Building tombs and entombing the dead as technologies of descent and affinity in Neolithic northern Scotland

Abstract

This article demonstrates the significance of incorporating aDNA into wider archaeological analyses to investigate Neolithic tombs in contiguous regions. The results demonstrate close genetic relatedness between individuals whose remains were placed in these tombs, providing unique evidence for sustained contact between communities in Caithness and Orkney beyond the onset of the Neolithic, shared understandings of kinship, including descent and a broader sense of affinity, and emerging local differences in how kinship was materialized. This approach is innovative and critical for understanding the spread and use of monumental architecture and interpretations of kinship in northern Europe more widely.

Introduction

Early Neolithic tombs are widespread across northern Scotland, including Caithness and Orkney. Many of those which have been excavated have produced assemblages of human remains. However, our understanding of these monuments, and the people buried within them, has been limited by sparse radiocarbon sequences and the fragmented and comingled nature of the human remains found within them. It has been hard to identify the number of individuals of each sex within these tombs, constraining our ability to draw inferences about key aspects of society such as gender and kinship. Now, the application of ancient DNA analysis in combination with osteological and archaeological contextual and architectural analysis affords the opportunity to radically improve our understanding of Neolithic social relationships, including gender dynamics and kinship (e.g. Carlin *et al*. 2025; Cummings and Fowler 2023; Fowler 2022; Fowler *et al*. 2022). This study presents analysis of 40 new aDNA samples from 22 individuals, seven of whom were previously identified by one sample each (Olalde *et al*. 2018). It presents an analysis of genetic relatedness among these individuals whose remains were placed in five chambered tombs in Caithness and Orkney, the first such analysis of multiple contemporary Neolithic sites spread across nearby islands. We are now aware that some Neolithic tombs in Europe contained the remains of close genetic relatives (e.g. Fowler *et al*. 2022; Seersholm *et al*. 2024), while others perhaps did not (Carlin *et al*. 2025), raising the question of how much the construction and use of tombs supported varied kinship practices. We address that question for five tombs with similar architectural features, including three with chambers subdivided by slabs (‘stalled

cairns'). Three tombs are in close proximity around Loch Calder (Tulloch of Assery A and B, and Tulach an t-Sionnaich), a fourth (Rattar East) is on the coast looking out over the Pentland Firth (Figure 1) towards Orkney where the fifth tomb in this study (Holm of Papa Westray North) was built (Figure 2).

The genetic analysis reported below reveals that Rattar East contained the remains of two brothers, while a father-son pair and a maternal uncle or half-brother to the father were found in the tomb at Holm of Papa Westray North. The remains of three males in a father-son-grandson genetic relationship were placed next to one another at Tulloch of Assery A, while a fourth male who was either an uncle, half-brother or a grandfather to the first of those men was entombed at Tulach an t-Sionnaich. A woman who was a third-degree relative of this latter male was entombed at the Holm of Papa Westray North, while another woman who was a fourth-degree relative of his was entombed at Tulloch of Assery B. Two of the women entombed at Holm of Papa Westray were fourth-degree or fourth-to-fifth degree genetic relatives of the man entombed at Tulach an t-Sionnaich and the male from Tulloch of Assery B, suggesting their genetic ancestry connected both of those males. Thus, these two women at Holm of Papa Westray North were genetically related within five degrees to males from groups who used the tombs at Loch Calder, while not being related to any of three closely-related males at Holm of Papa Westray North closer than the ~ sixth-to-seventh degree. In each case, these genetic relatives have been detected despite obtaining suitable DNA for analysis from only a subset of the minimum number of individuals identified through osteology.

Figure 1. The distribution of stalled cairns in Caithness, with the plans of sites included in this study. From left to right: Tulloch of Assery B, Tulloch of Assery A, Tulach an t'Sionnaich and Rattar East (after Davidson and Henshall 1991)

Figure 2. The distribution of stalled cairns in Orkney, with the plan of Holm of Papa Westray North (after Davidson and Henshall 1989)

Both the similarities in tomb architecture across the tombs and the biological relationships identified through aDNA demonstrate a web of connections among the entombed individuals, suggesting they were members of a small interwoven community sharing both architectural and mortuary practices. In this article we consider what inferences we can draw about kinship based on these results, and suggest that affinity with previous tomb-builders in the

region was signalled each time a new tomb was built - or modified - in the style of the existing tombs. We infer that attitudes towards tracing descent and affinity through these practices continued well into the latter part of the fourth millennium, but that local differences emerged between the positioning of tombs and selection of the dead for interment in Orkney compared with Caithness ahead of a major divergence in settlement and monumentality in the Late Neolithic.

Building tombs: interpreting form

The Early Neolithic of northern Scotland dates from c.3800 to 3200 cal BC and saw the first construction of chambered tombs in this area. The tombs can be considered part of the stalled cairn tradition (Davidson and Henshall 1989; 1991). These monuments comprise a chamber, which was constructed using drystone walling, set within an encircling cairn. A series of upright stones set at 90 degrees to the chamber orientation protrude into the chamber area to create ‘stalls’ (see Figures 1 and 2). The number of stalls within each cairn varies enormously from those with just two stalls such as the northern chamber at Tulloch of Assery A to those such as Midhowe on Rousay, which has 13 stalls. At both of these sites the excavators located a series of stone benches (horizontal slabs between the stalls) on which human skeletons were placed (Callander and Grant 1934; Corcoran 1967).

Some stalled cairns were constructed in different phases. At Holm of Papa Westray North, Orkney, for example, the site began life as a small single box-like chamber set within a small round cairn. At a later date this monument was extended into a four-stalled cairn (Ritchie 2009). A multi-phase sequence of construction and alteration was also identified at Point of Cott, Orkney, where the size and shape of the cairn were repeatedly modified (Barber 1997). This has also been suggested for Tresness, Orkney (Anderson-Whymark and Cummings 2021), as well as other stalled cairns (Lawlor 2024), although was clearly not the case at all sites. There is also evidence that some sites at least saw extended periods of use. From the differences in chamber form it is possible to argue that the northern chamber at Tulloch of Assery A was earlier than the southern chamber. The excavations at Tulach an t-Sionnaich demonstrated this was a composite, multi-phase site (Corcoran 1967).

Earlier typological approaches considered stalled cairns to be broadly Early Neolithic in date, with the smaller examples generally considered earlier than the larger and later examples. Broad similarities in form were argued to be indicative of wider shared practices amongst the earliest farmers in these areas (Davidson and Henshall 1989; 1991). These approaches considered stalled cairns to have been constructed by early farmers arriving into northern Scotland as the Neolithic spread to the northern extremes of Britain (Corcoran 1967; Piggott

1954). However, more recent analyses of radiocarbon dates identify that the stalled cairn tradition was long-lived. While the chronology of contemporary houses found in recent years on Orkney is both detailed and precise (Richards and Jones 2015), the chronology of the chambered tomb sequence of northern Scotland has remained poorly defined and reliant on single dates from most sites (Bayliss *et al*. 2017; Griffiths 2015).

The deposits of human remains: contextual and osteological observations

The excavations at each of the five sites recovered low numbers of individuals (total MNI = 37), and the distribution and partial nature of the bone deposits suggest that at least some of the remains were decayed or manipulated prior to the final formation of those deposits. The remains have now been re-assessed by Sarah Cuthbert.

No human remains were found in the south chamber of the Tulloch of Assery A, which seems to have been repurposed for occupation in the 19th century, while the osteological minimum number of individuals from the north chamber is six, three of which were subadults (aged 5-7, 10-11 and 14-16). These were spread across six bone groups (A-F, Figure 3): Corcoran (1967, 31-33) interpreted bone groups A and B as disarticulated remains that had been placed here once the flesh had decayed (suggesting cut-marks on bones from F, which Cuthbert identifies as root etching). Corcoran described deposits A, C, D and E as each likely a single individual, and groups B and F as consisting of at least two individuals. However, bones from the 5-7 year old and 14-16 year old are coded D, and some from the 14-16 year old were coded E. The aDNA results on three male adults who are close genetic relatives with Early Neolithic dates reported below come from bone groups D (I36006) and B (I36007), which are from the stone stack bench in the western alcove, and E (I2635), which was positioned semi-articulated on sloping flagstones in front of the bench. Bone group B was coated in clay (Corcoran 1967, 32), suggesting the handling and preparation of disarticulated remains prior to placement on the stone benches. Cuthbert identifies the surfaces of many of the bones, including cranial elements, as heavily eroded, possibly supporting Corcoran's view that the bones had been moved here following decay elsewhere. No artefacts were recovered from the chamber.

Figure 3: Plan of the north chamber of Tulloch of Assery A showing the location of bone groups A-F (after Corcoran 1967, Fig. 9).

On the basis that there were no articulated bones, Corcoran also suggested that the fragmented remains from the chamber at Tulloch of Assery B had been collected from elsewhere. However, it is also possible that the remains were derived from skeletons within the chamber that had decayed there and/or were largely removed: Cuthbert identifies very little erosion on the surfaces of these bones, which constitute a minimum of four individuals: two adults, the larger of which had a leaf-shaped arrowhead embedded in a lower thoracic vertebra (Corcoran 1967, 63), one neonate and one 14-16 year old. Genetic analysis detected five different individuals (three males, including the 14-16 year old, and two females). Although the bones are described as 'heaped together' the likely later date of one of these individuals suggests that this configuration of the bones was not produced in the Early Neolithic. Some bones were burnt but seem to have been dry at the time of their burning.

Corcoran again inferred that the fragmented human remains in the single chamber at Tulach an t-Sionnaich were collected from elsewhere, though it is possible that later disturbance was at least partly responsible for the fragmentation and comingling. The human remains were intermixed with limpet shells and animal bone and were sandwiched between a layer of stones and a layer of animal remains, including cattle, deer, bird, fish and mollusc. Remains of two dogs (almost certainly later additions), and flint and pitchstone and a sherd of pottery, were also recovered from the chamber. Cuthbert reports extensive post-mortem fracturing of the human bones (98%), but was able to identify at least seven individuals: three adults (at least one female), a child, an infant, and a neonate (the latter with high bone porosity consistent with scurvy). The aDNA results reported below come from a single adult male.

There are very limited records of the 1960s excavations into the cairn at Rattar East. Osteological analysis is also partial, since only six crania have been retained, with all other remains having been reburied at the site 'without examination' (Davidson and Henshall 1991, 166). Five of the six crania are adult, and one is from a child. The successful DNA results are from the five adults, three of which are male and two female.

The human remains from the Holm of Papa Westray North are also disarticulated and partial, and many may have been moved from their original point of deposition within the tomb. As Ritchie (2009, 30) argued, since 'all parts of the body were represented' … 'there is no need to invoke excarnation to explain what is missing'. Cuthbert identifies at least 14 individuals, consisting of eight adults, two juveniles (17-20 and c. 17 years), and four children (aged c. 10 years, c. 6-7 years, four years and below three). Most likely due to Petrie's 1854 excavation, only compartments 3-5 yielded 'any quantity of undisturbed bone' in 1981-2: those include

the remains of three adult males who were close genetic relatives, and an adult female with a similar radiocarbon date to those males. There were no 'joins or pairs' between the undisturbed areas 4 and 5 and bones from the areas explored by Petrie (Harman 2009, 43-4), and the bones in this area were also less prone to erosion than those in areas excavated by Petrie. The aDNA results derive from the eight adults.

Genetic relatedness

Genetic analysis revealed that most of the individuals were represented by several samples, with up to five samples deriving from a single individual, underlining that the samples derive from a smaller number of individuals than the osteological MNI (22 compared with 37: see Appendix 3). We identified nine pairs of close genetic relatives (third-degree or closer), all between men. Two of these pairs of close relatives featured individuals from different tombs, specifically male I2634 from Tulach an t-Sionnaich who is a second-degree relative of I36007 from Tulloch of Assery A and third-degree relative of I36006, I36007's first-^{t}-degree relative. Additionally, shared Identity By Descent (IBD) calling allowed us to detect ~100 more distant relative pairs in our dataset of 22 individuals, including 11 pairs with more than 200cM in IBD segments longer than 12 cM, which very likely represent fourth or fifth-degree relatives (supplementary Table 3; Figure 4).

Figure 4. Visualization of genetic relatedness and chronological relationships between the individuals in the study. Lines between individuals relate to degree of relatedness. Black = first-degree; Red = second-degree; Orange = third-degree; Green = fourth-degree; Blue = ~fourth-fifth degree; Grey = ~fifth-degree; not shown here = ~fifth-sixth degree. MNI is from the osteological analysis

We identified two main Y-chromosome haplogroup lineages: I2a-CTS10057 (I2a1b1a2) and I2a-L161 (I2a1a2). Both were present at Holm of Papa Westray North and Rattar East, while Tulach an t'Sionnach and Tulloch of Assery A only feature males with I2a-L161. The only male from another haplogroup was I36224 from Tulloch of Assery B who belonged to R1b-M269, suggesting the presence of steppe-related ancestry in this second-millennium BC individual. Mitochondrial variability was high, with 19 different lineages in 24 individuals. Three groups of individuals share the same mitochondrial haplotypes, implying a relatively recent common matrilineal ancestor: I35761-I36003, a pair of second-degree relatives from Holm of Papa Westray North, I36004-I36006-I36019-I36022 from three different tombs

(I36019 and I36022 are first-degree relatives and I36004-I36019 are distant relatives), and I2633-I36028, a pair of ~sixth-degree relatives from Tulloch of Assery B.

Genetic ancestry analysis

The majority of individuals plot within the genetic diversity of previously published Neolithic populations from Great Britain (Figure 5), with 20-25% of ancestry deriving from pre-Neolithic European hunter-gatherers and 75-80% of ancestry deriving from Early European farmers (EEF) (supplementary Table 2). None of them display high hunter-gatherer admixture levels such as those observed in a subset of Neolithic individuals from Raschoille Cave, Ulva Cave and Carding Mill Bay II (Patterson *et al*. 2021). Four individuals plotted outside the main cluster of Neolithic individuals from Scotland in PCA, of which I36022's position is likely due to low quality data since I36022's brother, I36019, locates within the cluster. Individuals I36224, I36225, I36227 from Tulloch of Assery B are clearly shifted towards higher values in PC2 and are located close to post-Neolithic populations from Britain. When we try to model their ancestry as a mixture of WHG and EEF, we obtain a very poor fit. The model is significantly improved by adding 55-72% of Corded Ware-related ancestry as a source of steppe-related influence. These observations, together with R1b-M269 Y-chromosome lineage and Bronze Age date for I36224, indicates a post-Neolithic chronology for these individuals.

Figure 5. Plot of the genetic diversity of previously published Neolithic populations from Great Britain in relation to the samples reported here

A chronology for tomb use

If we accept that in each case a phase of tomb construction took place during the lifetime of the earliest individuals deposited in these chambers, then Tulach an t-Sionnaich was likely constructed between 3703 and 3534 cal BC, the northern chamber of Tulloch of Assery A between 3648 and 3528 cal BC, Rattar East in the decades surrounding 3520 cal BC (based on the gap in date ranges of the two brothers), and Tulloch of Assery B is likely to have been constructed between 3787 and 3653 cal BC. However, each tomb could pre-date any of those individuals. If I2651 was the great-great-great grand-daughter of I36028, this would pull him towards the end of his date range (3653 BC) and push her towards the start of hers (3360 BC), leaving 293 years between their deaths (Figure 4). This temporal distance seems

improbable for such a relationship, however, potentially raising a question about the date of I2651 (given I36028 is also a fourth-degree relative to I2636 at Holm of Papa Westray and the dates of both individuals are consistent with that). There is a small probability that the date range for I2651 is as early as 3480 cal BC (unlikely), or that these individuals were connected by two different 6th-degree relations each one sharing ~150 cM (highly unlikely). The main phase of Holm of Papa Westray North is probably later, with the earliest dates running from 3631-3377 and 3629-3370 cal BC, and the combination of dates for father-son pair I36003 and I2650 suggesting they were entombed in the mid 3300s (perhaps the c. 3380s for the son and c. 3340s for the father).The primary single-cell phase is likely to have been earlier than the deposition of some or all of the dated individuals, although by how much we cannot ascertain due to later disturbance (Ritchie 2009). Fragments of Beaker pottery at Tulach an t-Sionnaich and a Middle Bronze Age date from I36224 at Tulloch of Assery B indicate later deposition.

Inferences about kinship

Kinship is a complex and multi-dimensional social phenomenon which cannot be reduced to the study of descent (Bruck 2021; Ensor 2021; Fowler 2022). Mortuary practices have many purposes and effects but form one of the arenas through which kinship is articulated (Fowler 2022). The evidence outlined above resulted from Neolithic mortuary practices in built architecture, including decisions over whose remains to place where and with whom. We have noted the inclusion of some individuals connected by patrilineal descent at Tulloch of Assery A and Tulach an t-Sionnaich, but this need not mean that patrilineal descent was the only important aspect of kinship, nor that it structured all dimensions of life: for instance, lineages need not be linked to specific territories (cf. Kuper 1982), and identifying lineal descent does not tell us which members of the community played what roles in parenting (cf. Fowler under review). Relationships drawn to the fore during these mortuary practices may have selectively focussed on single lines of descent within a more complex system of lateral relationships that shaped everyday life. Thus, where patrilineal descent connected those within a Neolithic tomb it likely formed one strand in a broader fabric of kinship: at Hazleton North that could perhaps have involved a bilateral or cognatic descent system initially (cf. Whittle 2024), but if this was so then there was clear a ‘patrilineal bias’ within that system in which males were preferentially buried in the tomb of close male relatives (Fowler 2022, 72). This makes it difficult to identify distinct kinds of kinship system, and many anthropologists have argued that kinship is always more fluid and contingent than models of such systems allow. We therefore resist drawing conclusions about kinship *systems*, instead reporting on

specific *practices* that are visible through trends in the evidence. At Hazleton North this approach allowed us to identify patrilineal descent with sub-lineages stemming from four female ancestors in the first/second generation, highlight the presence of elective kin, and trace the decline in frequency of half-siblings from multiple reproductive partnerships during the third to fourth generations (Fowler *et al*. 2022; Cummings and Fowler 2023). Kinship-related mortuary practices here were contingent and dynamic, but patterns were nonetheless evident. We apply a similar approach across five tombs here, with some complementary yet differing results.

Close genetic relatives can be identified across four of the tombs in this study. We can infer some recurring kinship practices: fathers and sons were placed together in two tombs, and brothers at Rattar East, while half-brothers or a paternal uncle and nephew were placed in two neighbouring tombs around Loch Calder. While the second-degree relationship between I35761 and I36003 was maternal, and I2633 and I36028 likely shared a maternal ancestor a few generations back, mothers and daughters do not seem to have been entombed together, and nor were sisters, while two women at Holm of Papa Westray North - I2636 and I2651 - had a closer male relative at one of the Loch Calder tombs than any of the males at Holm of Papa Westray North. The only deposit that seems to have survived undisturbed since the early Neolithic, the bone groups at Tulloch of Assery A, also provided the only evidence for a father-son-grandson connection, consistent with tracing patrilineal descent. These remains had been placed together on stone benches, in one case coated in clay, presumably sometime after the corpses had initially entered the tomb, suggesting their relatedness was remembered through that process of physical transformation. Given the remains of the dead were so heavily fragmented and partial, that some of the tombs were disturbed or only partially excavated, that three individuals were likely post-Neolithic insertions, and that 22 sampled individuals is a much smaller number than the 37 minimum number identified osteologically, it seems likely that these genetic relationships are surviving fragments from among a denser web of Neolithic people connected by lineal descent. While the fragmentary nature of the evidence means we cannot exclude the possibility that bilateral or cognatic descent was traced during some mortuary deposition, there is no direct evidence for matrilineal connections: there were no cases of genetic mothers and daughters in the same tomb or across tombs, with the closest genetic relationship between any two women being fifth-degree, and we detected no offspring of any of the women in the dataset.

The sequence of radiocarbon dates combined with the genetic evidence suggest that the male I2634 at Tulach an t-Sionnaich was either the paternal uncle, half-brother or grandfather of male I36007 at Tulloch of Assery A. Perhaps depositional practice at these two tombs acknowledged shared membership of a single patriline (a social group, not all

members of which need be close paternal genetic relatives), or two closely-related patrilines. It is open to speculation as to whether a different kin group was identified with Tulloch of Assery B, but I2636 was a fourth- or fourth-to-fifth-degree relative to one male from each of the other Loch Calder tombs (I36007, I36028, and I36028). While a father-son pair were entombed at Holm of Papa Westray North, it is not possible to discern whether patrilineal descent was significant here: the only other close relationship is between that father and a maternal second-degree male relative, who may have been his half-brother or uncle. It is possible that depositional tendencies changed over time and/or differed between the Loch Calder area and the Holm of Papa Westray, as no adult females were deposited at Tulloch of Assery A but aDNA results exist for an equal number of males and females at Holm of Papa Westray North. Further work is needed on Orcadian tombs from this period to assess whether kinship connections were traced differently here from the 3400s and later compared with 37th to 36th century Caithness.

Tomb construction and form as technologies of descent and statements of affinity

The evidence for the deposition of close genetic relatives within and across these tombs needs to be set in context alongside the construction and form of the monuments in order to understand how kinship was materialized in early Neolithic northern Scotland. Our study has shown a small number of simple chambered tombs were constructed in northern Scotland from as far back as 3650 cal BC, but initial Neolithic occupation of these areas is likely to date to before this period (Whittle *et al*. 2011, 824 but see Bunting *et al*. 2022). This means that the sites in this study were most likely not constructed by the first Neolithic people in the area. Rather, those who built them adapted an historic practice already well-established in other parts of Britain. The three Loch Calder tombs were seemingly built and used in fairly rapid succession in the 3600s to early 3500s, and assuming those buried in them were involved in their construction, this included closely-related individuals at Tulloch of Assery A and Tulach an t-Sionnaich. Yet, the form of each site is quite different: Tulach an t-Sionnaich is a single, box-like chamber, Tulloch of Assery A has two opposing chambers and Tulloch of Assery B a tripartite chamber. Moreover, these tombs were built in close proximity to each other: the Tullochs of Assery are 30m apart, and Tulach an t'Sionnaich is only 200m away. All are intervisible. This clustering of tombs is replicated across Caithness as at Rattar (Figure 1). If we understand *kinship as a process*, the form of the chambered tomb architecture could have been key in materialising that kinship (Crellin 2021; Fowler 2022). Thus, by positioning each tomb close to pre-existing sites *and* interring the remains of close genetic relatives, people in Caithness materialized a web of descent. However, rather than

doing so by identically replicating tomb architecture, each community building a tomb drew affinity with other groups through proximity and mode of architectural construction whlie also establishing difference through architectural form. This may have signalled the renegotiation of social relations, as we have argued for sequences elsewhere (see Cummings and Fowler 2023).

In Orkney, descent was perhaps traced differently to in Caithness. Early tombs like the primary single-celled phase at Holm of Papa Westray North were constructed in places – but unlike in Caithness (as far as we currently know) - these were soon accompanied in the Orcadian landscape by dry-stone walled houses (Richards and Jones 2015). These houses, occurring as isolated constructions, drew on chambered tomb architecture in their materials, construction techniques, and form; a strong indication that the principles guiding tomb construction were carried over into house-building. In Orkney, houses were built in the same centuries as existing chambered tombs were altered and new tombs were built. In Orkney, though, sites were *not* built in close proximity to one another instead being set *away from* existing sites, and even the dense concentration of stalled cairns on Rousay are not typically intervisible with one another. At the Holm of Papa Westray North, once it had been modified, several closely-related male individuals – a father and son, and the father's maternal uncle or half-brother – were buried, perhaps indicating the persistent nature of patrilineal descent in the early Neolithic. Thus, we can suggest that the shared architecture of stalled cairns seemingly constructed for small kin groups in both Caithness and Orkney indicates a shared focus on materializing descent and a shared sense of affinity at the broad scale. However, this was manifested differently, with early tomb aggregation and modification on Caithness compared with dispersed stalled cairn and house location on Orkney. In both areas, dry-stone walled constructions materialized some kin relations, and 'housed' others, but in Caithness this was focussed on the places of the dead, while in Orkney spaces for both the living and the dead were built in this way.

Conclusions

The builders of at least four different stalled cairns drew on a shared tradition of tomb construction, and some of them very likely knew one another. It is possible that people entombed at the Holm of Papa Westray in the 3300s cal BC traced descent from people entombed at the Loch Calder tombs from the 3600s-3500s cal BC through oral histories as well as tomb architecture. While stressing that descent is only one dimension of kinship, we have interpreted the construction and use of these tombs as technologies through which lines of descent were projected into the future and traced from the past, and also inferred

reference to a broad sense of affinity in the shared features of tomb architecture and mortuary practice. The longest strings of direct genetic descent within the tombs connect males, including three to five generations of males across Tulloch of Assery A and Tulach an t-Sionnaich. This suggests that patrilineal descent was traced within funerary practices in early Neolithic northern Scotland. Female relatives also appear in tombs other than the tombs of their closest male relatives, as is the case for two women buried in Holm of Papa Westray who we speculate may have played key roles in forming or maintaining connections across the water. Lines of descent may have been traced through both male and female individuals potentially in a wider system of cognatic descent, perhaps more so at Holm of Papa Westray North than at the Caithness tombs, though the resolution of our data is not sufficient to tell.

We have argued for a shared sense of community and kinship across northern Scotland in the early Neolithic where kin group identities were expressed through tomb construction, tomb location and deposition. At the same time, we have noted differences in how local kin groups were situated in relation to one another: in 37th-36th century Caithness, additional tombs were built close to existing sites, whereas in 34th century Orkney new tombs (and stone-built houses) were constructed away from existing sites, indicating a different approach to connections between kin groups. Thus, from a similar start, and while probably maintaining ongoing connections, within a few centuries Neolithic communities either side of the Pentland Firth sought out new ways of shaping and expressing kinship through tomb construction, modification and the selective deposition of the dead.

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Ethics statement: Open science principles require making all data used to support the conclusions of a study maximally available, and we support these principles here by making fully publicly available not only the digital copies of molecules (the uploaded sequences) but also the molecular copies (the ancient DNA libraries themselves, which constitute molecular data storage). Those researchers who wish to carry out deeper sequencing of libraries published in this study should make a request to corresponding author D.R and request permission from National Museums Scotland.

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