How long was the Mesolithic–Neolithic overlap in Western Scotland? Evidence from the 4th millennium BC on the Isle of Islay and the evaluation of three scenarios for Mesolithic–Neolithic interaction

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How Long was the Mesolithic–Neolithic Overlap in Western Scotland? Evidence from the 4th Millennium BC on the Isle of Islay and the Evaluation of Three Scenarios for Mesolithic–Neolithic Interaction

By STEVEN MITHEN[1]

I dedicate this article to the memory of Caroline Wickham-Jones (1955–2022), an outstanding archaeologist and inspiration to Mesolithic studies and to me personally for more than 30 years.

Ancient DNA studies have identified western Scotland as the only known region in Britain where inter-breeding occurred between early 4th millennium BC Neolithic migrants and the indigenous Mesolithic population. By drawing on excavations at Mesolithic and Neolithic sites on the Isle of Islay, I identify a period of population overlap and suggest three scenarios for Mesolithic–Neolithic interaction: swift succession, dual population, and biocultural merger. These scenarios are evaluated against the archaeological evidence from Islay and elsewhere in western Scotland, and with reference to patterns of Mesolithic–Neolithic interaction in continental Europe. A cautious preference is expressed for biocultural merger, occurring between the mid-4th and mid-3rd millennia BC, a period that could be termed the 'Neomesolithic'.

Keywords Mesolithic–Neolithic transition, Neomesolithic, western Scotland, Isle of Islay, radiocarbon dates, DNA

The long debate about the Mesolithic–Neolithic transition in Britain has been taken forward by the publication of an ancient DNA analysis of 67 Neolithic and six Mesolithic individuals (Brace *et al.* 2019). Although we must be cautious about generalisations from such small samples, the results indicate the indigenous Mesolithic hunter-gatherers were replaced by the arrival of Neolithic migrants in the early 4th millennium BC. The only indication of inter-breeding came from western Scotland, suggesting population overlap for 'a maximum of a few centuries' (Brace *et al.* 2019, 770).

Is it possible to identify that period of overlap in the archaeological record? If so, can we identify the nature of interaction? To address these questions, I will consider five sites on the Isle of Islay, three Neolithic and two Mesolithic, with dates in the 4th millennium BC. Here, and throughout this manuscript, by Neolithic sites I refer to those with material culture of either leaf points, polished stone axes, diagnostic pottery, and/or chambered cairns, identifying this material culture as deriving from an incoming population at or soon after 3800 BC. By Mesolithic sites, I refer to those with microlithic technology of the Narrow Blade Industry (NB; Saville 2004), identifying this with an indigenous population. Numerous sites in western Scotland have both types of material culture. These remain open to alternative interpretations, providing a key focus of this contribution.

Despite having this cluster of excavated Mesolithic and Neolithic sites on Islay, the archaeological data remains limited and often ambiguous. To facilitate its interpretation, I propose three scenarios for Mesolithic–Neolithic interaction, covering the period between Neolithic arrival and the Bronze Age

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population incursion at *c.* 2500 cal BC (Olade *et al.* 2018). These will be evaluated in the context of recent research on Mesolithic–Neolithic interaction from across Europe.

NEOLITHIC MIGRANTS AND THE NATIVE MESOLITHIC

Even prior to the study by Brace *et al.* (2019), there was persuasive archaeological evidence for the arrival of Neolithic migrants from the continent (e.g., Collard *et al.* 2010; Sheridan 2010; Whittle *et al.* 2011). With entry routes into south-east England and along the western seaways, the Neolithic had spread to Britain's western and northern margins by *c.* 3800–3700 cal BC (Garrow *et al.* 2017; Copper & Armit 2018).

Thomas (2004, 126) argued that a 'colossal movement of population from the continent' would have been required to displace the Mesolithic communities. That is unlikely because the rarity of 5th and 4th millennium Mesolithic sites suggest a low population density throughout Britain (Collard *et al.* 2010). Garrow *et al.* (2017), for instance, were unable to report on any Mesolithic sites dating to the 4th millennium in their study region of the Scilly Isles, Isle of Man, and Outer Hebrides. In response to Brace *et al.* (2019), Thomas (2022) argues for a 'minimal Neolithic' in south-east England 4100–3900 cal BC prior to a major influx of Neolithic migrants, the minimal Neolithic arising from interaction between Mesolithic groups in south-east England and Neolithic communities in north-east France and Belgium. He suggests this 'provided the conditions' for the 'more durable migration stream', as identified by Brace *et al.* (Thomas 2022, 14). While sympathetic to Thomas's arguments for southern England and recognising there may have been late 5th millennium BC Mesolithic–Neolithic interaction along the western seaways (Sheridan 2010), the case provided by the genetic and archaeological evidence for swift replacement of the Mesolithic population by Neolithic migrants throughout Britain soon after 4000 cal BC is compelling, allowing for interbreeding in western Scotland.

For northern Britain, the Neolithic migrants are likely to have entered a sparsely populated landscape, enabling small groups of colonists to become swiftly established. The sensitivity of the Mesolithic population to environmental events in this region suggests it was demographically fragile (Wicks & Mithen 2014; Mithen & Wicks 2021). Moreover, the stability in chipped stone technology following the appearance of the Narrow Blade Industry (NBI) at *c.* 8300 BC (Conneller *et al.* 2016; Waddington *et al.* 2017), characterised by platform blade cores and microliths (Saville 2004), suggests population numbers were too low to enable cultural innovation and change (cf. Shennan 2001; Wicks & Mithen 2014). The Mesolithic population level is likely to have been only just above the minimum number of persons required for population viability, estimated to be *c.* 150 (White 2017). This is the combined population from a network of interbreeding communities, potentially dispersed over a large spatial area (Wobst 1974). Below this population threshold, hunter-gatherers cannot withstand random fluctuations in fertility, mortality, and sex ratios. Even marginal reductions in the fertility and mortality of the Mesolithic population arising from competition with the Neolithic migrants for resources would have pushed it below the demographically viable threshold.

Although we lack equivalent studies of Mesolithic population dynamics in southern Britain to that provided by Mithen and Wicks (2021) for the north, competitive exclusion of Mesolithic communities by Neolithic migrants appears to have occurred through the country. The genomic data indicate population replacement with no evidence for interbreeding except for two Neolithic individuals from Raschoille Cave, Oban (Brace *et al.* 2019). They were dated to 4000–3300 cal BC with genomes indicating a part-Mesolithic ancestry arising 4.0±3.4 generations before they lived. The extent to which they are representative of the 4th millennium BC population in western Scotland remains unclear: it is conceivable that other persons will have had either higher or lower degrees of genetic mixing or have been entirely indigenous or migrant. Nevertheless, the breakthrough study by Brace *et al.* (2019) enables us to review the archaeological evidence with confidence that some interbreeding had occurred. Can that period of overlap and its consequences be identified?

IN THE VICINITY OF RASCHOILLE CAVE

Western Scotland has benefited from a long history of research to find and excavate Mesolithic sites: around Oban (Anderson 1898; Pollard 1990; Connock *et al.* 1992; Bonsall *et al.* 1993) and on Kintyre (Cummings & Robinson 2015); on Harris (Gregory *et al.* 2005;

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Church *et al.* 2011); Lewis (Church *et al.* 2012; Bishop *et al.* 2013; Snape-Kennedy *et al.* 2013); Rum (Wickham-Jones 1990); Skye (Hardy & Wickham-Jones 2009; Saville *et al.* 2012); Coll (Wicks & Mithen 2017); Risga (Pollard *et al.* 1996; Pollard 2000); Mull (Bonsall *et al.* 1991; 1992; 4; Russell *et al.* 1995; Mithen & Wicks 2018); Jura (Mercer e.g. 1968, 1970; 1971; 1972; 1974; 1980); Colonsay (Finlay *et al.* 2019; Mithen 2000a); Oronsay (Mellars 1987); Islay (McCullagh 1989; Mithen 2000a; Ritchie 2005; Wicks *et al.* 2014; Ellis 2015; Mithen *et al.* 2015); and Arran (Affleck *et al.* 1988). As of 2021, this has produced a corpus of 30 radiocarbon dated Mesolithic sites within a 100 km radius of Raschoille Cave, these being a fraction of those identified by the presence of the NBI artefacts alone (Fig. 1). The earliest sites date to the 8th millennium BC with the distribution of radiocarbon dates suggesting activity/population reached a peak between 6500 and 6200 cal BC (Wicks & Mithen 2014; Mithen & Wicks 2021). Only six Mesolithic sites have 4th millennium BC and later dates, providing candidates for the Mesolithic–Neolithic overlap: Carding Mill Bay near Oban; Lussa River on Jura; Gleann Mor, Rockside, Bolsay and Storakaig on Islay (Table 1).

Carding Mill Bay is a limpet dominated shell midden that has been extensively analysed, involving dating programmes and the isotopic analysis of human remains (Bonsall & Smith 1992; Connock *et al.* 1992; Schulting & Richards 2002; Milner & Craig 2009; Bownes *et al.* 2017; Schulting *et al.* 2022). The midden has been designated as Mesolithic because of bevelled bone artefacts similar to those found in the 5th millennium BC Oronsay shell middens. Such artefacts, however, were also used in Neolithic and Bronze Age (e.g., at An Corran, Saville *et al.* 2012). The human remains post-date 3650 cal BC. As concluded by Brace *et al.* (2019), these would derive from a migrant Neolithic population with the potential for Mesolithic admixture – unfortunately there is no genomic data available from these samples. Schulting and Richards' (2002) analysis of isotopic data from these bones indicated minimal marine protein in their diet, confirming their view that the incoming Neolithic population relied on terrestrial resources alone and implying their insertion into a pre-existing midden. Their dietary inference was challenged, however, by Bownes *et al.* (2017) whose re-analysis using the FRUITS Bayesian modelling software indicated an intake of marine protein at between 15% and 21%. That re-analysis has since been deemed invalid because of methodological errors (Schulting *et al.* 2022). Despite these outstanding but contentious applications of archaeological science, it remains impossible to designate the midden and the skeletal remains as either 'Mesolithic' or 'Neolithic'. In the absence of genomic analysis, the human remains can only be called 'Neolithic' on the assumption that Mesolithic populations had already become extinct.

That assumption is challenged by evidence from Lussa River on the north-east coast of Jura, 50 km south-east of Carding Mill Bay. This has a scatter of NBI artefacts interpreted as a hunting camp on a flat sandy terrace at the head of an estuary (Mercer 1971). Two samples of charcoal were acquired from within the artefact scatter for dating. These provided dates in the late 4th millennium: 3025–2475 cal BC (BM-555) and 3645–2931 cal BC (BM-556) (Table 1). Mercer describes the presence of four leaf shaped pointed flakes, but the illustrations provide no indication that these might be Neolithic leaf points, leaving the assemblage entirely within the NBI technology. These dates have been largely ignored in debates about the Mesolithic–Neolithic transition. This might reflect their large uncertainties (±100, and ±145) and lack of confidence in the pre-AMS dating method, although such issues could have been noted. Their neglect has been convenient for models of a transition to the Neolithic in the early 4th millennium because they fall outside the conventional time-range of the Mesolithic.

Similar evidence of young dates associated with NBI technology come from two 'Mesolithic' sites on Islay, Gleann Mor and Rockside (Fig. 2). Gleann Mor has a dense scatter of NBI artefacts and been interpreted as a hunting camp used on a small number of occasions (Mithen & Finlayson 2000). Two samples of charcoal were dated, both from the same small trench (4.0 × 4.0 m) and within the same palimpsest of blade cores, microliths and debitage (Table 1). One sample returned a date of 6233–5737 cal BC, that was consistent with TL dates on burnt flint. The second sample returned a date of 1923–1465 cal BC. This was explained away in the site report as possibly contaminated by recent carbon but with no suggestion of how that had occurred or why only one sample was affected.

The nearby site of Rockside also has a dense scatter of NBI artefacts, with no traces of Neolithic or Bronze Age material culture (Mithen *et al.* 2000a). Three

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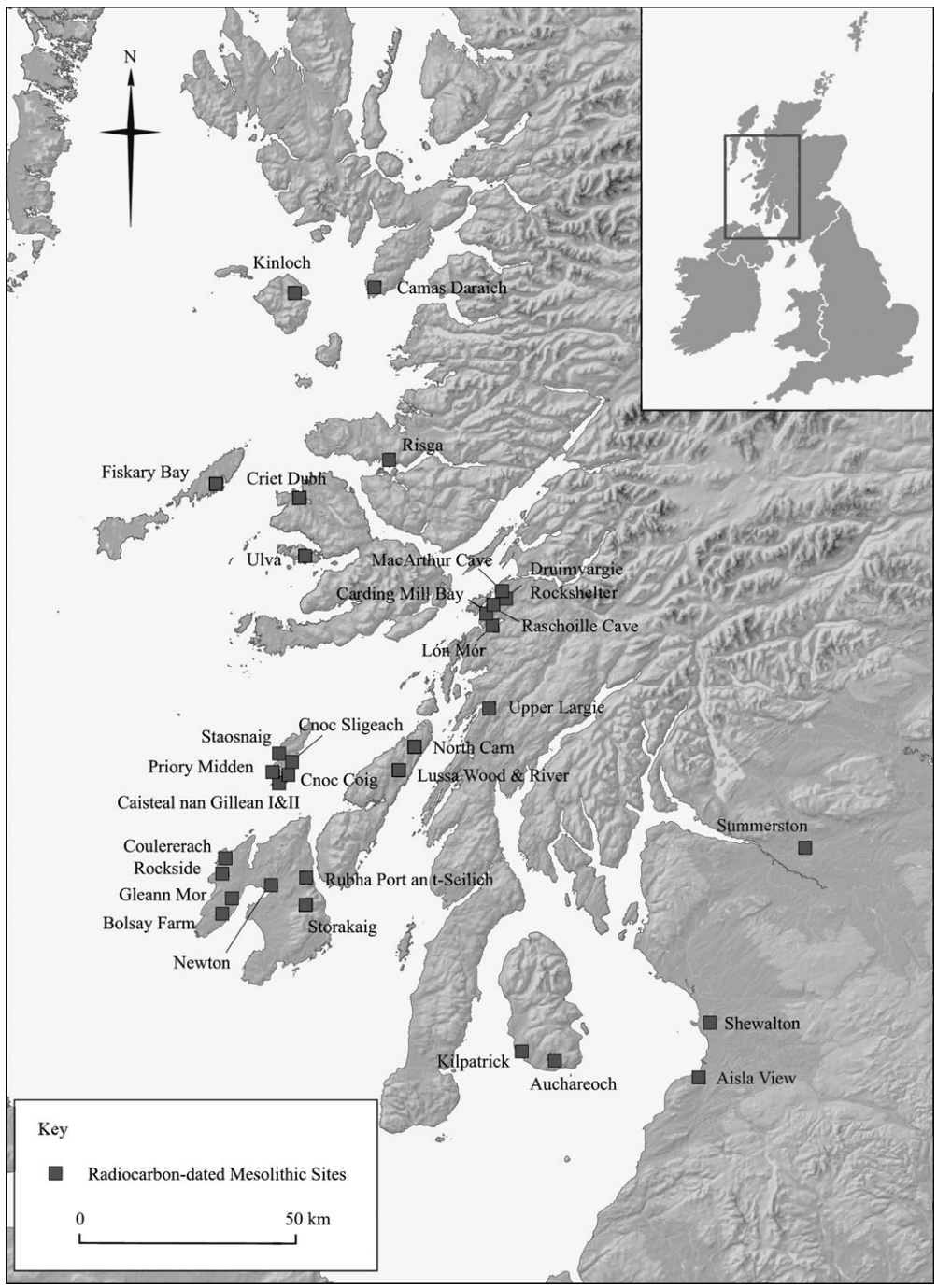

Fig. 1.
Radiocarbon dated Mesolithic sites within a 100 km distance of Raschoille Cave.

charcoal samples were selected for radiocarbon dating from the stratified horizons of the trench section, all of which contained NBI artefacts with no trace of later cultural material (Table 1): the basal horizon, a layer of peaty clay, met expectations with a date of 5743–5626 cal BC. The two horizons above, both

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TABLE 1: RADIOCARBON DATES FROM SITES REFERRED TO IN THE TEXT

Site/sample	δ^{13}	*Material*	*Context*	*95% range, cal BC*
Lussa River (Mercer 1971)				
BM-555 (4200±100)	Na	Charcoal. Indet.	Within NBI artefact scatter	3025–2476
BM-556 (4710±140)	Na	Charcoal. Indet.		3787–3029
Port Charlotte (Harrington & Pierpoint 1980)				
HAR-2084 (4540±70	Na	Charcoal: indet.	Within chamber	3509–3015
HAR-2086 (4710±70)	Na	Charcoal: indet.		3634–3368
HAR-2836 (4660±90)	Na	Charcoal indet and charred hazelnut shell	Within pre-cairn horizon	3640–3103
HAR-3486 (4940±70)	Na	Charred hazelnut shell		3946–3543
HAR-3487 (5020±90)	Na	Charred hazelnut shell		3981–3641
Newton (McCullagh 1989)				
GU-1951 (4880±60)	Na	Charred hazelnut shell	Within pit cutting fence line	3793–3526
GU-1951 (4965±60)	Na	Charred hazelnut shell	Within pit associated with Neolithic pottery, cut by fence line	3945–3640
Bolsay (Mithen et al., *2000)*				
Beta-32236 (3525±80)	Na	Charcoal. Indet.	Within NBI artefact scatter of 1989 test-pit	2122–1627
Q-3219 (7250±145)	Na	Charcoal. Indet.	Within pit containing NBI artefacts (1990)	6421–5843
AA-21631 (4740±50)	–27.9	Charcoal: *Salix* sp.	Within NBI artefact scatter (dryland area)	3636–3375
AA-21632 (7400±55)	–24.3	Charcoal: *Corylus avellana*		6399–6087
AA-21633 (6810±55)	–26.2	Charcoal: *Alnus* sp.		5829–5622
AA-21634 (4460±50)	–26.9	Charcoal: *Salix* sp.	Within NBI artefact scatter (boggy area)	3346–2935
AA-21635 (4290±45)	–27.6	Charcoal: *Betula* sp.		3075–2706
AA-21636 (3930±55)	–26.2	Charcoal: *Alnus* sp.		2574–2209
AA-21637 (4200±55)	–27.6	Charcoal: indet.		2907–2624
AA-21638 (4640±55)	–30.1	Charcoal: *Corylus avellana*		3636–3132
Gleann Mor (Mithen & Finlayson 2000)				
Beta-32237 (3390±90)	Na	Charcoal: indet.	Within NBI artefact scatter	1923–1465
Beta-32228 (7100±125)	Na	Charcoal: indet.		6223–5737
Rockside (Mithen et al. *2000)*				
Beta-37624 (6800±40)	–25.0	Charcoal. Indet.	Within stratigraphic order in NBI artefact scatter	5753–5625
Beta-37625 (3980 ±150)	–25.0	Charcoal. Indet.		2894–2047
Beta-37626 (3420± 80)	–25.0	Charcoal. Indet.		1925–1518
Storakaig (Wicks et al. *2014)*				
Beta-264734 (5350±50)	–21.3	Charred hazelnut shell	Within NBI artefact scatter	4330–4040
Beta-288429 (5120±40)	–26.2	Charred hazelnut shell		4037–3797
Beta-288430 (4970±40)	–24.2	Charred hazelnut shell		3933–3647
Beta-288431 (5130±40)	–23.3	Charred hazelnut shell		4041–3797
Beta-307787 (5540±40)	–21.3	Charred hazelnut shell		4455–4331
Beta-307788 (5250±40)	–24.3	Charred hazelnut shell		4231–3975
Beta-307789 (5100±40)	–24.8	Charred hazelnut shell		3978–3794
Beta-307790 (5060±40)	–23.4	Charred hazelnut shell		3962–3715

(Continued)

TABLE 1: (Continued)

Site/sample	δ^{13}	*Material*	*Context*	*95% range, cal BC*
Nereabolls (pre-1000 cal BC dates) (Maricevic & Mithen, n.d)				
OxA-40048 (3410±19)	−26.35	Charcoal: *Calluna/Erica* sp.	Within fill of construction cut for chamber	1751–1625
OxA-40049 (4608±20)	−25.04	Charcoal, Maloidae	Surface sealed by collapsed façade	3496–3348
OxA-40050 (4545±20)	−26.05	Charcoal, twigwood: Corylus *avellana*		3368–3105
Ox-A-40051 (4731±21)	−27.46	Charcoal, twigwood: Corylus *avellana*	Within pre-cairn buried soil	3629–3378
OxA-40104 (3410±19)	−26.77	Charcoal: indet.	Within cist fill containing EBA pottery vessel	1751–1625
OxA-40130 (4652±29)	−24.80	Charcoal, twigwood: *Corylus avellana*	Within fill of construction cut for chamber	3515–3367
OxA-40131 (4929±31)	−25.19	Charred hazelnut shell	Within pre-cairn buried soil	3771–3644
Ox-A-40132 (4746±29)	−23.38	Charred hazelnut shell		3634–3380
OxA-40134 (2828±26)	−26.01	Charcoal: *Calluna/Erica* sp.	Within cist fill containing EBA pottery vessel	1054–905

Na = not available

Calibrations using IntCal20 (Reimer *et al.* 2020) and Oxcal (Bronk Ramsay 2001, http://c14.arch.ox.ac.uk/oxcal.html)

containing NBI artefacts, provided dates of 2894–2047 cal BC and 1880–1620 cal BC, respectively (Mithen *et al.* 2000a, fig. 4.4.7). Although the charcoal samples were unidentified, the risk of old wood is not an issue because these 3rd and 2nd millennium BC dates are significantly younger, not older, than expected. The site report explained them away as arising from the redeposition of microlith-rich sediment. But where the charcoal with 3rd and 2nd millennium BC dates arose from, and how redeposition left the three dates in stratigraphic order and with no trace of later cultural material, was not addressed.

The Islay sites of Bolsay and Storakaig, have more substantive evidence for 4th millennium activity. They are close to the chambered cairns of Port Charlotte and Nereabolls, and the Neolithic location of Newton, making a unique cluster of five excavated Mesolithic and Neolithic sites in Britain, all with dates in the 4th millennium BC. This cluster is found within an island landscape of further Mesolithic sites dating from the 7th millennium and four undated Neolithic chambered cairns in the south of Islay (Fig. 2). We will consider the five 4th millennium sites in the order in which they were excavated. This is relevant for the quality of dating they provide because dates derived prior to 1990 have not been reported with their δ^{13} values and, in some cases, without charcoal identifications (Table 1).

EXCAVATIONS ON ISLAY

Port Charlotte chambered cairn

Port Charlotte chambered cairn is located on the Rinns Peninsula in the west of Islay (NR 233 584; CANMORE ID 37313) (Figs 2 & 3). It is one of six such monuments on the island (Fig. 2; Mithen 2021) and one of two that has been excavated in the modern era to provide radiocarbon dates, the other being Nereabolls (see below). Excavation in 1976 identified its façade and a chamber with four compartments (Harrington & Pierpoint 1980). Finds from the chamber included human bones, three leaf-shaped arrowheads, flint knives, sherds of five Neolithic vessels, and charcoal that provided two radiocarbon dates, both falling into the mid-4th millennium BC (Table 1). Although the charcoal samples were unidentified, causing a risk of old wood, the dates are stratigraphically consistent with those from pre-cairn activity. CANMORE records the bones as having been accessioned into the Islay Museum, but

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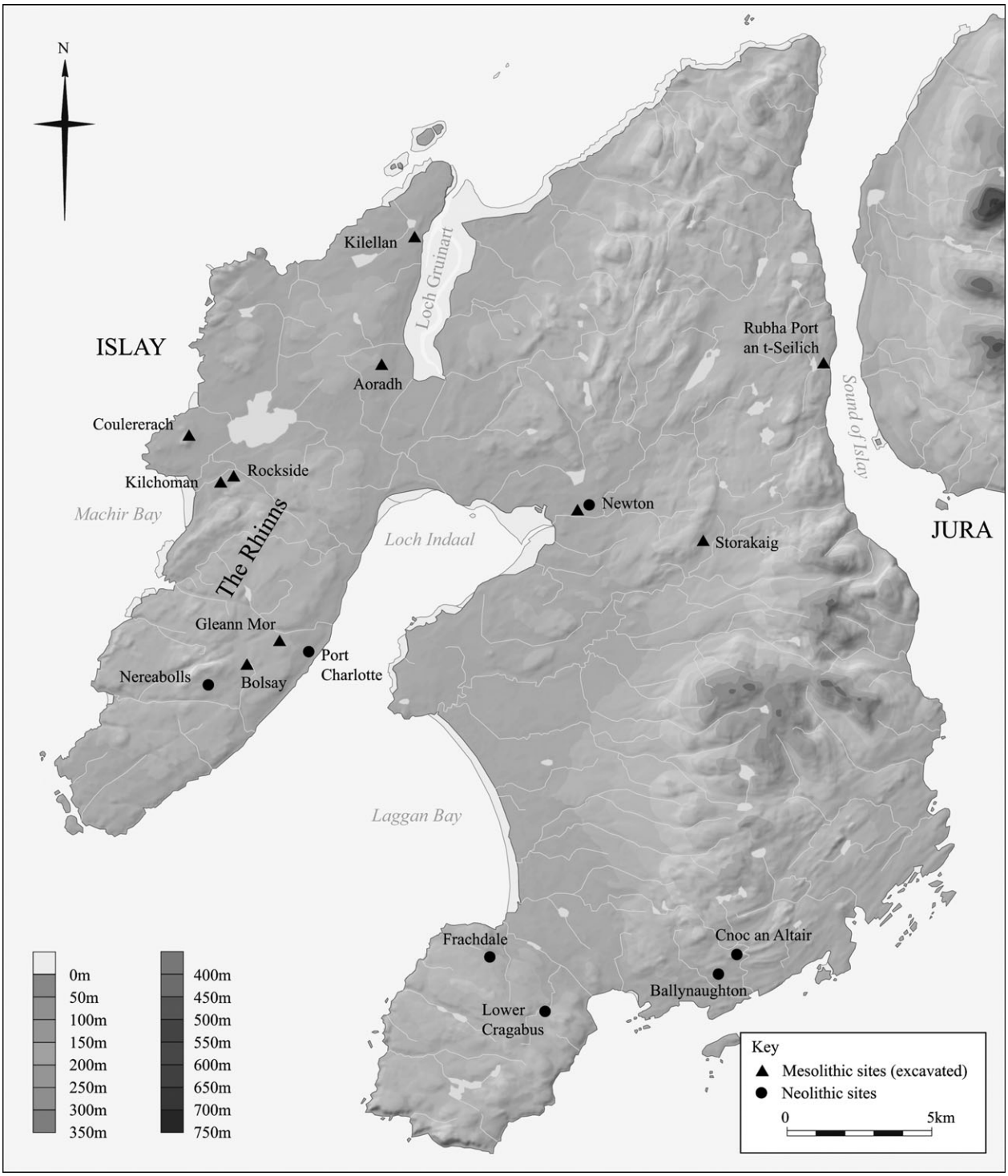

Fig. 2.
Mesolithic and Neolithic sites on Islay.

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Fig. 3.
The Port Charlotte chambered cairn (photo: Steven Mithen).

Fig. 4.
Excavation at Bolsay, August 1992 (photo: Steven Mithen).

this appears not to have occurred (Islay Museum, pers comm). There is no known report on the bones and their whereabouts remain unknown.

An occupation horizon below the cairn was described as containing over 2000 flint flakes, charred hazelnut shells, and fragments of sheep bone, this providing three further dates falling into the 4th millennium (Table 1). There is no published report of these finds and hence the technology of the flint remains unknown. Connock *et al.* (1992) suggest the bones might be from roe deer rather than sheep, raising a possibility that the pre-cairn deposit is culturally Mesolithic rather than Neolithic.

Newton

Newton is located close to the head of Loch Indaal, 10 km to the east of the Port Charlotte chambered cairn (NR 34179 62830; CANMORE ID 37769). Excavations in 1988 identified a Mesolithic occupation dated to the early 6th millennium BC and a sample of features associated with Neolithic pottery (McCullagh 1989). The Neolithic features consisted of narrow grooves *c.* 20 cm wide and 25 cm deep. Two ran parallel to each other for about 20 m, with one continuing at an angle for a further 5 m. Another groove cut these at an approximate right-angle. Some had stake-holes along their bottoms, with a further cluster of stake-holes and pits found nearby. McCullagh interpreted the grooves as the remnants of a fence line, repeatedly rebuilt. The fence, or whatever the grooves represent, had been constructed over a pit containing Neolithic pottery and charcoal, while a second pit had been dug over a groove line to hold a massive post. Both pits provided radiocarbon samples that dated to the 4th millennium (Table 1). The proposed fence was interpreted by McCullagh as representing an initial attempt at farming. This was supported by near-by pollen evidence indicating weed species associated with arable cultivation and pastoralism, although lacking any traces of cereal pollen. If correct, such farming was unsuccessful, with no further archaeological traces at Newton until the Bronze Age, while the pollen record had soon become dominated by heather, bog myrtle, and other plants indicative of increasing soil acidity (McCullagh 1989).

Bolsay

The Mesolithic site of Bolsay is 2.5 km south-west of Port Charlotte chambered cairn. It is inland at 70 m OD on the lower slope of Beinn Tart a'Mhill (NR 227 571; CANMORE ID 70280). Following reports of microliths being collected from a ploughed field in the 1960s, the site was located by test-pitting through pasture in 1989 and excavated in 1990 and 1992 (Mithen *et al.* 2000b; 2000c). The test-pitting recorded an extensive and dense scatter of NBI artefacts. Charcoal from amidst a cluster of NBI artefacts within a test-pit provided a late 3rd millennium date (Beta-32236, Table 1). A 7 × 4 m trench was excavated in 1990 to establish site stratigraphy and gain a sample of artefacts. A radiocarbon date from a sealed feature indicated activity in the mid-7th–late 6th millennium BC (Q-3219, Table 1). Although this date provided an ideal fit with the material culture,

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the charcoal was not identified and hence could be old wood, giving a spuriously early date. This trench, and the 1989 radiocarbon dated test-pit, were encompassed by a 20 × 15 m trench in 1992 that focused on mapping the spatial distribution of finds within a 5 cm spit (Fig. 4). This involved the excavation, wet sieving, and sorting of material from 4429, 0.25 m^2 square quadrates.

Drawing on sedimentary, geochemical and micromorphological data, artefact distributions, and the location of 19th century field drains, the settlement was identified as having been adjacent to a natural spring located on a gentle slope. Primary occupation was on the dryland immediately above the spring, where flint knapping, tool manufacture, the use of coarse stone tools, processing of hazelnuts, and use of wood from hazel, alder, birch, and oak occurred. Post-holes and stake-holes may have related to shelters but were too few to discern patterning. The spring cut into the slope, forming a step below which small pools of standing water and an expanse of boggy ground was formed. Gradual downslope erosion of sediment occurred from the occupation area into the boggy ground, this containing flint debris, discarded tools, and wood charcoal (Fig. 5). Some waste appears to have been deliberately discarded into the boggy ground, while there were periods in which this area evidently dried out because features had been cut through it and then sealed by further sediment deposition. Activity is also likely to have occurred directly on the sometimes-boggy area itself.

The quantity of finds was considerable: 329,667 pieces of NBI chipped stone were recovered, estimated to be 20% (at most) of that within the pasture at Bolsay and including almost 12,000 microliths, microburins, and truncations (Fig. 6). In comparison to other Mesolithic sites on Islay, Bolsay has a high frequency but narrow range of retouched artefacts; although a wide range of microlith forms are present, the microliths are dominated by scalene triangles (Finlay *et al*. 2000). Together with the large quantity of artefacts and their limited spatial patterning (Fig. 5), these features imply many short-term visits to an especially ecologically attractive location for a specific task, most likely hunting deer (Mithen 2000b). Beinn Tart'Mhill is known today as a favoured location for red deer hunting, as reflected in its name derived from the Old Norse for 'Stag Mountain' (Macniven 2015). The spring and nearby wetland of Loch a'Bhogaidh, with evidence of woodland exploitation from the 6th millennium BC onwards (Edwards & Berridge 1994), and ready access to beaches rich in flint pebbles (Marshall 2000), would have made Bolsay a particularly attractive location for a Mesolithic hunting camp.

Forty-seven coarse stone artefacts were recovered. Of these, 31 are elongated pebble tools, eight are hammerstones, four stone flakes and two unworked pieces, as typically found on Scottish Mesolithic sites. One of the remaining pieces is a perforated stone, found within the dryland area, which has been flaked but not polished and was likely the weight for a digging stick or a fish-net sinker, of which no other examples are known from Mesolithic sites (to my knowledge) (Fig. 7).

While dominated by NBI artefacts, the Bolsay assemblage also contains two diagnostic Neolithic artefacts, a leaf point and the blade end of a ground stone axe made from locally available stone (Fig. 7). Both were found within what would have been the boggy, downslope area. The axe had been broken in antiquity, probably during use. Several flake scars extend below the fractured surface all around the axe head. Their number suggest they are unlikely to have derived from accidental mis-hits during manufacture, while they are not sufficiently extensive to suggest the reflaking of the broken axe for rehafting. The impression is of broken axe head used as a platform core. A small number of other artefacts might also reflect post-Mesolithic activity although these are not culturally diagnostic: multi-platform, amorphous and bipolar cores that had been reworked after patination; a petit-tranchet derivative arrowhead; several double-sided and convex 'thumbnail' scrapers.

Pottery was recovered: 655 heavily fragmented and abraded sherds were intermixed with the chipped stone and dispersed throughout the former dryland and boggy areas. A sample of 180 sherds represented four fabrics, with the large majority being undecorated body sherds. Two sherds are from Early Bronze Age beakers, one decorated with twisted cord impressions and the other with comb impressions. Only four others were decorated, three with incised lines and one with a row of nail impressions. Apart from the two beaker sherds, the assemblage is undiagnostic.

More than 10,000 pieces of wood charcoal were recovered, these also intermingled with the chipped stone in the former dryland and boggy areas. Eight samples of wood charcoal were selected for

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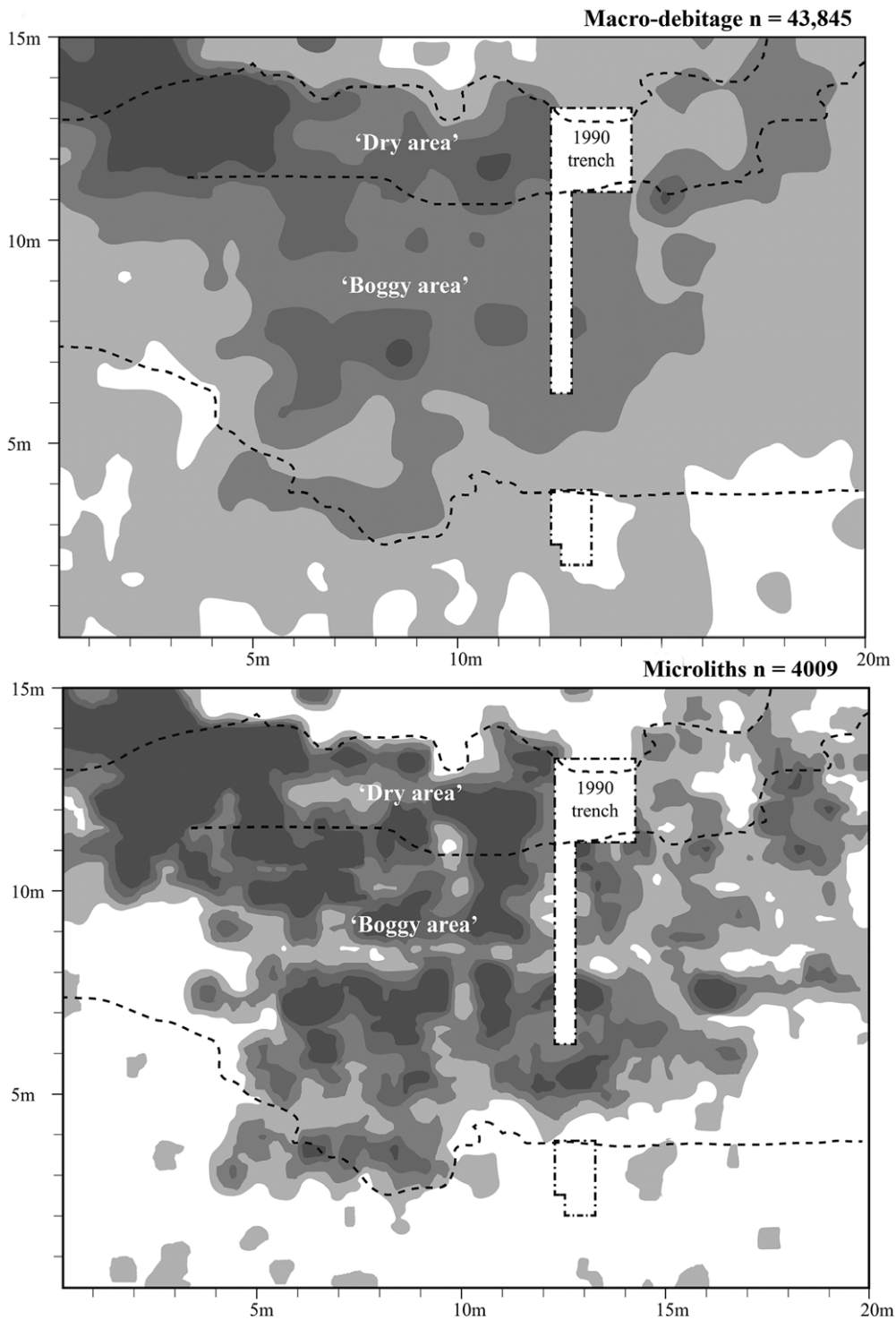

Fig. 5.
Macro-debitage and microlith distributions at Bolsay (after Mithen *et al.* 2000c).

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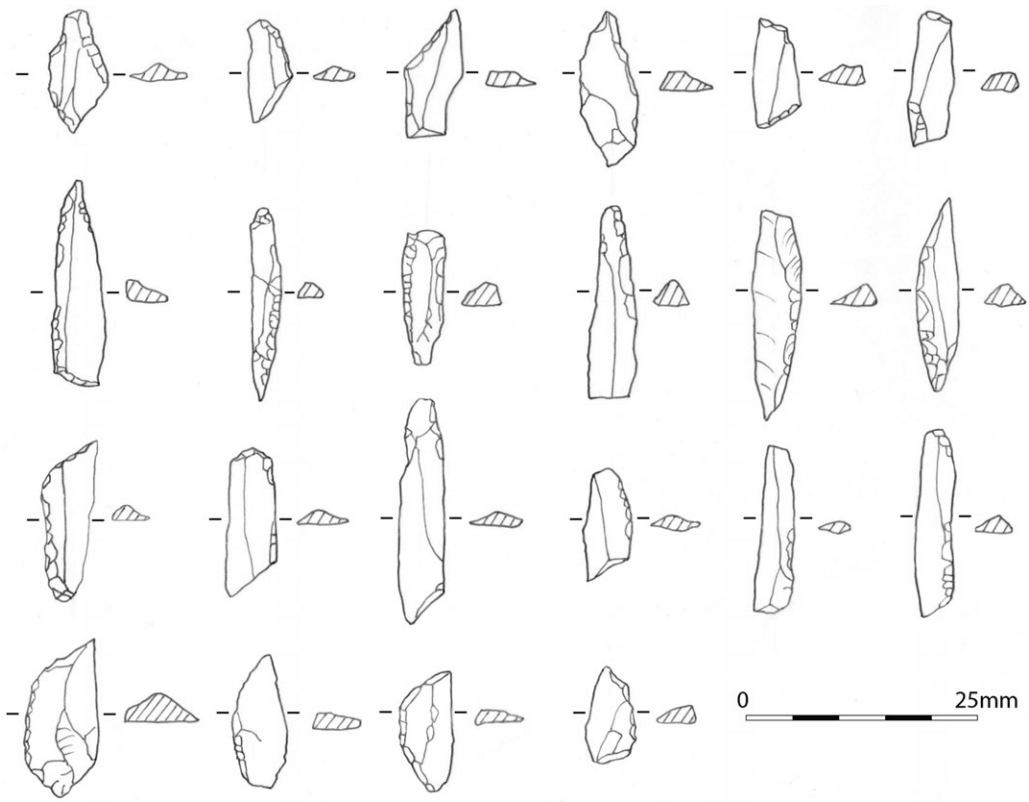

Fig. 6.
Selection of microliths from Bolsay (after Mithen *et al.* 2000b).

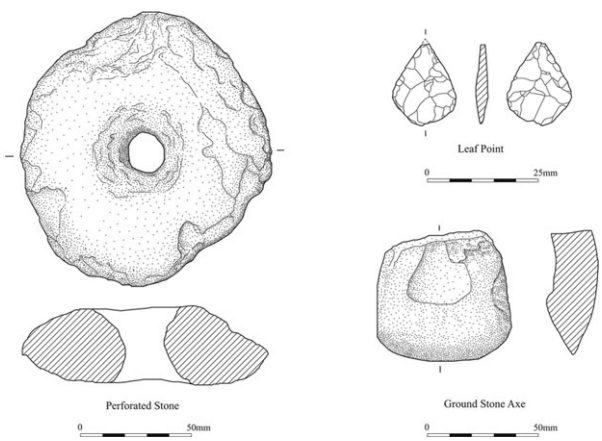

Fig. 7.
Perforated stone, leaf point and fragment of polish stone axe from Bolsay (Mithen *et al.* 2000c).

radiocarbon dating, supplementing the two dates acquired from the 1989 test-pit and 1990 trench, both of which were encompassed within the 1992, 20 × 15 m trench. The samples were randomly chosen from across the former dryland and boggy areas (Table 1). Of these, one indicated activity in the mid-7th millennium BC, one in the 6th millennium, four in the mid–late 4th millennium, and two in the 3rd millennium. The absence of 5th millennium dates is commensurate with the rarity of such dates throughout western Scotland, attributed to climate-induced population decline (Wicks & Mithen 2014; Mithen & Wicks 2021)

Storakaig

Storakaig lies 5 km to the east of Newton at *c.* 115 m OD (NR 3963 6264; CANMORE ID 304908) (Fig. 8). It consists of a *c.* 18 × 13 m area of organic-rich sediment underlain by clay and sealed by peaty topsoil, containing at least 80,000 NBI chipped stone artefacts intermixed with charred hazelnut shell and heavily calcined fragments of animal bone, primarily from red deer, roe deer, and

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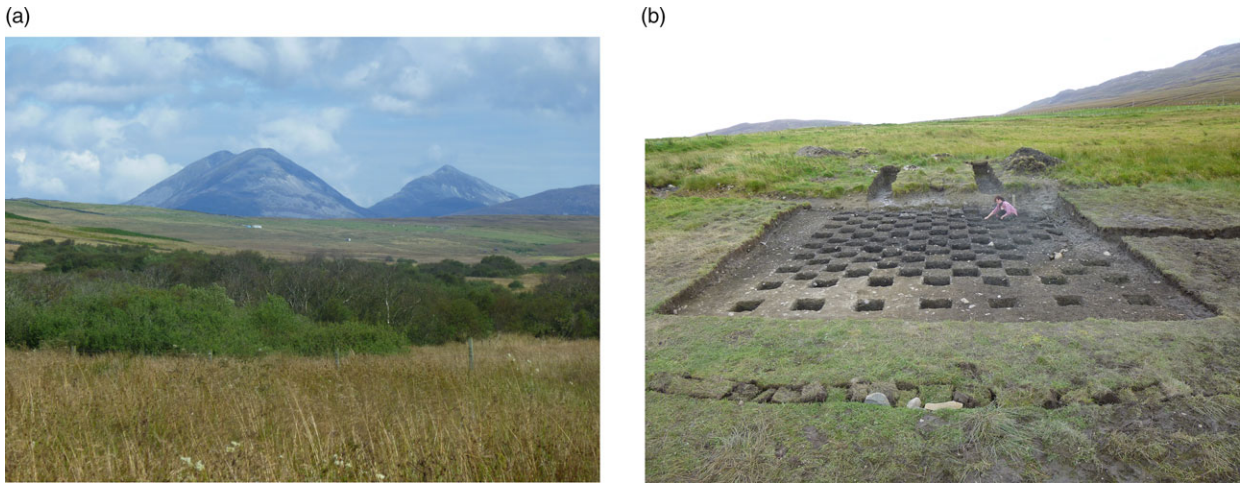

Fig. 8.
Excavation at Storakaig, August 2011. The site location is marked by the white polytunnel in the lefthand image (photo: Steven Mithen).

wild boar (Wicks *et al.* 2014). The site is interpreted as a repeatedly used, upland hunting camp.

Storakaig was sampled in 2010–11 by a 9.5 × 7 m trench located within its western extent. Twenty out of 7539 catalogued artefacts have characteristics suggestive of the Neolithic. These include relatively broad, regular blade fragments that may be retouched, used, and/or occasionally truncated. Several artefacts have regular invasive retouch, including two knives and various flakes, while others have ad hoc 'tangs', some of which also have invasive retouch. Such characteristics have been considered diagnostic of Neolithic assemblages (Edmonds 1995), although Islay lacks Neolithic chipped stone assemblages for a direct comparison. These artefacts were found scattered across the site, indistinguishable from the diagnostically Mesolithic artefacts in their condition and patination.

Eight radiocarbon dates were obtained from fragments of charred hazelnut shell recovered from within the artefact and bone-rich deposit (Table 1). The returned dates straddled the late 5th and early 4th millennia BC, suggesting activity was spread over 610 years, most likely taking the form of multiple short-term visits (Wicks *et al.* 2014). The 5th millennium dates overlapped with those from the Oronsay middens suggesting a mobile settlement pattern exploiting both coastal and terrestrial resources. Based on ethnographic records of hunter-gatherer mobility (Kelly 2013. table 4.1), the annual range of single residential group exploiting Islay and Oronsay would have also encompassed Raschoille Cave and Carding Mill Bay.

Nereabolls

Nereabolls chambered cairn is 2 km to the south-west of Bolsay and hence just 4 km south-west from the Port Charlotte cairn (NR 2015 5642; CANMORE ID 37355). This site was originally named Slochd Measach and is known locally as the Giant's Grave. Although partially obscured by peat growth, the cairn had evidently been extensively robbed and was in a poor state of preservation when surveyed by the RCHAMS (1984).

Survey and excavation were undertaken in 2015, 2016, and 2017 to investigate pre-cairn activity, the architecture of the Neolithic monument, and its use in later prehistoric and historic periods (Maričević 2017; Maričević & Mithen in prep.) (Fig. 9). Regarding pre-cairn activity, four areas of a buried soil were exposed at the base of trenches in different areas of the site. Three provided radiocarbon dates falling into the 4th millennium, while a further date of this period was acquired from the fill of the cut for the chamber (Table 1). The fourth area of exposed buried soil produced a leaf-shaped arrowhead and a flint flake, with charcoal that provided a 2nd millennium BC date.

When constructed, the monument had a chamber with four compartments, a massive façade, and cairn

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Fig. 9.
Excavation at Nereabolls chambered cairn, August 2011 (photo: Steven Mithen).

constructed with stone slabs and rubble that likely extended for 30 m in length. Activity in the forecourt had continued until 3368–3105 cal BC. Small cists for the deposition of pottery vessels had been constructed within the rubble of the partially collapse cairn during the 2nd and early 1st millennia BC, with extensive robbing and re-use of the site occurred during the latter half of the 1st millennium BC and recent times.

MESOLITHIC–NEOLITHIC OVERLAP ON ISLAY

The 21 4th millennium BC dates from Port Charlotte, Newton, Bolsay, Storakaig, and Nereabolls are plotted in Figure 10. These fall into four statistically consistent groups (Table 2), indicating that the activity represented within each group has a high likelihood of being contemporary.

Group 1 contains the four earliest 4th millennium dates from Storakaig, which have a combined date of 3967–3804 cal BC (95.4%). By virtue of a shared date (Beta-307790) this group overlaps with Group 2 that contains the two youngest dates from Storakaig, both dates from Newton, the two pre-cairn dates from Port Charlotte, and the earliest from Nereabolls. This group has a combined date of 3787–3654 cal BC (95.4%) but its value is constrained by the large margins of error associated with the Port Charlotte dates. Group 3 is quite separate, containing two dates from Bolsay, two from Port Charlotte and four dates from Nereabolls, with a combined date of 3521–3377 cal BC (95.4%). Similarly, Group 4, with single dates from Port Charlotte, Nereabolls, and Bolsay, is also distinct, with a combined date of 3364–3102 cal BC (95.4%). Whether the chronological gaps between Groups 2, 3, and 4 are meaningful or simply a chance consequence of the limited data set is unclear.

Groups 1 and 2 are consistent with a colonising model for the Mesolithic–Neolithic transition. The Group 1 radiocarbon dates are restricted to Mesolithic Storakaig, while the Group 2 dates include those from both Mesolithic Storakaig and Neolithic sites of Newton and Port Charlotte. This suggests that at 3787–3645 cal BC there were two populations on the island – indigenous hunter-gatherers and immigrant farmers. This represents, therefore, all or part of the population overlap for a 'maximum of a few centuries' as identified by Brace *et al* (2019, 770). Both Group 3 and Group 4 contain dates from Bolsay, Port Charlotte, and Nereabolls. The dates from the Mesolithic site of Lussa River on Jura overlap with those from Group 4 while also extending into the 3rd millennium because of their large uncertainties. The Group 3, Group 4, and Lussa River dates are open to three interpretations as to 'what happened next' in the Mesolithic–Neolithic interaction on Islay (Fig. 11):

Scenario 1: Swift succession. The swift succession scenario might otherwise be known as the conventional model for the Mesolithic–Neolithic transition: following a brief period of overlap, with some interbreeding and acculturation, the Mesolithic population became extinct. To be valid, this scenario requires all the NBI chipped stone at Bolsay to have been deposited prior to the mid-4th millennium. As such, the mid-4th millennium and later dates at Bolsay must either come from contaminated samples or derive from Neolithic and later activity at the abandoned Mesolithic site. This scenario also requires the 4th, 3rd, and 2nd millennium dates associated with NBI artefacts from Lussa River, Gleann Mor, and Rockside to be rejected as arising from either contaminated samples or redeposited material.

Scenario 2: Dual population. This scenario might also be termed the 'long Mesolithic': the Mesolithic population continued to co-exist with that of the Neolithic throughout the 4th millennium with a limited extent of gene flow and acculturation. The Mesolithic population continued making NBI tools, as associated with the mid-4th millennium and later dates at Bolsay and Lussa River. In this scenario,

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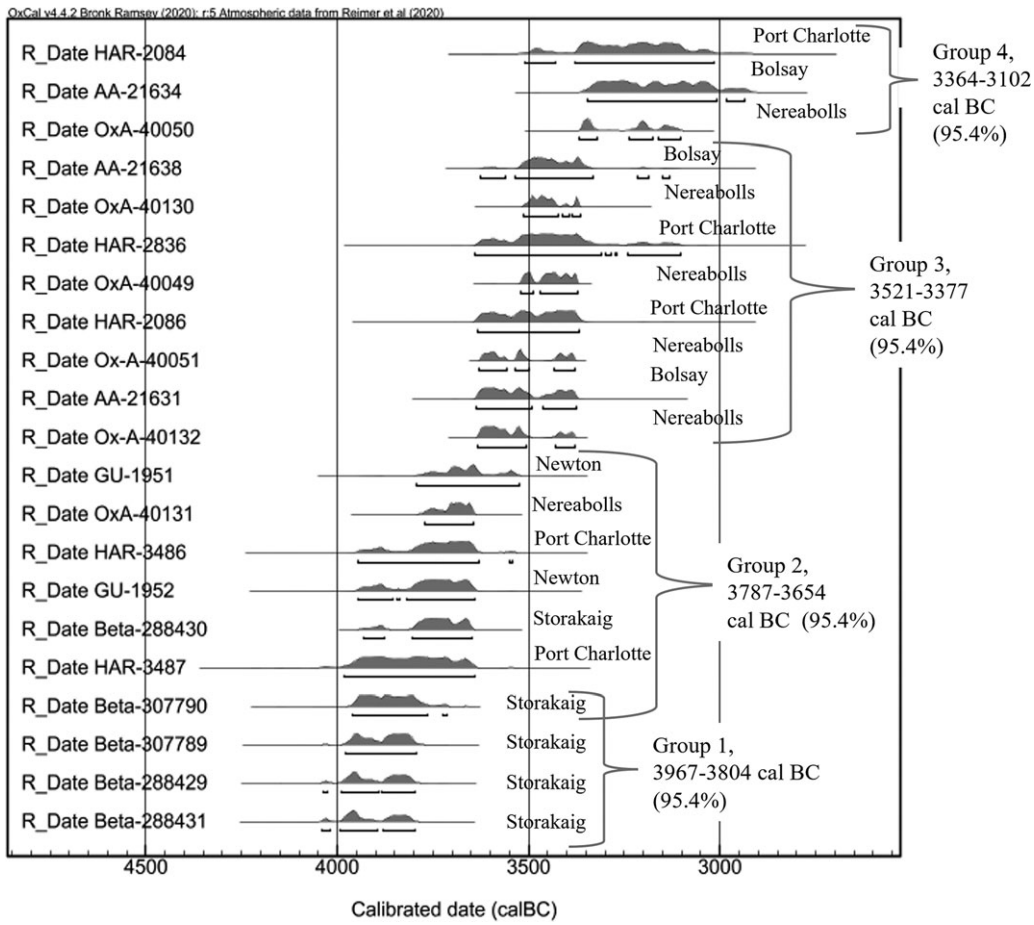

Fig. 10.
4th millennium radiocarbon dates from Islay (see Table 1). Intcal20 (Reimer *et al.* 2020); OxCal (Bronk Ramsay 2001, http://c14.arch.ox.ac.uk/oxcal.html).

the ecologically attractive location of Bolsay was used on different occasions by different populations, the Mesolithic continuing to deposit NBI artefacts and the Neolithic discarding a few of their flint artefacts and a broken axe head (unless these has also been made by the Mesolithic people following acculturation). Assuming the axe head is Neolithic, its flake scars suggest it may have been found by a Mesolithic occupant who utilised it as a platform core. Mercer (1971) had implicitly invoked this dual population scenario when he suggested that the relatively high use of local quartz on Jura at the NBI site of Lussa River was because the Islay flint deposits were now in 'Neolithic territory'. An extreme version of this scenario would suggest a 'very long Mesolithic', by accepting the 3rd and 2nd millennium BC dates associated with NBI technology at Gleann Mor, Rockside, and Bolsay as indicative of the continued existence of a hunter-gatherer population.

Scenario 3: Biocultural merger. This scenario proposes the Mesolithic and Neolithic communities merged into a single population by combining both their genes and culture during the 4th millennium. It envisages a single, mobile population on Islay and throughout western Scotland with a blend of Mesolithic and Neolithic traits: hunting, gathering, and fishing, while also herding cattle and sheep; using both microliths and leaf points, making pottery, constructing crannogs and chambered cairns. The Neolithic component is likely to have been relatively high in the Outer Hebrides where Mesolithic settlement appears to have been sparse – although that

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TABLE 2: 4TH MILLENNIUM GROUPING OF DATES FROM ISLAY

Group	*Statistically consistent dates*	*Calibrated combined date*
1	Beta-288431 (Storakaig) Beta-288429 (Storakaig) Beta-307789 (Storakaig) Beta-307790 (Storakaig)	95.4% probability 3967 (32.3%) 3912 cal BC 3877 (63.2%) 3804 cal BC X^2 df = 3, T = 1.8 (5% 7.0)
2	Beta-307790 (Storakaig) HAR-3487 (Port Charlotte) Beta-288430 (Storakaig) GU-1952 (Newton) HAR-3486 (Port Charlotte) OxA-40131 (Nereabolls) GU-1951 (Newton)	95.4% probability 3787 (75.8%) 3699 cal BC 3684 (19.6%) 3654 cal BC X^2 df = 6, T = 9.5 (5% 12.6)
3	OxA-40132 (Nereabolls) AA-21631 (Bolsay) OxA-40051 (Nereabolls) HAR-2086 (Port Charlotte) OxA-40049 (Nereabolls) Har-2836 (Port Charlotte) OxA-40130 (Nereabolls) AA-21638 (Bolsay)	95.4% probability 3521 (24.2%) 3494 cal BC 3457 (71.2%) 3377 cal BC X^2 df = 7, T = 13.2 (5% 14.1)
4	OxA-40050 (Nereabolls) AA-21634 (Bolsay) HAR-2084 (Port Charlotte)	95.4% probability 3364 (29.2%) 3317 cal BC 3239 (66.3%) 3102 cal BC X^2 df = 2, T = 2.5 (5% 6.0)

may reflect limited fieldwork in a landscape not conducive to finding pre-4th millennium artefact scatters (Piper *et al.* 2018). This scenario suggests we should refer to the mid-4th to the mid-3rd millennia BC as the 'Neomesolithic' – an explicit recognition of biocultural merger.

EVALUATION

Each of these scenarios is a feasible interpretation of the evidence for Mesolithic–Neolithic interbreeding and the radiocarbon dates from Islay. To evaluate which is most likely we need to consider their use of radiocarbon dates and by placing Islay into the wider context of western Scotland, Britain and continental Europe.

Cherry-picking or an uncritical acceptance of dates?

Each scenario involves a level of risk regarding either cherry-picking supportive radiocarbon dates or uncritically accepting dates that may be contaminated or derive from redeposited material. The swift succession scenario must explain why 12 single entity samples from contexts associated with NBI technology fall into the mid-4th millennium BC or later, these coming from Bolay, Lussa River, Gleann Mor, and Rockside, none of which was identified as potentially contaminated by the laboratories and, when available, their δ^{13} values are within the expected range. Citing 'contamination' for these samples but not others might be considered as cherry-picking dates that conform to chronological preconceptions while rejecting others that challenge the conventional notion of a swift Mesolithic–Neolithic succession. Otherwise, why would seven of the dates from Bolsay be contaminated but not the remaining three? Why would two of the dates from Rockside be contaminated but not the third?

An alternative means to sustain the swift succession scenario is to claim the post-mid- 4th millennium dates at Bolsay, Gleann Mor, Rockside, and Lussa River are intrusive into Mesolithic deposits from later prehistoric activity. Other than at Bolsay there is no evident case for this because there is no known later prehistoric activity within the vicinity of Gleann Mor, Rockside, and Lussa.

Might post-depositional disturbance at Bolsay have mixed-up charcoal from Neolithic and later activity

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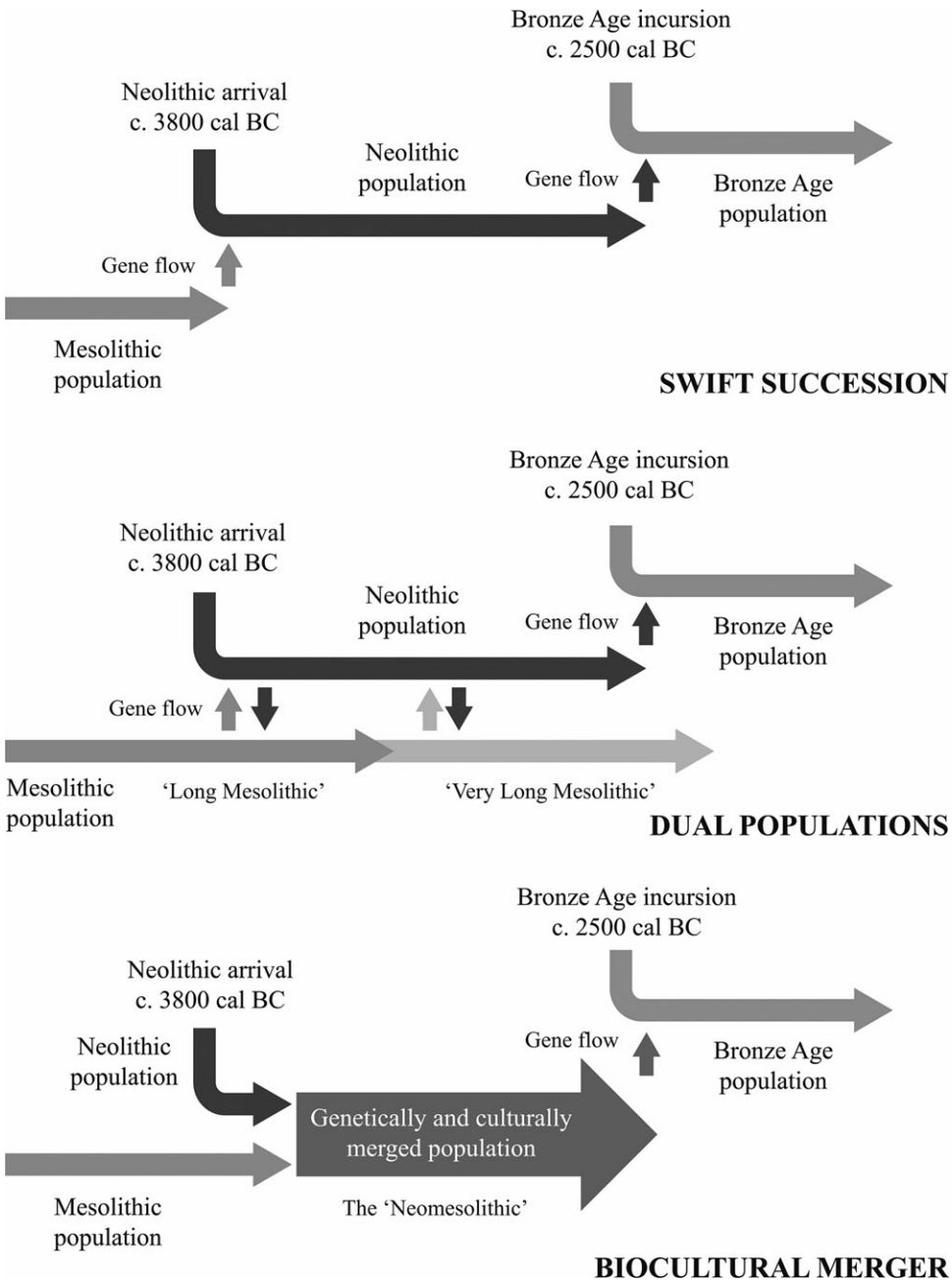

Fig. 11.
Three scenarios for Mesolithic–Neolithic interaction on Islay and western Scotland.

with the NBI artefacts deriving from 6th millennium and earlier Mesolithic activity? The seven 4th and 3rd millennium dates are difficult to accept as intrusive. How would such marginally represented Neolithic activity in this area – just two diagnostic Neolithic artefacts compared to almost 12,000 from the Mesolithic (microliths, microburins, and truncations) – generate 70% of the radiocarbon dates when the samples were randomly selected from over 10,000 pieces of wood charcoal/charred hazelnut

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shell? One might imagine a large Neolithic fireplace generating considerable quantities of charcoal which then became dispersed by post-deposition mixing. This, however, would be special pleading and fails to accord with the evidence. There are no traces of large fireplaces and the character of the Bolsay wood charcoal and charred hazelnut shell – its fragmentation, species representation, pervasive and unform distribution – is entirely consistent with that found at Mesolithic sites elsewhere on Islay, such as Storakaig, Gleann Mor, and Rubha Port an t-Seilich.

Neither the dual population nor the biocultural merger scenarios need to 'explain away' the post-mid-4th millennium dates from Bolsay and Lussa River by contamination or intrusive charcoal. Both models could also accommodate the 3rd and 2nd millennium dates from Gleann Mor and Rockside as indicative of a 'very long Mesolithic' (for the dual population) or the continuation of NMI technology within a merged population (bioculture merger).

Accounting for settlement and economic continuity in western Scotland

The swift-succession scenario appears incongruous with the evidence for settlement and economic continuity between the Mesolithic and Neolithic throughout western Scotland (Armit & Finlayson 1992; 1996; Mithen *et al.* 2007). On Islay, this is represented at Bolsay and at 14 undated artefact scatters containing NBI and non-NBI technology (Mithen *et al.* 2000b; 2000c). At Kinloch, Isle of Rum, the archaeological remains attributed to the Mesolithic and Neolithic are almost identical in terms of their chipped stone technology and types of features, although microliths and blades are less common in the Neolithic component (Wickham-Jones 1990); a bifacially worked leaf point was recovered from a pit containing charred hazelnut fragments. Both Mesolithic and Neolithic people used the shell midden sites of Oronsay (Mellars 1987), Ulva Cave (Bonsall *et al.* 1991; 1992), and An Corran (Saville *et al.* 2012), although the sites may have been used for different purposes (Milner & Craig 2009). At Risga, a leaf-shaped arrowhead made from Rum bloodstone was recovered from the shell midden (Pollard 2000), while a flake from a polished stone axe of Antrim porcellanite was found within the microlithic scatter at Lussa Wood, Jura (Mercer 1968). Although there are traces of Mesolithic settlement in the Western Isles (eg, Church *et al.* 2011; 2012; Bishop *et al.* 2013), that available is too sparse to comment on Mesolithic–Neolithic settlement continuity. Intriguingly, occupation may have begun at Eilean Dòmhnuill on North Uist prior to 3720–3510 cal BC (Copper & Armit 2018) and, hence, has the possibility of being Mesolithic.

The dual population scenario explains such technological mixes by use of the same location on different occasions by contemporary Neolithic and Mesolithic populations, living within separate communities but with a sufficient degree of interbreeding to have created the Raschoille Cave genome. The biocultural merger scenario suggests there is a single population with a chipped stone technology that made both microliths and leaf points.

Use of the same locations in western Scotland need not imply continuity in diet and economy. Schulting and Richards (2002; Richards & Schulting 2006) used isotopic analysis of human remains to argue the Neolithic people had excluded marine foods from their diet, these being a Mesolithic mainstay. Their conclusion has been challenged on methodological grounds (Milner *et al.* 2004), claiming it to be partially incorrect for 'Neolithic' individuals at An Corran (Milner & Craig 2009) and Carding Mill Bay (Bownes *et al.* 2017) but with Schulting *et al.* (2022) arguing the Carding Mill Bay re-analysis is methodologically invalid. Whatever the correct interpretation of the isotopic data, the quantity of samples remains too sparse to make generic statements about Mesolithic and Neolithic diet in the coastal regions of western Scotland, especially for the entire duration of these periods.

The rarity of Neolithic archaeobotanical assemblages from western Scotland also leaves the contributions of plants to the Neolithic diet, and overlap or otherwise with that of the Mesolithic, as unresolved. Bishop *et al.* (2009, 87) noted an absence of cereal remains from the west coast of mainland Scotland and the Inner Hebrides although a single grain of barley has since been recovered from Nereabolls. Bishop *et al.* (2009) also noted a continued use of hazelnuts in the Neolithic. A possible indication of continuity comes from Staosnaig, Colosany. Its scale of hazelnut shell exploitation, with their shells potentially used as a glowing fuel source within a large pit (Mithen *et al.* 2001; Mithen 2019), suggests feasting of a type not dissimilar to that

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proposed for the Neolithic in the Outer Hebrides (Copper & Armit 2018).

Interbreeding and the maintenance of demographic viability and food security

The swift succession scenario assumes interbreeding occurred soon after the Neolithic arrival and was quickly followed by the extinction of the Mesolithic population and culture. The dual population scenario allows for a longer period of interbreeding on an intermittent basis between independent populations; if such interbreeding was frequent, any meaningful distinction between the populations would collapse leading to biocultural merger. While interbreeding may have arisen for several reasons, one motivation – whether consciously articulated or not – may have been to sustain the demographic viability of a local community, whether Mesolithic or Neolithic.

As noted above, the Mesolithic population of western Scotland is always likely to have been demographically fragile, only just above the minimum viable threshold of *c*. 150 persons. As White (2017) explained, the viability of small populations can be enhanced by relaxing marriage rules. While he was writing about rules within a hunter-gatherer population, the relaxation of rules between populations/cultures would also compensate for the random and potentially fatal fluctuations in the balance of males and females of reproductive age. Interbreeding with a migrant Neolithic group may, therefore, have been a group decision made by a demographically fragile Mesolithic community. An alternative perspective is that of Mesolithic individuals, whether male or female, seeking to follow the Darwinian imperative of ensuring their own reproductive success by interbreeding with Neolithic migrants.

Likewise, for the Neolithic migrants themselves – they too needed to remain demographically viable. With the notoriously treacherous coastal waters of western Scotland it is difficult to envisage large numbers of colonists having originally arrived in western Scotland, nor for that population to have been continually replenished by new arrivals. Other than the chambered cairns, which may have been constructed soon after arrival, the Neolithic population on Islay is almost invisible, with only Newton and sparse finds of leaf points suggesting a presence. The conservatism of Hebridean pottery in the Outer Hebrides throughout the 4th millennium BC (Copper & Armit 2018) also suggests a low population density, one lacking the capacity for innovation and change (cf. Shennan 2001). The proposed collapse in Neolithic populations throughout Britain and Europe that occurred a few centuries after initial colonisation (Collard *et al.* 2010; Shennan *et al.* 2013; Bevan *et al.* 2017; Colledge *et al.* 2019) may have been a cause of, or further exacerbated, the marginal viability of the Neolithic population in western Scotland.

The proposed collapse is based on the analysis of summed calibrated probability distributions of radiocarbon dates from 12 regions of Europe, involving rigorous statistical tests to control for sampling variation and features of the calibration curve (Shennan *et al.* 2013). Having shown a marked boom in the inferred population during the first half of the 4th millennium BC, reflecting Neolithic immigration and farming, Scotland has one of the most significant collapses seen within Europe. The reason for the European-wide collapse remains unclear, although soil degradation from intensive cereal cultivation and a shift to greater reliance on livestock systems appear significant (Steven & Fuller 2012; 2015; Bishop 2015; Colledge *et al.* 2019), Bevan *et al.* (2017) favour a climate driven population collapse. As Shennan *et al.* (2013, 4) note, irrespective of the cause, Neolithic population decline would have inevitably influenced their economy and society. It may have driven local communities to relax their marriage rules to allow interbreeding with local Mesolithic groups and/or motivated individuals to interbreed to maintain their own reproductive success.

The Neolithic population of western Scotland may have also been impacted by local environmental factors. While there is no consistent pattern towards or away from warmer and wetter conditions in the late 4th millennium BC (Schulting 2010), Tipping (2010) suggests that climatic instability may have been significant – just as we see today with local communities challenged by alternating periods of droughts and flooding. Sediment cores from Islay indicate notable periods of storminess at 3955–3810 and 3255–3040 BC (Kylander *et al.* 2020). The likely failure of initial attempts at cultivation at Newton (McCullagh 1989) might be an example of the wider decline of cereal farming as identified by Stevens and Fuller (2012), even if cereal farming continued longer on other Scottish islands than it did on the mainland (Bishop 2015; Stevens & Fuller 2015). This may have driven the Neolithic migrants on Islay and elsewhere in western

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Scotland to supplement their pastoralism with hunting and gathering – for which they may have required Mesolithic-type knowledge and technology.

Dual population and biocultural merging in continental Europe

It is useful to reflect on the Mesolithic–Neolithic interaction scenarios for western Scotland from the perspective of continental Europe, where the genomic database is substantially larger. This indicates Mesolithic populations had a longer, varied, and more profound impact on the Neolithic than initial interpretations of demic diffusion and swift-succession scenarios implied (Lipson *et al.* 2017).

The 'hunter-gatherer resurgence' in Neolithic genomes within continental Europe at *c.* 4500 BC indicates that after initial Neolithic colonisation, dual populations were present for centuries throughout the region, with the Mesolithic hunter-gatherers remaining archaeologically invisible (Brandt *et al.* 2013; Haak *et al.* 2015; Lipson *et al.* 2017; Fernandes *et al.* 2018; Jensen *et al.* 2019; Rivollat *et al.* 2020). Detailed analysis of the genomic data indicates the hunter-gatherer resurgence arose from multiple local populations of hunter-gatherers rather than from one source (Lipson *et al.* 2017; Lazaridis 2018), resulting in a complex pattern of population interactions (Fernandes *et al.* 2018).

Analysis of genomic-data from 101 individuals from France and Germany by Rivollat *et al.* (2020) confirmed the long period of co-existence between LBK and hunter-gatherer populations in south-west Germany – a dual population scenario. Relatively swift biocultural merger appears more applicable to southern Europe where the genomes of the Neolithic colonists have a significantly higher Mesolithic contribution than those in continental Europe. Neolithic material culture was also more evidently influenced by that of the Mesolithic in southern Europe, with observations by Rivollat *et al.* (2020) building on Guilaine and Manen's (2007) notion that Mesolithic population has 'perpetuated' itself in the Neolithic system.

The existence of dual populations within restricted regions of northern Europe is illustrated by those on Gotland during the 4th and early 3rd millennia BC (Fraser *et al.* 2018). Two groups co-existed for several hundred years with separate cultural identities, lifestyles, and dietary patterns, one with greater use of marine protein and deriving from an indigenous Mesolithic population and the other reliant on terrestrial sources and arising from migrant farmers, the Pitted Ware Culture and Funnel Beaker Cultures respectively. The extent of genetic admixture is yet to be determined (Fraser *et al.* 2018, 331). At *c.* 3000 km^2, Gotland fits comfortably into the area of the Inner Hebrides (*c.* 4000 km^2) and is approximately the same latitude north as the Isle of Islay. A site specific example is the burial site of Blätterhöhle, Germany. A combination of isotopic and genomic analysis demonstrated the co-existence of a Neolithic farming community and a 'Neolithic' foraging and fishing community for over 2000 years, with the latter having a much higher degree of Mesolithic ancestry (Bollongino *et al.* 2013). Such location sharing provides a precedent for that at Bolsay within the dual population scenario for western Scotland.

Mathieson *et al.* (2015) note the hunter-gatherer resurgence is also represented by the re-appearance in Europe of the Mesolithic tradition of extended supine burial, this replacing the Early Neolithic tradition of flexed burial and suggesting a shift towards complete biocultural merger. This appears to have been driven by the movement of hunter-gatherer males into the farming communities (Gamba *et al.* 2014; Mathieson *et al.* 2015). Such integration may have been for the provision of hunter-gatherer environmental knowledge and technology into Neolithic communities, as proposed by González-Fortes *et al.* (2017). They detected a cline across eastern Europe with greater Mesolithic–Neolithic genetic admixture in northern regions, suggesting a 'progressive mixing with local hunter-gatherers and the acquisition of local knowledge'. That might also be applicable to the far north-west of Europe, with the environmental knowledge of Mesolithic hunter-gatherers in western Scotland being an attractive resource for the Neolithic immigrants to acquire, especially in the context of demographic stress and food insecurity from farming.

Ethnographic analogies

The feasibility of both dual population and bioculture merger is evident from the ethnographic record. This has well-documented studies of hunter-gatherers living alongside farmers, with the exchange of material goods and food items (eg, Turnbull 1965), as might

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have occurred with a dual population model for Neolithic western Scotland. Ahedo *et al.* (2021) found that mixed farming-foraging economies constitute 25% of 1290 societies documented in the Ethnographic Atlas, the majority of which also contained a fishing component. Such mixed economies are ethnographically well documented in south-east Asia (Barton 2014) and North America (Spielmann 2014), where clear-cut dichotomies between farmers and foragers are rare and it is common for groups to switch between a predominance of hunting and gathering to agriculture, and then back again.

CONCLUSION

A swift succession from the Mesolithic to the Neolithic without interbreeding appears to have occurred throughout the whole of Britain except for western Scotland (Brace *et al.* 2019). That region may have also experienced a swift succession following a brief period of interbreeding during a short period of population overlap, identified on Islay as encompassing 3787–3654 cal BC. Swift succession in the Inner Hebrides is questioned, however, by the cluster of 4th millennium dates associated with the NBI artefacts at Bolsay and Lussa River. Those dates require the consideration of alternative scenarios: an extended period of dual populations and biocultural merger. I find no reason to reject the NBI associated 4th millennium dates from Bolsay as arising from either contamination or post-depositional mixing, and feel inclined to accept the 4th, 3rd, and 2nd millennium dates associated with NBI artefacts from Lussa River, Gleann Mor, Rockside, and Bolsay. Despite evidence for the co-existence of Mesolithic and Neolithic populations for over 2000 years in continental Europe, an extended period of population overlap in western Scotland seems unlikely considering the arguments about demographic stress for any single population in this region. Consequently, I cautiously favour biocultural merger. This appears the most likely scenario in the context of: 1) settlement and economic continuity in western Scotland; 2) mid-4th millennium Neolithic population collapse, climatic instability; and 3) the evident complexity of Mesolithic–Neolithic population interactions elsewhere in continental Europe. Others are likely to favour the swift succession model, arguing – correctly – that the data remain inconclusive and more evidence from genomic studies, radiocarbon dating, and fieldwork is required. Until that is available, the mid-4th to the mid-3rd millennia BC on Islay, if not throughout western Scotland, appears best described as the Neomesolithic.

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RÉSUMÉ

Combien de temps a duré la transition Mésolithique/Néolithique dans l'ouest de l'Écosse? Des témoins du IV^e millénaire avant J.-C. sur l'île d'Islay et l'évaluation de trois scénarios pour l'interaction Mésolithique/Néolithique, par Steven Mithen

Les études sur l'ADN ancien ont identifié l'Ouest de l'Écosse comme la seule région connue en Grande-Bretagne où des métissages ont eu lieu entre les migrants néolithiques du début du IV^e millénaire av. J.-C. et la population mésolithique indigène. En m'appuyant sur les fouilles de sites mésolithiques et néolithiques de l'île d'Islay, j'identifie une période de chevauchement des populations et je suggère trois scénarios d'interaction Mésolithique/Néolithique: succession rapide, population duale et fusion bio-culturelle. Ces scénarios sont évalués par rapport aux preuves archéologiques d'Islay et d'ailleurs dans l'Ouest de l'Écosse et comparés aux modèles d'interaction Mésolithique/Néolithique en Europe continentale. Une préférence prudente est exprimée pour la fusion bio-culturelle, qui se produit entre le milieu du IV^e et le milieu du III^e millénaire av. J.-C., une période que l'on pourrait appeler le 'Néomésolithique'.

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ZUSAMMENFASSUNG

Wie lange überlappten Mesolithikum und Neolithikum in Westschottland? Hinweise aus dem 4. Jahrtausend BC *auf der Insel Islay und die Bewertung von drei Szenarien für mesolithisch-neolithische Interaktion*, von Steven Mithen.

Westschottland wurde in aDNA-Untersuchungen als die einzige bekannte Region in Großbritannien identifiziert, in der es zu einer Vermischung zwischen neolithischen Einwanderern aus dem frühen 4. Jahrtausend v. Chr. und der einheimischen mesolithischen Bevölkerung kam. Anhand von Ausgrabungen mesolithischer und neolithischer Fundorte auf der Isle of Islay ermittle ich eine Periode der Überlappung der Bevölkerungen und schlage drei Szenarien für die mesolithisch-neolithische Interaktion vor: rasche Abfolge, zweiteilige Population und biokulturelle Fusion. Diese Szenarien werden anhand der archäologischen Daten von Islay und anderer Orte in Westschottland sowie unter Bezugnahme auf die Muster der mesolithisch-neolithischen Interaktion in Kontinentaleuropa bewertet. Es wird eine vorsichtige Präferenz für die biokulturelle Verschmelzung geäußert, die zwischen der Mitte des 4. und der Mitte des 3. Jahrtausends v. Chr. stattfand, eine Periode, die als „Neomesolithikum" bezeichnet werden könnte.

RESUMEN

¿Cuánto duró el solapamiento entre el Mesolítico y el Neolítico en el oeste de Escocia? Evidencia del IV milenio BC *en la Isla de Man y la evaluación de los tres escenarios para la interacción entre el Mesolítico y el Neolítico,* por Steven Mithen.

Los estudios de ADN han identificado en el oeste de Escocia la única región en Gran Bretaña donde se produce la interacción entre los primeros inmigrantes neolíticos y la población mesolítica indígena a principios del IV milenio BC. A través de las excavaciones en los sitios mesolíticos y neolíticos de la Isla de Islay, he identificado un período de superposición poblacional y he sugerido tres escenarios para la interacción Mesolítico–Neolítico: sucesión rápida, poblamiento dual y fusión biocultural. Estos escenarios se evalúan en función de la evidencia arqueológica de Islay y, en general, en el oeste de Escocia, con referencia a los patrones de interacción Mesolítico-Neolítico en la zona continental europea. Una preferencia conservadora es la marcada por la fusión biocultural, que ocurre entre mediados del IV y del III milenio BC, un período que se podría denominar 'Neomesolítico'.

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