at important stages in their calendars? Or is it a primitive structure remarkable mainly for the size and weight of its component standing stones, their skilful dressing and shaping, and for the ingenuity and effort which must have been involved in raising them into their final positions (R.J.C. Atkinson, 1961)?

These questions are seldom asked in modern British archaeology. A recent comprehensive review and analysis of all the archaeological work ever done at the site, prepared for English Heritage about twenty years ago, says not a single word about the site's possible geometrical properties and astronomical capabilities, apart from some comments on the main axis of the site (Cleal 1995). Indeed, so great was that author's lack of interest in – perhaps lack of awareness of – the possibilities of studying Stonehenge from a geometrical and astronomical point of view that he does not refer to two very accurate plans of the site which have been made within the last thirty-five years. One is a ground survey by Alexander Thom now in the National Monuments Record in Edinburgh (Ferguson 1988). The other is a photogrammetric plan, prepared from air photographs by Hunting Surveys for G.S. Hawkins in the early 1970s (Hawkins 1973; F3 in Appendix). The author does not know the whereabouts of the original.

Instead, he relied on the old Office of Works plan of 1919 as the basis for his new maps and plans (Newall 1959: it appears as a fold-out at the end of the book). By contrast, Chippindale's 1994 detailed assessment of the site deals fairly with its possibly more esoteric aspect. Recent reports on excavations at Stonehenge have been published, namely those of the Riverside Project (by Parker Pearson 2003 and 2004, and Tim Darvill *et al.*, 2012) which have further revised the understanding of the sequence of developments at Stonehenge. A remarkable report was written by Ranieri (2003) on which the geometrical descriptions in this chapter are based.

[1] The first version was the author's 2014 paper

5.1. The astronomy of Stonehenge: modern studies

Recent attempts to discover whether Stonehenge was designed to perform any astronomical functions really started in 1965 with the publication of *Stonehenge Decoded* by Gerald Hawkins (and J.B. White) – an English astronomer working in America. With the help of an early computer he claimed to have discovered many indications of rising and setting points of the sun and moon at important times in the calendar. In other words, there were pairs of artificial features – standing stones, gaps between stones, stone holes and so on – which lined up quite convincingly on these solar and lunar events; the assumption was made that these had been deliberately arranged by the prehistoric designers and builders. The book was ill-received by a sceptical archaeological profession which was not accustomed to thinking about this aspect of the past. As noted earlier the smooth horizon around most of Stonehenge means that accurate astronomical alignments would have to have been orientations very carefully arranged.

Two years later Alexander Thom described the results of his accurate surveys of scores of standing stones and stone circles throughout Britain (1967). Thom found abundant evidence of deliberate solar and lunar alignments of the kind suggested by Hawkins, including many which were miles long and therefore potentially quite accurate. Stonehenge – architecturally our most elaborate stone circle – was not dealt with but was surveyed in the early 1970s and an analysis of its geometry and astronomy appeared in a later book (Thom and Thom, 1978). Thom's work was new in several ways, not least because it seemed to show that sophisticated geometrical and astronomical knowledge could have been intertwined. This book, at least at first, was given a more respectful hearing than Hawkins' (Atkinson 1968).

The Stonehenge sequence

The site (Figure 5.1) has a very long history which is usually divided into three main Phases (not shown in the drawings). In outline, and omitting some details, Phase 1 dates to around 3100 BC and consists of the surrounding bank and ditch with the ring of Aubrey holes just inside the bank. The outlying Heel stone probably also belongs to this period and it will be argued later that the Station Stones do, as well. Phase II consisted of the addition of a number of timber settings but the most spectacular changes came in Phase III, when standing stones were erected on the site. At first – in Phase III.1 at about 2600 BCE – the settings were of bluestones brought from Wales and another major addition to the site at this time was the Avenue (Figure 5.1). This consists of two parallel ditches forming what looks like a straight ceremonial way running northeast from the site. The Heel stone stands alone on this roadway a few yards in front of the site, but the hole for a vanished companion stone has been found.

5.2. A new look at the astronomy and geometry of Stonehenge

Apparently in Phase III.2 – dating from about 2600-2400 BCE – the huge sarsen stone structure which dominates the site today was put up. These included the outer lintelled ring and the inner horseshoe of five tall lintelled archways, or trilithons. These settings have a clear axis of symmetry which is aligned northeast to southwest on midsummer sunrise and, in the opposite direction, on midwinter sunset. The four sarsen standing stones known as the Station stones – which form a rectangle surrounding the sarsen circle – are usually assigned to this period but there is no definite evidence of their age.

Possible prehistoric astronomical alignments

It has been known probably for centuries that the midsummer sun rises over the Heel stone when viewed from the centre of the sarsen circle; this is the best-known astronomical feature of Stonehenge. However Hawkins does seem to have been the first to point out in detail that, not only were there probably other solar alignments built into the site, but that moon alignments could also have played

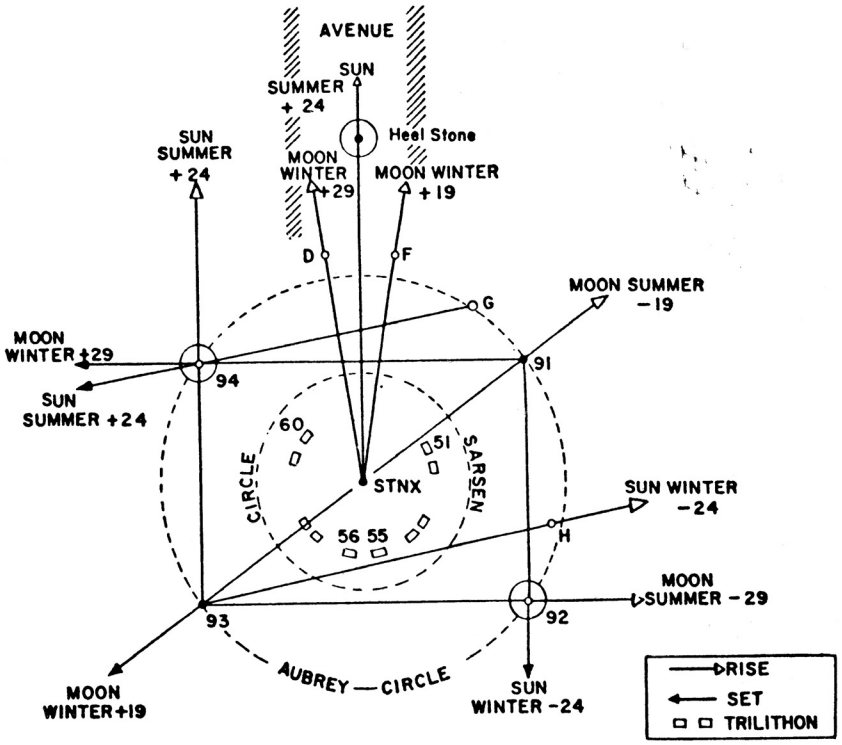


Figure 5.1. Plan of the astronomical alignments detected in Stonehenge by G.S. Hawkins, but omitting those using the archways in the Sarsen Circle. The figures next to the arrowheads represent the declination, or astronomical latitude, of the body concerned. The Station Stones 91, 92, 93 and 94 are marked and the lettered positions are various post-holes and stone-holes.

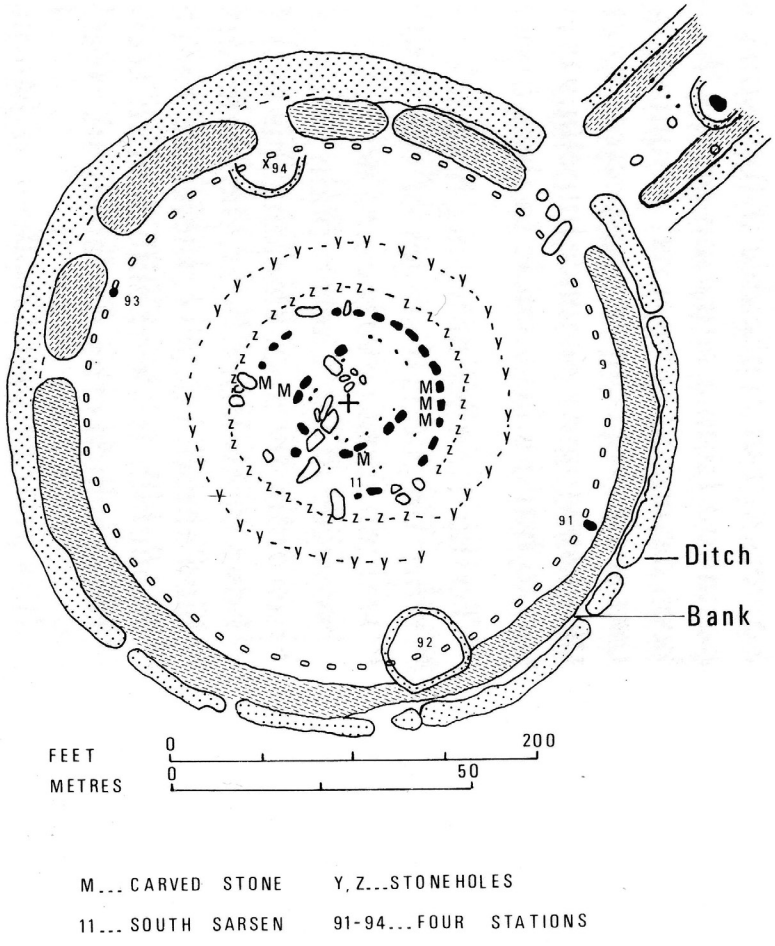


Figure 5.2. Plan of the main features of Stonehenge in Phases 1 – III (Burl 1979).

an important part in prehistoric astronomical practices there. His diagram (Figure 5.1) shows the most important of his supposed sight-lines; moonrises and moonsets were thought to be marked by the long and short sides of the Station Stone rectangle, and by several other artificial elements on the site, particularly the gaps between the stones of the sarsen circle as viewed from the centre of the site (Hawkins, 1965, fig. 14).

What lunar and solar 'targets' might have been recorded by prehistoric Britons? The sun's rising position on the horizon fluctuates from northeast (midsummer) to southeast (midwinter) and back again once in a year; sunsets do the same of course, but from northwest to southwest and back again. The difficulty for naked eye observers is that, on either side of the extremes (the midsummer and midwinter solstices) the position changes extremely slowly for about a week; one of Thom's original ideas was that very long alignments (using notches on the horizon) could have pinpointed these, perhaps to the exact day.

More controversial is the possible existence in ancient times of a solar calendar based entirely on the sun's movements (Thom 1967, chap. 9). This was constructed by dividing the year beyond the natural split into halves which are created by the sun's rising position slowing down, stopping and reversing twice, at midsummer and midwinter. The difficulty in marking these subdivisions is that, between the solstices, the sun is moving along the horizon in one direction, so there are no natural clues to the dates of any subdivisions required; they have to be established by counting the days in the year and sub-dividing. Thus each half-year was divided into quarters of about 92 or 93 days (giving the equinoxes around March 21st and September 21st), and then into eighth periods of 45 or 46 days. These give the four 'Quarter Day' dates halfway between the solstices and the equinoxes; it is particularly interesting that these four dates – around February 2nd, May 2nd, August 2nd and November 2nd – coincide closely with the four ancient Celtic festivals of Imbolc, Beltane, Lughnasadh and Samhain. There is some evidence from the standing stone alignments that the year was further divided into sixteenths, giving 'long weeks' of 21 or 22 days. Because the year is slightly less than 365.25 days long, these subdivisions cannot be exact numbers of days; the calendar alignments therefore tend to point at their average position on the horizon.

The position of moonrise (and moonset) also fluctuates along the same arc of the horizon as the sun, but much faster and over a monthly period (because it spins round the Earth); shorter alignment markers to keep track of it are therefore possible. However the lunar extremes themselves – better called 'standstills' than 'lunar solstices' – fluctuate on either side of the solstice positions over a period of 18.61 years, so the moon can sometimes rise monthly well *outside* the solar limits. It can go beyond midsummer sunrise position to the north, and correspondingly to the south of the midwinter position (the two major standstills); but 9.3 years later it will rise monthly well *inside* these solar limits (the two minor standstills) and will therefore be much lower in the sky. There are, therefore, two lunar standstills to mark instead of one, and a total of eight possible extreme lunar risings and settings instead of four for the sun. Hawkins believed that six of these moon positions were marked at Stonehenge, mainly by the Station Stones (Figure 5.1).

There is another very small fluctuation in these extreme positions, knowledge of which could have led to the prediction of eclipses and which is therefore highly controversial. It is not discussed here but new evidence bearing on the phenomenon is found elsewhere (Gough 2010). It is important to state at this point that no-one now claims that there are any accurate astronomical *alignments* at Stonehenge: that is, long sight-lines capable of pinpointing individual days in the year and therefore of practical use in time-keeping. The horizon is too close for that and lacks suitable notches and peaks. Any plausible indicated lines would be *orientations*: pairs of artificial features which point at the rising or setting of celestial objects on days already known. They would thus have been a *record of existing knowledge* rather than observing instruments trying to establish something new.

Another general comment needs to be made. The author now believes that the evidence favours a working hypothesis which argues that prehistoric British astronomical practices were intimately bound up with the geometric and metrological knowledge of the time, to such an extent that the two branches of knowledge are really inseparable. This is not a popular view. Alexander Thom's inferences about the geometry underlying stone circles, and his concept of the standard unit of length then used – the megalithic yard (MY) of 0.829m – have, not been accepted.

Clive Ruggles finds no plausible astronomical lines at Stonehenge apart from the well-known phenomenon of the main axis being directed towards midsummer sunrise and midwinter sunset (Ruggles 1997). Alignments towards the equinoxes – those dates in the spring and autumn which are halfway between midwinter and midsummer – are ruled out as improbable *a priori* and no other possibilities are discussed (Ruggles 2006). He accepts that elements of the architecture of the sarsen circle and trilithons were almost certainly orientated on the midsummer sunrise. The foam reconstruction of the same view (made for a TV programme) shows well how the pair of outlying stones – the Heel stone and its vanished companion – framed the first appearance of the sun on June 21st early in the third millennium BCE (Ruggles 2006, fig. 1b).

Ruggles argues that midwinter was also important at Stonehenge and 'Foamhenge' again showed clearly how. When looking into the centre of the site *from* a specific point to the north-east, the setting midwinter sun would have shone through the small space between the underside of the lintel of the central and tallest trilithon and the tops of the lintels of the sarsen circle below and beyond it. However, no other lunar or solar sight lines are discussed and – except for an expressed scepticism that the five trilithons were laid out round an ellipse (an idea of the Thoms) – the possibility that geometrical designs are incorporated in the site is not mentioned (Thom and Thom 1978, fig. 11.5).

Is it reasonable to dismiss by implication all these other design elements? Any evidence that sophisticated geometry underpins the design of the site surely needs to be addressed; if it did, we can be more confident that geometry and astronomy were intertwined, and that there may, therefore, be more astronomy in the site than Ruggles allows. The Station Stone rectangle is the key; here, if anywhere on the site, geometry and astronomy are combined at a high level.

In 2017 Ruggles took part in a TV programme about Stonehenge and offered a simple idea of how restricted the astronomical links were. He said that the site was similar to a Christian church, in which the members came in from one end and faced the important features – like the altar – at the other end. In the case of Stonehenge they must have come in from the avenue on north-east and only seen the north-western sunset through a gap in two uprights. But this ignores the Heel stone a few yards out on the north-east side (Figure 5.4). However the idea of a Neolithic parallel to a modern Christian church is encouraging!

Precisely drawn circles

In the 1870s William M. Flinders Petrie was the first to survey the site with real accuracy and the first to discover that the inner, dressed faces of the sarsen ring form a true circle 97.33 ft in diameter (by 'true circle' is meant one laid out with a compass – probably a central peg, a rope attached to it and a marker peg at the chosen distance – the radius – from the first peg (Petrie 1880: 23). In the 1960s Richard Atkinson gave the same figure, though it is not clear if he had done his own survey or was quoting Petrie. Petrie realised that this length was very close to 100 'Roman' feet of 11.68 inches (0.296m); there are a number of examples carved in stone of this foot length – which was used in earlier times in Greece. These interesting metrological inferences have subsequently been largely overlooked, mainly because the use of standardised foot lengths seemed implausible in a British prehistoric context. However,

the geometrical structure and astronomical capabilities of the sarsen circle are not discussed further here because these stones were not originally on the site. It seems more important to try to discover what the *original* builders were trying to do in geometrical and astronomical terms – or, indeed, if they were trying to do anything of the kind – when laying out the Phase 1 site. In other words, was the position and design of Phase 1 Stonehenge determined for such abstruse reasons as geometry and astronomy? If they were, our understanding of the site and its later history would be transformed.

Pythagorean triangles

So far we have only talked about circles laid out on the ground accurately with a peg-and-string 'compass' and quite possibly (though not necessarily) with a radius (the length of the string) in whole numbers of some standard unit of length. Now, triangles have to be considered – particularly the triangles with one right- angled corner known as 'Pythagorean' after the ancient Greek philosopher who defined them. Pythagoras showed that – whatever the lengths of the sides – the sum of the squares on the two shorter sides of a right-angled triangle is equal to the square on the longest side – the hypotenuse. There are a few right-angled triangles in which the three sides feature whole numbers of any length unit – the so-called 'perfect' Pythagorean triangles – and these seem to have been of particular interest to the stone circle builders. The best-known of these is the one with sides in the proportion of 3, 4 and 5 but the most important one in the present context has sides in the ratio of 5, 12 and 13.

When considering the geometry of the Station Stones and the Aubrey Holes at Stonehenge one simple geometrical fact has to be taken into account (Figure 5.3). If the diameter of a circle is taken to be the longest side of a triangle, then any two lines drawn from its ends to a point on the circumference will make a right angle – a Pythagorean triangle, in fact. If the diameter of the circle is 13 units long, then lines of 12 and 5 units can be drawn to a point on the circumference. Of course the other 'perfect' Pythagorean triangles can also be drawn within a circle, and with their corners touching it; but the 5:12:13 triangle has an additional unique property. Its shortest side (5 units) will fit exactly eight times round the circumference, so that eight, non-overlapping such triangles form an octagon (Figure 5.3). This remarkable geometrical fact could provide a key to understanding the origins of Stonehenge.

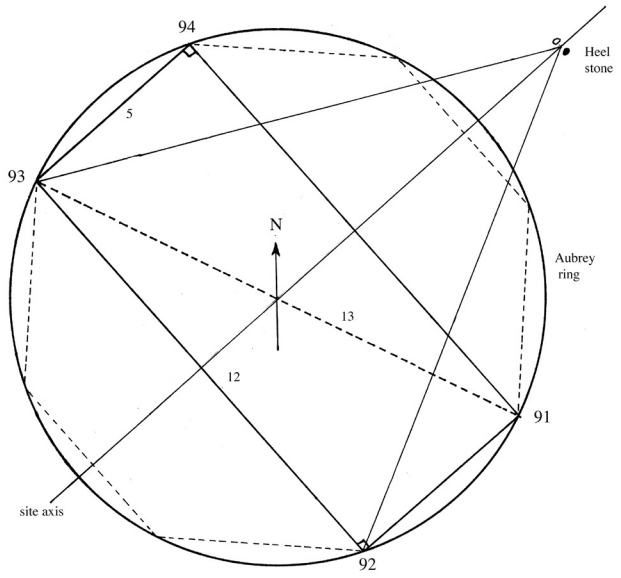


Figure 5.3. Possible geometrical principles underlying Stonehenge I (which is assumed here to include the four Station Stones and the Heel stone as well as the Aubrey holes). The 5:12:13 Pythagorean triangle fits exactly eight times into the Aubrey hole circle. It is also a fundamental part of the Station Stone rectangle itself and of Aubrey circle construction; another 5:12:13 triangle seems to connect the Heel stone to the site axis and to one long side of the Rectangle. The reader can check the correctness of Pythagoras' theorem by confirming that 9 + 16 = 25 and that 25 + 144 = 169.

The geometry of the Aubrey holes

The ring of Aubrey holes is just within the bank (Figure 5.2) and some seem originally to have held wooden posts (or even bluestones according to some recent evidence). This feature is firmly dated to Phase 1 of Stonehenge – at about 3100 BCE – and it was carefully surveyed by Richard Atkinson and Alexander Thom in 1973 (Thom and Thom, 1978: p. 146). The centres of the 56 holes mark a circle with a radius of 140.8 feet, or 42.92m. The standard deviation is ± 0.08 feet or 0.96 inches. This means that there is a 68 percent chance that the circle as laid out by prehistoric designers had a radius within 1 inch on either side of the calculated one. It also means that there is a 96 percent chance that the original radius was within 2 inches of the calculated one.

So the circle on which the pits were to be placed was very probably marked out on the turf first with a peg-and-cord 'compass'. It has been observed that Aubrey Holes 56, 7 and 28, and every other similar set of three, also form Pythagorean triangles with sides in the proportion of 5, 12 and 13, and with the hypotenuse as the diameter. As we saw, only a multiple of 8 holes will show this property of the design and, 56 being 7 times 8, this may be one of an additional reason for there being 56 Aubrey holes. It is evident that the Aubrey circle was designed by people who knew about the peculiar properties of the 5:12:13 Pythagorean triangle in relation to a circle, described above.

The standard deviation is ± 0.08 feet, or 0.96 inches. This means that there are 68 chances in a hundred that the circle as laid out by the prehistoric designers had a radius within 1 inch on either side of the modern calculated one, and about 96 chances in a hundred – almost a certainty – that the original radius was within two inches (actually 1.92 inches) of the calculated one (Cleal *et al.* 1995: 378). In 1971 the author received a letter from the late R.S. Newall, in response to an enquiry about his 1959 booklet on Stonehenge which pointed this out. He also mentioned in it (several years before Dibble's 1976 Note) that the Station Stone rectangle is composed of two triangles of similar proportions, that stones 92, 93 and the Heel stone also form two similar, larger triangles and that the Heel stone stands at the mean of the two winter extremes of moonset (see J.H. Robinson 1970: 1236-37) (Figure 5.1). Perhaps the positions of the pits were laid out by placing every seventh one on the angles of the octagon described earlier and then filling in the rest with careful measurements.

The geometry of the Station Stone rectangle

As was mentioned earlier this rectangle of once-standing sarsen stones (two of which have vanished) formed a vital element in Hawkins' hypotheses about the astronomical orientations built into Stonehenge (the stones are numbered 91, 92, 93 and 94 – Figure 5.4). He claimed that the long sides marked the rising and setting positions of the moon at the major standstill and that the diagonal of 91/93 marked those at the minor standstill. This claim dramatically increases the sophistication of the astronomical knowledge assumed for the designers of the site. Unfortunately there is no direct evidence for the place of the Rectangle within the site sequence, or any independent evidence for its age from radiocarbon dates. However, it probably predates the sarsen stone settings of Phase 3 because it would have been hard to set out accurately with the sarsen stones in position. One could also assume it to be of earlier construction because the two surviving stones are not dressed or shaped in any way: they are like the Heel stone but unlike most of the others in the sarsen settings of Phase III. Although it is usually assigned to Phase III.1 this timing is accepted as uncertain (Cleal *et al.* 1995: 378). It will be argued here that the Station Stone Rectangle was established as a geometrical figure in Phase 1, though the four stones may have replaced original posts at a later date.

The geometry of the Station Stone Rectangle and of the circle of Aubrey pits were surely interlinked (Figure 5.3). If the rectangle itself is a genuine 'perfect' double Pythagorean triangle then the sides must

have been measured out using a standard unit of length; such triangles do not come about by accident. This unit could have been the 'megalithic yard' (MY) – a standardised unit of 0.829m (2.72 ft) derived statistically by Thom from his analyses of the geometry underlying scores of stone circles throughout Britain. In this case – as Table 1 in the Appendix shows – the sides of the two 5:12:13 triangles are very close to 40, 96 and 104 MY respectively. Likewise the diameter of the Aubrey circle – independently assessed – is also close to 104 MY; the Station Stones and sockets fall almost exactly on the circumference of that circle, the diameter of which must therefore be the same as the diagonals of the Rectangle.

It does look as if the Aubrey circle and the Station Stone Rectangle were set out as a single geometrical construction, and this must have been in Phase 1, at the beginning of the site's history. A few years ago Stonehenge was re-examined by Ranieri for possible geometrical qualities using the most accurate available plans in the English Heritage report (Ranieri 2003). Two of the several new inferences made are of particular interest here. The first is one result of a statistical analysis of the various measurements collected, which showed that a unit of length of 0.665m – or two of these making 1.33m – could have been used. Ranieri thought this was probably of little general importance but was evidently unaware that these lengths are multiples of the Drusian or 'Northern' foot of 0.333m which survived in England into Saxon times when it was used in the dimensions of some religious buildings, such as the old minster at Winchester. (B. Kjolbye-Biddle, 1986). The 7th century minster at Winchester was interpreted in L.A.S. Butler and R.K. Morris (eds.), 1986. It is intriguing that this unit fits the 'ideal' dimensions of the Station Stone Rectangle slightly better than does the megalithic yard (see Table in Appendix). The sides of the Station Stones triangle then become 100, 240 and 260 Drusian feet.

The second new inference was that the point on the main axis of the site, where it passes through the gap between the Heel stone and its vanished companion on its northwest side, appears to be connected geometrically to the Station Stone Rectangle (Figure 5.3). If the line between stone 92 and 93 is regarded as the base of two opposed right-angled triangles – the upright sides of which are the site axis (Figure 5.4), and the points of which are at the Heel stone point just mentioned – then these too are in the proportions of 5, 12 and 13. Here, however, the megalithic yard does not work (see Table in the Appendix) because two sides of the triangle have to be in fractions, namely 48, 115.2 and 124.8.

In terms of the Drusian foot, however, they are 120, 288 and 312, which supports the idea that this was the unit of measure used in early Stonehenge. The large triangles form a huge arrowhead pointing to the northeast and surely reinforce the idea that the

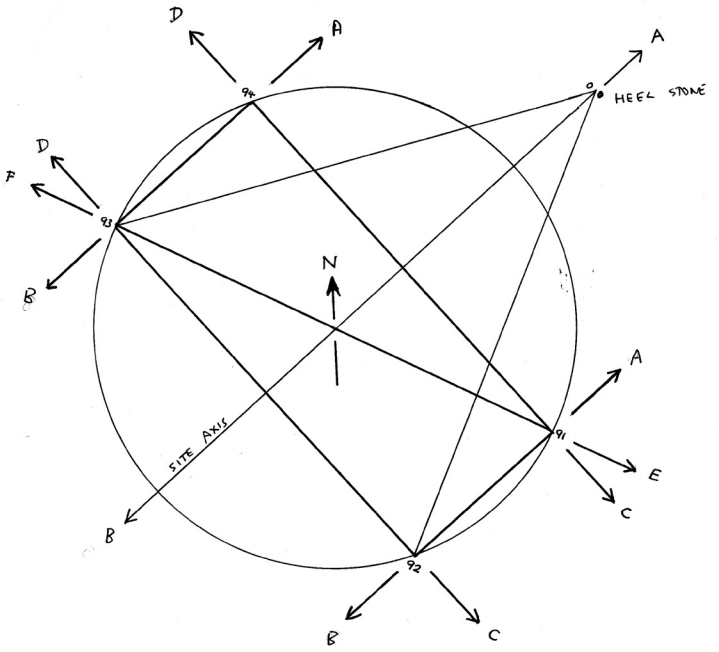


Figure 5.4. The astronomical capabilities of the geometrical figure formed by the Station Stone rectangle and the Aubrey Holes at the latitude of Stonehenge. 'A' = midsummer sunrise, 'B' = midwinter sunset, 'C' = minor standstill moonrise, 'D' = major standstill moonset, 'E' = Quarter Day sunrises on Feb 2nd and Nov. 2nd, and 'F' = Quarter Day sunsets on May 2nd and August 2nd.

midsummer sunrise was the main item of astronomical interest to the builders in about 3100 BCE – at least in terms of something spectacularly visible to the population at large.

Stonehenge astronomy

What was the point of all this elaborate geometry? The fact that the Rectangle is set out with its short sides parallel to the main site axis – towards midsummer sunrise and midwinter sunset – surely means that geometry and astronomy are intertwined here. The new rising positions indicated by the long sides still support Hawkins' hypothesis that the moon at its 'major standstill' was being recorded (Figure 5.2) – rising position approximately in the southeast and setting in the northwest; this was computed from Atkinson's survey (1978: 50-2). The two sides are not quite parallel; it may be that both the first appearance of the rising lunar disc and the point at which it ceased to touch the horizon were being marked separately.

However, thanks to Atkinson's 1978 survey, we have better information about the orientation of diagonal 93-91 and this no longer supports Hawkins's idea that it indicates the risings and settings of the moon at the 'minor standstill' (Figure 5.1). The diagonal 93 to 91 actually points slightly too far north for this rising moon but does indicate sunrise on two of the Quarter Days of the prehistoric solar calendar (Figure 5.5) – at the beginning of February and the beginning of November, respectively (Thom 1967, fig. 5.1). The opposite direction marks sunset on the other two Quarter Days, at the beginning of May and of August. The results are explained in more detail in the author's 2009 paper.

Thus the four basic 'eighths' of the year (halfway between the solstices and the equinoxes) were marked by the Rectangle; this strongly supports the reality of the prehistoric solar calendar, which has often been doubted. It also makes the marriage between geometry and astronomy in Phase 1 even more remarkable. Of course if the diagonal 93/91 was intended as a useful reminder of approaching Quarter Day dates, it must have been set up in either Phase 1 or 2. In Phase 3 the sarsen stone circles would have completely hidden stone 91 from 93. (Cleal et. al. 1995 – Plan 1 at the back).

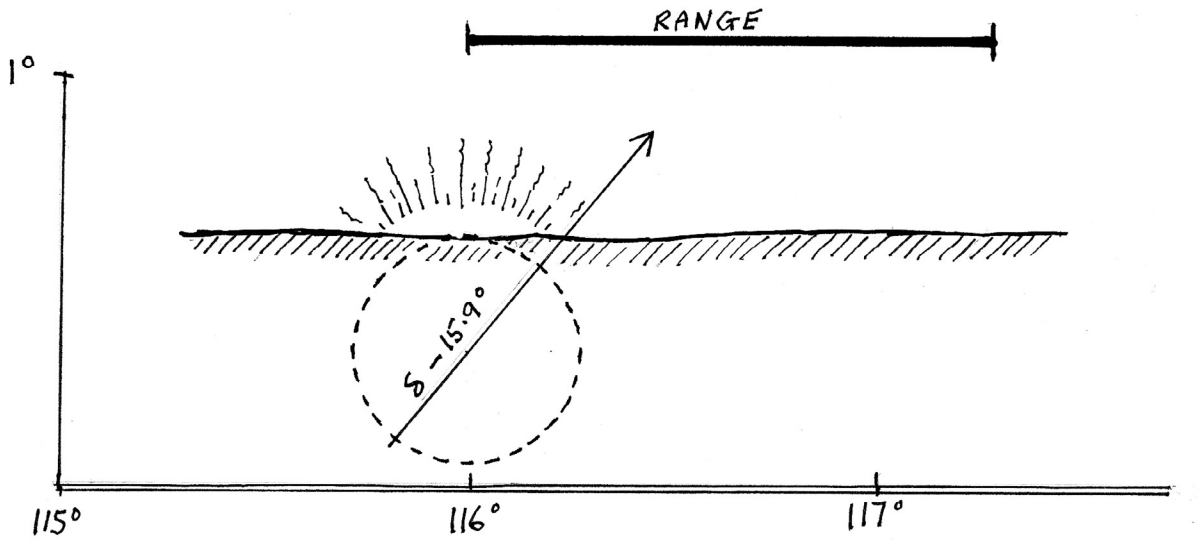


Figure 5.5. The Sun rising on the part of the SE horizon at Stonehenge indicated by the diagonal 93 to 91 of the Station Stone Rectangle. The 'range' is the span of horizon in which sunrises marking the two Quarter Days (early February and early November) can occur (Thom 1967, Figure 9.2). Whether this orientation was effective when it was set up – in view of the completely flat, featureless horizon – is not clear, in view of the long range.

As noted earlier, the 56 Aubrey holes could simply be a result of the peculiar geometry of that circle, and of the way the 5:12:13 rectangle fits into it. However the number probably also has astronomical significance. As Hawkins pointed out many years ago it is close to three of the moon's 18.61 year standstill cycles, totalling 55.83 years (Hawkins and White, 1988; 140ff.).[2] In practical terms of whole years the cycles would have worked well with two of 19 and one of 18. With some of the standstills being recorded in the Station Stone Rectangle, this explanation for the number of Aubrey holes seems highly plausible.

5.3. Conclusions

We may summarise the facts and conclusions discussed and ask whether it is likely that they can be explained as coincidences. First there are the geometrical and astronomical facts. A right-angled triangle can always be formed on the diameter of a circle by two straight lines running from each end to one point on the circumference. When a 5:12:13 rectangle – composed of two such triangles – is drawn in this way the short side fits exactly eight times along the circumference. Multiples of eight of these triangles can subdivide the circle exactly. This seems to be the only one of the 'perfect' Pythagorean triangles which has this property. The Aubrey circle has 56 holes, a multiple of eight, and three cycles of the moon from one major standstill to the next take 55.83 years. Two cycles of nineteen years and one of eighteen (total 56) will keep track of this lunar cycle for many years.

The Station Stone Rectangle (with proportions of 5 and 12) has its corners almost exactly on the Aubrey ring (Figure 5.3). At the latitude of Stonehenge (51.18° N) the long sides of the Station Stone Rectangle can be made to point at the minor standstill moonrise in one direction and at the major standstill moonset in the other. In this case the short sides simultaneously point at midsummer sunrise in the northeast and midwinter sunset in the southwest. The diagonal 93/91 also points simultaneously to sunrise on the two Quarter Days – in early February and early November – and to sunset on the other two – in early May and early August.

Only over a fairly narrow band of latitudes about 100km wide would the lunar standstills and the solstitial suns rise and set at right angles to one another; this suggests that the site could have been chosen for astronomical reasons. If the right-angle mentioned is defined by a rectangle with sides in the proportion of 5 and 12 instead of any old rectangle, one diagonal will also point at Quarter Day sunrises and sunsets. It may be that the range of latitudes where all three of these phenomena are possible is even narrower.

All these points strongly imply that Phase 1 of Stonehenge included the geometrical construction shown in Figure 5.3 and that the Station Stones as well as the Heel stone and its vanished companion were all part of it. This implies that 5000 years ago understanding of the solar calendar and the intricate movements of the moon over its 18.61-year cycle were already well understood and that the new circular site on Salisbury plan was designed to record this basic data in an ingenious design based on Pythagorean triangles.

To us geometry is simply a branch of mathematics; but to the priests and wise men of Wiltshire in the late fourth millennium BCE these geometrical and metrological discoveries must surely have seemed like an amazing insight into the nature of the universe and into the minds of their gods. Perhaps, and because these remarkable phenomena only took place there, the latitude of Stonehenge at 51.18° N was a sacred one, and that is why the famous site was placed there. Something similar seems to have been found at the ancient site at Ringlemere in Kent on the same latitude, and the remarkable bronze and gold Nebra 'sky disc' was found on a ceremonial top of the Mittelberg at almost exactly the same

[2] Found on-line at 'Stonehenge Decoded'

latitude in eastern Germany (MacKie 2009, fig. 14: Hammond 2010). No geometry has yet been found on the Mittelberg but conspicuous distant mountains visible from the hilltop mark the summer solstice sunset, and also sunset on the Quarter Days of May Day (local Walpürgisnacht) and inevitably also at the harvest festival, Lammas or Lunasda in the Anglo-Saxon and Celtic traditions. Perhaps we may expect more significant Neolithic ritual sites to be found on this latitude, preferably also with some indication of the importance of the 5:12:13 Pythagorean triangle.

Any claimed modern relations between Stonehenge and Orkney are discussed in Chapter 3. Also there are new discoveries at Stonehenge which might affect the geometrical structure of its early phase described in this chapter.

5.4. Other modern opinions

In 2015 Mike Parker Pearson published a book about Stonehenge with four other contributors. He considered some of the geometrical and astronomical ideas that had been offered previously. For example on p. 40 is a section called 'A sacred place?' His own excavations revealed a series of parallel chalk ridges along the avenue approaching Stonehenge from the north-east. They were underneath the post-glacial soil and were therefore apparently products of the melting of the ice at the end of the ice age, which might have been noticed by the first hunter-gatherers who moved in. If they saw them they may have realised that they were aligned to the midwinter sunrise and the midsummer sunset! A few huge post-holes from the Mesolithic period were found nearby.

He also mentions monumental 'tombs of the dead' which had begun to be built in Mesolithic times (before the arrival of farmers). The one called Knowth in Ireland is also mentioned with its sunrise alignment shining through a narrow 'window' above the outside end of the entrance passage. But the carved kerb stone of this huge cairn – described in detail in Chapter 6 as evidence of detailed calendar – is not mentioned. Maeshowe in Orkney (Chapter 3) does not seem to be mentioned either. Ness of Brodgar is mentioned on p. 101 but only as a link between land and heavens. This may mean a religious site. Concerning the ones in Wiltshire the following comment is made (p. 13). 'The period between 3500 and 3000 BC was clearly a time when certain of the dead were more important than the others. Large tombs were being built in Britain to commemorate particular individuals, not groups of people. Earlier mortuary rituals that focused on groups of ancestral remains were replaced by burials of individual ancestors.' This concentration on dead individuals could easily be explained by the new existence of dominant classes – chiefdoms and/or priesthoods.

The sophisticated design of Stonehenge supports this idea and the existence of astronomical alignments surely supports the existence of a priesthood. On p. 114 the design of Stonehenge is discussed under 'Measuring the monument', but only the stone structures are commented on, the result of surveys by Alexander Thom and Flinders Petrie. The fascinating geometry of the earliest phase of the site – the Aubrey holes, the Station stones and the Heel stone – is not mentioned. Durrington Walls henge monument nearby is mentioned but the excavator's idea that it might have been a complex circular house suitable for training priests is not mentioned.

However the picture of the site presented in this book – derived from some new excavations there – is one which suggests that there was a hierarchical society in Neolithic times in Wiltshire during which the dominant class dominated the site and encouraged crowds of people to go there.

Another interesting point is the connection between Wiltshire and Orkney demonstrated by the same pottery. Mike Parker Pearson discussed this in his 2012 book about Stonehenge (p. 330). 'Certain of these innovations (at the end of the fourth millennium BC) – Grooved Ware and henges – may have

originated in Scotland, most likely in the islands of Orkney. By 2800 BC Grooved ware had spread to Wessex ...' In the south it was found at Durrington Walls, close to Stonehenge, and which might have been a training school for the priesthood, or for the amateur astronomers who must have been working for them (p. 99). 'Archaeologists have recently discovered a large settlement in Orkney at the Ness of Brodgar, with hall-like buildings and a thick boundary wall separating it from the Ring of Brodgar, Orkney's version of Stonehenge. This complex was built before 3000 BC so it pre-dates Stonehenge and Durrington Walls. Perhaps the remote northern islands spawned a religious and cultural reformation that eventually spread across the whole of Britain. Similar square house plans of this period are known from Wales and eastern England. This was probably the standard form of housing across Britain, replacing the long rectangular houses of the previous millennium and itself to be replaced in the Bronze Age by round houses.' He also notices a very similar house (a shed or store) in Durrington Walls to a very similar one at Skara Brae. 'Comparing the plans of the small 'ancillary' structures, we could see that the Scottish outhouse was virtually identical to the one we were digging in Wiltshire.'

5.5. Appendix

The following table compares the surveyed distances at Stonehenge with their 'ideal' equivalents in megalithic yards of 0.829m and in Drusian feet of 0.333m, assuming that the suggested Pythagorean geometry is correct. Under 'Larger triangle' α is the mid-point between stones 92 and 93 and marks the two '5' sides of the pair of 5:12:13 right-angled triangles based on Stones 92 and 93 and with their apices at the Heel stone. The dimensions marked 'Thom' are measured from the 1:250 general plan, no. DC 4708/c in the National Monuments Record in Edinburgh (Ferguson 1988: 53); those marked 'Hawkins' are from his photogrammetric plan (Hawkins 1973: 59, Pl. 15; 1989: 52 and map at end). In almost every case the Drusian foot is closer to the actual measurements on the ground.

All this evidence is fairly conclusive about the intellectual skills of the Neolithic priesthood and wise men and how important they all thought that the movements of the Sun and the Moon were – presumably to reveal some of the activities of the gods they believed in. However some people in Archaeology don't believe this. For example Clive Ruggles gave a brief interview early in 2017 in a TV programme about Stonehenge and said the only plausible astronomical alignment on the site was the one opposite to the Heel stone – towards sunset on the shortest day at midwinter. This is visible between two of the tall stones of the ring. The reason he gave for this – and for ignoring the Heel stone and other indicated alignments – was that the Neolithic visitors to the Stonehenge 'church' in Neolithic times behaved in the same way as congregations in modern Christian churches, who came in through doors at one end of the church and looked at important items – the altar for example – at the opposite end. This is a strange argument (because sunset there occurs only once a year!) and overlooks a mass of archaeological evidence they are not happy with. One wonders what evidence would be needed to convince Ruggles to abandon his null hypothesis.

	metres	*Meg Yards* (.829m)	*Drusian ft* (0.333m)	*Meg. Rods* (2.5 MY or 6.80m)
Aubrey Holes				
Diameter (Thom)	86.44	**104** (86.22m)	**260** (86.58m)	--
do. (Hawkins)	86.87	**104** (86.22m)	**260** (86.58m)	
Circumf. (Thom)	271.56	-	-	**131** (271.50m)
do. (Hawkins)	272.90	-	-	**131** (271.50m)
Station Stones				
91-92 (Atkinson)	34.17	**40** (33.16m)	**100** (33.30m)	-
93-94 (Atkinson)	32.70	**40** (33.16m)	**100** (33.30m)	-
do. (Ranieri)	33.23	**40** (33.16m)	**100** (33.30m)	-
92-93 (Atkinson)	79.93	**96** (79.58m)	**240** (79.92m)	-
do. (Ranieri)	79.78	**96** (79.58m)	**240** (79.92m)	-
91-94 (Atkinson)	80.26	**96** (79.58m)	**240** (79.92m)	-
do. (Ranieri)	79.75	**96** (79.58m)	**240** (79.92m)	-
Diagonals				
93-91 (Atkinson)	86.66	**104** (86.22m)	**260** (86.58m)	-
92-94 (Ranieri)	86.44	**104** (86.22m)	**260** (86.58m)	-
Larger triangle				
α to Heel (Ranieri)	95.97	**115.2** (95.50m)	**288** (95.90m)	-
93 to α (Ranieri)	39.89	**48** (39.79m)	**120** (39.96)	-
do. (Atkinson)	39.97	**48** (39.79m)	**120** (39.96)	-
92 to Heel stone (Thom)	104.00	**124.8** (103.50m)	**312** (103.9m)	-
93 to Heel (Thom)	105.25	**124.8** (103.50m)	**312** (103.9m)	-

Chapter 6
The Neolithic solar calendar, as seen on a kerb stone at Knowth, Ireland

6.1. Introduction.

Since the Neolithic period in northern Europe was a pre-literate time – when no writing was known about (until the Romans first arrived in the first century BC) – most of the evidence for archaeoastronomy has to be archaeological and therefore, according to many, controversial as many do not believe in it. However there were remarkable skills in some places in carving symbols on to rocks, and one might hope that – since Thom identified alignments marking several sub-divisions of the solar year – this calendar may have been carved on to stone somewhere. If it was found the interpretation of it should match Thom's views, unless he was wrong about the sub-divisions

6.2. Independent evidence discovered at Knowth chambered cairn in Ireland.

The author's description of his fieldwork at Knowth, examining the elaborately carved kerb-stone of the cairn, has already been published in 2013 by Time and Mind. This is reproduced here.

Abstract

Interpreting Neolithic passage grave art is difficult but, according to middle range theory, could be achieved with analogies with known other factors. Celestial phenomena present one possibility and can easily be assessed qualitatively and quantitatively; however, a single match in modern eyes need not necessarily have been intended by Neolithic minds; independent corroboration is needed. The late fourth millennium BC kerbstone K15 at Knowth, Ireland, bears a fan-shaped pattern that has been controversially interpreted as a solar calendar yet it has not been noted until now (as far as I know) that there is independent evidence for exactly this calendar, in fine detail, in the standing stone alignments of Britain. A new examination and reinterpretation of the rock carving reveals a strikingly good match with this 'menhir calendar' of Alexander Thom and strongly supports his statistical deductions from his survey data. Also offered is an interpretation of the 'diamond and spiral' symbol that appears rarely on passage grave art and once on a sherd of Orkney Grooved ware. A link with the solar calendar is possible.

Interpreting passage grave art

The interpretation of passage grave art is notoriously difficult. Clearly it must start with the systematic cataloguing of the material and an attempt to classify the motifs into groups. This is the approach of Shee Twohig (1981) who has prepared a comprehensive catalogue of the 'megalithic art' of Western Europe, region by region. However since we cannot directly recover the knowledge and belief systems of the designers and builders of the Irish passage graves 5,000 or more years ago, understanding the motifs obviously requires a different approach. The Neolithic designs must be compared with what look like analogous patterns produced by historically documented societies, or under experimental conditions in modern times. If these latter consistently resemble the prehistoric ones they could have been produced for similar reasons. This is the approach of 'middle range theory,' pioneered by Lewis Binford (Trigger 1995: 450), which advocates the *use of analogy* to reconstruct the intangible aspects of prehistoric societies. An example is the correlation attempted by Dronfield (1995 and references therein) between Irish Neolithic rock art motifs and those created by modern people under the influence of mind-altering drugs, trances, and so on; the similarities are such that it was claimed, allegedly with

an 80 percent degree of confidence, 'that Irish passage grave art is *fundamentally similar* to (as opposed to merely resembling) arts derived from endogenous subjective vision, and fundamentally dissimilar to arts not so derived.' (Dronfield 1995: pp. 547-8). This approach treats the artistic motifs as separate items, albeit within each separate 'composition,' defined as an individual face on a stone.

There were also many spectacular phenomena in the clear prehistoric skies which doubtless inspired rock artists – rainbows, the Moon's phases, the Sun's passage along the horizon throughout the year, the occasional comet, the movements of the brighter planets among the fixed stars, and even the constellations of the stars themselves. Some designs could have been entirely practical, not induced by altered mind states, particularly if the sky was being studied systematically. Investigating such possibilities need not be a challenge to the 'subjective vision' interpretation but could add plausibility to it; there seems no *a priori* reason why all Neolithic rock art should be explained in a single way. Yet distinguishing such 'practical' designs from the rest seems hardly possible without independent corroboration.

Astronomical interpretations

Astronomical interpretations of Irish passage grave art are now popular,though such usually originate outside the archaeological profession. Brennan (1983) has offered detailed astronomical and calendrical explanations of a large number of Irish passage grave carvings, and has also suggested how a few of the tombs – in addition to Newgrange – are lined upon specific sunrises. He suggests that the fan-shaped design on kerbstone K15 – the subject of this chapter – could have been a gnomon, with a stick projecting from the central cup mark and casting a shadow over different symbols at different times of the day during the year. This is ingenious but seems speculative (Brennan 1983: 191) – could a stick have been fastened firmly and horizontally into such a shallow cup mark, and has the orientation of the upright face of the stone been checked to see if the sun ever shines across it? Thomas (1988) offers other similar, and often complex, astronomical interpretations of many of the patterns on the Knowth kerbstones.

The use of analogy

The methodology used by such researchers also depends on analogy. The number, design, or placing of a specific feature of a design is matched to a number found in astronomy or mythology—or to a useful astronomical or calendrical procedure, or a pattern found in celestial phenomena, and the assumption is made that the two are connected. Since we are dealing with vanished preliterate societies there can be no way of verifying such correlations so faith is relied upon to make these explanations plausible. Yet if a reasonable number of similar designs occur that can be interpreted in the same way, it may gain in plausibility. What is really needed is evidence from some *independent* source that bears on these interpretations. But such are notoriously difficult to come by; middle range theory would expect that, if some of the art is astronomical, it might resemble modern pictorial representations of celestial phenomena but such work has not been yet been carried out.

6.3. Is the Knowth fan-shaped pattern a calendar?

Thus the need for support from entirely independent evidence is particularly acute for astronomical explanations of rock art. One of the most complex examples is kerbstone K15 at Knowth which has – among a mass of pecked rings, spirals, and wavy lines (Figure 6.1) – an unusual fan-shaped pattern that is the most regular, detailed, and complex example of several broadly similar patterns. There is a similar but cruder version in cairn X at Loughcrew (Shee Twohig 1981: 220 and fig. 244; Thomas 1988: 71-3 and figs) and Brennan illustrates two further simple and cruder examples from Newgrange (1983: 158 ff.) on the assumption that they are sundials. Thomas has a detailed interpretation of almost every carved feature on K15, and suggests that the fan-shaped design represents a sixteen 'month' solar calendar. He

also has claimed that the sixteen 'month' year can be seen in a variety of other circular sites in Britain and Ireland but this depends on numbers of posts, stones, and so on. The Knowth carving is the only possible clear graphic representation of the precise details of this calendar, including the number of days in each 'month.'

This interpretation seems to have been ignored by many of the archaeological profession – probably because astronomical interpretations of prehistoric sites and artwork were generally viewed with a lack of enthusiasm and even suspicion (MacKie 2009: 10 ff.). However, one obvious reason is the almost complete lack of corroborative evidence. The arguments always depend on the validity of links between rock art designs and astronomical phenomena – between numbers of symbols and numbers of days, months, and so on – which are assumed to be valid by their authors. The idea of testing the ideas with independent evidence rarely seems to occur. For example, directly relevant and entirely independent material which broadly supports Thomas' interpretation of K15 had already been published for twenty-one years before 1988 – obtaining some notoriety at the time – but it is not referred to in his book (see below). Thus the only known window into a better understanding of this specific aspect of passage grave art at Knowth has remained closed. This demonstrates the frequent failure by many writers on the subject to apply the scientific method; for them an apparent similarity is too often taken to mean a real one involving cause and effect. The idea of checking a hypothesis with independent data – of making a prediction from it and testing it – seems foreign although it is the basis of the scientific method.

The prehistoric solar calendar hypothesis

If the fan-shaped pattern on K15 is to gain plausibility from the details of the Neolithic solar calendar derived from standing stones it must be shown that the latter has not – as is commonly believed – been completely discredited and that there is new and varied evidence in favour of it. This possibility was first put forward more than fifty years ago from a statistical analysis of those standing stone alignments that seemed to be directed at the sun (Thom 1967: Ch. 9). The unique feature of this 'menhir calendar' is the absence of any connection with the Moon; it is derived from a sixteen-fold subdivision of the solar year – the solstices marking two halves, the equinoxes four quarters, and so on. Four of the remaining 'eighth' divisions (about forty-five days long) start at the Quarter Days, at the beginning of February, May, August, and November respectively – close to the old Celtic festivals of Imbolc, Beltane, Lughnasa, and Samhain. The beginnings of the remaining sixteen 'months' – twenty-two or twenty-three days long – do not to fall at significant times in the modern calendar.

Criticisms of the solar calendar

Nevertheless, the concept of the solar calendar remains controversial, and many British archaeologists take their cue from Clive Ruggles who has challenged the whole hypothesis of the use of accurate long alignments to mark specific days in the year (1999). In particular he doubts that the concept of an equinox was understood in prehistoric times (1997: 208), so the solar calendar must be a figment of the modern imagination. His discussion of astronomy and Stonehenge ignores the solar calendar alignment which has been claimed for one of the diagonals (stone positions 91/93) of the station stone rectangle at Stonehenge. The author has several times put forward the counter arguments to this specific and generalized scepticism (and also offered new evidence in favor of the solar calendar hypothesis – MacKie 2002a, 2002b, 2006, 2009, 2013) but it is important to be clear again about the prehistoric equinox.

Doubts about the concept of the equinox in prehistory

The equinox is certainly a modern astronomical concept (Ruggles 1997: 206-7 and fig. 1); astronomers define it as the time that the Sun reaches declination 0° – directly above the equator at midday and halfway between the solstices. Ruggles deduces that this modern definition means that a prehistoric

people would not have tried to define a date near the equinox; why should they since – without knowledge of the Earth as a sphere and hanging in space – the idea of an *astronomical* equinox must have been inconceivable to them?

Yet if one only wants a calendar, and can count the days between midwinter and midsummer and divide the total in half, it was easy with pebbles to define the midway points between these dates. The resulting 'equinoctial' alignments then define the *average* of these halfway points; unlike the solstices, this and other intermediate dates cannot be detected directly with long alignments because the sunrise and sunset positions are moving along the horizon in the same direction, most rapidly at the equinoxes. Earth's orbit is slightly elliptical so such counting produces two mid-point dates, one slightly later than the true astronomical spring equinox and the other slightly earlier than the fall one. Thom's histogram of solar calendar alignments has shown this for many years (Thom 1967: fig. 9.2) and this evidence from standing stone alignments is one of the most striking confirmations of the reliability of his basic work in this area (MacKie 2009: 23-4).

6.4. The fan-shaped design at Knowth

The great Neolithic passage grave at Knowth probably dates, like its neighbour Newgrange, to the late fourth millennium BC (Eogan 1986: 170-2). The perimeter of the huge mound is defined by large, prone kerbstones that had long been buried, but many more than at Newgrange are elaborately decorated with pecked designs. Kerbstone K15 (Figure 6.1) shows, among a mass of other symbols, a distinctive fan-shaped pattern that is the only one of its kind at either Newgrange or Knowth. This has been controversially interpreted as an exact representation on stone of a sixteen-'month' solar calendar with all its details (Thomas 1988: 4-7, 1 plate, two figures). This is the best and most complete of a small scattered group of fan-shaped or rayed symbols. Does the pecked design on K15 make more sense when interpreted by the solar calendar hypothesis? If so it is particularly important because of its early date.

As Thomas (1988) does not discuss the prior discovery of the solar calendar in British standing stone alignments by A. Thom there is nothing to distinguish his interpretation of the fan-shaped pattern from all his many other interpretations. It is unclear too how reliable his drawing is and how unequivocal his interpretation of the 'day symbols.' The author therefore visited the site in 2008 to inspect the stone at first hand, but the design is difficult to see now unless the Sun is slanting across the surface; the diagram (Figure 6.2) is drawn from the photograph in Figure 6.1 and also from several of the flash photographs taken at the time. Figure 1 is a fine view of the pattern taken in the sunshine some years ago and shows most of the details well.

Thomas' interpretation

Thomas maintains that the fan-shaped pattern represents the Sun's rays and this seems reasonable; the small cup mark at top center is the Sun and the nineteen, perhaps twenty, pecked rays radiate from it. Below the wider, outer ends of these rays is an arc of sixteen roughly rectangular symbols which, he suggests, are the 'months' which emerge if the year is subdivided; each rectangle then represents twenty-one days (numbered 1–16 on Figure 6.2). These 336 days leave twenty-nine days uncounted – thirty in a leap year. Above and below the rectangular symbols are varying numbers of small dash- like symbols that are the extra days in each of these short 'months.' Thomas's drawing shows all these 'month' and 'day' symbols unambiguously and they add up to 365 very satisfactorily. However, there are two obvious problems – the first being that, contrary to the impression given by the drawing, the design is damaged at the lower left of the fan; the 'month' 10 symbol has completely disappeared (Figure 6.2) so how can we tell how many day dashes were in this part of the design? The second problem is that an intermediate short dash or tick – at right angles to the rest – is included between 'months' 1 and 2, with



Figure 6.1. Carving on kerbstone K15 at Knowth passage grave, Ireland, dating from about 3100 BC. The fan-shaped pattern—lit by sunshine before the present ledge roof was installed—is a good graphic representation of Thom's solar calendar. Reproduced with the permission of the Department of the Environment, Heritage and Local Government, Ireland, with whom copyright remains.

another between 5 and 6; yet there are two other similar ones (including another at right angles) that are not included, though they are plain on the photograph. The pattern is not the unambiguous one that the published drawing suggests.

6.5. A fresh look at the Knowth 'fan'

Details of the carving (Figures 6.1 and 6.2)

For consistency it was decided to ignore the four short, irregularly placed 'ticks' and to use only the long 'day dashes.' These are fairly consistently carved next to the rectangles and in line with them radially; they also follow two arcs centered on the 'sun' cup mark – one just inwards from the 'month' blocks and the second just outwards from them. It quickly appeared that 'month' 1 (at the right end) probably has only two extra dashes, and not three as shown by Thomas; the third is in a natural groove and the traces of pecking are ambiguous, contrasting with the outer dashes of the neighboring two 'months.' The other main difference from Thomas's interpretation is that 'month' 8 clearly has a day dash below the rectangle and would therefore have twenty-three days, not twenty-two. Also 'month' 12 has twenty-three days rather than twenty-two: the inner dash is quite visible and in line with the rest. Likewise 'month' 9 – though scratched – also appears to have twenty-three days. The Appendix contains

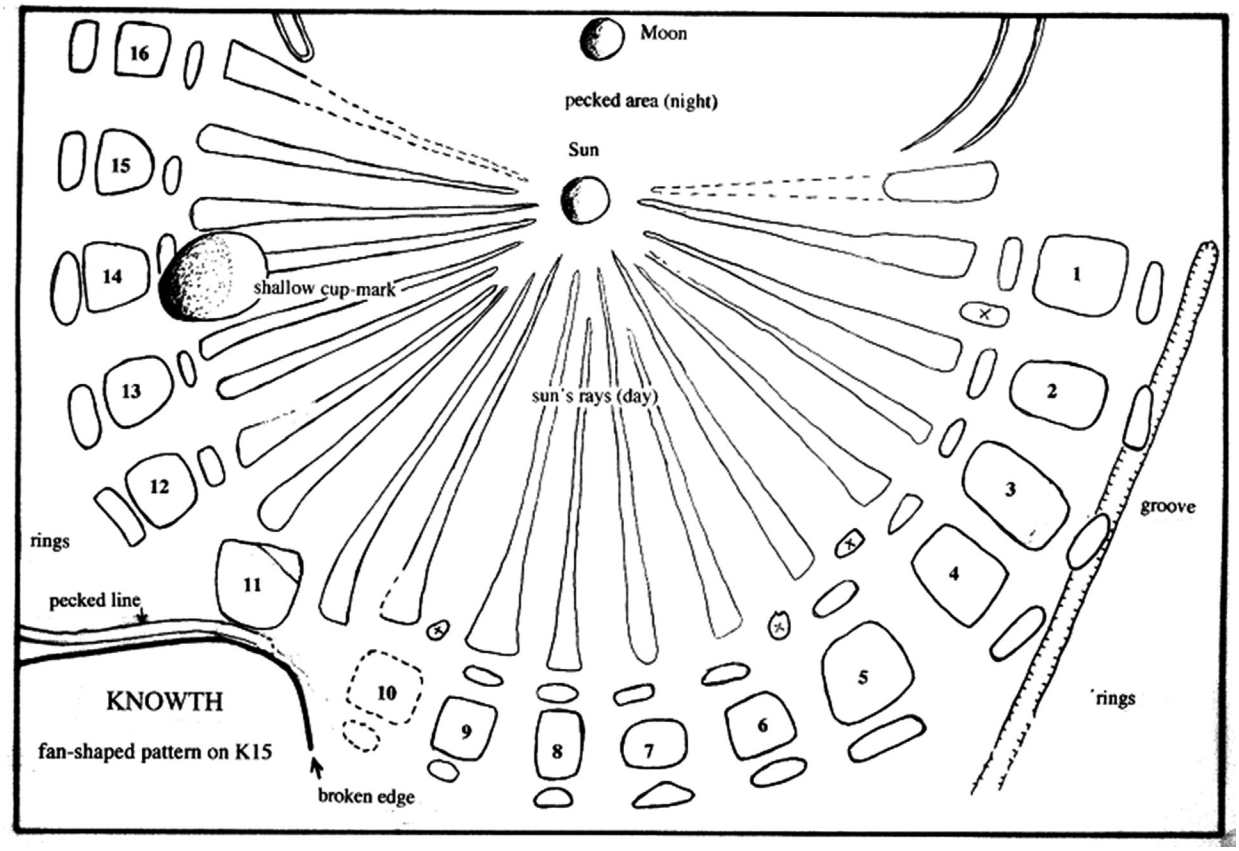


Figure 6.2. Drawing by the author of his interpretation of the fan-shaped pattern on kerbstone K15 at Knowth, showing how the extra days were probably added to each of the sixteen twenty-one-day 'months' to make a 365 day year. Copyright: Author.

a description of the sixteen symbols, based on a study of flash photographs taken by Anthony Murphy from several different positions as well as of the excellent sunlit one (Figure 6.1).

The sixteen 'month' symbols can usefully be divided among four quarter-years and the damaged and obliterated 'months' – 11 and 10 respectively – then fall into the third of these. The other fourteen 'months' are all fairly clearly composed of twenty-three days – totalling 322, including three quarter-years of ninety-two – and this leaves only eighty-nine days for the fourth quarter (excluding a leap year day). This helps us to work out what 'months' 10 and 11 were composed of – there being only forty-three to be split between the two uncertain 'months.' 'Month' 10 has vanished so it is not possible to be sure how the days were distributed between these, especially as number 11 is a little unclear also. But the unique eighty-nine-day quarter-year provides the key to the problem; if there really is a good match with Thom's solar calendar the Knowth calendar also has to have its third quarter shorter than the rest.

The rectangle for 'month' 11 is large and – though assumed to lack the additional day mark suggested by Thomas – appears at first sight to have a fairly clear extra dash below it, next to the broken-off edge; however, closer inspection suggests that this supposed outer dash is part of the sinuous pecked line that runs along close to the month symbols here, and next to the broken-off edge of the carved surface. Unfortunately it is not possible to be sure if there is supposed to be an inner day dash here; the month rectangle seems too large if the whole pecked area is included but there is a deeper notch at the top edge. Number 11 could therefore have had either twenty-two or twenty-three days.

The completely obliterated number 10 should therefore also have had either twenty-one or twenty-two days – the opposite way round to number 11. It is unfortunate that these two symbols – which bear almost the entire burden of proof that the whole design adds up to 365 days – are either obliterated or very unclear. At least it is plain that the design of the calendar need not incorporate any of the irregular extra four ticks. Table 1 in the original paper shows five variations of a 365-day, sixteen-'month' calendar derived from the fan-shaped pattern at Knowth as well as the one derived by A. Thom from his analysis of British standing stone alignments. The first of the five is by Thomas and the remaining four are experimental versions based on the author's reading of the 'month' symbols. Figure 6.2 shows one of these.

The prehistoric equinox and its implications

Before considering these various alternatives one must recall a basic fact – referred to earlier – about any prehistoric solar calendar that relies on day counting. Because Earth's orbit is slightly elliptical, the year has two halves of slightly different lengths; a few more days occur between the spring and the autumn equinoxes. Assuming that our Neolithic ancestors can have had no concept of the modern astronomical equinox (Ruggles 1997: 208), the only 'equinoxes' they could have understood would be the dates halfway between the solstices, found simply by counting and subdividing. These dates would inevitably have fallen slightly after the astronomical spring equinox and slightly before the autumn one respectively (Thom 1967: Table 9.1). Alexander Thom analyzed those declinations that seemed to be solar – indicated by the standing stones he had surveyed – to discover the ideal pattern for a sixteen-month calendar. Each alignment, except for the solstices, marked two sunsets (or sunrises) six months apart, and the members of each of these pairs would themselves be in slightly different places on the horizon each year because its length is not a whole number of days. His table shows how many days there ought to be in each 'month' – starting with the spring equinox – of this statistically 'ideal' solar calendar (column B in Thom 1967: Table 9.1). The summer half of the year contains 184 days and the winter half 181. The match with Thomas's version of the Knowth pattern is not good. However the third quarter contains – like every other version – the fewest number of days, indicating that the 'fan' calendar starts with the spring equinox on the right side and that the 'months' are counted clockwise. But the difference between the winter and summer halves of his year is much too large.

Table 1. Comparison of the distribution of the days in the sixteen-'month' solar calendar in (top) as originally calculated by A Thom and (bottom) as seen recently by the author on kerbstone K15 at Knowth. The numbers in bold are uncertain and could be the other way round.

'Month' 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

starting at spring equinox

Thom (alignments): 23 23 24 23 23 23 23 22 22 22 22 23 23 23 23 23: **quarters = 93 91 89 92**

starting at right end (spring equinox?)

MacKie (Knowth): 23 23 23 23 23 23 23 23 23 **21 22** 23 23 23 23 23

The author's four alternative versions are shown in Table 1 (MacKie 2009); versions 1 and 2 assume that 'month' 1 has only twenty-three days and versions 3 and 4 that, much less probably, it has twenty-four. In these last two cases 'months' 10 and 11 both have to have twenty-one days each – the minimum. In D

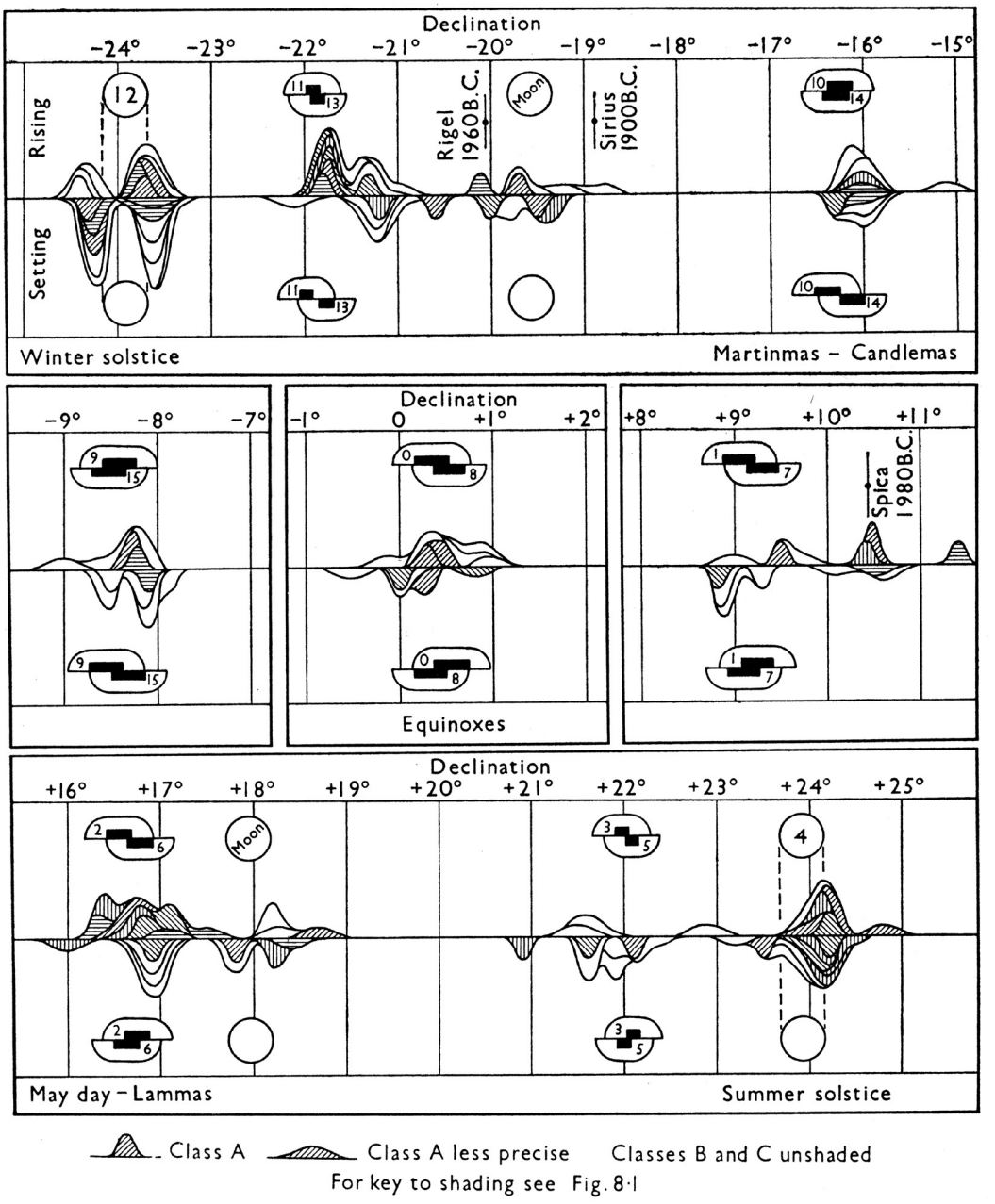


Figure 6.3. Histogram prepared by A. Thom of those of his surveyed standing stone alignments which fit the sixteen-'month' solar calendar (Thom 1967, fig. 9.2).

and E 'months' 10 and 11 have to total forty-three days so have either twenty-one or twenty-two days. These two alternatives are the most plausible because the difference between the winter and summer half of the years is three days – the same as in Thom's 'menhir calendar.' If 'month' 1 is given twenty-four days the difference rises to five days and the fit with the menhirs is much less clear. The purpose of the four small pecked ticks remains enigmatic in this interpretation; they may not have anything to do with the solar calendar at all.

A symbol for the prehistoric calendar?

If this interpretation of the fan-shaped design on K15 is correct it should help us to understand other symbols in Irish passage grave art. There is one that might represent both the sixteen 'month' solar

calendar and the method by which the alignments concerned were laid out in the field; there are several examples among the rock art, and one on a pot in Orkney, that feature the 'diamond and spiral' (Figures 6.4 and 6.5). The spiral is a well-known solar symbol – there is a large one right next to the calendar fan-shape on K15 (Figure 6.1) – but the connection of the diamond-shape with the Sun is not obvious.

One key to understanding the diamond is the position of midsummer and midwinter sunrise (or sets) on a low, level horizon. From a given observation point at the latitude of Stonehenge (about 51° N) there is a horizontal angle of about 81° between them. This is clearly represented on two Early Bronze Age artifacts – the larger of the two Bush Barrow gold plaques and the Nebra disc from near Leipzig, Germany. The two crescent-shaped gold shapes on the disc subtend an angle of 82° from its centre (MacKie 2006: fig. 23.3), similarly the patterns on it, the more acute angles of which are 81° (Thom et al. 1988; MacKie 2009, fig. 13). A.S. Thom claims that if a simple version of this diamond pattern was marked out accurately on a larger, flat, wooden diamond (Figure 6.4), and orientated east/west along the line through the two acute angles; a Neolithic surveyor could have set out approximately, or checked, the various solar alignments of the sixteen-'month' calendar, including the solstices, equinoxes, Quarter Days, and some of the intermediate 'sixteenth'' divisions of twenty- one to twenty-three days. The final back sight positions would have to be modified slightly because of varying horizon altitudes, but the device would surely have saved a lot of time searching for possible suitable sites for calendar markers in new terrain. Figure 6.4 shows what such a wooden plaque might have looked like.

Because of this practical function for the elite this particular diamond shape may have been significant enough to feature, with the sun spiral symbol, on several of the decorated kerbstones at Newgrange and Knowth, two of the most important ritual sites of that period. Its appearance on a Grooved ware pot

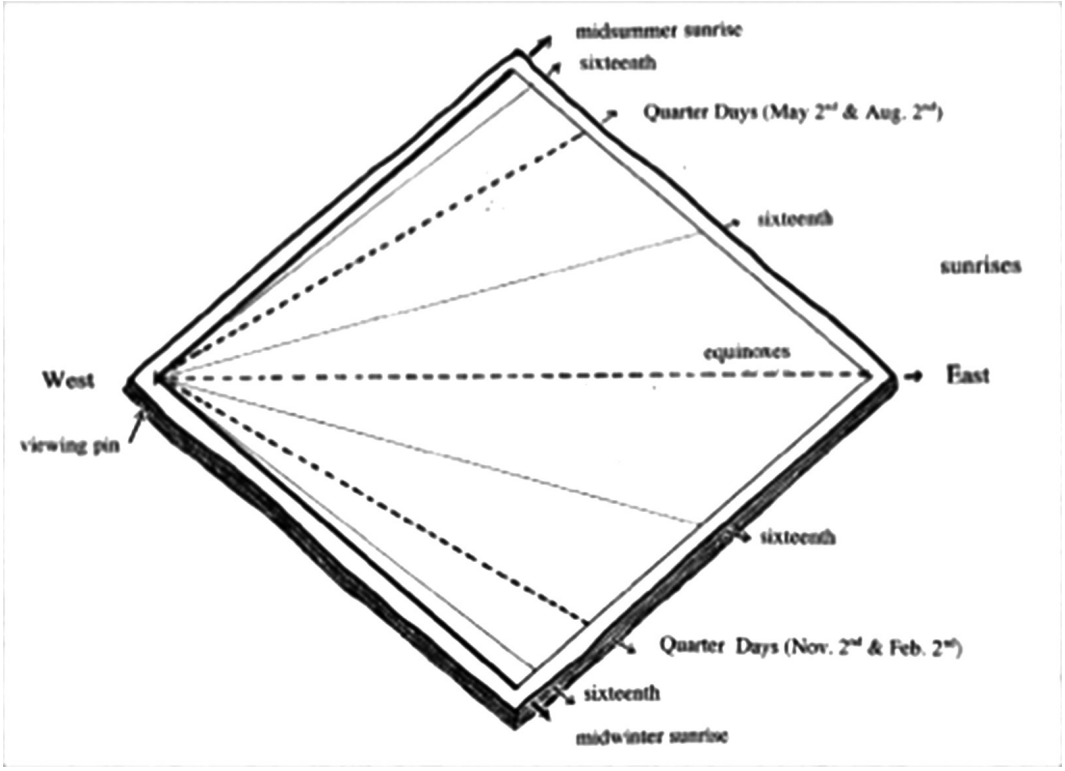


Figure 6.4. Design by the author for a wooden plaque suitable for Latitude 51° N and marked with the nine directions for sunrise or sunset on the sixteen short 'months' of the solar calendar. Based on the larger of the two gold lozenges from Bush Barrow, the idea is that it would help to identify in advance possible useful solar alignments in the field. Perhaps there were small upright pegs to assist in the sightings.

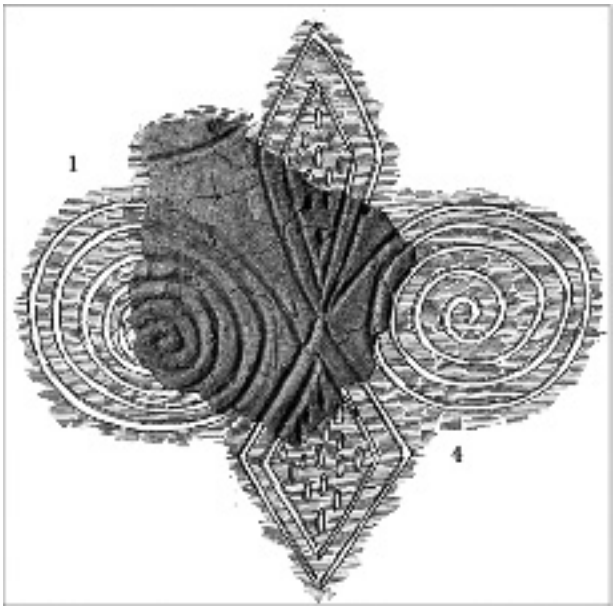


Figure 6.5. Potsherd of Grooved warefrom Skara Brae Neolithic village in Orkney showing part of the 'diamonds and spirals' symbol (Piggott 1954: Pl. XII). Middle Neolithic Grooved ware is found widely over the British Isles and often in association with major ceremonial sites. Reproduced with the permission of Cambridge University Press with whom copyright remains.

from Skara Brae in Orkney (Figure 6.5) confirms that the standard view of this stone village – as an impoverished settlement of peasant fishermen – is unlikely and that it was indeed a residence for the local priesthood as long argued by the author (MacKie 1977: 184-203). The existence of such a priesthood in Orkney is also supported by the several huge stone circles nearby, by the Maeshowe chambered tomb with its clear calendar alignments (MacKie 1997) and is surely confirmed by the discovery and continuing excavation of a genuine temple precinct near the circle at Ness of Brodgar (Card 2011) (Chapter 3).

Two of the 'classic' versions of this symbol are shown in Figures 6.5 and 6.6, but other patterns at Newgrange reflect it – for example, the striking arrays of spirals and diamonds on K1 and K52 (Figure 6.7). It looks as if the carvers had seen the primary, simple symbol and had then elaborated on it, giving their creativity full play.

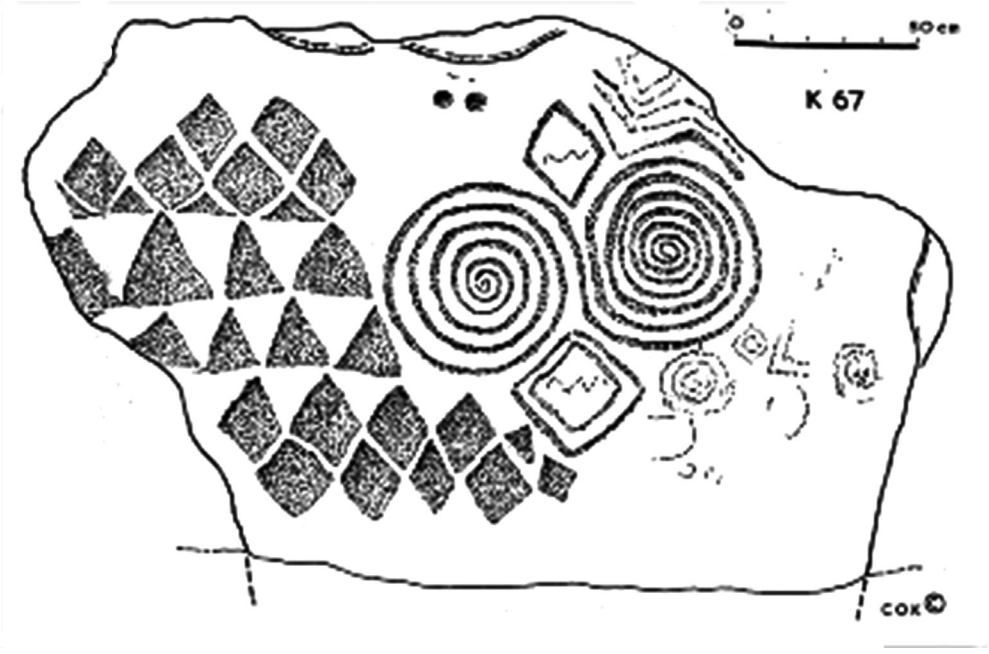


Figure 6.6. Pecked symbols on kerbstone K67 at Newgrange, Ireland, based on a full-size copy by Clare O'Kelly (O'Kelly 1982: fig. 29). The 'diamond and spiral' motif is very similar to that from Skara Brae in Orkney. One of the diamonds has a double border, like the Bush Barrow gold lozenge, and both contain a zigzag line which could refers to the border pattern on the lozenge. Reproduced with the permission of Thames & Hudson, with whom copyright remains, and Eve O'Kelly.

From Shee Twohig's excellent corpus of Western European 'megalithic art' (1981: New Grange and Knowth are not included) – found mostly in passage graves and rock-cut tombs in the Atlantic zone—it appears that the 'diamond and spiral' motif is confined to the British Isles, mainly Ireland. There is a crude version on the Welsh passage grave Barclodiad y Gawres but the heavily decorated Gavrinis in Brittany, while it has many sets of concentric rings and horseshoe shapes, appears to lack diamonds. There are crude diamonds at Sess Kilgreen in Co. Tyrone, and perhaps in Cairn H at Loughcrew, Co. Meath, while cairn L at the latter site has a set of crude diamonds and zigzags beside what might be the remains of two sets of concentric rings or spirals (there is also a rough fan-shaped design in Cairn X). Sets of diamond shapes appear at Seefin, Co. Wicklow, and at Fourknocks, Co. Meath, but without the circular or spiral designs. Hints of the symbol appear at Dun Laoghaire, Co. Dublin. At Skara Brae settlement, Orkney, zigzags are more common but one slab has a suggestion of a row of diamond-shapes. Inside Newgrange there is a related motif on L19 in the passage, on C2 in a recess and suggestions of it are on a roof stone (O'Kelly 1982: figs 41, 45, and 51). There was no published corpus of the Knowth carvings by 2009.

Certain aspects of the diamonds in some of these carvings seem to support the hypothesis. For example the Bush Barrow gold lozenge is engraved with four concentric diamond shapes of diminishing size (each of four close-set engraved lines); the diamonds on the Skara Brae potsherd have a double outline as does one of those on the same symbol on K67 at Newgrange. Also the old lozenge has a carefully inscribed zigzag pattern between the two outer borders,and the two diamonds in the symbol on K67; each enclose a short zigzag pattern. This seems to suggest that the diamond motifs at Newgrange were based on the golden, symbolic version of the plaque rather than the practical one.

6.6. Conclusions concerning K15

Despite the destruction of the 'month' 10 symbol, the author's two best interpretations of the Knowth calendar stone match Alexander Thom's hypothetical version – deduced from his analysis of menhir alignments – very well. The way the day totals of the winter and summer halves of the year are identical is convincing, as is the fact that the third quarter in each version has the lowest day count; this confirms that the calendar starts with the spring equinox on the right and also that it was probably constructed originally by counting the days from the solstices and subdividing. The Knowth calendar is less complex than Thom's – all the 'months' having twenty-three days except numbers 10 and 11 – and seems more plausible. Thom constructed his ideal version from modern astronomical knowledge and careful calculations but the Irish priests of *c*. 3000 BC were presumably not mathematicians and built up their solar calendar by trial and error, aided by years of observing the Sun with accurate long alignments, and counting the days with pebbles.

The question of the leap year must be briefly considered. The modern calendar is a written artifact with an existence independent of the seasons—everyone knows what day it is. The Gregorian calendar adds an extra day every four years to keep it in line with the seasons and by ignoring one in every three out of four centuries when the correlation is more or less exact. However by 1750 in Britain, the old Julian calendar had drifted from the seasons by eleven days because of the failure to accept the latest modification of Julius Caesar's original reformed calendar (by Pope Gregory XIII in 1582). The unmodified Julian calendar would eventually have caused Christmas to occur in the autumn, and ultimately in the summer.

Five thousand years ago it is unlikely that the mass of the population knew what the date was, or indeed had much of an idea what a calendar was; such knowledge was probably the preserve of the priesthood, the wise men and the chiefs. There may have been names for the sixteen 'months,' and numbers for the days in them; there were surely names for the important Quarter Day festivals. Yet the average farmer

would probably have known only that a festival was coming soon, perhaps with reference to the Moon's phases. A lunar calendar would probably have been more useful for agricultural work, if correlated with the seasons. Checking regularly with the long alignments would have allowed the priests to keep the solar calendar in line with the seasons automatically, by adding an extra day occasionally. As long as the



Figure 6.7. Two of the kerbstones at Newgrange show well how the 'spiral and diamond' motif may have been elaborated into more complex designs. Top – K1 now bars the way to the entrance to the tomb: bottom – K52 is exactly opposite it on the other side of the mound. Their positions suggest that they were two of the most important carved stones on the site; the vertical line pecked on each seems to define the centre line of the monument, running down the passage and through the chamber (Photographs by the author).

count was kept it may not have been necessary to give any information about leap years on the calendar stone.

The author accepts that this chapter has attempted to explain only one complex motif on one carved stone in one large Irish passage grave; most of the others still await their 'Rosetta stones'. However, this recognition of the sixteen-part solar calendar will surely help to explain some aspects of the designs on some of them; a new interpretation of the 'diamond-and-spiral' motif was discussed earlier. What is truly extraordinary however is how Alexander Thom – after making exact surveys over many years of the scattered wreckage of an elaborate system of prehistoric standing stones, about five millennia after they were set up – managed to infer the details of an ancient solar calendar almost identical to the one depicted on a 5,000-year-old carving at Knowth. The author has been engaged in this field since the late 1960s and believes that Thom knew nothing of the fan-shaped pattern at Knowth; he almost certainly knew nothing about Thomas's book because he died in 1985.

Notes

1. The website http://www.carrowkeel.com/sites/boyne/knowth1.html has a long and useful account of Knowth, its excavation and its carvings but K15 is not mentioned.

2. The site was described in detail on television in January 2012, in the BBC2 'History of Britain' series, in a program called *Orkney's Stone Age Temple*.

3. Details of the fan-shaped pattern on kerb stone K15 – inferred from photographs, are given in an Appendix to the original article (MacKie 2013).

Acknowledgments

Neil Thomas had the original idea that the fan-shaped design on K15 represented a solar calendar. I am extremely grateful to Anthony Murphy for accompanying me to Knowth in 2008 and for taking a large number of flash photographs of K15 from a variety of positions; the analysis of the carving could not have proceeded so successfully without this help. I also thank George Eogan for his interest in what I was doing, and for advice about publication, and Clare Tuffy, manager of the Bru na Boinne Visitor Centre, for giving us free access to the site and for arranging for me to give a talk there.

Chapter 7
Current aspects of the research situation

A brief look at some of the books and articles which have been published since about the year 2000 shows that a large number of archaeologists are interested in the results of Thom's research. The American periodical *Archaeoastronomy: the Journal of the Center for Archaeoastronomy*, was apparently founded in the late 1970s and has published material from all over the world. The examples reviewed briefly here are some of those which the author has collected over the last sixty years.

Yet there are good, early examples of rational investigation of Thom's work and the tests made of it. Douglas Heggie's 1981 book is fine. However the deduction is that the astronomical work was 'Megalithic science' rather than religious work.

In Chapter 2 there is a detailed description of Douglas Scott's 2011 paper on Kintraw, in which he shows absolute confidence in the 'theory first' attitude and calls Thom's interpretation of the Kintraw standing stone a 'myth'. Because of the absence of any dating material on the platform, or any artefacts, a different kind of analysis was required to test whether the layer of stones behind the boulder was a natural accumulation or laid by man. Such layers of stones do accumulate naturally if soil gradually moves down a slope, for example as scree. The petrofabric analysis was kindly undertaken by Mr J.S. Bibby of the Macaulay Institute of Soil Research in Aberdeen (Bibby in MacKie 1974) (Figure 2.8). However, Scott asserts that there was no sign of human activity in my excavation of the platform, and ignores Bibby's analysis, the results of which are confirmed by his similarly analysing a definitely human-made pebble floor in the Sheep Hill Iron Age hillfort near Glasgow (Figure 2.8). Thus it is clear that rejection of Thom's ideas still exists in modern times, and this results in the ignoring of evidence which is consonant with them. One reason for this attitude is suggested later in this chapter.

7.1. A PhD thesis in 2016

The first is a copy of a Ph D thesis by David A. Fisher, titled 'Employing 3-dimensional computer simulation to the archaeoastronomy of Scottish megalithic sites.' I was invited to go down to Bath several years ago to help the university there to assess the thesis. I have recently – for this book – examined it again in detail. The logical test for me is to see what is said about the Argyll sites in Chapter 1, which I tested long ago to see if Thom's predictions are correct. The most significant one for archaeoastronomy is the Kintraw standing stone.

Fisher describes the site in detail (from p. 184) and says how 'Thom suggests an orientation to a Col between two peaks of Jura, that are not directly visible from the menhir, and he suggests an observation point higher up the hill behind the stone (1978: 37-39). This viewpoint, that is a possible observation point, looks down on the menhir, but from this vantage point the stone does not provide a sight-line toward the stated sunset foresight. When viewing the menhir from the observation point it could be considered that the shadow-line it produced would have delineated a sighting perspective. However a secondary marker would be required to denote the correct orientation. The cairns do not provide the necessary marker and subsequently none could be discerned.'

This is amazing. He quotes the place of my 1974 article but does not mention anything in it, most important of which is my excavation test of the platform up on the steep slope behind the standing stone. Figure 2.3 in this book shows the view from the hill platform at that time, and the Kintraw standing stone provides a clear indicator of the distant horizon foresight notch which Thom deduced

was a classical sunset marker. There is no mention of my excavation of the platform or of the analysis of the pebble surface of it by Bibby (Chapter 2).

Fisher does mention the mass of bushes and trees that have grown on the steep hillside since 1970 but the photographs in my early papers were taken before that (Figure 2.3). Also the small standing stone a few yards up the hill from the platform makes it clear that the latter is the observation point for the sunset alignment (Figure 2.7). Another 'theory first' person (Douglas Scott) said that this stone must have fallen down the hill. If this is true – highly unlikely – the organisers of the site set it upright. Otherwise they would have had to carry it up there from somewhere else. It could not have fallen down a steep slope and ended up neatly upright for several thousand years (Figure 2.7).

7.2. 'Inside the Neolithic mind: consciousness, Cosmos and the Realm of the Gods' (Lewis-Williams and Pearce – 2005)

This book deals with the evolution of religion and its links with understanding the universe all over the world. The two authors are members of staff at the University of Witwatersrand in Johannesburg in South Africa.

A section of the Preface illustrates these themes (p. 8). 'Contrasts between the sites of Atlantic Europe and those in the Near East enable us to ask further questions. In what ways did beliefs about the rock-immured dead of Gavrinnis, Newgrange and other megalithic sites differ from beliefs about skulls buried beneath Near-Eastern mud-plastered floors? Was there an underlying, not easily detected bedrock of belief that expressed itself in contrasting ways? In geological terms, was there a subterranean chamber of molten rock that rose to the surface in different places to form batholiths, each similar to others in its origin but each shaped by the forces of erosion to display its own hills and valleys?'

Today, many archaeologists are reluctant to seek generalities of this kind. They prefer to see each society as possessing its own unique culture, that is, the set of beliefs and norms which individuals learn from birth and with which they creatively interact. There is of course truth in the concept of uniqueness in human cultures, but it is by no means the whole story. In his book *The Blank Slate; the Modern Denial of Human Nature*, Steven Pinker writes 'culture is crucial, but culture could not exist without mental facilities that allow humans to create and learn culture to begin with.'

Yet many archaeologists have tended to ignore these 'mental faculties' and have committed themselves seemingly irrevocably to the notion that environment (especially) and culture are everything. In line with contemporary politically-correct thought, they accept that all people are born with empty minds and that their environment and culture inscribe their nature on a *tabula rasa* or a blank slate – the popular phrase that Pinker uses in the title of his book. As he points out, to believe otherwise today is to court career disaster and to invite accusations of racism, elitism, sexism, endemic violence, genocide and a host of other ills. As a result of such pressure many archaeologists uncritically believe that the influence of the (principally) natural and (secondarily) cultural environments are so powerful that innate human commonalities are of no importance. They therefore dismiss commonalities as superficial and worthless generalisations and, perhaps, a hangover from a now passé archaeological interest in finding 'covering laws'. Differences are what interest these archaeologists.

This argument is a little strange. The numerous prehistoric monuments that relate to archaeoastronomy have a mass of interesting details but there are no contemporary written records with them. So archaeologists and archaeoastronomers have to interpret them with modern knowledge, but there are written accounts of early science and religion in other parts of the world which might help this. The rest of the book discusses numerous sites.

7.3. 'The Materiality of the Sky (2014)'. Proceedings of the 22nd annual SEAC conference in Malta in 2014. Edited by Fabio Silva, Kim Malville, Tore Lomsdalen and Frank Ventura

This book contains twenty-seven detailed papers. The first three are of 'Maltese Archaeoastronomy', the next six are of 'Cosmology and Cosmovision', the next nine are of 'Astronomical orientations', the next three are of 'Astronomy and Culture in Historical Times,' the following three are of 'North and South America' and the last three are of 'Egypt, the Mediterranean and Asia'. Those on astronomical orientations include two discussing prehistoric British sites, which are described below.

Thomas Gough writes one of these, called 'Evidence for the existence of solar and lunar alignments in western Scotland.' (pp. 145-54). His fieldwork on standing stone sites (not stone circles) was done to see if Clive Ruggles' criticism of Thom's ideas (Chapter 4) was valid. The area was Argyllshire and the islands of Mull and Islay, where 42 of the remaining 88 sites were still in good condition. He found that lunar alignments were quite convincing and that some solar ones are too. However his figs. 12.4 and 12.5 show the horizons seen from four lunar and solar sites and are rather curious; there is no indication of what part of the horizons are indicated by the standing stones. This is essential.

Gail Higginbottom and Roger Clay also produced a paper (pp. 177-188) in this section called 'Connections: The Relationship between Neolithic and Bronze Age Megalithic Astronomy in Britain.' She refers to numerous earlier papers that she had published, and also an on-line article which explains how the horizons at each site are linked with solar and lunar risings and settings. This is at http://www.agksmith.net/horizon/. There are four beautiful little coloured pictures of the horizons at nine separate sites, showing the complete solar and lunar risings and settings which might have been indicated. Again it is rather curious; two of the three horizons in one set (fig. 15.2) have vertical red lines which mark the alignments of the standing stones, but these are unconvincing because the two horizons are very level. But the other seven horizons, most of which are slightly more rugged and therefore useful to prehistoric astronomers, have no such lines so it is impossible to tell if there are any convincing alignments there.

7.4. Archaeoastronomy: the Journal of the Center for Archaeoastronomy

This started around 1978, in Maryland University on the east coast of North America. Most of the papers are about elsewhere in the world from Britain. This is a brief study of the papers in the earliest and latest volumes in the set I have, which runs from 1979 to 1989/93 (vol. XI). The early volumes are thin and seem to have been written by the editors, mostly about potentially astronomical sites in north and south America. However in the thicker vol. VI (1983) there are two articles about Stonehenge by Jack Robinson and R.J.C. Atkinson and several reviews of books, including three about Britain. In the 1985 volume there is on the front a large (un-named) photo of Alexander Thom who had just died and the author's article about Brainport Bay in Argyllshire (MacKie 1985b). Also a paper called 'Astronomical traditions in Ancient Ireland and Britain,' by Ronald Hicks. In the latest one in my set (vol. XI, 1989-93) most of the papers are about sites in foreign countries. There are also some amusing cartoons in this journal!

7.5. Astronomy before the telescope: edited by Christopher Walker (1996)

This is an interesting book as it studies in detail the developments of astronomy all over the world; Patrick Moore's 'Foreword' summarises it. These are the first three paragraphs, and they show that the development of archaeoastronomy in Britain is not fully understood; this is a puzzle because there are several articles about that in the book.

'There can be little doubt that astronomy is the oldest science in the world. The skies are all around us; the sun is dominant by day, the moon and stars by night. They do not stand still; they move slowly but inexorably from one horizon to the other, while the moon shows its phases from night to night and the planets wander around against the starry background. The Earth, our home, must initially have seemed to be all important, with the celestial bodies installed for our benefit, presumably by some divine agency. But how much could the people of Antiquity find out?'

'First, we must decide what is meant by 'Antiquity' in an astronomical context. By convention the Middle Ages begin with the fall of the Roman Empire, and end with the Renaissance, though obviously there can be no hard and fast limits. In astronomy it may be said that there are three distinct periods. There is the 'dawn' when people became aware of the phenomena in the sky but made no effort to interpret them, or even to observe them in any but the most superficial manner; until the art of writing was developed, there could be no records other than oral tradition. Next comes the long period in which scientific observations were made and mathematics became something more than simple counting; the stars were divided up into constellations, the movements of the bodies of the solar system were worked out in detail, and it was even possible to obtain some knowledge of the vastness of the universe. Moreover astronomy became of everyday importance, notably in regulating the calendar, and eventually in map-making and navigation. Then in the early seventeenth century came the first astronomical telescopes. The invention of the telescope was claimed by a Dutchman, Hans Lipperhey. Galileo, hearing of the new invention, made his own instrument and turned it skywards with results that changed the whole course of astronomy.'

'Earlier everything had to depend on the naked eye alone, which meant that there was no 'physical astronomy'; all that could be made out were the light and dark patches on the Moon, and occasional sunspots. In fact astronomy was positional only, and all interpretations had to be made against this limitation. Under the circumstances we can only marvel at what our ancestors managed to achieve.'

The development of archaeoastronomy in Neolithic Britain was much better than that sounds. Accurate alignments were developed using irregular horizons, days were counted using pebbles (Figure 2.21) and a detailed annual calendar was worked out (Chapter 6). This is most impressive for tribesmen who don't know how to write words and numbers, but some archaeologists decline to believe it. In this book Clive Ruggles describes 'Archaeoastronomy in Europe' (pp. 15-27), and two others describe its developments in the first millennium and the Middle Ages. The first paper is very complete about the archaeoastronomy of the British Isles but there are a couple of assertions in it which seem to exist because they contradict Alexander Thom. 'Thom's evidence for high precision astronomy did not stand the test of reassessment' (p. 25). See Chapter 4 which analyses Ruggles' criticism of Thom's work. On p. 27 he writes 'There is no evidence of the use of astronomical observations for practical purposes such as the determination of the time of year.' This ignores the quality of some of the alignments; a distant hill slope, indicated by a standing stone, will mark sunrise or sunset on a specific date exactly. The detailed calendar of the year which exists on a stone at Newgrange demonstrates this (Chapter 6). This is a trace in the archaeological record! It is surely clear that prehistoric Neolithic farmers would be very glad to have solar alignments which tell them the time of the year that they are in and what needs to be planted then. Ruggles argues that lunar alignments are much more common but that is not what Alexander Thom deduced (see Chapter 4).

7.6. The author's academic training

It is necessary to explain how my academic attitude is completely different to the 'theory first' school and comparable with most of the archaeological profession. I studied archaeology at Cambridge (St. John's College) from 1956-1959 and learned a vast amount of facts about the history of humanity from erudite

and knowledgeable lecturers. However when I took the exam for the degree in 1959 the result was not first class. Since we had not been taught in detail how to excavate archaeological sites (and thus produce the detailed evidence) I decided join the Cambridge expedition to British Honduras, intending to excavate some Maya sites and thus learn how to collect important evidence. In order to know how to do it in detail I bought a copy of Prof. Richard Atkinson's book *Field Archaeology* (1956) and took it out with me and read it carefully. The result was good excavations on two mounds at Xunantunich in what is now Belize.

This is the description of Atkinson's book on-line in www.waterstones.com. 'During the years before this book was first published in 1946, and re-editioned in 1953, much had been written on the results of archaeological research, but no account had been published of the methods by which those results are obtained. This book provides a simple introduction to the principles and practice of out-of-doors research in archaeology. It covers in detail all the main procedures with which the student should be familiar, including the use of maps and air-photographs, excavation, the drawing of plans, photography, the recording and interpretation of evidence, and the final publication of results. The bibliographies, glossary and appendices summarise much information not easily available elsewhere.'

I wrote back to the Dept. of Archaeology in Cambridge, describing what I was doing in detail. When I returned to England several of the lecturers there came down to London to hear me talk to the Society of Antiquaries about Xunantunich. A bit later, when I applied for a job at the Hunterian Museum in the University of Glasgow, they recommended me to the museum's director. Numerous excavations of brochs and semibrochs followed, all following Professor Atkinson's system. The latest one was Leckie broch in Stirlingshire (in the 1970s) but the report didn't get finished and published (by Archaeopress) until 2016. The title is *Brochs and the Empire* because of the remarkable array of Roman finds that were found there. The archaeologist Ian Armit, who is a leading researcher on brochs, wrote a brief review of it (in *British Archaeology*) and accepted the importance of the Roman finds. However he wrote an odd phrase after that, but justified it. 'The book has an unusual structure, with many lengthy digressions and some idiosyncrasies of presentation. Nonetheless, as a glimpse into the complex native-Roman relations of the frontier zone, it works rather well. *Ian Armit.*' No examples of 'digressions' and 'idiosyncrasies' were given.

7.7. Conclusion

In conclusion, this is a book about evidence of the astronomical capabilities of what I have termed the Neolithic priesthood. Everything that we know about this period of prehistory is inferred from the material evidence and culture that remains for us to excavate and interpret. The scientific method that has guided me during my professional life is one of hypotheses derived from both deduction and induction. Like all effective scientific hypotheses these have to compete amongst the many perspectives on Neolithic archaeoastronomy. Over time as new evidence emerges these theses will be refined, developed and in some cases discarded altogether in favour of a superior theory that offers a more comprehensive explanation of existing evidence and makes meaningful predictions about future discoveries. However for the profession to advance we do need a common methodology whereby there is a consensus on how to interpret evidence and test resulting hypotheses. When a radical concept emerges that provides a fresh and unique perspective on the Neolithic mind, like the work of Professor Thom, our collective professional response should not be the *a priori* dismissal of such insights because they may challenge so many of our own preconceptions. Instead we should welcome such episodes as opportunities to test, develop and modify the existing model. It is surely only by constructively engaging with new and challenging hypotheses, through the careful and considered empirical testing of the available evidence, that our collective understanding of this fascinating period in our prehistory will be further elucidated.

Appendix
Is there plausible evidence that the Ness of Brodgar priesthood had any esoteric knowledge?

A. Introduction

1) It seems to be generally accepted now that the excavations at Ness of Brodgar have shown the site to be a monumental Neolithic temple site – with its own precinct wall – of the late fourth and early third millennia BC and that there was therefore a professional priesthood in existence in Orkney at this time, closely associated with Grooved ware. I suggest that the following questions need to be asked about exactly what kind of priesthood this was; it has been predicted in effect that it should have possessed some kind of esoteric knowledge, including a basic understanding of Sun and Moon calendars and perhaps also of the elements of geometry and measuring. The questions to be asked about this fall into two broad groups – one concerning the site in its surrounding landscape and the other the design of the buildings of the site itself. Only some the former group (*a*-*d*) are investigated here, the evidence needed to answer questions in the latter group (*e* and *f*) not yet being available.

a. Was the stump of the standing stone inside Ness of Brodgar part of one or more deliberate orientations towards other nearby Neolithic monuments? Did any of these mark calendar alignments?
b. Do pairs of the local sites themselves form plausible lines pointing to significant rising and setting positions on the horizon, preferably including a conspicuous hill slope or notch?
c. Among the local standing stones and mounds are there any structures forming three-in-a-line, or any pairs of structures which indicate a prominent horizon feature?
d. Do the distances between the local Neolithic sites cluster at all, suggesting that these may have been measured out?
e. Were the buildings at Ness orientated, through their doorways, long axes, etc., towards other local sites, or towards natural foresights, marking calendar alignments?
f. Are the sizes and proportions of the buildings significant and is there any evidence for the use of geometry and a standard length unit by their designers?

B. Methodology

2) The first phase of the investigation – begun in August 2012 by Euan MacKie and Frank Zabriskie – is fairly simple and has been designed to collect the information needed to start answering questions *a* to *d* above. The author visited as many of the sites as possible in the few days available and established the exact positions of these on the O.S. national grid with a GPS. The grid azimuths of any lines joining the sites can thus be easily worked out and corrected to relate to true north. The same data would also provide the distances between the sites (q. *d* above).

3) He also recorded with a camera the views in any directions which seemed to be indicated by the sites themselves; these directions were also recorded with an accurate ex-Army prismatic compass. Classic examples are the standing stones formed of flat slabs the long axes of which point in opposed directions which obviously cannot be defined with the GPS. The magnetic variation in this part of Orkney is at present almost exactly 4º west.[1]

[1] See http://magnetic-declination.com

4) For those sites which seemed to have an intrinsic indication of a preferred direction – for example the slab-shaped standing stones already referred to – he also measured the indicated horizon altitudes with an Indian clinometer mounted on a solid photographic tripod. This gave the altitude to an accuracy of about ± 0.5º.

5) It is hoped that with enough of this kind of data Professor Zabriskie will be able to make a preliminary assessment of whether significant astronomical declinations are being pointed out and which of these sites need more detailed study.

6) The obvious clusterings of declinations which one might expect to see if there was a Neolithic interest in these matters include the four rising and setting points of the Moon at its extreme positions, and also the two extreme positions of the Sun at midsummer and midwinter (the solstices). One might also hope to see the other seven intermediate solar positions if the year was divided into a sixteen 'month' solar calendar.

C. Five standing stone sites that already look promising from visual inspection, plus one which turned out to be a dud

7) *The Deepdale standing stone* at HY/27179 11703. This is a large thin, flat slab which stands just above the main road at about a mile outside Stromness, with a good view of the 'Heart of Neolithic Orkney' sites to the NE. The slab is orientated to 2º/182º MN, almost due North/South, so is unlikely to be pointing at anything significant along its long axis.

8) However binoculars reveal easily what is in fact visible to the naked eye – that to the NE by E the Stenness stone circle and the Maeshowe cairn are in a straight line. From the stone the centre of Maeshowe is at 77.12º grid N and the centre of the Stenness circle is 77.20º grid N, a difference of 0.08º, or just under 5'. Whether this is significant depends on whether the horizon seen from along this line from either end provides any plausible solar calendar alignments.

9) In fact the photograph no. A.3. below shows how the horizon in the NE by E has a shallow hill slope which might be an indicated rising alignment. It would certainly be worth checking this; the altitude of the hilltop is 0º 35'.

10) Looking in the opposite direction – from Maeshowe to Stenness circle with the Deepdale stone beyond – the horizon indicated does not look very plausible as a setting alignment (no. A.2. below), but it might be worth checking. The altitude of the hilltop on this line is 0º 55'.





Figures A.1. and A.2. The Deepdale standing stone: left, the north alignment; right – the south.

12) *The Grimeston standing stone* at HY/31948 15660. This is a flat, thin slab standing on a sandstone rock outcrop with a steep, low cliff close by – probably an old quarry. It has a good view SW to the Brodgar and Stenness area. The slab is orientated 57º/237º MN (53º/233º TN). The NE orientation points to the left hand slope of what looks like Burrian Hill which forms a plausible rising foresight. This is worth checking for the reason given below. Two altitudes of this horizon were taken (Figure A.5). First the notch just to the left of the stone is at + 0º 50'; second, the top of the slope to the right of the stone is at + 2° 30'.



Figure A.3. Enlarged view of no. 1 above – from the Deepdale standing stone to the NE by E, showing how the Stenness stone circle and the mound of Maeshowe beyond are in a straight line. The left slope of the hill beyond could be an indicated rising foresight. Its altitude at the top is 0º 35'.

13) The SW orientation of the stone points just to the right of the Ring of Brodgar and also just to the right of the very prominent western cliff of Hoy (no. 4.6 above). However the prominent green mound next to the Ring of Brodgar – Salt Knowe, which may contain another passage grave like Maeshowe – is, as seen from the stone, *exactly* below the west cliff of Hoy (Figure A.7). This is quite a plausible, indicated, and potentially accurate, setting foresight on about 235º grid north which is well worth investigating. The altitude of the notch formed by the cliff base and the near horizon is 0º 20'. As the stone itself does not point exactly at the cliff it may be that the SW alignment is defined by the distant marker and the slab orientation is aimed at the NE.



Figure A.4. View from Maeshowe to Stenness circle with the Deepdale stone invisible beyond. The horizon indicated does not look very plausible as a setting alignment, but might be worth checking. The altitude of the hilltop on the line is 0º 55'.

14) The NE orientation. The altitude of the 'rising' slope to the NE (photo 5 above). The notch at the base if the slope is at **+ 0° 50'** and the summit of the hill to its right is at **2° 30'** (added 2013).

15) The Comet stone at HY/29634 13304. This is a regular thick slab just a short distance to the SE of the Ring of Brodgar. There are several possibilities to investigate.

a. Logically it could be interpreted as an outlier from the Ring, indicating a direction just S of E from the geometrical centre of the stone circle. This bearing is close to 101.43º grid (the position of the centre of the Ring will be obtained by a GPS reading) which points just to the right of Wideford Hill (if it is visible). The fact that Maeshowe is on a very similar bearing at 103.63º GN is probably a coincidence, but is worth looking into. I have no photograph along this line as I forgot to take one from the centre of the ring.
b. The SE orientation of the Comet stone slab – 138º MN (134º TN) towards the nearer, local Mid Hill – is shown in picture no. 8 below (in the NW direction is the rise with the Ring of Brodgar on it and the horizon is very close). Either the left slope of the hill or the shallow notch in it (between Mid Hill and





Figures A.5 and A.6. The Grimeston standing stone. Left, view along the slab's orientation to the NE, right the same to the SW.

South Rusky) immediately left of the stone seems to be plausible rising alignments; the notch has an altitude of 1º 50'.

c. There are two stumps of standing stones next to the Comet stone, the long axis of each slab being the same as that of a line drawn between them. This orientation is 229º/49º MN (225º/45º TN) which appears to be exactly at right angles to the alignment of the Comet stone itself. The NE horizon is the only potentially useful, distant one but seems fairly featureless, apart from a shallow slope just to the right of the line (defined by two yellow pins in the grass) which could be a rising foresight. The altitude here was measured at + 1° 20'.

There is still no photo of the eastern horizon indicated by this stone as seen from the centre of the Ring, and I still haven't established the exact centre of the Ring of B at the time of writing. However the photos with item 3 below show the south-eastern horizon from a slightly different position.

The altitude of the fairly level NE horizon from the Comet stone, indicated by the two stumps (p. 8, picture 9), is **+1° 20'.** (added 2013).



Figure A.7. Enlarged view to the SW from the Grimeston stone, showing how Salt Knowe is exactly in line with the west cliff of Hoy (the stones of the Ring of Brodgar are just visible to its left). The altitude of the apparent base of the cliff is 0º 20'.

16) *The Bridge of Brodgar stones,* larger at HY/30347 12824. There are two medium-sized standing stones, some 7.5m apart, in the grass immediately SE of the cottage at the NW end of the Brodgar causeway. The larger – A, of which the position is given – is to the NW. They are not regular, huge quarried slabs like the Stenness and Brodgar stones, and the Comet stone – with rectangular cross sections; their sections are more block-shaped and it is harder to make a convincing cases that their sides are orientated deliberately. For what it is worth A might be orientated 57º/137º MN (53º/133º TN) and the smaller, B, 80º/260º (72º/252º TN).



Figure A.8. View to the SE along the long axis of the Comet stone (138º magnetic, 134º TN). The shallow hill slope just to the left of the stone (Mid Hill) seems a plausibly indicated rising foresight. The altitude of the shallow notch just left of the stone is 1º 50'.





Figure A.9. Views along the two stumps (yellow pins) next to the Comet stone. Left – to the NE (49º MN, 45º TN): right – to the SW (229º MN, 225º TN). The altitude of the shallow summit to the NE is 1° 20'.

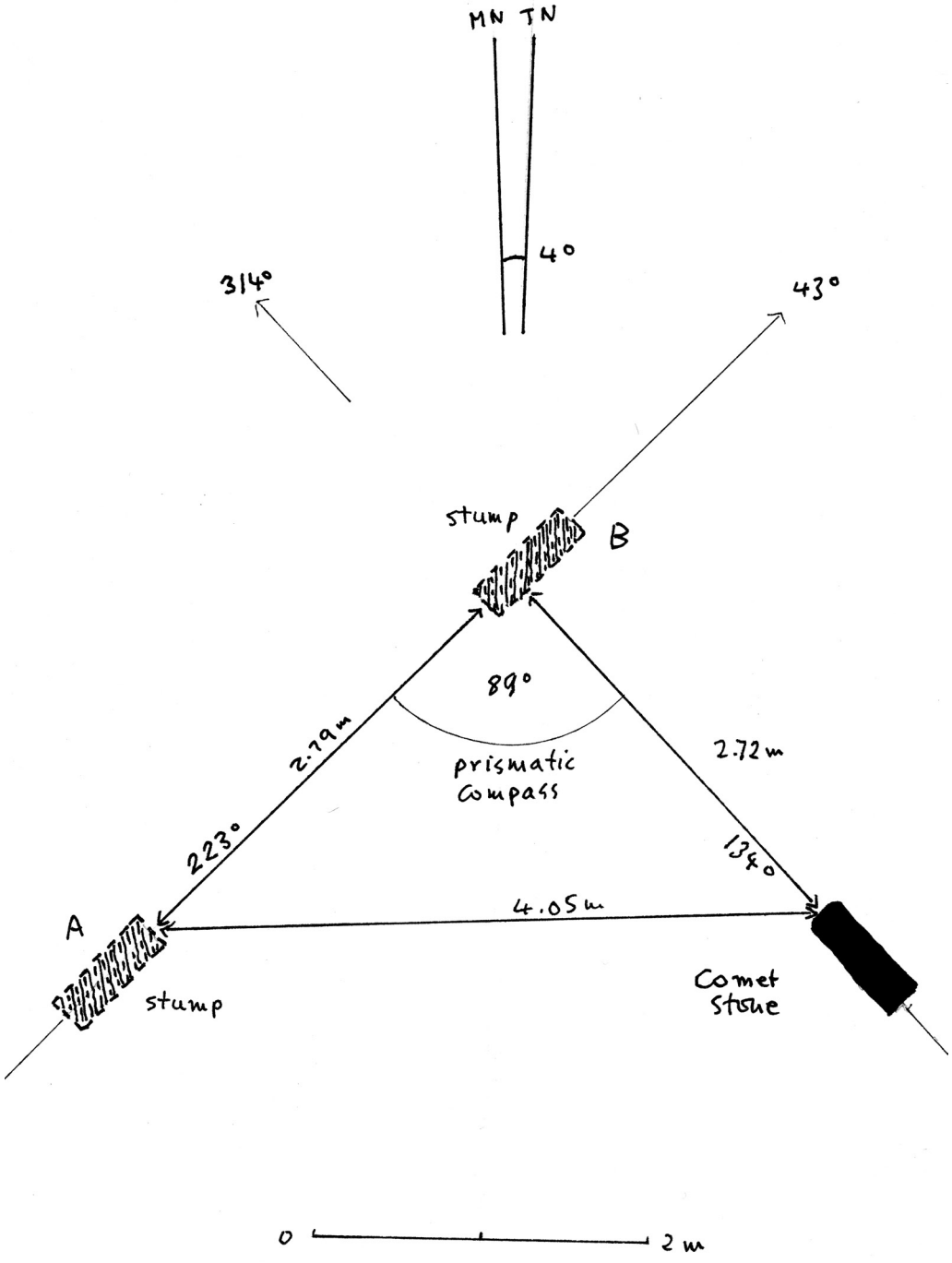


Figure A.10. Comet stone: sketch plan of the layout of the three stones, with magnetic bearings and basic measurements. The orientations of the stones are in relation to True North.



Figure A.11. Enlargement of no. 9, left, above showing the view NE along the two orientated snapped-off slabs next to the Comet stone, on a bearing of 49º MN (45º TN). This line runs just to the left of the small fence post to the right of the thick one and seems to be aimed at the base of the right slope of Hindera Fjold as it merges into Baillie Hill. The summit of the shallow hill to the right of this is 1° 20'. However there is no adequate horizon foresight indicated.

17) Much more convincing as a deliberate orientation is the line formed by the two stones themselves, which is 127º/307º MN (123º/303º TN); the two pictures below show the view SE along this line. The NW view is blocked by the cottage but the horizon just to the right of it seems level and featureless. The left slope of Mid Hill seems to be a plausible rising foresight and the altitude, of 0º 50', was taken of the short level horizon at the foot of the main slope, at the junction with South Rusky.

18) *Stenness stone circle* (at HY/30682 12497) and the stone a short distance to the NW – the *Watch stone* (at HY/30552 12628). The latter seems a natural outlier for the Stenness circle and one which points north-west, perhaps indicating the midsummer sunset. The Watch stone is a huge regular slab which has its own orientation along its long axis. The *stump of the stone in Ness of Brodgar* (at HY/30219 12838) is in about the same direction and might also be an outlier.

19) *Grid azimuths.* From the centre of Stenness circle the grid azimuth towards the Watch stone is 315.23º and that towards the stump of the stone in Ness of Brodgar is very similar at 313.2º.

20) The Watch stone is orientated on 149º/329º MN (145º/325º TN) – some distance to the right of the NW line between the sites. The SE alignment points slightly to the right of a fairly clear if shallow notch on the horizon (no. 14 below) which seems to be the gap between Ward Hill and Mid Hill to its left – a possible alignment to a significant rising position.





Figure A.12. Views along the SE line formed by the two stones at Bridge of Brodgar. The right one shows a clearer view of the probable rising foresight hill (Mid Hill), from just off the line; the altitude was taken of the short level bit at the foot of the main slope – 0º 50'.



Figure A.13. The stones of Stenness seen from the north-east. The Watch stone is out of sight to the right.



Figure A.14. The flat slab of the Watch stone looking along its SE alignment probably towards the gap between Ward Hill and Mid Hill (to the right of Stenness) . The altitude of rising slope indicated by the stone is + 3° 10' (added 2013). The orientation of the slab is 149º/329º MN.

The altitude of the shallow rising slope just to the right of the notch (indicated by the stone) is + 3º 10' (added 2013).

21) In the other direction (329º MN/325º TN) it points to a fairly featureless, flat horizon which seems to have no plausible natural foresights. Its altitude 0º 35' (added 2013)

22) *Altitudes* were taken from Stenness of (1) the top of the Watch stone at 0º 50' and of the far horizon just to its right – also 0º 50'. The altitude of the ground on which stands the Ness of Brodgar site is about the same.

23) View from the centre of Stenness circle to the NW; the Watch stone is an obvious direction-indicating outlier, as is the stump of the stone in the Ness of Brodgar site, just behind the cottage on the horizon to the left of the stone. The altitude of the level horizon indicated by the Watch stone is 0º 50'.

24) Enlarged view of part of no 15, showing one of the Bridge of Brodgar stones just showing above the left end of the roof of the lower grey-blue cottage. There seems to be a plethora of NW/SE orientations here.

EWM: August 2012



Figure A.15. View NW along the alignment of the Watch stone (329º MN/325º TN). The horizon, though distant, is fairly featureless and seems to have no plausible natural foresights. The altitude on 333º is + 0º 35' (added 2013).



Figure A.16. View from the centre of Stenness circle to the NW; the Watch stone is an obvious direction-indicating outlier, as is the stump of the stone in the Ness of Brodgar site, just behind the cottage on the horizon to the left of the stone. The altitude of the level horizon indicated by the Watch stone is 0º 50'.



Figure A.17. Enlarged view of part of no 15, showing one of the Bridge of Brodgar stones just showing above the left end of the roof of the lower grey-blue cottage. There seems to be a plethora of NW/SE orientations here.

The Bernie Stone (or 'Barnhouse 2') (HY/ 30787 12713)

This fallen flat slab with a typical pointed top lies just outside the Neolithic village of Barnhouse. I was told about it by Bernie Bell, after whom it is named because I have never seen any other reference to it in the archaeological literature. It lies in long grass a few metres east of the exposed part of the village. The surviving fragment looks as if it is about half the length of the original stone. It would be useful to probe round the area of the broken end to see if a stump can be traced in position.

As a start, the position of the stone in relation to Maeshowe was established with two ranging poles; the line joining the stone with the mound was established by placing a pole at the base of the stone and planting another among the ruins of the Neolithic village so that the two were aimed at Maeshowe. The purpose of this exercise was (1) to see if the line pointed westwards to a third artificial feature, or to a conspicuous land mark, and (2) to see what the stone pointed at if regarded as an outlier from Maeshowe.

Plotting the positions of the Neolithic monuments to a scale of 1:10,000 suggests that the grid bearing of Bernie's stone from Maeshowe is about 267ºgrid north, or 266.5º true north. This suggests that the stone could mark approximately the equinoctial sunset line from Maeshowe. Of course the equinoctial sunrise could have been seen over Maeshowe as watched from Bernie's Stone.

However this is all probably mere coincidence because further examination of the slab (c. 4 ins. thick) revealed that it was not stable; it rocks slightly when walked on. Moreover there is another substantial piece next to and partly under it, with chips and fragments between the two. It seems inconceivable that



Figure A.18. Bernie's stone, showing the pointed top at the far end.



Figure A.19. The line from Bernie's stone to Maeshowe (left) and pointing in the other direction (right).



Figure A.20. View westwards from Maeshowe showing the line formed by the outlying Bernie's Stone which lies just beyond the first loch and about a third of the way between the Watch stone (left of the house with the red roof) and the centre of the Stenness circle further left. This is based on the relative positions of the four points plotted with a GPS. On the other hand the line marked at BS seems to run to the right of the red-roofed house!

a prone and broken standing stone which had been lying in its present position for many centuries, would not have become firmly embedded in the ground. The looseness of the main piece and the presence of at least one other chunk clearly implies that Bernie's Stone is a fragment of one felled from the Stenness circle within the last two or three centuries by a local farmer and dragged to its present position.





Figure A.21. Top: view of the largest structure in Barnhouse village. Right: enlargement of the direction of the axis of the doorway. Again the horizon here lacks proper natural and efficient foresights but maybe some kind of shadow was arranged to have been cast on to the opposite wall inside the building, which marked the about NW sunrise satisfactorily.

D. Orientations of Buildings

Large Neolithic ceremonial buildings have been appearing in Orkney now for more than fifteen years and they represent possible repositories of esoteric knowledge in two ways. In the first place their shapes and dimensions could incorporate systematic geometry and the use of standardised length units and, in the second, the axis of each running through the doorway could be lined up on some astronomically significant point on the horizon. This could have had a practical function in that a specific Sun or Moon rising or setting could have been observed from inside the structure, and could have been observed fairly accurately if the axis pointed at a natural mark on the horizon. The second possibility is considered here first.

Barnhouse village. (HY/307127) Figure A.21 top and battom

Three structures are on display from the larger number which were exposed in the 1990s (ref.), and two of these are the first large, obviously ceremonial buildings which were discovered in Orkney. These two are approximately square, with rounded interior corners, a central stone fireplace and an entrance passage in the middle of one wall.

The largest building (photographs above).

The doorway faces just N of NW, at 333° MN; the opposite direction was measured at 153° NM. The True North equivalent is 328.5° (and 148.5°). The altitude of the relatively low and level horizon here is + 0° 35', and the building appears to line up a little too far north for the midsummer sunset. Grid ref. of doorway – HY/30760 12694.



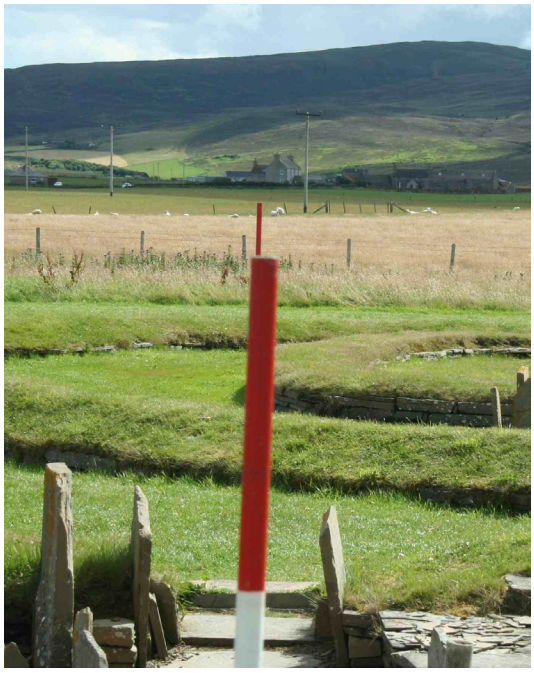


Figure A.22 (top and right). The second largest building in the Barnhouse village with the alignment of its entrance passage defined. There is no natural foresight on the horizon but maybe some kind of shadow was arranged to have been cast on to the opposite wall inside the building, which marked the SE sunrise satisfactorily.

This is similar to the above but slightly smaller. Its doorway is orientated in the opposite direction – towards the SE on 144° MN (the opposite direction was measured at 323° MN); the True North equivalent is 139.5° (and 318.5°). The altitude of the indicated horizon is somewhat higher at +3° 05'. This building may be lined up approximately on the midwinter sunrise. Grid ref. of doorway – HY/30757 12706.



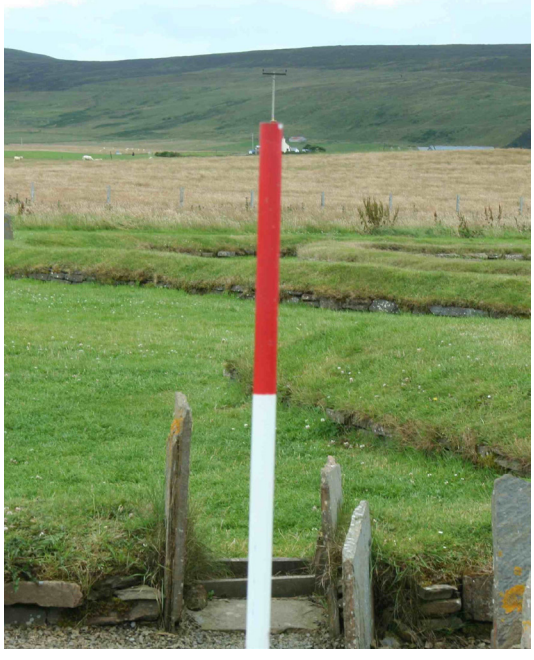


Figure A.23 (above and right). two views of the alignment of the entrance of the single exposed Skara Brae type buildings in Barnhouse. It is aligned slightly south of south-east, slightly south of the midwinter sunrise.

The smallest house at Barnhouse

Several dwellings of the standard Skara Brae type were found at Barnhouse but only one remains exposed. Its doorway is aligned towards the S of SE. The orientation of the entrance passage is at 158° MN (the opposite direction was measured at 338º MN); the True North equivalent is **153.5°** (and 333.5°). The altitude of the part of the shallow slope indicated by the axis is **+** 2° 50'. The line seems somewhat too far S for the midwinter sunrise. Grid ref. of doorway – HY/30756 12717. The horizon does not provide a clear foresight in line with the entrance but the interior of the house may have had marks on the wall which substituted it.

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