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The Lismullin Enclosure: Design Beyond the Obvious in the Iron Age

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Encounters between Peoples

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Cover illustrations

Main image
Leamanagh Castle, Co. Clare: a 17th-century manor house built against a late medieval tower-house (James Lyttleton).

Small panel, left
An Early Neolithic house at Dunsinane, Co. Wexford, excavated on the M11 Gorey to Enniscorthy motorway (AirShots Ltd).

Small panel, centre
Extract from Thomas Raven's 1622 pictorial map of a manor house and village at Movanagher, Co. Derry (Trustees of Lambeth Palace Library, MS 634, ff 85v–86).

Small panel, right
Elevated view of an early medieval enclosure at Camlin 3, Co. Tipperary, on the M7 Castletown to Nenagh motorway (AirShots Ltd).

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2. The Lismullin enclosure: design beyond the obvious in the Iron Age

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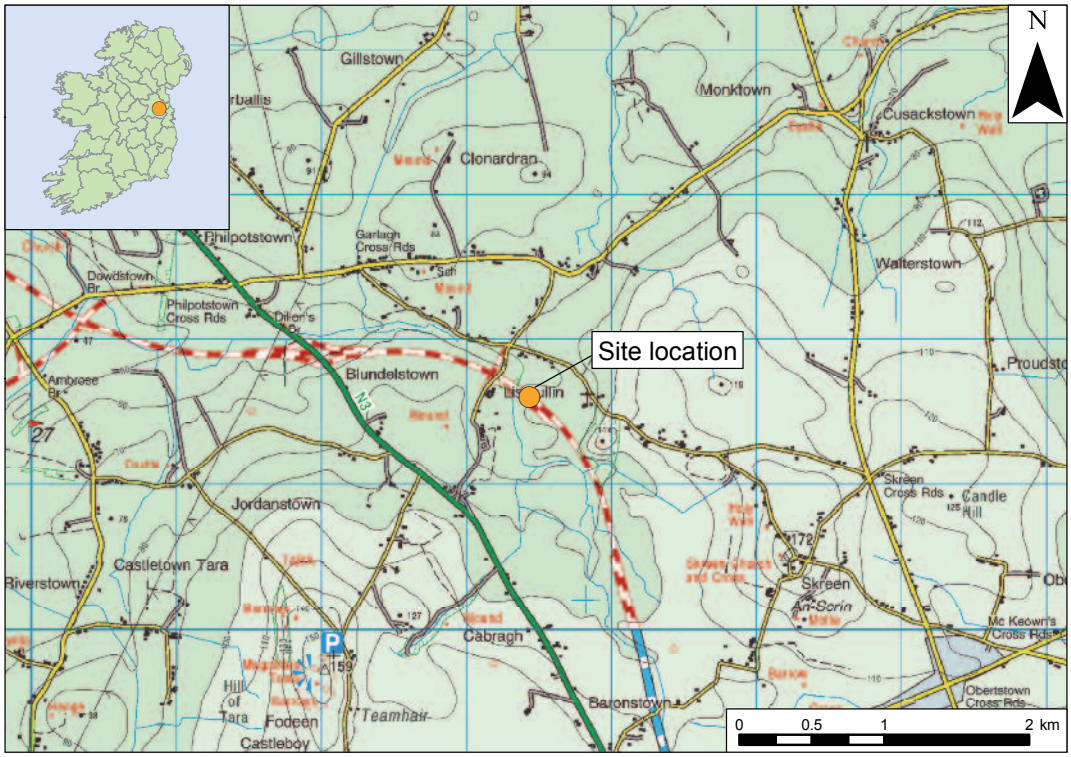
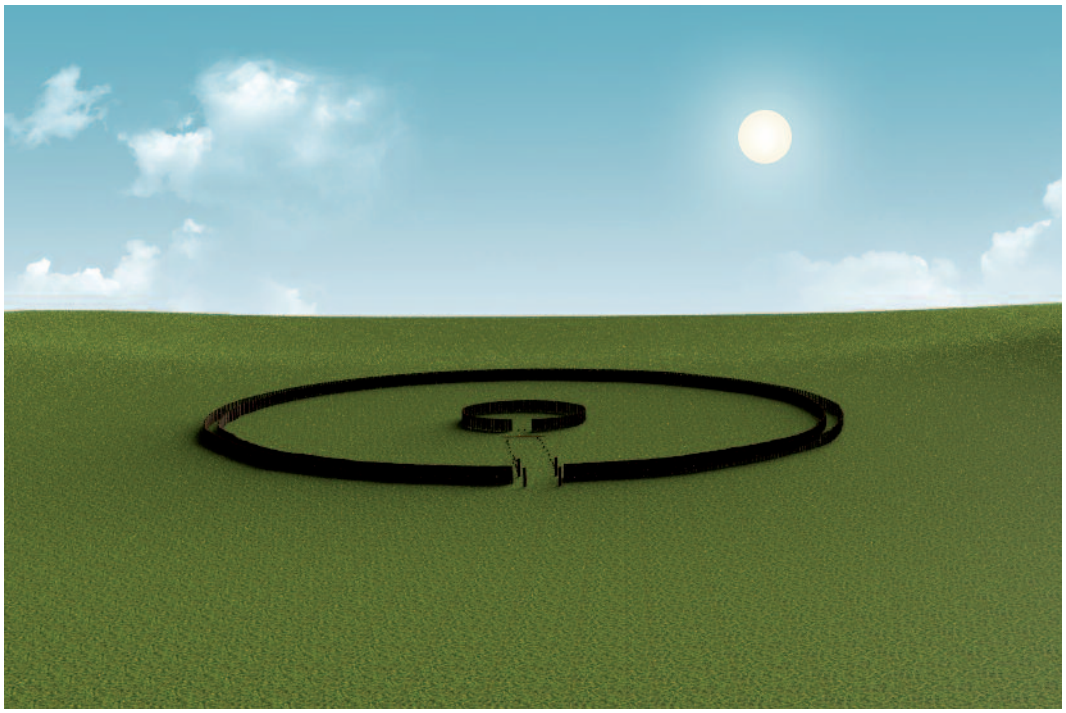


Illus. 1—Location of Lismullin 1, Co. Meath (based on the Ordnance Survey Ireland Discovery Series map).

When a post enclosure was discovered in the townland of Lismullin, Co. Meath, during the development of the M3 motorway, it was immediately evident to the excavation archaeologists that this was a site of major importance (Illus. 1–3) (O'Connell 2007a; 2007b; 2009a). The enclosure complex, which was radiocarbon-dated to the Early Iron Age, was constructed from a large number of small wooden posts set out in the form of a three-ring structure, with an easterly-facing avenue. The entrance to the avenue was accentuated by a four-post structure. The rings were concentric and delineated an inner enclosure, c. 16 m in diameter, defined by closely spaced post-holes, and a double-ring outer enclosure, c. 80 m in diameter. The structure was situated within a natural depression overlooked on all sides by a low ridge. To the west of the site, the ground falls sharply to the nearby River Gabhra, which flows northwards through the Gabhra Valley between the Hill of Tara and the Hill of Skryne. Archaeological excavations and dating of finds suggest a multiperiod but episodic use of the entire site, conceivably beginning in the Early Mesolithic period (c. 8000–5500 BC) (O'Connell 2009a, 25–6). Human activity is more certain from the Neolithic to the early medieval period, and the discovery of a Late Bronze Age structure south-west of the inner enclosure demonstrates the enduring importance and a continuity of use of this location in prehistory.

Illus. 2—Elevated view of the Lismullin post enclosure from the south-east, showing the extent of the outer enclosure (John Sunderland).

Illus. 3—Elevated view of the inner enclosure at Lismullin from the north-west (John Sunderland).



Illus. 4—Computer-generated reconstruction of the post enclosure at Lismullin, looking west. In this reconstruction it is assumed that the inner enclosure had an entrance and that the avenue posts were shorter than those of the various rings (courtesy of Aidan O'Connell, Archer Heritage Planning).

In terms of its scale and morphology, the enclosure complex exuded formality and symmetry (Illus. 4). The apparent simplicity embedded in its design belied an elegance of style. Overall, these qualities, the landscape setting and other archaeological evidence suggested a ceremonial and ritual function for the complex, consistent with the idea that large numbers of people would have gathered there periodically during the Iron Age. Such an interpretation is in harmony with the organised nature of ritual behaviour engaged in by people everywhere, now or in the prehistoric past. The date ranges obtained for the enclosures' built elements point to a highly developed but comparatively short-lived usage during the Iron Age. Bayesian statistical modelling of 15 radiocarbon-dated samples obtained from different contexts within the site (Marshall et al., forthcoming) suggests a commencement date of 455–400 BC (65% probability) and a terminal date of 370–330 BC (38% probability).

Ceremonial gathering is one expression of ritual and of ritual behaviour. It can act as the cultural/social driver for 'encounters between peoples'—the theme of this monograph and of this paper. Moreover, the site's discovery has yielded new insights into a period of Irish prehistory widely regarded by archaeologists as enigmatic, owing to the comparatively minimal quantity of recorded material remains. For these reasons, a brief description of the Iron Age is warranted here to provide cultural and chronological contexts for the archaeological findings, and for the outcomes and interpretation of the geospatial data analysis undertaken by the writer.

The enigmatic Irish Iron Age

Sequentially, the Iron Age lies between the Bronze Age and the early medieval period and has three recognised phases—the Early Iron Age from 700 BC to 400 BC, the Developed Iron Age from 400 BC to AD 1, and the Late Iron Age from AD 1 to AD 400 (Becker 2009, 354). While the chronology of the period is now better understood and defined, traces of its people and their material culture are curiously scarce in comparison to the more extensive evidence available for the preceding Neolithic period and Bronze Age (c. 4000–700 BC). Both Becker (ibid.) and Raftery (1994, 112) thus allude to the relative 'invisibility' of the period in terms of the settlement and material records. This relative invisibility continues despite the explosion in the number of sites excavated during the recent era of major roads infrastructural development (e.g. McLaughlin & Conran 2008; Taylor 2008). The majority of these discoveries were made after the publication of Raftery's seminal works on this period during the 1990s.

Analysis of the almost 1,000 sites currently on the web-based NRA Archaeological Database indicates that 8% have yielded Iron Age dates (McCarthy 2010) and these have improved the period's 'visibility'. Yet, despite these recent development-led discoveries, and as argued by Raftery (1994) and Becker (2009, 353), two central problems remain in relation to the study of the Iron Age in Ireland. These are the lack of material finds associated with domestic life and the comparative lack of a settlement record. Where detected, relevant finds are mostly 'high-status artefacts' such as decorated horse gear, weaponry, gold ornaments and ceremonial items, as well as tools and other metal objects. Furthermore, Raftery suggested that such gaps in the record were due more to our inability to find them than to their lack of existence. Accordingly, Taylor's (2008, 54) commentary on any evidence of life in Ireland in the Iron Age as being 'notoriously difficult to identify', and on the discovery of two Iron Age sites in County Tipperary as being 'especially exciting', is relevant.

The Lismullin 1 post enclosure was, in the context of this discussion, a discovery of a very different kind. Apart from its significance as a new Iron Age site, it was, in this author's opinion, the sheer quantity and quality of the excavated post-hole data that would ultimately propel this particular find to the forefront of importance amongst recent Irish archaeological discoveries and enable new light to be shed on the 'invisible people' of that period. Moreover, the uniqueness of the site is best emphasised by drawing brief comparisons with the five Irish hilltop Late Bronze Age/Iron Age royal sites. At each (Dún Áilinne, Navan Fort, Rathcroghan, Tara and Cashel) extant archaeological monuments and complexes have been identified (e.g. Newman 1998), and some have structural parallels with Lismullin 1. At Dún Áilinne, Co. Kildare, for example, the closely spaced timber enclosures belonging to the second phase have a funnel-shaped easterly-facing timber avenue. At Navan Fort, Co. Armagh, similarities with Lismullin 1 occur in the circular timber structures and the east-facing entrance. At Rathcroghan, Co. Roscommon, the circular enclosures and the probable entrance on the eastern side of the mound reinforce the link. At Tara, Co. Meath, the palisaded enclosures of the Rath of the Synods also allow for comparison with Lismullin 1 in a design sense.

Studies of timber circle sites in Britain and Europe have previously considered the issue of orientation (e.g. Gibson 2005, 87–9, 99) within broader archaeological attempts to 'interpret architectural alignments upon astronomical phenomena in relation to wider

questions of cognition and world view' (Ruggles 1998, 203). On a cautionary note, any attempt to interpret a monument's orientation based upon a single example of the type is potentially very risky, with many cultural or other factors to be considered (Prendergast 2011). In consequence, the astronomical hypothesis investigated here (see below) may just be one of many equally valid alternatives (including a random orientation) that could explain the avenue's alignment.

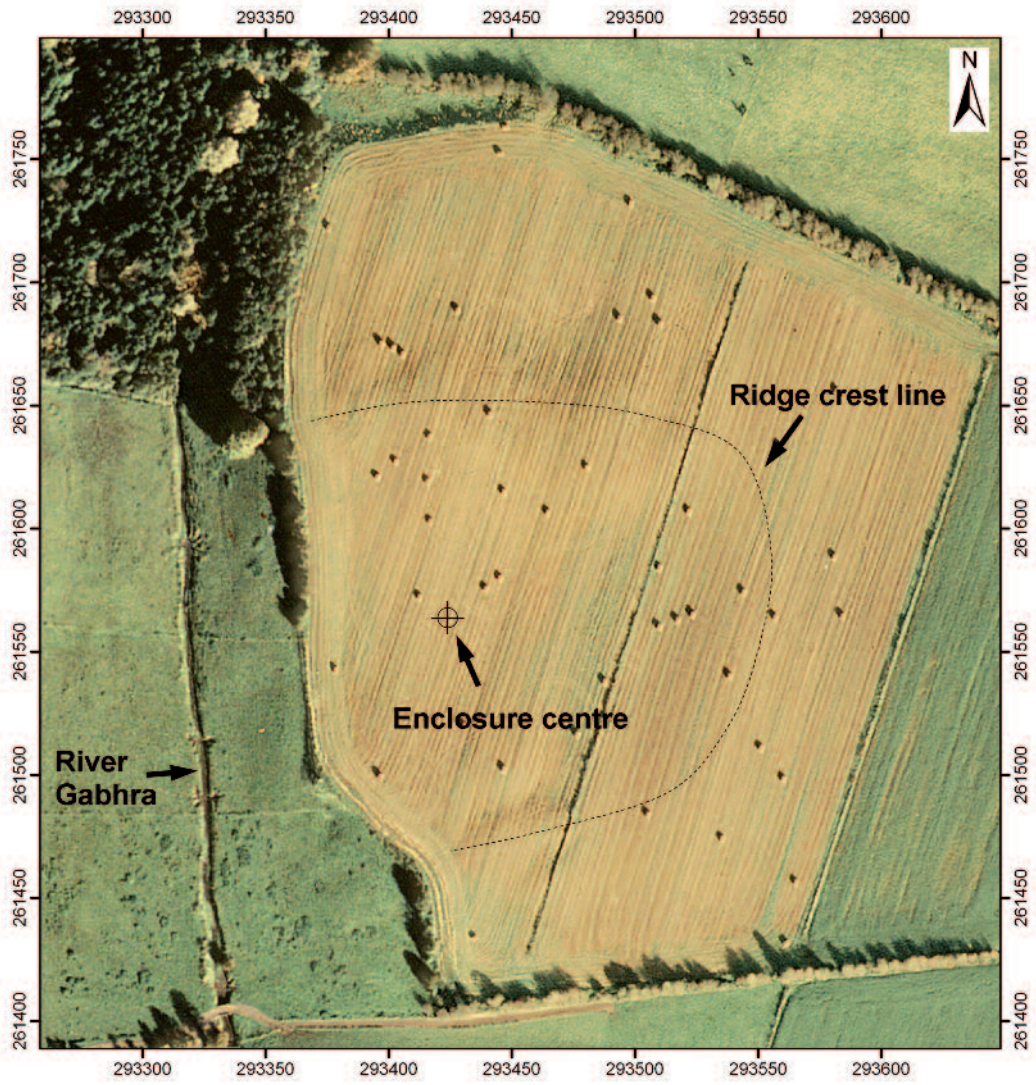
More broadly, previous analyses and consideration of the structural design and function of timber circles have been either graphical (e.g. Waterman 1997, 159–71) or theoretical (e.g. Fleming 1972). Importantly, the completeness and quality of the Lismullin 1 data set as recorded by the excavation archaeologists have provided a unique opportunity for the writer to undertake a more rigorous and holistic consideration of the monument and its likely function.

Site description

The Lismullin 1 post enclosure[1] was discovered in 2007 during archaeological investigations in advance of construction of the Dunshaughlin–Navan section of the M3 motorway. Although O'Connell (2007a; 2007b; 2009a; 2009b) has provided comprehensive descriptions of that excavation, and of the various post-excavation analyses undertaken by specialists (O'Connell 2009c), a selective summary of the relevant design features of this very rare type of enclosure complex is first given here. Two attributes can explain such rarity. First, the architecture replicates a style of construction more prevalent in the Late Neolithic period (c. 2850–2450 BC). Second, the landscape setting is in marked contrast to the prominent hilltop aspect of the Iron Age royal sites with which it has previously been compared. The structure is therefore interpreted by O'Connell as a 'post enclosure', so as to differentiate it from such Iron Age sites and from timber circles and henges, which predominantly date from the Late Neolithic period.

From a landscape setting perspective, the post enclosure sat above the adjacent River Gabhra in a shallow depression surrounded and overlooked by a natural ridge (Illus. 5). To the west, the terrain falls steeply from the ridge to the river. Furthermore, the enclosure is c. 83 m lower than the summit of the Hill of Tara to the south-west, and c. 43 m below the Hill of Skryne to the east. The immediate landscape surrounding Lismullin 1 trends north-west–south-east and indents into the northern end of the Skryne Hill land mass. The diameter of the ridge would probably have limited, and thus dictated, the overall scale of the built structure within (the mean diameter of the outer ring of the outer enclosure was 80.5 m). Viewed from the overlooking ridge, the enclosure would have seemed discreet, whereas Iron Age royal sites were invariably situated on prominent hilltops for maximum visibility from afar. The deliberately discreet setting of the Lismullin enclosure guaranteed relative invisibility and was perhaps intended to delay the visual impact of the site until the moment of arrival. It is also likely that such a setting, and its scale, would have easily facilitated the intimate gathering of a large number of people assembled around, or within, the post enclosure (if, indeed, it was used in this fashion). Crowd capacity analysis to support

[1] NGR 293423, 261564; height 77 m OD; Excavation Reg. No. E3074; Ministerial Direction Nos A008 and A042; Excavation Director Aidan O'Connell; RMP No. ME032-062.



Illus. 5—Modern landscape setting of Lismullin 1 prior to the archaeological excavation and the construction of the M3 motorway (base aerial image courtesy of Survey Mapping Consultants Ltd, with additions by the writer).

this view has already been undertaken (Prendergast, forthcoming).

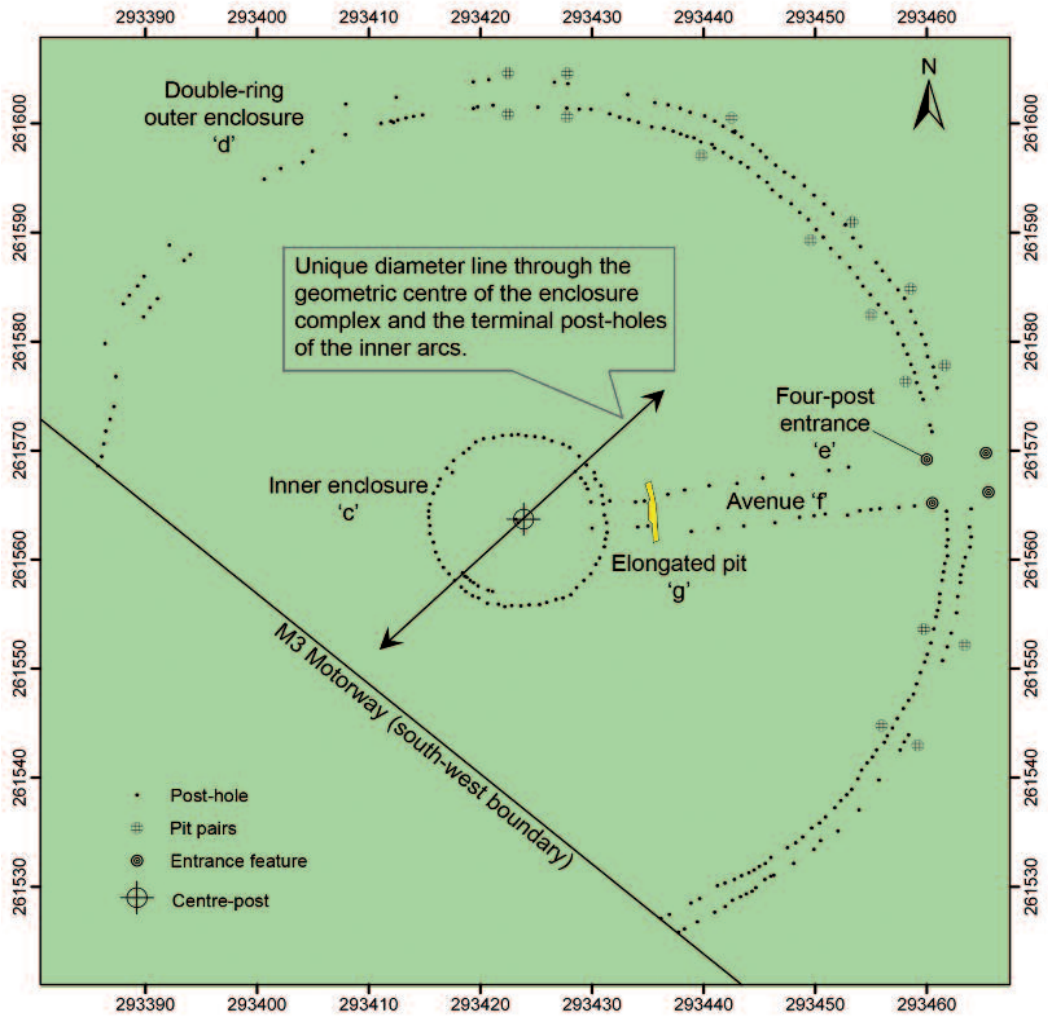
Although some of the view from the site is now restricted by modern tree cover (which may have been heavier in prehistory), it is possible and probable (depending on the location of the viewer) that the adjacent royal site on the Hill of Tara, 2.3 km to the south-west, would have been intervisible with the post enclosure in the Iron Age. The proximity of the nearby River Gabhra, which flows south–north on the western side of the ridge surrounding the post enclosure, may also have held ritual significance in the context of how the complex was used, and perhaps acted as a factor in the selection of the site.

Structural elements of the enclosure

The principal archaeological features as identified by O'Connell in the excavation zone consist of the following elements:

a. central post-hole;
b. two inner arcs of post-holes;
c. inner enclosure post-holes (radius = 8 m);
d. outer enclosure (double ring of post-holes with outer radius = 40.3 m);
e. four-post entrance feature to the avenue;
f. avenue post-holes;
g. elongated pit;
h. eight pit-pairs.

These are shown in Illus. 6, but the pit-pairs are now discounted by the excavation director as a coherent structural group. In the elongated pit, which was set transversely and symmetrically to the avenue, quantities of charcoal, burnt animal bone and burnt hazelnut shells were found. Charcoal deposits obtained from two post-pipes on the southern side of the outer enclosure have yielded radiocarbon dates of 520–380 BC and 490–370 BC, thus placing the complex in the Early–Developed Iron Age (Becker 2009, 354; see Appendix 5 in O'Connell 2009c for full details). Additionally, archaeological assessment of the dispersed



Illus. 6—Elements of the Lismullin 1 post enclosure (Frank Prendergast).

Illus. 7—Inner arc of posts at a Stoney Indian Sun Dance Lodge in Sibbald, Alberta, Canada, with willow sails woven in between them. The wattling at the Lismullin post enclosure may have been similar in appearance (Michael Stanley).

assemblage of pottery sherds recovered at Lismullin 1 (Grogan & Roche 2009) and the radiocarbon-dating programme undertaken by Marshall (2009) show that the site experienced prolonged and episodic use throughout prehistory.

Environmental assessment carried out at Lismullin 1 indicates the presence of significant quantities of hazel, which could reflect the use of wattles woven between the (probably ash) posts of the enclosure (Illus. 7) (Archaeological Services Durham University 2009, 23). The discovery of Maloideae (apple-type wood) further suggests that flower- or fruit-bearing branches may have been used to decorate the structure, possibly for their aesthetic effect. Because of the likely natural processes of weathering and decay, posts and wattles would probably have required regular replacement. The four entrance post-holes had a larger diameter than those forming the enclosure rings and the avenue. This is in keeping with the emphasised formality encountered in the entrances of other timber circles in Ireland and throughout the rest of Europe (e.g. Gibson & Simpson 1998; Gibson 2005).

Excavation of the site involved the thorough recording and the removal by hand of all archaeological layers across the majority of the enclosure within the road corridor. Based on the pattern of extant post-holes, a significant proportion of the outer enclosure (c. 19% of the total area of the post enclosure) may remain *in situ* outside the boundary of the M3 corridor on its south-western side (see Illus. 6). Although it is possible that the inner enclosure could have supported a roof, the current interpretation is that this component of the enclosure was unroofed and therefore open to the sky. Furthermore, owing to the lack of any evidence for either habitation or burial at the site, the prevailing opinion is that the complex had a probable ceremonial/ritual function and was primarily built to facilitate the gathering of people and their ceremonies.

Research questions

The likely methodology used originally to set out and construct the circular elements of the enclosure as shown in Illus. 4 and 6 would have required nothing more than a taut rope rotated around a centrally placed peg. Intentionally regular spacing between the post-holes (pitch), or their alignment as in the avenue, would also have been a simple task. Interestingly, Atkinson (1961) provides support for this view in his discussion of the engineering and building skills of Neolithic people in Britain.

During the excavation of Lismullin 1, the planimetric coordinates of each extant post-hole were recorded with centimetre accuracy using standard high-precision surveying techniques. Consequently, it can be assumed that the archaeological record is effectively error-free—at least for the purpose of investigating the retrospective construction methods (and intentions) of the builders of the Lismullin post enclosure. Although gaps and irregular spacing are apparent in the data set (see Illus. 6), the significantly large number of post-holes (>350) identified by the archaeologists were sufficient to allow meaningful quantitative analysis and qualitative assessment by the writer. Accordingly, three primary research themes were pursued.

Site morphology
Was the apparent regularity and symmetry of the complex, evident to the eye of the beholder, achieved through the use of a central peg? Were the circular elements (enclosures) concentric and to what degree? What method was used to align the post-holes in the avenue? Was the location of the elongated pit significant in terms of any ceremonial role for the complex?

Site metrology
If symmetry and proportionality were embedded in the data, was there evidence of the use of a unit of measurement at the site, and could this account for the apparent regularity of the design? Any such discovery would have significant implications in terms of providing insights into cognitive and social behaviour and group organisation in the Iron Age. Importantly, the existence of high-status monuments in the Iron Age (as previously described) and the extensive surviving corpus of prestige items of high-quality metalwork, and La Tène-style art (e.g. see Raftery 1994), are indicative of an already sophisticated culture in Ireland at this time.

Site archaeoastronomy
Was the avenue, or any other structurally aligned part of the post enclosure, orientated towards a seasonally prominent astronomical body? If detected, how might such data yield new knowledge about the ritual behaviour and cosmology of the people who frequented Lismullin?

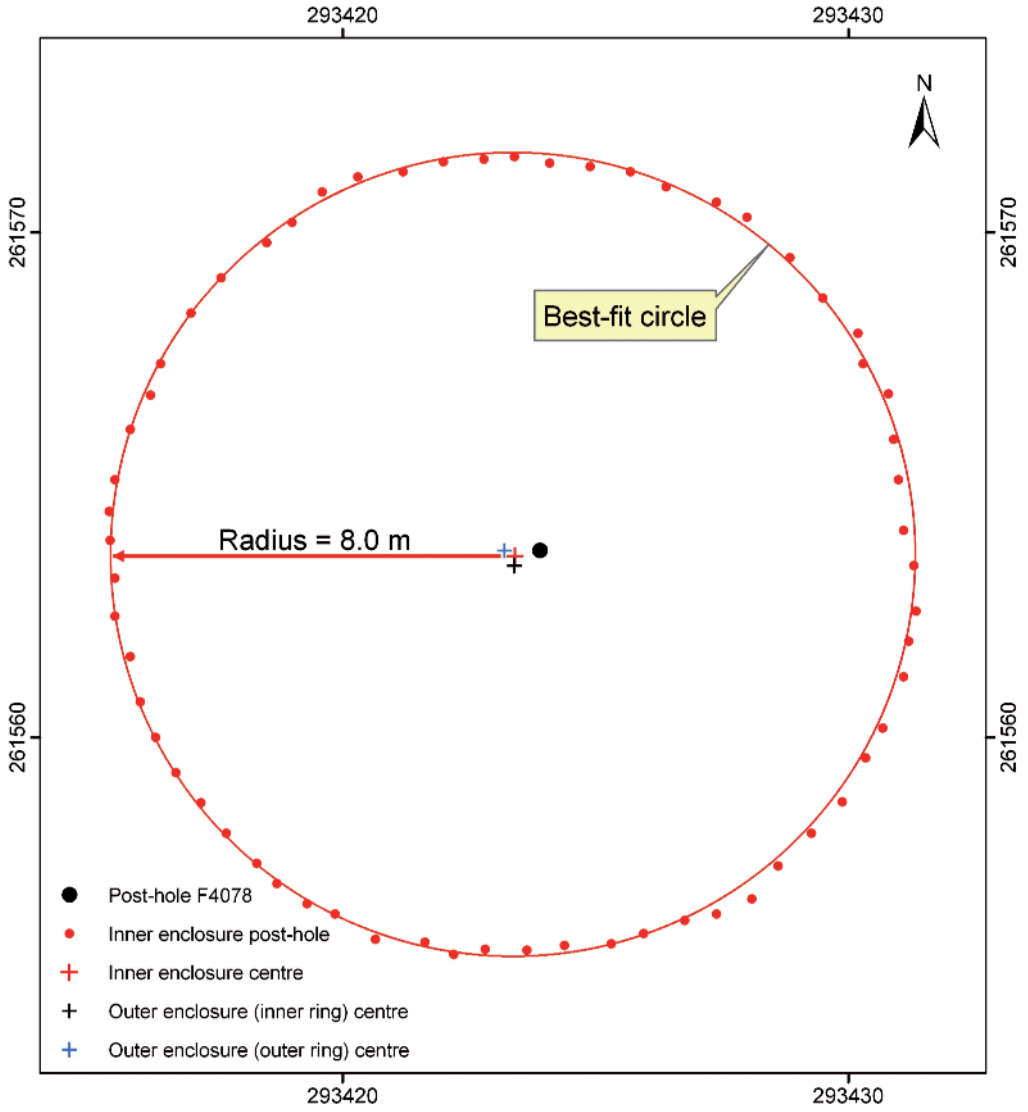
Results

Within the limitations of this paper, only a selective account of the broader research methodologies and their outcomes can be given here. A more detailed report is presented

elsewhere (Prendergast, forthcoming). From that, and in relation to the three research themes outlined previously, a summary of the major findings is provided below.

Morphology—regularity and proportionality in the complex?

The geometric centre of each of the three enclosures was mathematically determined using the method of least squares. (This method determines a unique mathematical model of the data such that the sum of the squares of the errors, or deviations/residuals, of the data from the best-fit model are at a minimum. Thus, statistically, the determined model is likely to be the most probable model.) This approach also yielded the length of each radius, as well as the residual errors between each post-hole and their respective best-fit circle. (The residual error is the estimated error derived from a comparison between an actual observation or measurement and the arithmetic mean value.) An example of this is presented in Illus. 8, which shows the derived geometric centres of the three rings, the location of a nearby post-



Illus. 8—Morphological analysis of the three enclosures. Note: only the post-holes of the inner enclosure are shown (Frank Prendergast).

hole (F4078) and the radius of the inner enclosure as determined from the post-hole data. Because of the very tight clustering of the three geometrically derived circle centres, there is convincing numerical and statistical evidence that each had a common centre. This argument allows for the effect of small undulations in the local terrain, its effect on the original construction method and, in turn, the reliability of the mathematical derivation of the centres from the post-hole data. Furthermore, and because of the close proximity (c. 0.6 m) of F4078 to those centres, it is argued that this post-hole was the probable ceremonial centre-point of the post enclosure and was likely erected after the construction of the enclosures. In terms of a date sequence for the construction of the monument, the archaeological evidence (see Marshall 2009; Marshall et al., forthcoming) suggests a multiphase development for the complex. In other words, not all of the rings may have been laid out as a single act of construction. When the design is viewed and appraised in its totality, however, the argument for an initial single phase of construction followed by recurring and/or cyclical replacement/refurbishment of the elements or their components may be equally valid.

In the outer enclosure, there was evidence that post-holes in the outer ring were evenly spaced at a mean interval of 1.05 m, while post-holes in the inner ring were systematically but more closely spaced at a mean interval of 0.93 m. The mean pitch between post-holes in the inner enclosure was 0.82 m. This suggests, using a one-way analysis of variance test (a statistical method that simultaneously compares the equality of three or more means by using their variances), that a radial method of construction was probably used to set these out, and from a common centre-point. In other words, both rings of the outer enclosure were laid out in a single sweep of the rope and thus were built together. Inspection of the data on the north-western and south-eastern sides (see Illus. 6) could suggest that the missing post-sockets there reflect instances where posts had decayed or fallen and were not replaced. Any such conclusion, however, is entirely reliant on the extant archaeological evidence, which is comparatively weaker in both of those sectors of the post enclosure.

Linear regression analysis of the avenue post-hole data did yield very strong evidence that both sides were intentionally laid out as straight lines. (Linear regression analysis is a technique used to fit a straight line model to an actual set of data points, usually given as numerical coordinates.) Here, the correlation coefficient determined for each side of the avenue was $R^2 = 0.99$ and 0.98 respectively (1 indicates a perfect fit to a straight line). (A correlation coefficient is a measure of the strength of the linear relationship between a straight line and an actual set of data points, or the linear relationship between two variables x and y.) By calculating and analysing the distances between post-holes across the width of the avenue, both avenue sides (between the entrance and the elongated pit) were found to be parallel to within one fifth of a degree (0°.2). This clearly demonstrates the simple but careful use of a standard width to construct the longer outer section of the avenue with parallel sides (see Illus. 6).

Metrology—use of a unit of measurement to construct the complex?

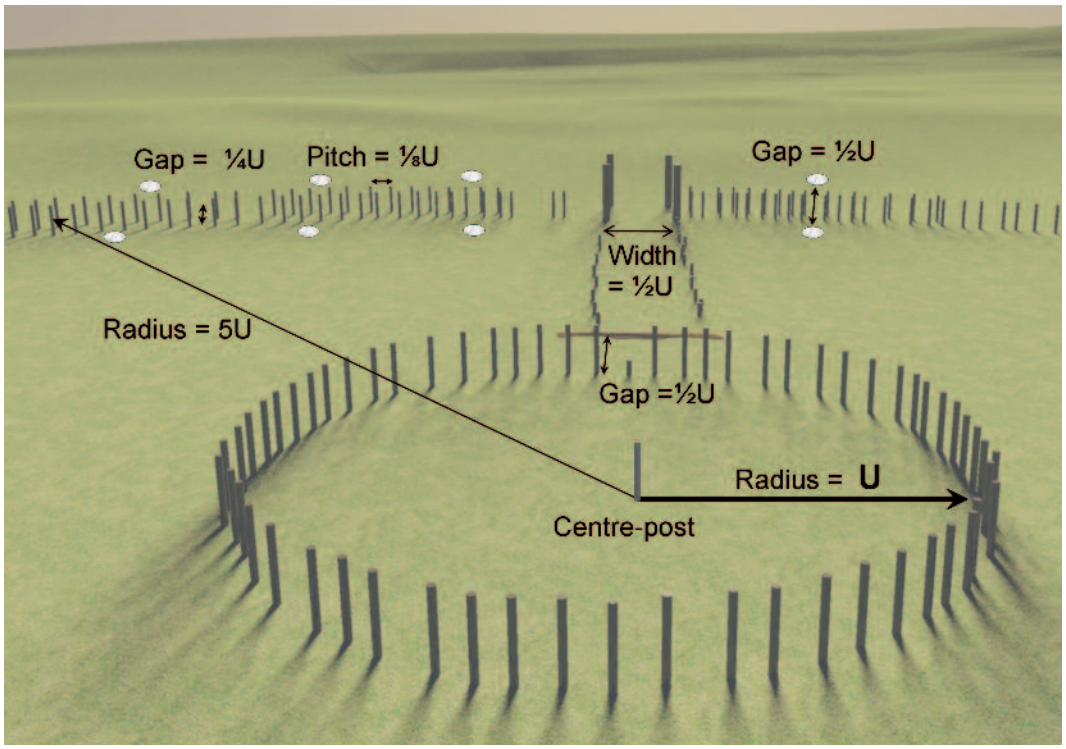
The dimensions of the principal elements of the enclosure were numerically determined from the available post-hole coordinates. Once derived, these were scaled to the radius of the inner enclosure for comparative analysis and statistical testing using the analysis of variance method (see one-way analysis of variance, above). From that work, the radius of the inner enclosure is argued to be the most likely candidate for a standard unit of

measurement used to construct the entire enclosure complex. Using the length of any other element as a standard is less simple and would incur a greater degree of measurement difficulty and construction error. The results are shown in Table 1 and Illus. 9.

Table 1—Dimensions of the enclosure elements.

Element	**Mean length (m)**	**Length scaled to U**		**Remarks**
Radius of the inner enclosure (U)	7.97	-	-	Unit of measure (U)
Width of avenue and entrance	3.96	0.49	x ½	Half of U
Outer enclosure radius	40.25	5.05	x 5	Five of U
Gaps between rings in outer enclosure	1.95	0.25	x ¼	Quarter of U
Gap between internal arcs and inner enclosure	1.02	0.13	x ⅛	Eighth of U
Gap between pit pairs	3.99	0.50	x ½	Half of U
Pitch between posts in the outer enclosure	1.04	0.13	x ⅛	Eighth of U
Gap between inner enclosure and west side of elongated pit	4.05	0.51	x ½	Half of U

The argument that a unit of measurement was used to provide dimensional control for the construction phase(s) of the post enclosure was statistically tested using the data summarised in Table 1. For this, the radius of the inner enclosure was first used (as the standard numerator) in the calculation of ratios (columns 3 and 4 in Table 1). These ratios were then used to scale (make equivalent) the lengths of each element so that their mean values could be compared. The results of that comparative test provide very strong statistical evidence that a unit of measurement was used, and that this was likely to have been based on the radius of the inner enclosure. Simply stated, these findings convincingly indicate (Prendergast, forthcoming) that the radius of the inner enclosure was successively halved so as to control dimensionally the construction of the complex, with the exception of the outermost ring. That could have been constructed with a rope length equal to five times that of the inner radius.

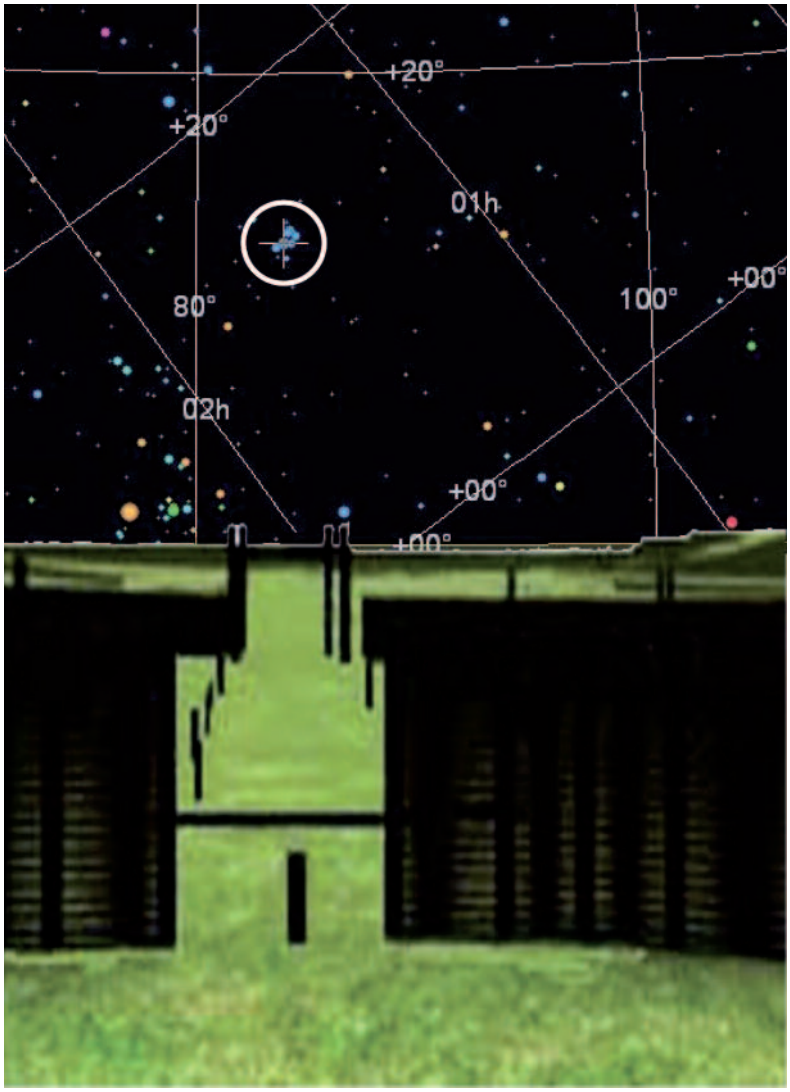


Illus. 9—Hypothetical construction method for Lismullin 1, in which U is the equivalent of the radius of the inner enclosure (base image courtesy of Archaeological Consultancy Services Ltd, with additions by the writer).

Archaeoastronomy—evidence of culturally relevant alignments?

For this analysis, the complex was first examined for any structures possessing obvious axial or structural linearity with an alignment potential. Only two such candidates were found. The first was a unique line within the inner enclosure defined by the diameter passing through the central post-hole (F4078) and the terminal post-holes of the two short inner arcs of post-holes—if, indeed, they were arcs (see Illus. 6). Archaeological uncertainty remains as to the function of these two elements, including the possibility that they may be the remains of an additional ring. Either way, the astronomical analysis (not shown here) yielded astronomical declinations for the two possible directions of this diameter line of +24°.9 in the north-east, and –23°.4 in the south-west. (Astronomical declination is the angle of altitude of any celestial body measured above (+) or below (–) the plane of the earth's equator. Currently, the declination for the sun ranges from +23° 26' (summer solstice) to –23° 26' (winter solstice), and is 0° at the true equinoxes.) Each alignment (derived from azimuth/true bearing and horizon altitude) is indicative of sunrise at the summer solstice and sunset at the winter solstice on the local horizon respectively. As such, this could suggest a ritual use of the complex focused around these periods of the year.

Analysis of the easterly axial orientation of the avenue proved to be more interesting. That yielded a declination of +4°.8, indicating that the avenue was not aligned on the rising sun at the equinoxes (at the equinoxes, the declination would be around 0°). Instead, the obtained value coincides with sunrise around 1 April and 10 September in the modern Gregorian calendar. Alternatively, in that sector of the night sky during the Iron Age, the only significant and recurring event that might have attracted interest may have been the



Illus. 10—Avenue alignment on the Iron Age night sky and the transit of the Pleiades star cluster. This computer-generated view of the avenue is blended with a sky view modelled for c. 500 BC using CyberSkyTM 4.0.2 and assumes that the inner enclosure had an entrance (Frank Prendergast).

transit of the Pleiades star cluster. This very obvious star grouping would have risen to the north (left) of the avenue alignment. Soon afterwards, it would have crossed the avenue at an altitude of about 12°, taking about 20 minutes to do so (Illus. 10). The analysis included a correction for the effect of precession of the earth's axis—the motion of the earth's pole of rotation. To an observer on the earth, this translates into a long-term (c. 26,000 years) cyclical movement of the celestial pole against the star background. In the intervening 2,500 years since the Iron Age, the effect is to cause the apparent positions of the stars to significantly change on the celestial sphere (sky), and with respect to the mean pole.

The Pleiades is a visually distinctive grouping of stars also known as the 'Seven Sisters'; it is not a constellation (star patterns named after mythological creatures and gods by the ancient Greeks). In the mythology of ancient Greece, the seven sisters (Alcyone, Electra, Maia, Merope, Taygeta, Celaeno and Asterope) were the daughters of the god Atlas and his wife Pleione. All seven stars thus complete the visible cluster, although typically only six are easily seen (this depends on the state of the atmosphere, and the acuity and elevation of the observer). There is extensive evidence to suggest the importance of the cluster in

mythological and calendrical terms to indigenous and prehistoric cultures (e.g. the supposed depiction of the Pleiades on the Bronze Age Nebra Sky Disc from Germany; see Pasztor & Roslund 2007, 269–70).

If the date of 10 September (coinciding with sunrise in the avenue) is taken as a hypothetical indicator of the time of year when sky-watching of the transit of the Pleiades over the avenue began, its appearance would have been noticeable in the eastern sky above the avenue at about 21:00 around that date. The phenomenon would have been repeated nightly, but its timing would have occurred about four minutes earlier on each successive evening (almost two hours over a month) owing to the gradual and cumulative divergence between apparent solar time (the period of time during which the earth makes a revolution on its axis relative to the sun: 24 hours) and sidereal time (the period of time during which the earth makes one complete revolution on its axis relative to a particular star: 23 hours 56 minutes). As a consequence, any observed star will appear to rise c. 4 minutes earlier each night. On that basis, the phenomenon would not have been visible after the end of October owing to the transit event becoming less visible in a brighter sky. Interestingly, the interval in question (September–October) would have demarcated a period of the year following the annual harvest and before the onset of winter—a time for gathering and ceremony, perhaps.

Encounters between people: assembly and ritual

For this writer, the obvious, and now proven, formality of the whole complex suggests a range of interpretive possibilities. An exploration of these might then help to address the important questions of why the complex was built in that manner and what the visitor experience was like. The most obvious attributes are enclosure and segregation, axis and procession, focal point, threshold, hierarchy and sacred space. These are logically ordered in terms of how the complex and its participants may have performed and engaged in any coordinated role or ceremony. Potentially, these qualities are the basic but connected elements of ritual behaviour and practice as well as a cosmology.

At Lismullin, enclosure is taken to mean the containment and segregation of people—either within or outside the two principal circular spaces. Like those who may have assembled on the surrounding ridge, they would have been excluded from yet psychologically drawn to whatever religious or commemorative ceremonies may have taken place at the site. The linearity and symmetry of the avenue is an obvious design metaphor for the axis of the site. This was the path or aisle that led towards the elongated pit and the inner enclosure beyond, and would have allowed up to four people walking abreast to process from the entrance. While speculative, such a scene conveys a deep sense of formality, hierarchy and ritual. The elongated pit, in which the deposition of burnt offerings is thought to have taken place, may have acted as a potential inhibitor to further progression and was, conceivably, a threshold as well as being depositional in purpose. In all designed spaces, a threshold holds deep significance. At Lismullin 1, it is argued that this carefully positioned element was the focal point of the whole complex and the crossover point/barrier between the public space and the inner restricted space. Thus, perhaps, it served to separate the sacred from the secular and the celebrant(s) from the laity. At the centre of the complex lay the probable sacred space where, conceivably, an individual or a group periodically conducted ceremonies and rituals of a celebratory or cosmological nature. This argument is supported by the possible solstitial axis (or alignment

feature) found within the inner enclosure and/or, more convincingly, by the alignment of the avenue and its potential link with the nightly autumnal passage of the Pleiades.

Conclusions

The record of use of the complex is now lost to us and any attempt at interpretation must be regarded as speculative. Nevertheless, it has been demonstrated that the application of rigorous numerical analysis techniques to high-quality archaeological data can yield a rich dividend. That dividend is measured in terms of the new insights provided here on how the Lismullin enclosure was built, probably aligned and possibly used. Arguably, this adds another 'excavation layer' to the archaeology of the site in the form of new quantitative and interpretative knowledge, and ideas, for further scholarly exploration and debate.

The wider study of ritual and cosmology, and their relationships with formally built structures and temples belonging to the prehistoric past, has received extensive treatment in the literature (e.g. Doxiadis 1972; Aveni & Romano 1994; Waldren et al. 1995; Bell 1997; Krupp 1997; Manley 2000; Bradley 2005; Boutsikas & Ruggles 2011; Insoll 2011). In Ireland, some structural similarities to Lismullin 1 can be found at Iron Age royal sites, as previously discussed. Of those, the commanding site at Dún Áilinne is the most intriguing. It lies 85 km to the SSW on the summit of Knockaulin Hill. That complex had a 25-m-diameter central circle of timber posts, radially set pits and extensive evidence of burning and feasting (Raftery 1994, 73; Crabtree 2002; Johnston & Wailes 2007; Johnston et al. 2010). Feasting may also have occurred at Lismullin 1, but on a much smaller scale. This is suggested by the charcoal, burnt animal bone and burnt hazelnut shells found in the elongated pit. This could be interpreted as one form of ritual behaviour practised locally or regionally. Interestingly, Joy (2011, 405) refutes the idea of the existence of a single European Iron Age religion, proposing instead a model that allows for 'regional and temporal similarities' that were practised on a local scale and 'within systems of belief that were intimately bound up and connected with every aspect of everyday life'. The outcomes of the interdisciplinary study presented here are consistent with such a model. Overall, the structural formalism, exactness and other attributes of the Lismullin post enclosure arguably now elevate it to an even higher plane of importance for the period—nationally and in a wider European context.

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