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Cereals, fruits and nuts in the Scottish Neolithic

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ABSTRACT

The importance of wild and domestic plants within British Neolithic economies has been much disputed but the contribution of the Scottish archaeobotanical evidence has previously been understated. This paper assesses the use of plants in the Scottish Neolithic economy using the archaeobotanical evidence from 75 sites. It is argued that plant exploitation was geographically and socially diverse in Neolithic Scotland; while domestic plants became the mainstay of the economy for some social groups, wild plant exploitation remained an important part of the subsistence strategies of other groups. In this context, geographic, social and temporal differences in the importance of wheat and barley are also discussed.

INTRODUCTION

Traditional Western thought has perceived hunter-gathering and farming as diametrically opposed economic and social systems, with the transition between these two ways of life occurring during a period of abrupt change during the Neolithic (Pluciennik 2002, 115; Stevens 2007, 375). However, this dichotomy has been questioned, and there has been increasing recognition that Mesolithic hunter-gatherers may have undertaken similar levels of plant exploitation to Neolithic farmers, through the active management of wild resources (Harris 1989; Zvelebil 1994). At the same time, the realisation that not all aspects of the so-called 'Neolithic package' of traits – monuments, pottery, permanent houses, and domestic plants and animals – occurred simultaneously throughout Europe, calls into question the idea that all European Neolithic societies were centred around sedentary settlements and the large-scale cultivation of domestic crops (Armit & Finlayson 1992, 671; Barrett 1994; Armit & Finlayson 1996, 287; Thomas 1996; 1999, 7–17; Whittle 1999; Thomas 2003, 72; 2004; 2008, 70).

In Britain, the nature of Neolithic subsistence strategies has been rigorously debated. While some have favoured the idea that settled agriculture was the main form of subsistence (Cooney 1997; Rowley-Conwy 2000; 2002; Barclay 2003a; Rowley-Conwy 2004; Warren 2004; Noble 2006, 22; Sheridan 2007, 381), others have argued that Neolithic communities lived in temporary settlements, focusing on the use of wild resources (Moffett et al 1989; Armit & Finlayson 1992; Barrett 1994; Armit & Finlayson 1996; Thomas 1996; 1999; Whittle 1999; Thomas 2003; 2004; 2007b, 334). Others have taken a middle position, favouring geographical diversity and viewing mainland populations as semi-mobile or transhumant farmers (Brophy 2006). This debate has developed for a number of interrelated reasons.

First, assumptions concerning the extent to which social or economic factors were responsible for driving change in the past have resulted in differing interpretations of the available archaeological evidence.

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Consequently, while some have assumed that the development of a monument-building society in the Neolithic required a prior shift to agriculture (eg Rowley-Conwy 2004), others have viewed the transition to agriculture as a secondary development contingent upon social and cultural change (eg Hodder 1990; Thomas 1999; 2003). Conversely, others have downplayed the level of social change that was necessary prior to the adoption of agriculture, suggesting that hunter-gatherers adopted agricultural practices to some extent within existing social systems (Armit & Finlayson 1992, 671).

Second, the settlement and archaeobotanical evidence from Neolithic Britain is highly ambiguous. In contrast to later periods, many archaeobotanical assemblages from Neolithic England contain significant quantities of hazelnut shell with relatively insubstantial quantities of charred cereal grains, which has led some researchers to suggest that wild rather than domestic resources were of greater importance in Neolithic plant subsistence strategies (Moffett et al 1989; Thomas 1996; 1999; Robinson 2000; Thomas 2003; 2004, 120; 2007b, 334). However, it is very difficult to determine the scale of cultivation because taphonomic processes may have resulted in an overrepresentation of wild plants in the archaeological record (Jones 2000; Rowley-Conwy 2004; Jones & Rowley-Conwy 2007). Likewise, while there is evidence that substantial stone- and timber-built structures existed in Neolithic Britain, much of the settlement evidence is highly ephemeral, consisting of scatters of pits, artefacts and stake-holes that suggest temporary rather than permanent settlement (Thomas 1996). The domestic status of the large timber 'hall'-like structures has also been questioned, with some arguing that they represent ritual focuses for an otherwise mobile society (Thomas 1996, 12; Topping 1996, 166; Thomas 2003, 71; 2004, 123; 2007b, 34; 2008, 32) or structures providing a central social focus for semi-mobile communities (Noble 2006, 59; Brophy 2006, 35; 2007, 89).

Despite these detailed debates, most discussions about the Neolithic economy in Britain have remained essentially theoretical, have failed to collate or analyse much of the available archaeobotanical evidence and have instead focused on a narrow range of published and outdated archaeobotanical reviews of English sites. While there have been some detailed reviews of Neolithic archaeobotanical evidence in some parts of Britain (Moffet et al 1989; Robinson 2000; Brown 2007; Jones & Rowley-Conwy 2007), much of the evidence for Neolithic plant use in Scotland has been ignored in debates about the British Neolithic economy. For example, the most recent and comprehensive review of British Neolithic plant remains by Jones and Rowley-Conwy (2007), only included 14 Scottish sites and Brown's (2007) analysis of the radiocarbon dates from British Neolithic sites with cereals totalled just 28 Scottish sites.

To some extent this situation can be seen as a result of the great expansion in the number of archaeobotanical studies undertaken on Scottish Neolithic sites in the last ten years, as a result of the large increase in developer-funded archaeology in Scotland, and the absence of a detailed regional review of plant remains written by specialists on Neolithic Scotland. As a result, general discussions about the Scottish Neolithic economy (eg Kinnes 1985; Boyd 1988; Dickson & Dickson 2000; Barclay 2003a; Noble 2006), have understated the available published archaeobotanical data, despite the fact that by 2000 there were at least 28 published sites (Tables 1 & 3) available for comparison and synthesis. This has contributed to the impression that little archaeobotanical evidence actually survives in Neolithic Scotland and that a broad-brush approach can be applied to the Neolithic economy of Britain as a whole.

Moreover, this reluctance to incorporate Scottish archaeobotanical evidence into discussions about the British Neolithic economy can be seen as a result of a number of more general theoretical misconceptions. Traditionally, the

Scottish Neolithic economy has been regarded as marginal and the availability of productive arable land in Neolithic Scotland has often been underestimated due to inaccurate reconstructions of the Neolithic environment – dividing Britain into a productive 'Lowland' and unproductive 'Highland' – which has been portrayed as being largely unsuitable for agricultural settlement (Barclay 2001, 8–9; Barclay 2004, 31–3). There has also been an Anglocentric focus on the South of England in the writings about the *British* Neolithic economy, with the exclusion or piecemeal inclusion of evidence from the other constituent parts of the British Isles that have been erroneously considered as peripheral and insignificant (Cooney 1997, 23; Barclay 2001; 2004; 2009).

Given the lack of evidence for substantial buildings and cereal assemblages in Southern England – the 'core' area of Britain – it has been assumed that this situation was the same in the more 'peripheral' areas of Britain (Cooney 1997, 23; Barclay 2004, 35; Sheridan 2003, 3; 2007, 465; Barclay 2009, 2). With the increasing acceptance that subsistence practices in Neolithic Britain were not uniform (Thomas 1999, 7; Fairbairn 2000, 110; Thomas 2004, 120; 2007b, 425), it seems simplistic to assume that the English evidence can be extrapolated to stand for the economic practices in the whole of Britain. Unlike the situation in England, there are now at least four large Neolithic timber longhouses in mainland Scotland (Richardson & Kirby 2006, 14), numerous stone-built settlements in Orkney and Shetland (Whittle et al 1986; Card 2005a, 48) and consistent evidence for smaller-scale permanent settlement in mainland Scotland (Barclay 1996; 2003a; 2003b; Brophy 2006, 18). While it is recognised that the 'Scottish Neolithic' as an entity probably never existed and that it is simply an arbitrary division reflecting modern political boundaries (Kinnes 1985, 16), it is clear that the nature of the Scottish Neolithic economy cannot be assessed on the basis of the English archaeobotanical evidence.

This review seeks to show that a diversity of subsistence practices existed within Neolithic Scotland, through the detailed analysis of the archaeobotanical data from 75 Scottish Neolithic sites. The overall research aims of this paper are:

- to assess the relative importance of wild and domestic plants in Scottish Neolithic palaeo-economies;
- to assess the relative importance of wheat, oats and barley in Scottish Neolithic palaeo-economies.

METHODOLOGY

DATA SELECTION

A database of 75 Neolithic sites with archaeo-botanical remains was compiled using published data obtained from major journals and other relevant publications, together with some unpublished data obtained from archaeological units (Table 1). The abundance of each plant taxon in each assemblage was recorded and the sample sizes and sampling methodologies employed were noted. Background information about each site was also recorded to aid comparison between different sites. Only sites where sampling and flotation for Neolithic remains was undertaken were included, to ensure the data was representative of the plant remains present onsite (van der Veen 1984, 193; Jones 2000, 79). As a result the database includes archaeobotanical remains recovered after 1960 only, when flotation became common on British archaeological sites.

GEOGRAPHICAL, CHRONOLOGICAL AND SITE CLASSIFICATIONS

Before data analysis was undertaken, each context at each site included in the review was classified, following accepted chronological ranges for the Neolithic in Scotland (eg Barclay 2005, 29; Brophy 2006, 9; Noble 2006, 15;

TABLE 1
Description of each site in the review: for a description of the site type classifications see Methodology section. Abbreviations: EN Early Neolithic; ELNT Early-late Neolithic transition; LN Late Neolithic; N Neolithic; NE north-east Scotland; S southern Scotland; A Atlantic Scotland. The locations of the sites are shown in illus 1

Site	*Site number*	*Area*	*Period*	*Site type*	*Site desciption*	*References*
Abernethy Primary School	1	NE	ELNT	5	1 fire pit	Conolly 2004; Hastie 2004a
Achnasavil	2	NE	EN	6	cultivation (charcoal spreads in colluvium)	Carter & Tipping 1992; Boardman 1992b
Allt Chrisal	3	A	EN	2	postholes, gullies, stone walls, open hearths, occupation deposits (remains of timber and stone structures)	Branigan & Foster 1995; Boardman 1995a
Allt Chrisal	3	A	LN	2	remains of stone settings, hearths, occupation layers, a platform	Branigan & Foster 1995; Boardman 1995a
Balbridie	4	NE	EN	1	large rectangular timber structure	Fairweather & Ralston 1993
Balfarg	5	NE	EN	5	pit	Barclay & Russell-White 1993; Fairweather & Smith 1993
Balfarg	5	NE	LN	4	ritual timber structures, ditched enclosures	Barclay & Russell-White 1993; Fairweather & Smith 1993
Barnhouse	6	A	LN	2	stone-built domestic settlement	Richards 2005; Hinton 2005
Beckton Farm	7	S	LN	3	small stake-built structures, 4-post structures, pits	Pollard 1997; Boardman 1992c; Boardman 1997
Bellfield Farm	8	NE	LN	3	small circular structure, a group of pits	Jones 2009; Timpany 2009
Bharpa Carinish	9	A	LN	3	3 stone-built hearths, 5 shallow pits and half a dozen postholes, spreads of ash and charcoal (remains of domestic structure)	Crone 1993; Boardman 1993b

TABLE 1 (*cont.*)

Site	*Site number*	*Area*	*Period*	*Site type*	*Site desciption*	*References*
Biggar Common 1	10	S	EN	4	ritual bonfires	Johnston 1997; Boardman unpublished a; Boardman and Pelling 1997
Biggar Common 2	10	S	EN	3	fires, postholes, stakeholes, possible structures	Johnston 1997; Boardman unpublished a; Boardman and Pelling 1997
Braes of Ha'breck	11	A	LN	2/3	timber and stone built oval domestic structures, midden deposits	Plant remains = RB's own analysis; Site info = Antonia Thomas, ORCA pers comm
Boghead	12	NE	EN	3	pit, hollows, stake holes = possible windbreaks, black layer, no clear hearths	Burl 1984; Maclean & Rowley-Conwy 1984
Bookan	13	A	LN	4	chambered cairn	Card 2005b; Alldrit 2005
Cairnwell	14	NE	ELNT	5	pits outside stone circle, stone circle socket	Rees 1997; Holden 1997a
Carding Mill Bay	15	A	EN	7	shell midden	Connock et al 1992; Boardman 1992a
Carsie Mains	16	NE	LN	1/4	rectilinear timber structure and timber circle	Brophy & Barclay 2004; Miller & Ramsay 2004b
Castle Menzies	17	NE	EN	5	posthole	Halliday 2002; Hastie & Wilson 2000
Carzield	18	S	EN	5	a single pit	Maynard 1993; Boardman 1993a
Chapelfield	19	NE	EN	3	group of pits and small oval stakebuilt structures	Atkinson 2002; Alldritt 2002
Chapelfield	19	NE	LN	3	a pit, 2 circular stake-built structures	Atkinson 2002; Alldritt 2002
Claish Farm	20	NE	EN	1	large rectangular timber structure	Miller & Ramsay 2002; Barclay et al 2002
Cowie Road	21	NE	EN	4	a pit-defined enclosure	Rideout 1997; Holden 1997b; Holden 1996
Cowie Road	21	NE	LN	4	a post-defined enclosure	Rideout 1997; Holden 1997b; Holden 1996

TABLE 1 (*cont.*)

Site	*Site number*	*Area*	*Period*	*Site type*	*Site desciption*	*References*
Crossiecrown	22	A	LN	2	midden deposits	Miller & Ramsay forthcoming; Downes & Richards 2000; Richards et al 2000; Richards et al 2001
Culduthel	23	NE	EN	5	pits	Haston 2008; Murray 2008
Culduthel	23	NE	LN	5	pits, ditch	Haston 2008; Murray 2008
Deer's Den	24	NE	EN	5	group of pits	Alexander 2000; Holden 2000
Dubton Farm	25	NE	EN	5	large pits and small pit clusters, scoops, fire-pits	Cameron 2002; Church 2002b
Eilean Domhnuill	26	A	N	2	small rectilinear boulder and possibly turf/earth built buildings with floors and hearths	Mills et al 2004; Grinter & Mills 2000
Embo	27	A	N	4	chambered cairn	Henshall & Wallace 1964; Johnson 1964
Eweford	28	S	EN	4	earth mound, with later earth mound and wood/ stone structures built on top, isolated pits	Lelong & Macgregor 2007; Miller & Ramsay 2007d
Eweford	28	S	LN	5	isolated pits	Lelong & Macgregor 2007; Miller & Ramsay 2007d
Fochabers to Mosstodloch Bypass	29	NE	EN	3	pits	Suddaby 2008; Hastie 2008
Forest Road 1/2/3	30	NE	EN	3/4/5	mound surrounded by segmented ditches, pits, working hollow – pit and stakeholes	Cook & Dunbar 2008; Holden et al 2008
Forest Road 2/3	30	NE	N	3/5	possible structure, pits	Cook & Dunbar 2008; Holden et al 2008
Garthdee	31	NE	EN	3	oval building: post-pits, floor deposit, hearths, artefact concentration	Murray & Murray forthcoming; Timpany 2008b
Geirisclett	32	A	N	4	chambered cairn	Dunwell et al 2003; Church & Cressey 2003

TABLE 1 (*cont.*)

Site	*Site number*	*Area*	*Period*	*Site type*	*Site desciption*	*References*
Hillend	33	S	LN	5	3 pits	Armit et al 1994; Coles & Boardman 1994
Hill of Tarvit pit 1	34	NE	ELNT	5	pit	James & Duffy 2001; Miller & Ramsay unpublished; Miller & Ramsay 2001
Holywood	35	S	EN	4	postholes in cursus monument	Thomas 2007a; Clarke 2007
Inchture	36	NE	EN	5	alignment of 4 pits	Rees 2004; Miller & Ramsay 2004a
Isbister	37	A	LN	4	chambered tomb	Lynch 1983; Hedges 1983
Kinbeachie	38	NE	ELNT	3	pits and postholes, rectangular timber structure	Barclay et al 2001; Holden & Hastie 2001
Knap of Howar	39	A	N	2	two stone-built houses and associated midden deposits	Ritchie 1983; Dickson 1983
Knowes Farm	40	S	ELNT	5	line of 12 pits	Lelong & Macgregor 2007; Miller & Ramsay 2007c
Knowes of Trotty	41	A	LN	2	stone-built rectangular house	Card et al 2007c; Card et al 2006; Card & Downes 2002; Alldritt 2007a; Alldritt 2006; Alldritt 2003
Lairg site 0870	42	A	LN	5	pit	McCullagh & Tipping 1998; Holden 1994; Holden 1998
Lairg buried soil	42	A	EN	6	cultivated soil beneath a cairn	McCullagh & Tipping 1998; Holden 1994; Holden 1998
Lamb's Nursery	43	S	N	3	groups of pits and postholes and a circular structure or curvilinear windbreak	Cook 2000; Rankin 2000
Larkhall Academy	44	S	EN	3	ditch, pits and postholes	Gillis & Franklin 2006; Dutton & Atkinson 2006

TABLE 1 (*cont.*)

Site	*Site number*	*Area*	*Period*	*Site type*	*Site desciption*	*References*
Lockerbie	45	S	EN	1	large rectangular timber structure	Hastie forthcoming; Richardson & Kirby 2006; Kirby 2006
Loudoun Hill	46	S	EN	5	2 pits	Atkinson 2000; Alldritt 2000
Maeshowe	47	A	LN	4	passage grave	Hinton 2005
Maybury Park	48	S	EN	3	pits and hollow – possible shelter	Moloney & Lawson 2006; Hastie 2006
Meldon Bridge	49	S	N	4	pits and timber enclosure	Speak & Burgess 1999; Griffiths & Roberts 1999
Mid Mill	50	NE	LN	3	pits, hearth, ard marks	Timpany & Masson 2009
Milton of Leys	51	NE	LN	3	cluster of small pits, hearths and postholes	Conolly & MacSween 2003; Hastie 2003c
Mountcastle Quarry	52	NE	LN	5	pit	Kimber 2008; Timpany 2008a
Ness of Brodgar	53	A	LN	2	large oval/cruciform stone structures	Alldritt 2007b; Card et al 2007a; Card et al 2007b; Card 2004; Card & Cluett 2005; Card & Sharman 2007
North Straiton	54	NE	LN	5	pit alignment	Carter 1996; Holden 1995
Overhailes	55	S	LN	3	pits, postholes, stakeholes	Lelong & Macgregor 2007; Miller & Ramsay 2007a
Parks of Garden	56	NE	LN	7	small wooden platform	Ellis et al 2002
Pencraig Hill	57	S	EN	4	low mound and timber mortuary structures surrounded by a timber palasade	Lelong & Macgregor 2007; Miller & Ramsay 2007b
Pitlethie Road	58	NE	EN	5	pit	Cook 2007; Hall & Inglis 2007

TABLE 1 (*cont.*)

Site	*Site number*	*Area*	*Period*	*Site type*	*Site desciption*	*References*
Pool	59	A	EN/LN	2	low mound of tip-like deposits, structural features	Hunter 2007; Bond 2007a
Ratho Quarry	60	S	EN	5	3 pits	Smith 1995; Holden & Rankin 1995
Scord of Brouster	61	A	ELNT/ LN	2	2 stone-built houses	Whittle et al 1986; Ballin 2005; Milles 1986a
Silvercrest	62	NE	EN	5	pits	Cressey & Lyons forthcoming; Cressey & Suddaby 2002
Skara Brae	63	A	LN	2	10 stone houses, midden deposits	Rowley-Conwy forthcoming; Clarke 1976; Childe 1931
Stonehall	64	A	LN	2	stone-built houses, midden deposits	Miller & Ramsay forthcoming; Downes & Richards 2000; Richards et al 2000; Richards et al 2001
Stoneyburn Farm	65	S	ELNT	4	pits and postholes beneath a cairn	Banks 1995; Dickson 1995
Stoneyhill Farm	66	NE	LN	5	pit	Hastie & Cressey forthcoming; Suddaby & Ballin forthcoming
The Howe	67	A	LN	4	chambered tomb	Ballin Smith 1994; Dickson 1994
Tinto Sands and Gravel Quarry	68	S	LN	5	pits	Conolly 2003; Hastie 2003b
Titwood	69	S	EN	5	pit	Johnson et al 2003; Hastie 2003a
Tofts Ness	70	A	LN	2	stone domestic structure and midden, cultivated soils	Dockrill 2007; Bond 2007b
Upper Forth Crossing	71	NE	LN	3	pits, postholes	Jones & Atkinson 2006; Timpany 2006b

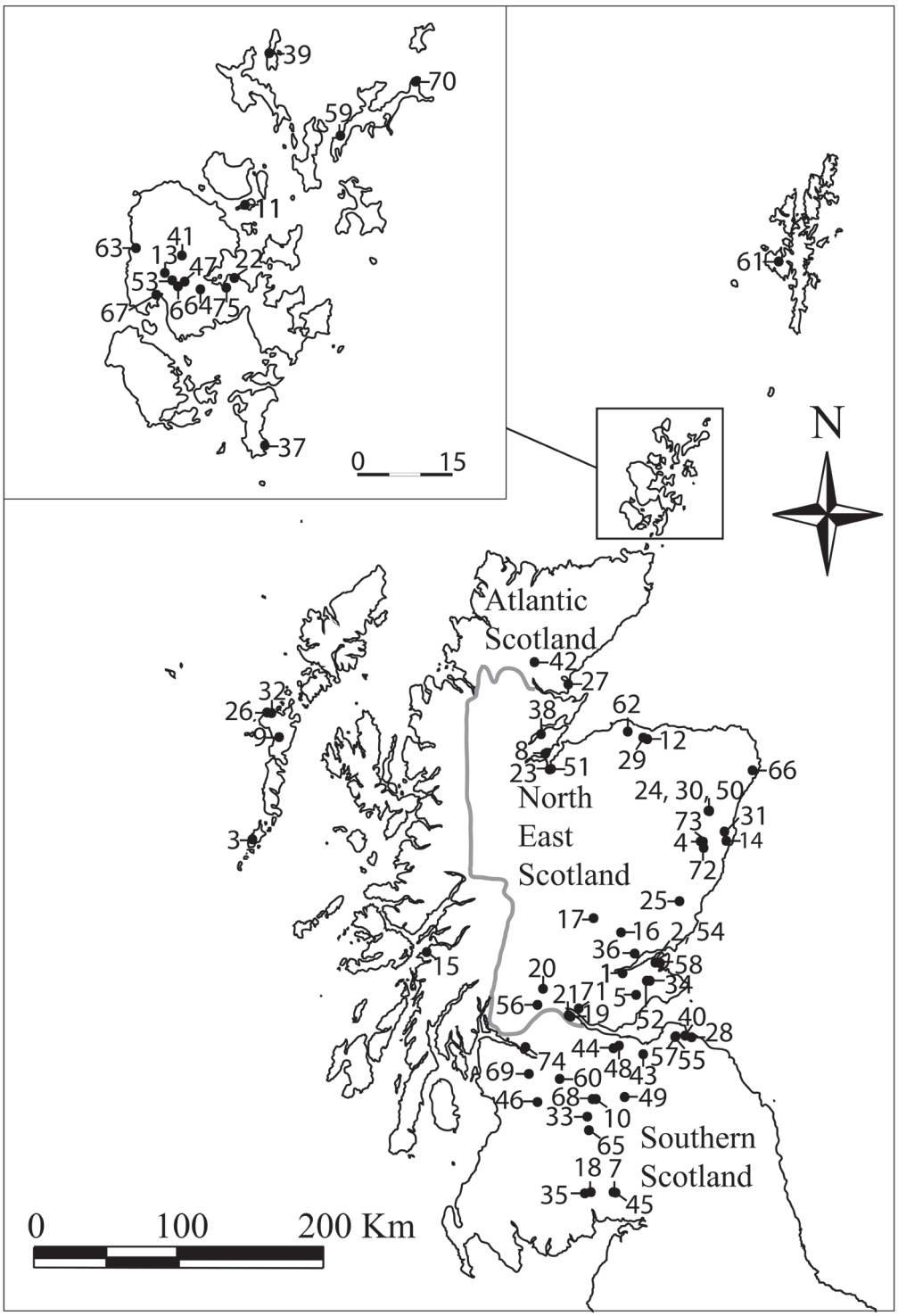
TABLE 1 (*cont.*)

Site	*Site number*	*Area*	*Period*	*Site type*	*Site desciption*	*References*
Wardend of Durris	72	NE	EN	3	slot, postholes (possible timber structure)	Russell-White 1995; Boardman 1995b; Boardman unpublished b
Warren Field	73	NE	EN	1	large rectangular timber structure	Murray et al 2009; Hastie 2004b; Timpany 2006a; Murray 2005; Lancaster 2009
West Flank Road	74	S	ELNT	3	pits and postholes (remains of a structure)	MacGregor & Cullen 2003; Miller & Alldrit 2003
Wideford	75	A	LN	2/3	3 timber and 1 stone structure, midden deposits	Richards 2007; Miller & Ramsay forthcoming

Bradley 2007, 27), into Early Neolithic (*c* 4000–3300 cal BC), Late Neolithic (*c* 3300–2500 cal BC) or Early–Late Neolithic transition (*c* 3500–3000 cal BC). These chronological classifications are based on the site stratigraphy and radiocarbon dating evidence where possible, and structural morphology and artefactual evidence where no radiocarbon dates are available. In some instances the chronological resolution was insufficient to allow this classification, therefore some sites were simply recorded as 'Neolithic' (*c* 4000–2500 cal BC); the data from these sites were not included in the comparative statistical analyses based on temporal changes through time. While it is recognised that Neolithic Orkney has its own chronology, separate from mainland Scotland (Card 2005a, 47), the Orkney sites were still divided into Early/Late Neolithic strictly by the radiocarbon dates (and not by structural or artefactual associations) to allow a temporal comparison with the rest of Scotland. However, in order to provide an indication of the chronological change between the Orkney Early Neolithic (*c* 3500–3000 cal BC) and Orkney Late Neolithic (*c* 3000–2000 cal BC), the Orkney sites were also classed into these categories in a further separate analysis (Table 3). Since the chronological range of this study is 4000–2500 cal BC, Orkney Neolithic sites dating to 2500–2000 cal BC were not included in this analysis.

The sites were further divided into the categories of Atlantic Scotland, north-east Scotland and southern Scotland (illus 1). These regional categories were based on Piggott's (1966) division of Scotland, but with the Solway–Forth and Tyne–Forth regions combined into the single category of southern Scotland. These categories were chosen because they broadly correspond to the differing topographic and climatic regions of Scotland (Armit & Ralston 2003, 170).

Additionally, each site was classified into one of seven different categories to attempt to ascertain whether the type of site had an effect on the economy (see Table 1): (1) large rectangular timber structures, eg Balbridie; (2) predominantly stone domestic structures and/or



ILLUS 1 Map of Scotland showing regions and site locations. Numbers correspond to those shown in Table 1

TABLE 2
Common and scientific names of plant components included in each plant group in Table 3

Plant group	*Common name*	*Latin name*	*Plant Part*	*Wild/domestic?*
Cereal indet.	Indeterminate cereal	Cerealia indet.	Grain	Domestic
Cereal indet.	Indeterminate cereal	*Triticum*/*Hordeum* sp.	Grain	Domestic
Oat	Oat	*Avena* sp.	Grain	Domestic
Oat	cf Oat	cf *Avena* sp.	Grain	Domestic
Barley	Barley	*Hordeum* sp.	Grain	Domestic
Barley	cf Barley	cf *Hordeum* sp.	Grain	Domestic
Barley	Twisted barley	*Hordeum* sp. asymmetric	Grain	Domestic
Barley	Straight barley	*Hordeum* sp. symmetric	Grain	Domestic
Hulled barley	Twisted hulled barley	*Hordeum* hulled asymmetric	Grain	Domestic
Hulled barley	Straight hulled barley	*Hordeum* hulled symmetric	Grain	Domestic
Hulled barley	cf Twisted hulled barley	*Hordeum* cf hulled asymmetric	Grain	Domestic
Hulled barley	cf Straight hulled barley	*Hordeum* cf hulled symmetric	Grain	Domestic
Hulled barley	Hulled barley	*Hordeum* hulled	Grain	Domestic
Hulled barley	cf Hulled barley	*Hordeum* cf hulled	Grain	Domestic
Naked barley	Naked barley	*Hordeum* naked	Grain	Domestic
Naked barley	Twisted naked barley	*Hordeum* naked asymmetric	Grain	Domestic

TABLE 2 (*cont.*)

Plant group	*Common name*	*Latin name*	*Plant Part*	*Wild/domestic?*
Naked barley	Straight naked barley	*Hordeum* naked symmetric	Grain	Domestic
Naked barley	cf Naked barley	*Hordeum* cf naked	Grain	Domestic
Naked barley	cf Straight naked barley	cf *Hordeum* naked symmetric	Grain	Domestic
Wheat	Wheat	*Triticum* sp.	Grain	Domestic
Wheat	Emmer/spelt wheat	*Triticum dicoccum* L./*spelta* L.	Grain	Domestic
Wheat	cf wheat	cf *Triticum* sp.	Grain	Domestic
Emmer wheat	Emmer wheat	*Triticum dicoccum* L.	Grain	Domestic
Emmer wheat	cf Emmer wheat	*Triticum* cf *dicoccum* L.	Grain	Domestic
Bread wheat	Bread wheat	*Triticum aestivum* L.	Grain	Domestic
Bread wheat	Bread wheat	*Triticum aestivo-compactum* Schiem	Grain	Domestic
Bread wheat	cf Bread wheat	*Triticum* cf *aestivum* L.	Grain	Domestic
Spelt wheat	Spelt wheat	*Triticum spelta* L.	Grain	Domestic
Rye	Rye	*Secale cereale* L.	Grain	Domestic
Flax	Flax	*Linum usitatissimum* L.	Seeds	Domestic
Flax	cf Flax	cf *Linum usitatissimum* L.	Seeds	Domestic
Hazelnut shell	Hazelnut	*Corylus avellana* L.	Nutshell, whole nuts	Wild
Crab apple	Crab apple	*Malus sylvestris* (L.) Mill	Pips and pericarp	Wild

TABLE 2 (*cont.*)

Plant group	*Common name*	*Latin name*	*Plant Part*	*Wild/domestic?*
Other wild fruits and nuts	Bearberry	*Arctostaphylos uva-ursi* (L.) Spreng.	Seeds	Wild
Other wild fruits and nuts	Billberry/Blaeberry	*Vaccinium myrtillus* L.	Seeds	Wild
Other wild fruits and nuts	Blackberry	*Rubus fruticosus* L. agg.	Seeds	Wild
Other wild fruits and nuts	Blackberry/Raspberry	*Rubus* cf *fruticosus* L. agg./*idaeus* L.	Seeds	Wild
Other wild fruits and nuts	Cowberry	*Vaccinium vitis-idaea* L.	Seeds	Wild
Other wild fruits and nuts	Cranberry	*Vaccinium oxycoccos* L.	Seeds	Wild
Other wild fruits and nuts	Crowberry	*Empetrum nigrum* L.	Seeds	Wild
Other wild fruits and nuts	Hawthorn	*Crataegus monogyna* Jacq.	Seeds	Wild
Other wild fruits and nuts	Strawberry	*Fragaria vesca* L.	Seeds	Wild
Other wild fruits and nuts	Sloe	*Crataegus* sp./*Prunus spinosa* L./ *Prunus* sp.	Fruit stones	Wild
Cereal chaff	Wild oat	*Avena fatua* L.	Floret base	Not included
Cereal chaff	Small/black/bristle oat	*Avena strigosa* Schreb.	Floret base	Not included
Cereal chaff	6-row barley	*Hordeum vulgare* L.; *Hordeum* sp. 6 row	Rachis, internodes	Not included
Cereal chaff	Barley	*Hordeum* sp.	Awn fragments, rachis internodes, rachis fragments, floret base	Not included
Cereal chaff	4 row barley	*Hordeum* cf naked - 4 row	Rachis	Not included
Cereal chaff	cf Naked barley	*Hordeum* cf naked	Rachis	Not included

TABLE 2 (*cont.*)

Plant group	*Common name*	*Latin name*	*Plant Part*	*Wild/domestic?*
Cereal chaff	Wheat	*Triticum* sp.	Glume base, spikelet fork, rachis internodes, chaff	Not included
Cereal chaff	Bread wheat	*Triticum aestivum* L.	Glume fragment	Not included
Cereal chaff	Emmer wheat	*Triticum dicoccum* L.	Glume base, spikelet fork, rachis, spikelet/glume base, chaff	Not included
Cereal chaff	cf Emmer wheat	cf *Triticum dicoccum* L.	Glume base, spikelet fork	Not included
Cereal chaff	Spelt/Emmer wheat	*Triticum spelta/dicoccum* L.	Spiklet/glume base, chaff	Not included
Cereal chaff	cf Spelt/Emmer wheat	cf *Triticum spelta/dicoccum* L.	Spiklet/glume base	Not included
Cereal chaff	Einkorn/Emmer wheat	*Triticum monococcum/dicoccum* L.	Spikelet fork	Not included
Cereal chaff	Cereal	Cereal indeterminate	Rachis segment	Not included
Cereal chaff	Cereal	Cereal indeterminate	Internodes	Not included
Other seeds	All other seeds not listed in 'other wild fruits and nuts' category	All other seeds not listed in 'other wild fruits and nuts' category	Seeds	Not included

domestic midden material, eg Skara Brae and Stonehall; (3) small/ephemeral rectangular/oval/round timber structures and concentrations of pits, post-holes, stake-holes and hearths found together, which were probably of a 'domestic' nature (Ashmore 1996, 59; Barclay 2003b, 81; Brophy 2006, 22), eg Beckton Farm and Kinbeachie; (4) 'ritual' sites such as cairns, timber/stone circles and enclosures, eg Isbister and Carsie Mains timber circle; (5) isolated pits/post-holes and groups of pits not associated with structures and of no clear function, eg Dubton Farm and Abernethy Primary School; (6) cultivation evidence: Achnasavil and Lairg; (7) and the two remaining sites, which do not fit into any of these categories: Carding Mill Bay (a shell midden) and Parks of Garden (a working platform). Sites with contemporary samples derived from very different context types/functions, were separated to allow a more reliable analysis of the relationship between function and plant species to be established.

DATA ANALYSIS

The abundance of each plant taxon present within each assemblage was recorded numerically where possible and on a scale of 'present' ('P'), absent (blank), or 'abundant' ('A') when plant components were not numerated in the archaeobotanical reports. To summarise the archaeobotanical species identifications made at each site, the cereal species were grouped as cereal indet. (cerealia indet. and *Triticum*/*Hordeum* sp.), oat (*Avena* sp.), barley (*Hordeum* sp.), hulled barley (*Hordeum* hulled symmetric and asymmetric), naked barley (*Hordeum* naked symmetric and asymmetric), wheat (*Triticum* sp. and *Triticum dicoccum* L./*spelta* L.), emmer wheat (*Triticum dicoccum* L.), bread wheat (*Triticum aestivum* L. and *Triticum aestivo-compactum* Schiem), spelt wheat (*Triticum spelta* L.), rye (*Secale cereale* L.), flax (*Linum usitatissimum* L.), hazelnut shell (*Corylus avellana* L.) and crab apple (*Malus sylvestris* L. Miller). Totals for cereal chaff pieces, wild edible seeds and seeds of other wild plants were also complied. A full list of each plant species and component is given in Table 2. Plant species classed as 'cf' were added to the definite species identifications, for example, grain identified as *Triticum* cf *dicoccum* L. was classed as emmer wheat in the Table 3. Quantification in Tables 3 and 4 was based on the numerical counts of plant components presented in the archaeobotanical reports, rather than the mass of specific plant identifications.

The percentage of each assemblage made up of wild (fruits and nuts) and domestic plants (cereal grain and flax seeds), as well as the main cereal species (wheat, oats and barley) were calculated for each site, where possible. Cereal chaff was not included in these percentages due to the low frequency of chaff remains, the differences in quantification criteria evident from the archaeobotanical assemblages, and the differential preservation of grain and chaff (Boardman & Jones 1990). These percentages were used to establish the mean percentages of wild and domestic species and the main cereal species present in each site type, chronological and geographical category. The use of percentages provides a standardisation which removes the discrepancies between assemblages of different sample sizes and allows a direct comparison between different sites (Jones 1991b, 69; van der Veen 1992). Sites with less than ten cereal grains were excluded from the calculations involving the proportions of different cereal species at different sites, as were sites with less than ten wild/domestic plant remains from the wild and domestic plant calculations, to prevent low frequencies of particular species being overestimated in the overall calculations. While it would have been preferable to only include sites with over 100 (rather than over ten) cereal grains/wild and domestic plant remains in these calculations, this would have restricted the number of sites available for consideration and the range of interpretations possible from the data. However, it is not considered that the inclusion of sites with small numbers of

TABLE 3

Summary of the plant remains present at Scottish Neolithic sites; each site is split into chronological and site type blocks (see Methodology section). The dominant cereal group is highlighted in bold for each site (excluding cereal indet.). For a description of the site type classifications see Methodology section. Abbreviations: P present; A abundant; NE north-east Scotland; S southern Scotland; A Atlantic Scotland; OEN Orkney Early Neolithic; OLN Orkney Late Neolithic

Site	*Area*	*Site type*	*Cereal indet.*	*Oat*	*Barley*	*Hulled barley*	*Naked barley*	*Wheat*	*Emmer wheat*	*Bread wheat*	*Spelt wheat*	*Rye*	*Cereal chaff*	*Flax*	*Hazelnut shell*	*Crab apple*	*Other wild fruits and nuts*	*Other seeds*	*Cereal grain total*	*Total volume of samples (l)*
Early Neolithic																				
Achnasavil	NE	6	3		**1**									1				3	4	16
Allt Chrisal	A	2	12		17		**56**								12		6	116	85	33
Balbridie	NE	1		2		*c* 98	3550		**15950**	*c* 400			P	>48	P	>12	P	P	20000	
Balfarg	NE	5				**15**												2	15	
Biggar Common 1	S	4	1		**1**										>714			P	2	
Biggar Common 2	S	3			1			4	**17**	4					P			P	26	
Boghead	NE	3	68				**305**		38						14			119	411	1000
Carding Mill Bay	A	7													737		1	19		217
Carzield	S	5	2				**3**		1						128				6	
Castle Menzies	NE	5													P				0	
Chapelfield	NE	3													65		2	57	0	
Claish Farm	NE	1	60		11	1		7	**19**	2					>855	7		29	100	
Cowie Road	NE	4							1	**2**								8	3	2130
Culduthel	NE	5					**A**								P			P	P	
Deer's Den	NE	5			1				**2**				1		P			1	3	10
Dubton Farm	NE	5	142	8	61	20	82	69	**191**	13			524		381	>252	2	4688	586	>155

TABLE 3 (*cont.*)

Site	*Area*	*Site type*	*Cereal indet.*	*Oat*	*Barley*	*Hulled barley*	*Naked barley*	*Wheat*	*Emmer wheat*	*Bread wheat*	*Spelt wheat*	*Rye*	*Cereal chaff*	*Flax*	*Hazelnut shell*	*Crab apple*	*Other wild fruits and nuts*	*Other seeds*	*Cereal grain total*	*Total volume of samples (l)*
Eweford	S	4	31		36	12	**47**		2						84			3	128	
Fochabers to Mosstodloch Bypass	NE	3	P				P	P							P				P	
Forest Road 1	NE	4		4	**168**	47	64											5	283	
Forest Road 2	NE	3			**386**	11	232		158		10				52				797	
Forest Road 3	NE	5		>2	>4	P		**25**	>4				P		P				35	
Garthdee	NE	3	43				**60**		2	13					82		1	2	118	
Holywood	S	4	1					**5**							19			5	6	
Inchture	NE	5	159		99	2	74	450	**810**				126					163	1594	
Lairg buried soil	A	6		1	P														P	
Larkhall Academy	S	3	P	P	1				**A**	**A**					P			P	P	
Lockerbie	S	1	125	4	20		5	44	**50**	1			3	43	P			2	249	411.5
Loudoun Hill	S	5	1		**2**										P			8	3	
Maybury Park	S	3													P				0	
Pencraig Hill	S	4	4		**4**		1	3							7		1		12	
Pitlethie Road	NE	5			***c* 100**			***c* 100**	P		P							1	>200	
Pool (OEN)	A	2	86		**25**	2	**25**								5			166	138	55
Ratho Quarry	S	5	33	2	**12**	5	1			1								2	54	80
Silvercrest	NE	5			**1**										P			P	1	

TABLE 3 (*cont.*)

Site	*Area*	*Site type*	*Cereal indet.*	*Oat*	*Barley*	*Hulled barley*	*Naked barley*	*Wheat*	*Emmer wheat*	*Bread wheat*	*Spelt wheat*	*Rye*	*Cereal chaff*	*Flax*	*Hazelnut shell*	*Crab apple*	*Other wild fruits and nuts*	*Other seeds*	*Cereal grain total*	*Total volume of samples (l)*
Titwood	S	5													P				0	0.1
Upper Forth Crossing	NE	3					**A**		P						P				P	
Wardend of Durris	NE	3	2	5	**9**	2	1								69			6	19	34.8
Warren Field	NE	1	211	1	2		119		8	**237**					112			6	578	
Wideford 1 (OEN)	A	3	3226		**1778**		1590	15										6	6609	
Early-Late Neolithic Transition																				
Abernethy Primary School	NE	5		P			P												P	
Cairnwell	NE	5	9		**329**		32		2						2		1	2	372	98
Hill of Tarvit	NE	5													P				0	
Kinbeachie	NE	3	217		**168**	3	41	11	11						>22		1	10	451	169
Knowes Farm	S	5													161				0	
Scord of Brouster house 2	A	2	208		**371**	**A**	P	2					1					350	581	165
Stoneyburn Farm	S	4			**1**		**1**								1				2	
West Flank Road	S	3			**5**										P			P	5	
Late Neolithic																				
Allt Chrisal	A	2	6		20	2	**26**						2				8	196	54	
Balfarg	NE	4	P	P	P										P	1	2	1	P	

TABLE 3 (*cont.*)

Site	*Area*	*Site type*	*Cereal indet.*	*Oat*	*Barley*	*Hulled barley*	*Naked barley*	*Wheat*	*Emmer wheat*	*Bread wheat*	*Spelt wheat*	*Rye*	*Cereal chaff*	*Flax*	*Hazelnut shell*	*Crab apple*	*Other wild fruits and nuts*	*Other seeds*	*Cereal grain total*	*Total volume of samples (l)*
Barnhouse (OLN)	A	2	21	1			**227**						2		30	4	17	4997	249	864.9
Beckton Farm	S	3					***c* 6**								>220			1	6	
Bellfield Farm	NE	3	P				**A**								P			P	P	
Bharpa Carinish	A	3	8		7	2	**33**	10	11						733	8		20	71	92.5
Bookan (OLN)	A	4																	0	30.5
Braes of Ha'breck* (OEN?)	A	2/3	P	P		P	**A**								P				P	
Carsie Mains rectangular structure	NE	1	7		27		**42**											62	76	
Carsie Mains timber circle	NE	4													2		5	10	0	
Chapelfield	NE	3													11			16	0	
Cowie Road	NE	4	1		**3**														4	30
Crossiecrown midden (OLN)	A	2																2	0	
Culduthel	NE	5													P			P	0	
Eweford	S	5			**2**										16				2	
Hillend	S	5													264.5		1	P	0	*c* 32kg
Isbister (OEN)	A	4	6		24		**32**		1								8	232	63	200kg
Knowes of Trotty (OEN)	A	2	2		**21**		6										2	108	29	1173.75

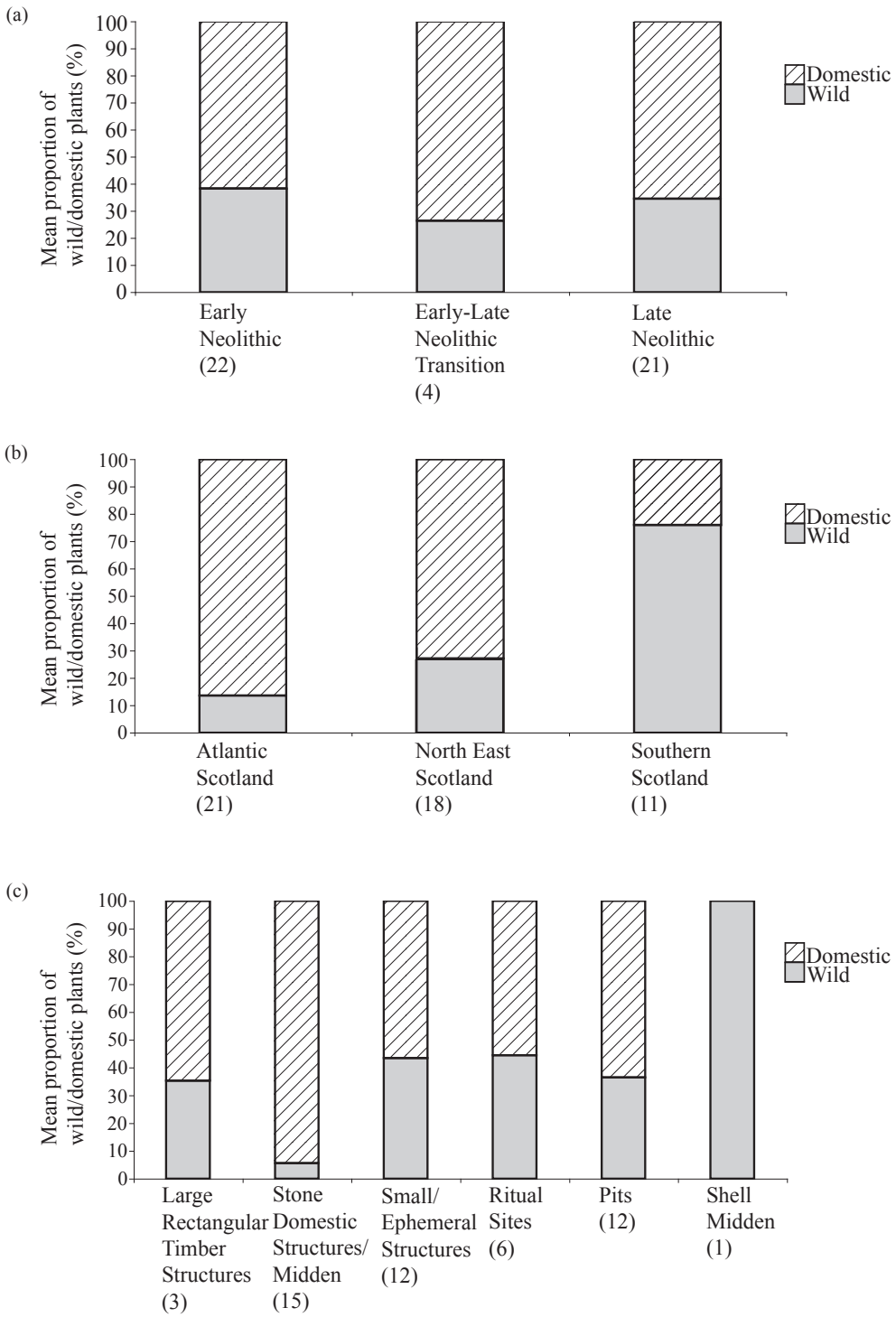
TABLE 3 (*cont.*)

Site	*Area*	*Site type*	*Cereal indet.*	*Oat*	*Barley*	*Hulled barley*	*Naked barley*	*Wheat*	*Emmer wheat*	*Bread wheat*	*Spelt wheat*	*Rye*	*Cereal chaff*	*Flax*	*Hazelnut shell*	*Crab apple*	*Other wild fruits and nuts*	*Other seeds*	*Cereal grain total*	*Total volume of samples (l)*
Lairg	A	5			1158		**1980**		408				275					12	3546	15
Maeshowe (OLN)	A	4																39	0	
Mid Mill	NE	3					**A**								40.6g				P	
Milton of Leys	NE	3		P			P								P				P	
Mountcastle Quarry	NE	5													1				0	
Ness of Brodgar ** (OLN)	A	2	57	11	**33**	3	12										5	59	116	
North Straiton	NE	5													3			3	0	
Overhailes	S	3	4	1	**2**										160				7	
Parks of Garden	NE	7													P				0	
Pool (OLN)	A	2	306		83	**141**	99	9	5				10		1		67	2825	643	325
Scord of Brouster house 1	A	2	20		85	**A**	P						9					440	105	123.11 and 12.2kg
Skara Brae (OLN)	A	2	16			4	**307**		28				2					30849	355	>14240
Stonehall (OEN & OLN)	A	2	124		**120**	1	43										9	361	288	
Stoneyhill Farm	NE	5	1		1		**823**								0.8g				825	19
The Howe (OLN)	A	4																P	0	
Tinto Sands and Gravel Quarry	S	5	1		**1**										P				2	

TABLE 3 (*cont.*)

Site	*Area*	*Site type*	*Cereal indet.*	*Oat*	*Barley*	*Hulled barley*	*Naked barley*	*Wheat*	*Emmer wheat*	*Bread wheat*	*Spelt wheat*	*Rye*	*Cereal chaff*	*Flax*	*Hazelnut shell*	*Crab apple*	*Other wild fruits and nuts*	*Other seeds*	*Cereal grain total*	*Total volume of samples (l)*
Tofts Ness (OLN)	A	2	302		257	**364**	137						19				1	962	1060	271
Upper Forth Crossing	NE	3	P				**A**		P	P		P			P				P	
Wideford 1 (OEN)	A	3	146		**157**		91											2	394	
Wideford 2 (OEN)	A	2	15		**15**		7												37	
Neolithic																				
Eilean Domhnuill	A	2	159		**1372**	225	12			6			178		>123		2	290	1774	>67.5
Embo	A	4															2		0	
Forest Road 3	NE	5		3	**602**	113	11	3	23	3			6					4	758	
Forest Road 2	NE	3			**31**	**31**													62	
Geirisclett	A	4													4			13	0	22.5
Knap of Howar (OEN)	A	2	22				**10**								1				32	
Lamb's Nursery	S	3			**A**	P			P	P					P			P	P	
Meldon Bridge	S	4													P				0	
Total			5868	45	7635	1104	10193	757	17742	682	10	P	1158	92	5091.5	284	144	47283	44036	21849.15
Total Identified Remains																				98088.5

*NB: initial sample assessment only: analysis ongoing part of Rosie Bishop's PhD – overall composition of the assemblage may change after all the samples have been analysed
**NB: based on 2004–2006 samples only: excavation and analysis of samples is ongoing



ILLUS 2 Mean proportion of wild and domestic plants in each period (a), region (b) and site (c) category. The number of sites is indicated in brackets after the class on the x-axis

TABLE 4
Fruits and nuts present at Scottish Neolithic sites. Each site is split into chronological and site type blocks. Abbreviation: P present

	Bearberry seed	*Billberry/ Blaeberry seed*	*Blackberry seed*	*Blackberry/ Raspberry seed*	*Cowberry seed*	*Crab apple fruit*	*Crab apple pip*	*Cranberry seed*	*Crowberry seed*	*Hawthorn seed*	*Sloe stone*	*Strawberry seed*	*Whole hazelnuts*	*Total volume of samples (l)*
Early Neolithic														
Allt Chrisal		2			4									33
Balbridie						>6	>6	P						
Biggar Common 2													1	
Carding Mill Bay				1										217
Chapelfield											1			
Claish Farm						6	1							
Dubton Farm	1				1	>127	125						68	>155
Garthdee			1											
Pencraig Hill										1				
Early–Late Neolithic Transition														
Cairnwell				1										98
Kinbeachie											1			169
Late Neolithic														
Allt Chrisal												8		
Balfarg			1				1				P			

TABLE 4 (*cont.*)

	Bearberry seed	*Billberry/ Blaeberry seed*	*Blackberry seed*	*Blackberry/ Raspberry seed*	*Cowberry seed*	*Crab apple fruit*	*Crab apple pip*	*Cranberry seed*	*Crowberry seed*	*Hawthorn seed*	*Sloe stone*	*Strawberry seed*	*Whole hazelnuts*	*Total volume of samples (l)*
Barnhouse							4		17					864.9
Bharpa Carinish							8						3	92.5
Carsie Mains timber circle			5											
Hillend											1		26	*c* 32kg
Isbister									8					200kg
Knowes of Trotty									2					1173.75
Ness of Brodgar **									5					
Pool									67					325
Stonehall									9					
Tofts Ness									1					271
Neolithic														
Eilean Domhnuill	2												1	>67.5
Embo		2												

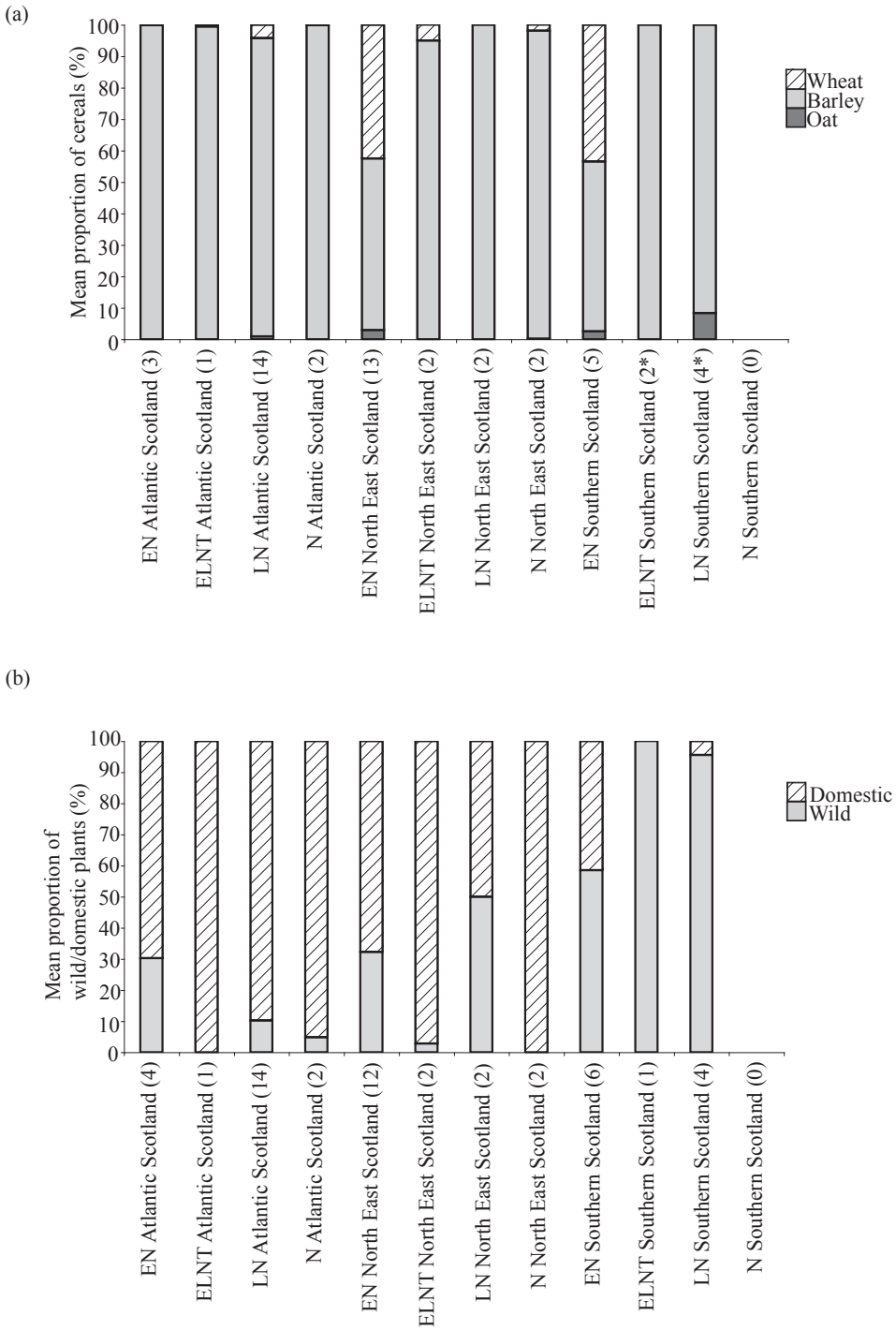
remains has significantly affected the general conclusions made because very few sites had less than 50 plant components in each of the geographical, chronological and functional categories (eg three Atlantic Scottish sites, two north-east Scottish sites and three southern Scottish sites had less than 50 wild/domestic plants). Also, the percentages calculated from these sites fit within the general spread of the data (see below). Sites with between one to ten cereal grains were included in the calculation of the proportions of wheat, oats and barley in the Early to Late Neolithic Transition and Late Neolithic categories in southern Scotland due to the absence of any sites with greater than ten cereal grains in these categories. Again, while it would have been preferable to avoid this, the calculated percentages are considered to be reliable because of the absence of wheat and the extreme rarity of oat in either of these categories. Sites where the number of hazelnut fragments had not been quantified were not included in the calculations of the proportions of wild and domestic plants. Where minimum numbers of remains were recorded at certain sites, these were used as the actual number of components identified of a particular species. While this may have led to a slight underestimation of the importance of a particular species, it has probably not greatly affected the overall proportions of species at these sites.

RESULTS

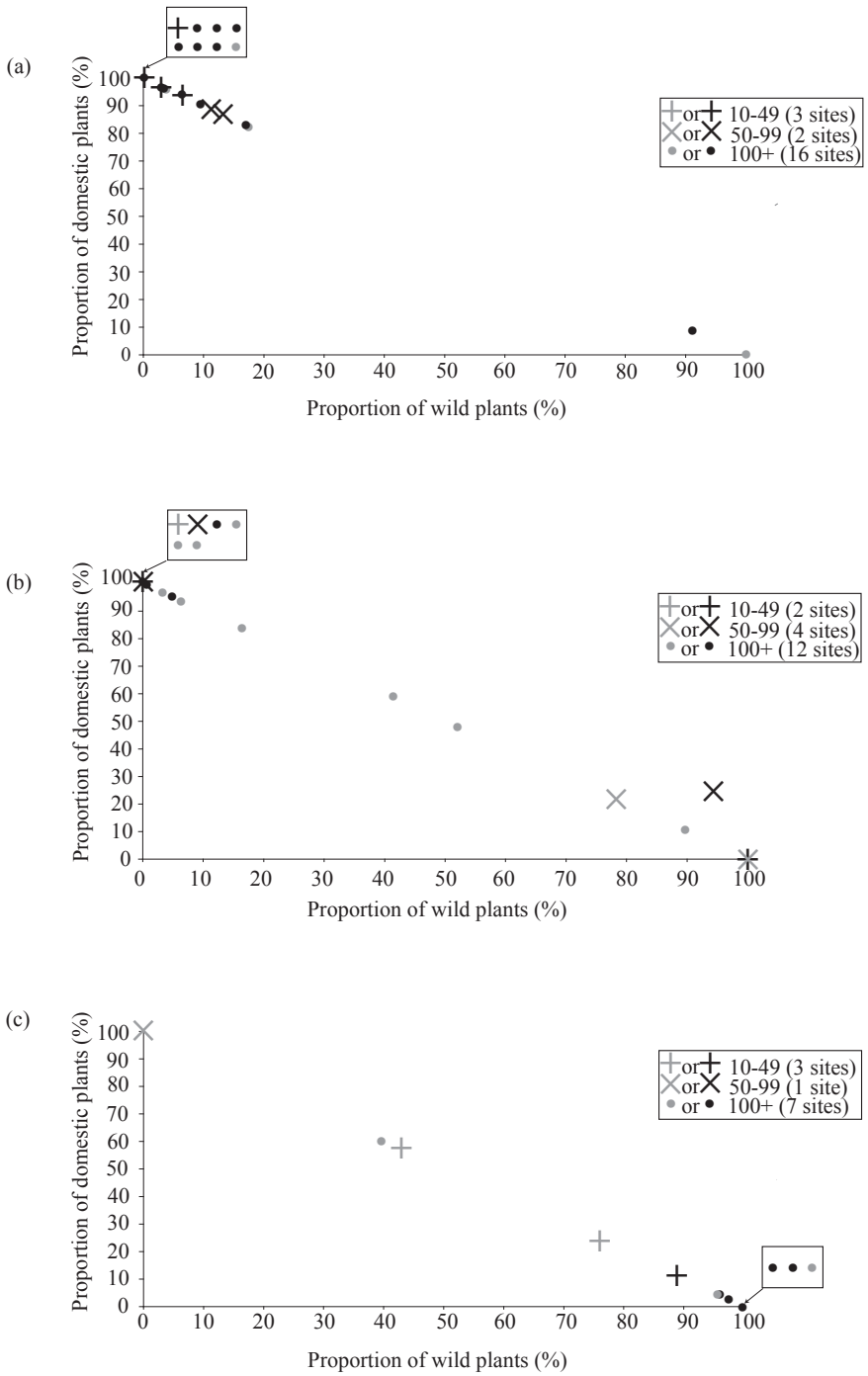
This section presents the results of the survey of 75 Scottish Neolithic sites with plant remains, split into 93 separate chronological and functional site blocks, to take into account multiple functions of features and periods at a single site. Of these 93 site blocks, 39 were Early Neolithic, 38 Late Neolithic, eight Early–Late Neolithic Transition, and eight were classed as Neolithic. Twenty-nine site blocks were located in Atlantic Scotland; 42 in north-east Scotland; and 22 in southern Scotland. There were five large rectangular timber structures, 18 stone domestic structures and/or domestic midden material, 24 small/ephemeral domestic sites, 17 ritual sites, 26 isolated or groups of pits/post-holes, two cultivation sites, one shell midden and one working platform. However, due to the low frequency of remains in many assemblages a smaller number of sites was available for analysis – the numbers of sites included in the percentage calculations are shown in brackets after each chronological, geographical and site category in each illustration.

The primary conclusion is that domestic species dominated the assemblages during all three chronological periods, although hazelnut shell was present at most sites (illus 2a; Table 3). Flax was present on three sites. Fruit and berry seeds were present in just 24 of the site blocks (Table 4). While domestic species made a far more significant contribution to the assemblages in Atlantic Scotland and north-east Scotland, southern Scottish plant assemblages were mostly composed of wild plants throughout the Neolithic (illus 2b, 3b, 4). There appears to be an increase in the use of wild plants in the later Neolithic in north-east and southern Scotland, and an increase in the use of domestic plants in Atlantic Scotland (illus 3b). Domestic plants remained dominant in both the Orkney early and Late Neolithic.

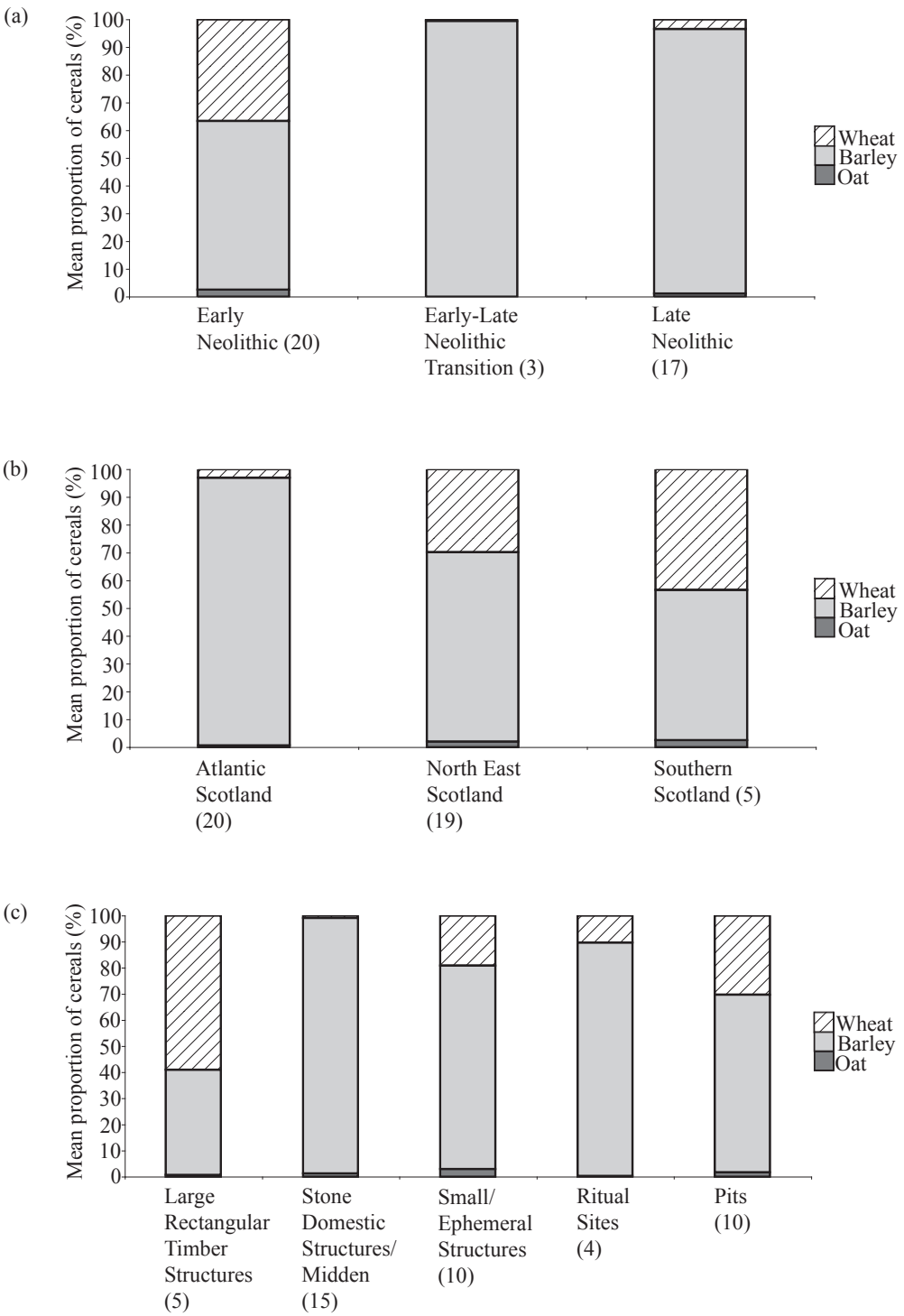
Overall the stone and timber structures contained a higher proportion of domestic species than the other site types (illus 2c). The shell midden had the greatest proportion of wild species, while the ritual sites, ephemeral structures and pit sites had a roughly equal quantity of wild and domestic plants. Although it appears that the samples from the rectangular timber structures contained a similar percentage of domestic species to the pit sites, this is not a true reflection of the compositions of the assemblages from the timber structures. Since the exact numbers of hazelnut shell fragments from Balbridie and Lockerbie have not been published, these sites could not be included in the calculations. However, it is known that



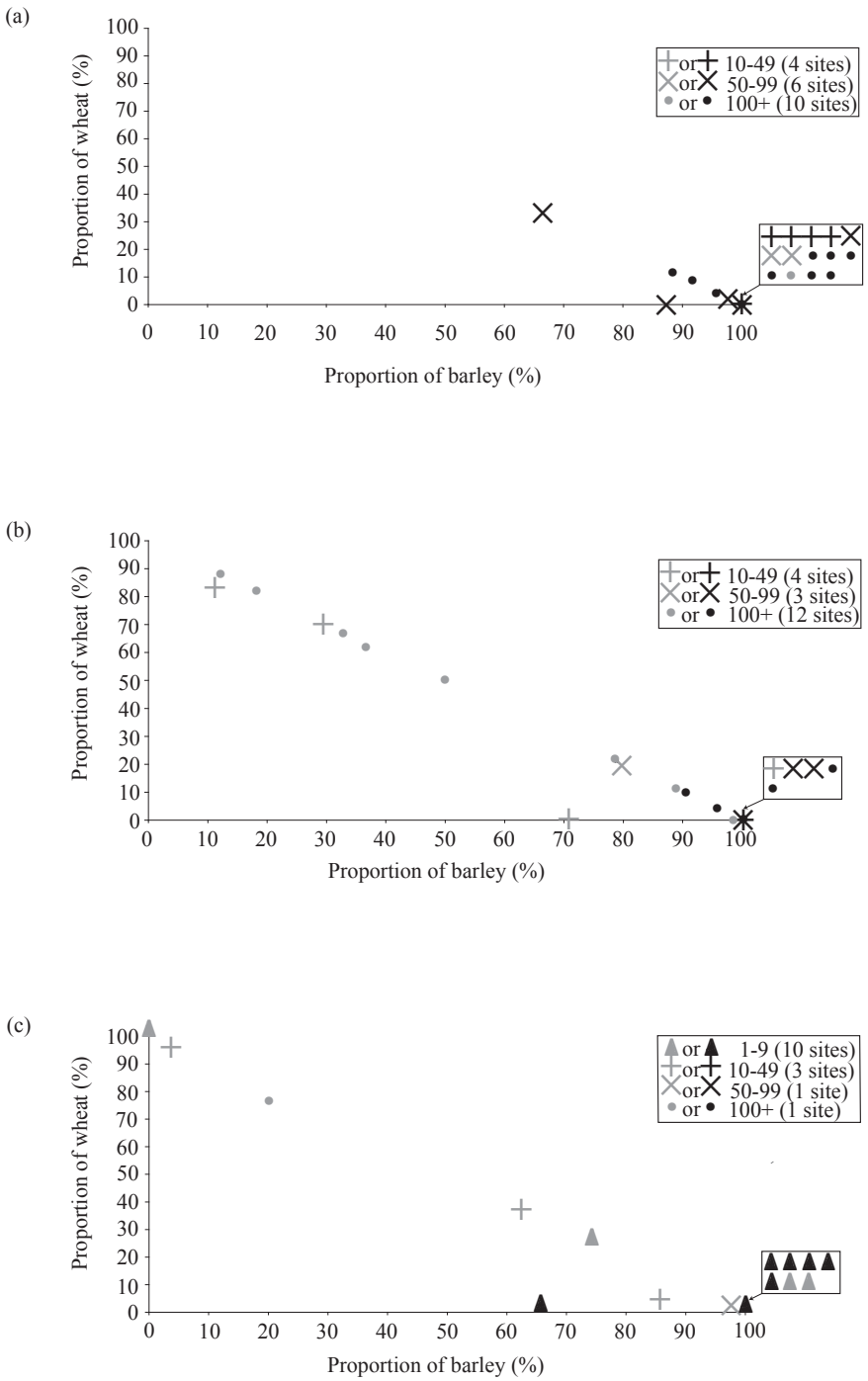
ILLUS 3 Mean proportion of cereals (a) and wild and domestic plants (b), divided into each period and region. The number of sites is indicated in brackets after the class on the x-axis. * indicates class incorporating sites with fewer than ten identified plant remains



ILLUS 4 Proportion of wild and domestic plants in Atlantic Scotland (a), north-east Scotland (b) and southern Scotland (c) assemblages, with the number of plant remains in each assemblage (10–49, 50–99 and 100+) indicated. Grey symbols denote EN sites and black symbols denote ELNT, N and LN sites. The number of sites in each of the assemblage size groupings (10–49, 50–99 and 100+) is indicated in brackets in the legend



ILLUS 5 Mean proportion of cereals in each period (a), region (b) and site (c) category. The number of sites is indicated in brackets after the class on the x-axis



ILLUS 6 Proportion of wheat and barley in Atlantic Scotland (a), north-east Scotland (b) and southern Scotland (c) assemblages, with the number of plant remains in each assemblage (1–9, 10–49, 50–99 and 100+) indicated. Grey symbols denote EN sites and black symbols denote ELNT, N and LN sites. The number of sites in each of the assemblage size groupings (1–9, 10–49, 50–99 and 100+) is indicated in brackets in the legend

Balbridie contained a substantial carbonised cereal assemblage (Fairweather & Ralston 1993, 316) and consequently the proportion of domestic species at these sites should have been more similar to the frequencies at the stone structures. Claish Farm was the only rectangular timber structure at which there were more hazelnut shell fragments than cereal grains.

In Scotland, there are four main patterns in the proportions of cereal species in the assemblages (Table 3; illus 3a, 5 & 6). First, considering the arable economy in Neolithic Scotland as a whole, barley was the main cereal crop, though some individual assemblages contained more wheat than barley. Of the 55 site blocks that included barley identifiable to variety, 42 contained more naked than hulled barley grain. Emmer wheat was the main wheat crop, though bread wheat was significant on a few sites. Oat, spelt wheat, rye and cereal chaff were rare at all sites in all periods. Naked barley was thus the dominant cereal crop cultivated in Neolithic Scotland, with emmer wheat also important at some sites.

Second, there is a significant increase in the use of barley and a decrease in the use of wheat between the early and later Neolithic periods in southern and north-east Scotland (illus 3a, 5a & 6). All 11 sites (Balbridie, Biggar Common 2, Claish Farm, Cowie Road, Deer's Den, Dubton Farm, Holywood, Inchture, Larkhall Academy, Lockerbie Academy and Warren Field) with more wheat than barley were dated to the Early Neolithic period and are located in southern and north-east Scotland (illus 7).

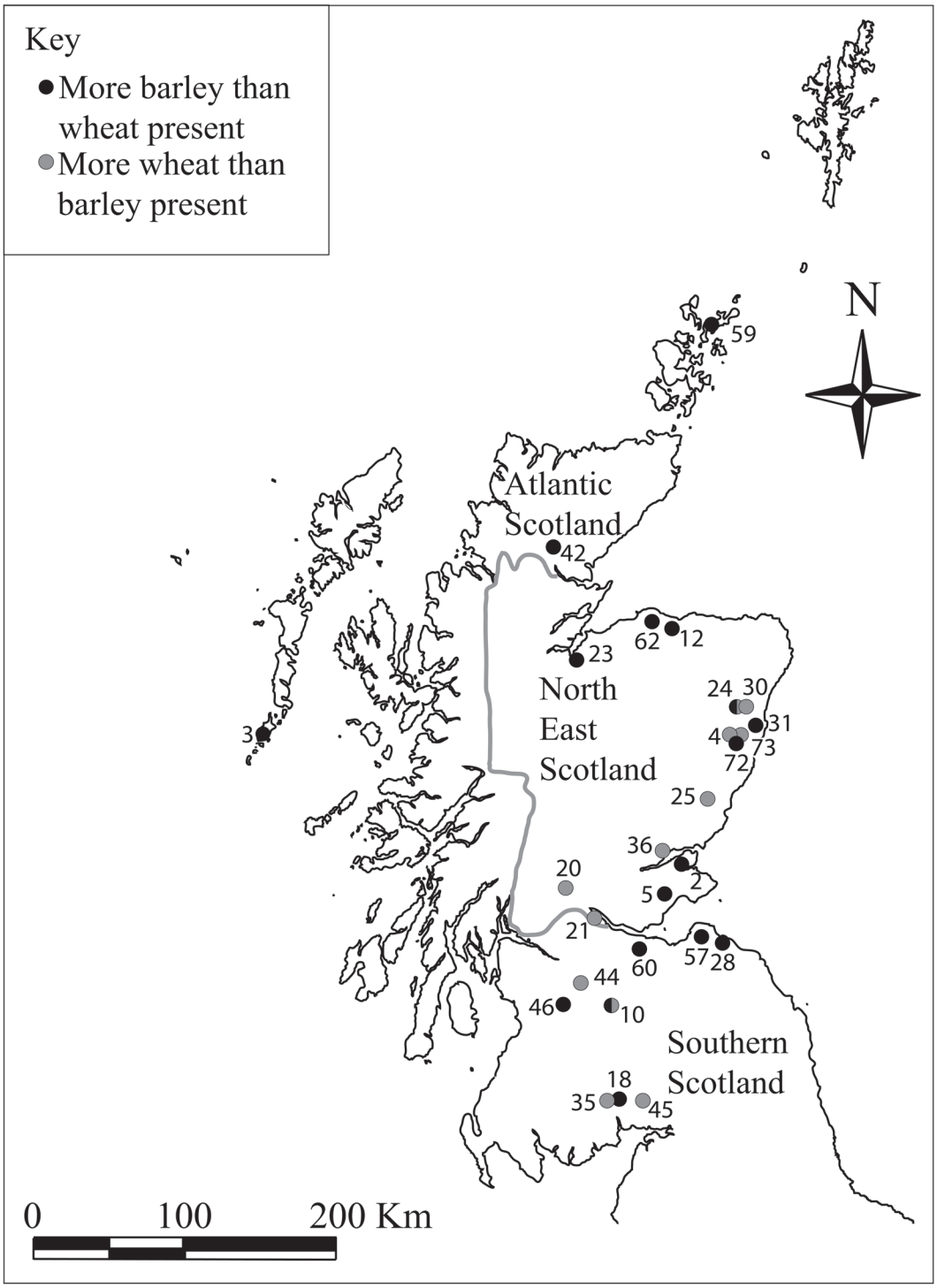
Third, barley was far more prevalent at the Atlantic Scottish sites than at the north-east and southern Scottish sites (illus 3a, 5b & 6). All of the assemblages from the Atlantic Scottish sites contained more barley than wheat. There was no change in the proportions of cereals between the Orkney Early Neolithic and the Orkney Late Neolithic assemblages, which contained over 94% barley grain in both periods.

Finally, only the assemblages from the Early Neolithic rectangular structures contained considerably more wheat than barley (illus 5c). The only other site types with significant concentrations of wheat were Early Neolithic pit sites and Early–Late Neolithic ephemeral structures (Table 3).

Despite these general trends in the data set, it is clear that the calculation of mean proportions of plant remains in each of the chronological, geographical and site type categories masks some of the variability in the data set (Table 3; illus 4 & 6). In fact, a diversity of subsistence practices existed in north-east and southern Scotland; some sites had plant economies based mainly on the collection of wild plants or cereal cultivation, and at other sites these practices seem to have been equally important. Also, though a clear chronological divide exists between the Early and Late Neolithic arable economy, there was considerable variability in the importance of wheat and barley in the assemblages in southern and north-east Scotland. In contrast, only two of the 21 sites in Atlantic Scotland had plant economies based mainly on wild plants, and the proportions of cereals in the Atlantic Scottish assemblages were extremely uniform, with barley dominant in all assemblages.

RELIABILTY OF DATA ANALYSIS

The interpretation of mean percentages based on small numbers of sites must be undertaken with caution. The apparent decline in the use of domestic plants in north-east Scotland and the increase in domestic plants in Atlantic Scotland in the Late Neolithic (illus 3b) are probably a function of the low number of assemblages in the Early Neolithic of Atlantic Scotland and the Late Neolithic of north-east Scotland. Taking together the variability in the proportions of wild and domestic plants in the Early Neolithic of north-east Scotland (illus 4b) and the fact that one of the two sites in the Late Neolithic of north-east Scotland contains 100% domestic plants and the other contains 100% wild plants (Table 3), there is no clear evidence for any



ILLUS 7 Map of Scotland showing Early Neolithic site blocks (see Table 3) showing the predominance of wheat or barley. Split circles indicate site blocks with different predominances

change between the early and Late Neolithic in this area. Likewise, the presence of only one site with greater than 20% wild plants in the Early Neolithic of Atlantic Scotland (illus 4a) suggests that in this area there was no real change between the early and Late Neolithic. In contrast, the near absence of domestic plants in the later Neolithic in southern Scotland (illus 4c) shows that the apparent decline in domestic plants in southern Scotland in the later Neolithic (illus 3b) is a real trend, and not a result of the small number of sites available for analysis.

Despite the fact that there are only three assemblages in the Early Neolithic of Atlantic Scotland, two in the Late Neolithic of north-east Scotland, five in the Early Neolithic of southern Scotland and four in the Late Neolithic of southern Scotland, all of the above trends in arable economy can be considered reliable. This is because wheat and oats are almost completely absent from the Early Neolithic Atlantic Scottish assemblages and the Late Neolithic north-east and southern Scottish assemblages (illus 3a, 6). Consequently, the greater importance of barley in Atlantic Scotland than elsewhere and the apparent decline in wheat between the Early and Late Neolithic are not the result of the calculation of mean percentages using small numbers of assemblages.

Equally, the results of mean percentages based on sites with small numbers of remains must also be considered critically. With the absence of any sites with greater than ten cereal grains in the Late Neolithic and Early–Late Neolithic Transition in southern Scotland, six sites with less than ten cereal grains were analysed, and a number of sites with fewer than 100 plant remains were included in the rest of the analysis (illus 4 & 6). However, it is not thought that the inclusion of these sites in the mean calculations has significantly affected the calculated averages because the results from these sites fit within the general spread of the data, and in the case of the Late Neolithic and Early–Late Neolithic Transition sites in southern Scotland, wheat was absent and oats were extremely rare and so the calculated mean proportions (illus 3a) can be considered to be reliable (illus 4 & 6).

TAPHONOMY

TAPHONOMY AND SPECIES ABUNDANCE

Assessing the relative importance of wild and domestic plants in the Scottish Neolithic is extremely problematic because taphonomic processes will have significantly affected the apparent abundance of different species in archaeobotanical assemblages. The frequencies of hazelnut shell fragments, fruit remains, cereal grains and flax seeds are not directly comparable, and this must be taken into account in the interpretation of these data.

First, each species differs in its likelihood of exposure to fire and subsequent carbonisation. Hazelnut shell is the unwanted waste product of consumption, which would either be deliberately discarded – often onto domestic fires – or used as kindling (Jones 2000, 80; Rowley-Conwy 2004, 90; Jones & Rowley-Conwy 2007, 400). On the other hand, cereal grains, which were intended for consumption, would only be charred accidentally and so even in societies dependent on cereals, charred grains are relatively rare (Jones 2000, 80; Jones & Rowley-Conwy 2007, 400). Fruit seeds would normally be consumed with the fruits (Boardman 1992a, M100) and neither the seeds nor the fruit itself would come in close contact with fire unless the fruit was being dried for future consumption, in which case carbonisation would be accidental. Both crab apples and sloes are bitter before drying so these species may have been dried before consumption (Dickson & Dickson 2000, 247 & 281); crab apples may also have been dried for winter storage (Renfrew 1973, 139). Most fruits, however, would probably have been consumed raw and may never have come into close contact with fire (Boardman 1995a, 152). Also, flax processing for linen production does not necessitate close contact to fire (Bond & Hunter 1987, 176) and flax seeds would only be

burnt accidentally, for example, if the stems were hung up to dry near a fire after the retting process (Dickson & Dickson 2000, 254). However, the absence of linen production material culture at any of the three sites where flax was recovered suggests that the seeds were used for the production of oil, so they may have become accidentally charred on domestic hearths during pressing (ibid). Therefore, hazelnut shell has the highest chance of becoming charred.

Second, the different plant species have vastly differing probabilities of preservation once exposed to fire. Hazelnut shell is dense and likely to become charred, while the considerably lighter cereal grains, fruit and flax seeds are likely to be burnt to ash (Hillman 1981a, 189; Wilson 1984; Jones 2000, 81; Rowley-Conwy 2004, 89; Jones & Rowley-Conwy 2007, 400). Hazelnut shell therefore has a greater chance of carbonisation. Having said this, experiments have also shown that only about 20–25% of hazelnut shell exposed to fire will become charred and survive, so even hazelnut shell frequencies in archaeobotanical assemblages are severe underestimates of the quantities originally present (Score & Mithen 2001, 512).

Third, recovery and quantification biases distort the apparent abundance of wild and domestic plants in archaeobotanical assemblages. It is likely that sites where judgement sampling, rather than a total sampling strategy (Jones 1991a, 57), was undertaken will have a greater chance of hazelnut shell recovery than cereal grains, because nutshell is far more visible during excavation (Rowley-Conwy 2004, 89; Jones & Rowley-Conwy 2007, 400). Also, hazelnut shell breaks easily into many fragments (Score & Mithen 2001, 511) so a single piece of hazelnut shell does not equate to a single hazelnut. Arguably therefore, Neolithic groups using hazelnuts, even in relatively small quantities, would produce assemblages dominated by nutshells.

Therefore, cereal grain, fruit and flax remains were probably underrepresented in the archaeobotanical record compared to hazelnut shell. Since hazelnut shell is the most significant wild plant species in the assemblages, it is arguable that taphonomic biases are responsible for its high frequency at some sites. It is therefore difficult to be sure whether assemblages with more wild than domestic plant remains necessarily indicate an economy based on wild plants. It is therefore highly significant that such a large number of sites should contain more domestic than wild species, and it seems probable that these sites accurately reflect a plant economy based on domestic rather than wild plants.

However, it should also be noted that a wide diversity of other wild plant species – such as leafy green vegetables and edible roots – were probably used. These would be virtually archaeologically invisible (Hillman 1981a, 189; Zvelebil 1994, 48). Considering that the leaves of wild plants would have been harvested before they set seed, it is very unlikely that seeds of these species would become carbonised and preserved (Boardman 1995a, 152; Dickson & Dickson 2000, 51). The seeds of edible green plants, such as fat-hen (*Chenopodium album* L.) and brassica (*Brassica* sp.), have been recovered from many Scottish Neolithic sites, but many of these plants are also common weeds of cultivation and may represent crop-processing waste rather than foodstuffs. Tubers and roots may also have represented a significant source of food, because they are high in carbohydrates and are available all year round (Hardy 2007). However, roots and tubers have rarely been recognised by archaeobotanists since they cannot be identified using conventional methods (Mason et al 1994, 55; Zvelebil 1994, 48; Hather & Mason 2002, 2), though they have frequently been found in European assemblages analysed appropriately (Hather & Mason 2002, 5; Mason et al 2002, 195). Consequently, there is at present very limited evidence for edible tubers on Scottish Neolithic sites. Possible pignut (*Conopodium majus* (Gouan) Loret) and false oat-grass (*Arrhenatherum elatius* ssp. *bulbosum* (Willd.) Hyl.) tubers have been recovered from Barnhouse (Hinton 2005, 341) and some tuber

remains have been recovered from Pool (Bond 2007a, 198) and Skara Brae (Dickson & Dickson 2000, 53–4; Rowley-Conwy forthcoming), though some of these may represent non-edible tubers accidentally gathered with turf collected as fuel (ibid). Perhaps the significance of tubers and leafy plants in Neolithic palaeoeconomies has been greatly underestimated.

Comparing the proportions of different cereal species between different types of site is far less problematic. While there probably was a difference in the deposition, preservation, recovery and quantification of cereals from different sites, these factors probably did not affect wheat and barley cereal grains differently. It seems probable that the differing proportions of these species provides a reasonably reliable indication of the relative importance of these species in each of the site, chronological and geographical categories.

TAPHONOMY AND INTER-SITE COMPARISON

Taphonomic processes will have affected each assemblage differently. For instance, different storage methods may account for the variations in the frequencies of cereal grains at different sites. The large concentration of grain recovered from Balbridie may relate to the indoor storage of grain within the structure (Rowley-Conwy 2000, 51; 2004, 90). In contrast, it is likely that grain was stored outside many of the more ephemeral structures due to lack of suitable storage space in the roofs (Rowley-Conwy 2000, 47; Jones & Rowley-Conwy 2007, 401) and grain may have had a lower chance of carbonisation. Alternatively, perhaps little cereal storage took place on many sites, with cereals mostly being consumed in the autumn soon after processing (Stevens 2007, 383). The short duration of occupation of many Neolithic sites may also account for the low frequency of cereals, compared to later prehistoric assemblages recovered from sites that may have been occupied for several generations (ibid, 379). It does not necessarily follow, therefore, that people living in less substantial houses were not reliant on cereals.

Likewise, heterogeneous preservation conditions on the different sites may have been responsible for the variation in the proportions of wild and domestic species. Cereal grain preservation is affected by the context of deposition and preservation (Renfrew 1973, 10; Church 2002a, 71), the type of fuel used on the hearth (Church & Peters 2004, 110), the ripeness of the grain on charring (Renfrew 1973, 11; Hubbard & al Azm 1990, 105), the length of time the remains were exposed to heat and the temperature of the fire (Boardman & Jones 1990). These factors probably differed from site to site. Since hazelnut shell is better preserved in fires than cereal grains, it is probable that cereal grains are underrepresented relative to hazelnut shell in the more poorly preserved samples.

In addition, there is no standardised hazelnut shell quantification methodology. While some sites may have quantified all of the hazelnut shell regardless of how small the fragments were, on other sites only the larger fragments may have been counted. Generally this information was not detailed in archaeobotanical reports, so the extent to which different quantification methods have been employed is unknown. Equally, on many sites hazelnut shell fragment frequencies were not quantified at all and simply recorded as a level of abundance or estimated rather than counted (Table 3). Consequently, assessing the relative abundance of hazelnut shell between different sites is very difficult.

TAPHONOMY AND SITE FUNCTION

The function of the Neolithic timber 'halls' in Scotland (Balbridie, Claish, Warren Field, Lockerbie, Carsie Mains) has been much disputed. Some favour the view that they were permanent houses (Rowley-Conwy 2002; Jones & Rowley-Conwy 2007, 404), or structures providing a central social focus for semi-mobile communities (Brophy 2006, 35; 2007, 89); others argue that they represent ritual

structures (Thomas 1996, 12; Topping 1996, 166; Thomas 1999, 25; 2003, 71, 2004, 122; 2007b, 34; 2008, 72; Noble 2006, 59), perhaps acting as 'specialised storage, consumption or redistributive locations' (Thomas 1999, 25). Given the detailed discussions elsewhere, the arguments for and against the domestic function of these sites will not be reiterated here. However, one important point must be made regarding the rarity of chaff in the large rectangular structures: cereal chaff was rare on *all* sites in Neolithic Scotland, not just the timber 'halls'. Chaff was only present on 14 of the 75 sites and only four sites had over 20 chaff fragments. It is highly improbable that all of these sites had a non-domestic function. If all of these sites contained fully processed crops, then cereal processing and/or deposition of processing waste must have been taking place elsewhere (Jones & Rowley-Conwy 2007; Stevens 2007, 379); or the chaff and straw was used as fodder or building materials (Jones 2000, 80), with only clean grain being brought to domestic habitation sites (Bogaard & Jones 2007, 66). Alternatively, considering that chaff is the least well-preserved cereal component in fires (Boardman & Jones 1990), poor preservation may have been responsible for the dearth of chaff on Scottish Neolithic sites. This idea is supported by the poor preservation of many of the assemblages included in the review. Of the 34 plant macrofossil reports that commented on the state of preservation of the archaeobotanical remains, only four described the cereal assemblage as being well preserved. Therefore, the rarity of chaff at the timber 'halls' cannot be used as an indicator of the function of these sites.

HUNTER-GATHERING OR AGRICULTURE IN NEOLITHIC SCOTLAND?

CEREAL CULTIVATION AND WILD PLANT COLLECTION

Overall, domestic species dominated throughout Scotland in both the Early and Late Neolithic (illus 2a). Seventy-two of the 93 site blocks contained cereals (Table 3). Considering the taphonomic factors discussed above, this suggests that cereals did indeed form a more significant part of Neolithic subsistence strategies than the collection of wild plants for most groups. While some individual sites either lacked cereals altogether or contained more wild than domestic species, many of these sites, such as Cowie Road, Geirisclett, Maeshowe, Embo and Bookan had a non-domestic function. Also, though many of the pit sites, such as Deers Den, contained few cereal remains, these sites may have been places of structured deposition (Richards & Thomas 1984) rather than domestic settlements (Speak & Burgess 1999, 105; Alexander 2000, 66). Consequently, the types of activity that would result in the preservation of domestic economic evidence probably did not take place at these sites (Church & Cressey 2003, 22). Equally, given the differential preservation of hazelnuts and cereal grains (see above) it is uncertain whether these proportions really do indicate economies based on wild plant gathering at all. Therefore, many of the sites with very low concentrations of cereals were not representative of the Neolithic domestic economy as a whole.

Moreover, the recovery of 20,000 cereal grains from Balbridie indicates that arable production was undertaken on a substantial scale in Neolithic Scotland (Cooney 1997, 27; Rowley-Conwy 2000, 51; 2004, 90). Further support for this is the presence of significant numbers of flax seeds at Balbridie and Lockerbie. This indicates a considerable level of agricultural sophistication, because the cultivation and processing of flax requires greater levels of management than other crops (Bond & Hunter 1987). Furthermore, the substantial evidence for field systems (Whittle 1986, 45; McCullagh 1989, 48; Barber 1997, 144–5; Edwards & Whittington 1998, 7; Barclay 2003a, 142; Noble 2006, 37–8), ard marks (Romans & Robertson 1983; Clarke & Sharples 1985, 73; Haggarty 1991, 67; Ashmore 1996, 73; McCullagh & Tipping 1998, 115; Guttmann et al 2004, 55; Noble 2006, 170; Hunter 2007, 65),

and soil amendment practices (Ritchie 1983, 45; Clarke & Sharples 1985, 73; Romans 1986; Guttmann et al 2004; Guttmann 2005; Guttmann et al 2006; Dockrill 2007, 36) in Neolithic Scotland shows a considerable investment in the arable component of the economy and the existence of developed and stable agricultural systems. This is supported by pollen evidence for widespread cereal agriculture across Scotland (Tipping 1994; Edwards & Whittington 1998, 2003).

Yet it is clear that the collection of wild plants remained an important part of the Neolithic economy in many parts of Scotland. Hazelnut shell was found on the majority of sites, and 28 sites contained more wild than domestic species (Table 3). The occurrence of wild fruit remains of crab apple (*Malus sylvestris* L. Miller), sloe (*Prunus spinosa* L.) and various berry species on 23 sites (Table 4) is very significant considering how unlikely these species are to become preserved (Hillman 1981a, 189). Crowberry was the most frequently present species, with seeds found on seven sites – all in Late Neolithic Orkney. While crowberry may represent a deliberately harvested foodstuff, it is equally possible that it was gathered along with peat and turf which was commonly burnt as a fuel in the Northern Isles by this period (Fenton 1978, 217–32; Dickson 1998; Dickson & Dickson 2000, 52–3; Hinton 2005, 342; Church et al 2007; Rowley-Conwy forthcoming). The abundance of other wild plant seeds in the plant assemblages from Orkney (Table 3) may also be a reflection of this practice (ibid).

There appears to be an increase in the use of wild plants in the later Neolithic in southern Scotland (illus 3b). The reasons for this increase are uncertain, but this may be a result of the taphonomic problems discussed above. Another possibility is that in the later Neolithic there may have been some abandonment of the more permanent settlements introduced in the earlier Neolithic. This is supported by the presence of small stake-built structures in the Late Neolithic at Beckton Farm associated with a plant assemblage composed almost entirely of hazelnut shell, and located in close proximity to the earlier Neolithic timber 'hall' at Lockerbie Academy, which had a larger cereal assemblage (see illus 1 for site proximities).

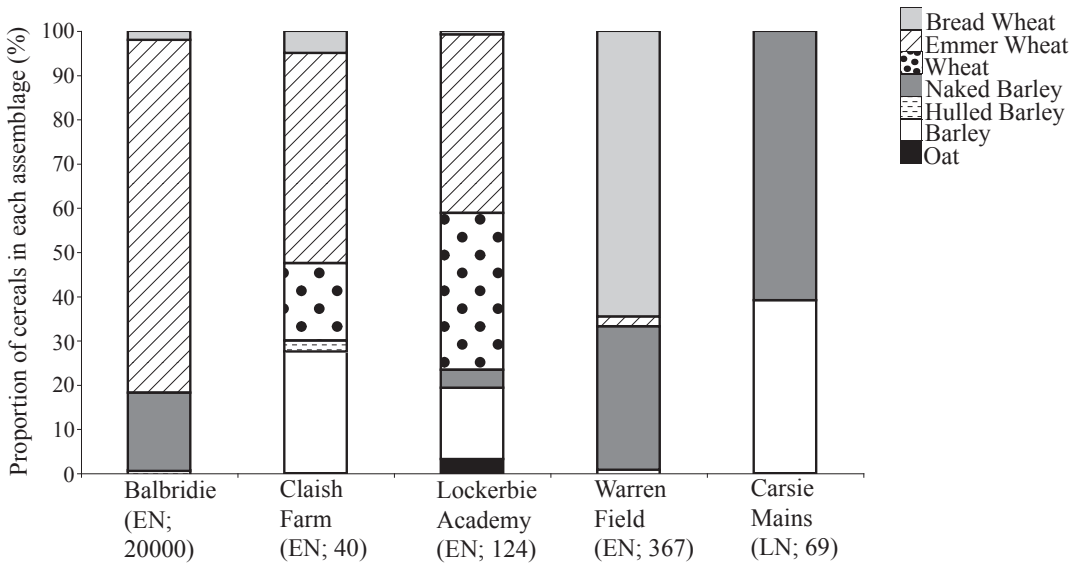
GEOGRAPHICAL AND SOCIAL DIFFERENCES IN PLANT EXPLOITATION

The Scottish Neolithic economy was far from uniform (Table 3; illus 4 & 6). The close proximity of ephemeral structures and pit sites, which were dominated by wild species to more permanent settlements where agriculture was more important, such as Claish Farm to Chapel Field, and Deer's Den to Warren Field and Balbridie (see illus 1 for site proximities), suggests that there were differences between contemporary groups living in close juxta-position.

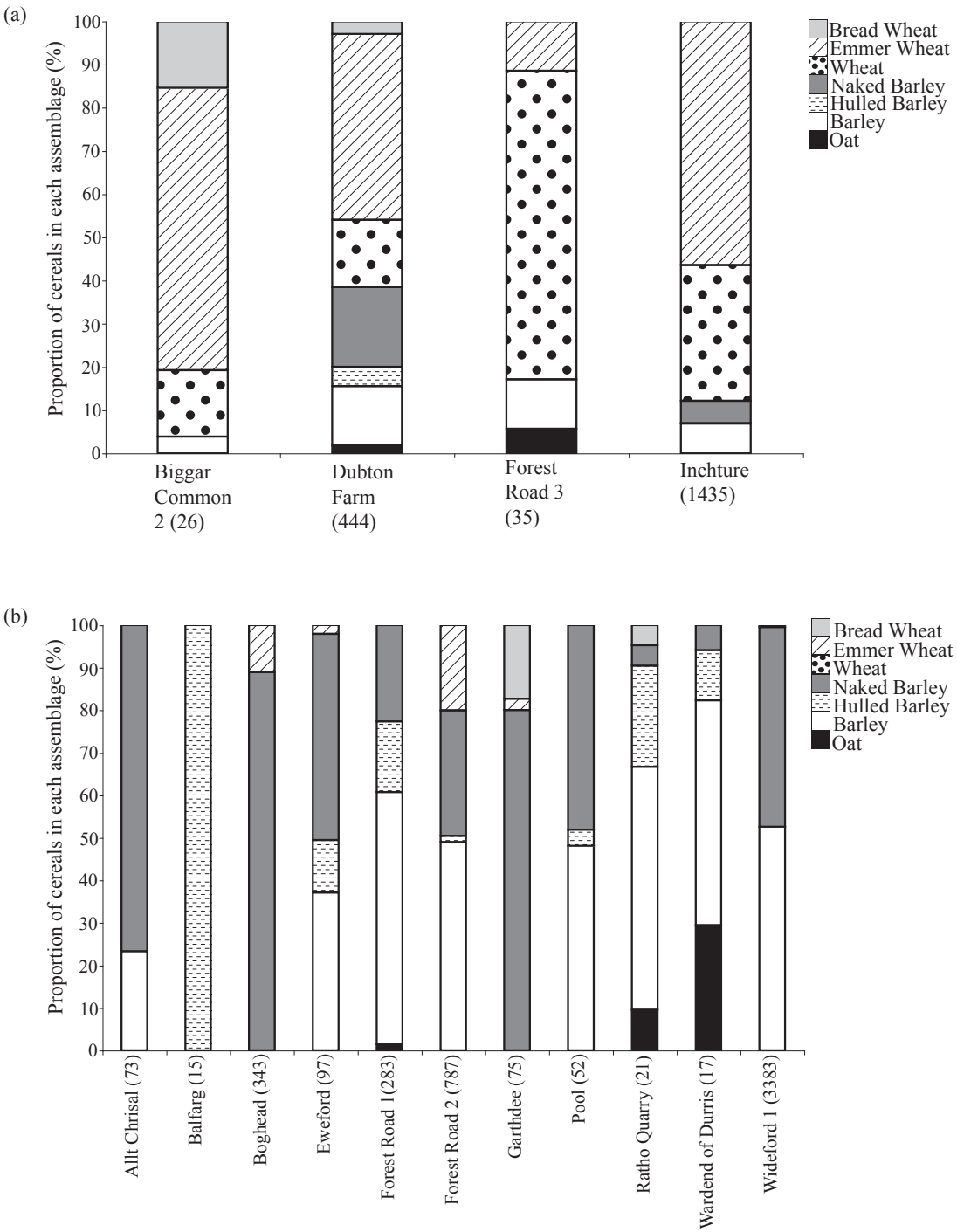
At a broader level, it is probable that agriculture was more prevalent in some areas of Scotland than others (Barclay 2003b, 81). Archaeobotanical data indicate that there was regional variation in plant subsistence practices, with a much greater reliance on wild species in southern Scotland than in north-east and Atlantic Scotland (illus 2b, 3b, 4). This may be a reflection of the fact that there are fewer sites with archaeobotanical remains available for analysis in southern Scotland than elsewhere, and perhaps more sites will be found in the future which contradict this pattern. Alternatively, it is possible that more settled agricultural communities existed in north-east and Atlantic Scotland than in southern Scotland. With the exception of the timber structure at Lockerbie, all of the sites in southern Scotland are either small/ephemeral domestic sites (seven), ritual sites (six) or pits (eight), which tend to have lower frequencies of domestic plant remains present. In contrast a larger proportion of the sites from Atlantic and north-east Scotland were either large timber rectangular structures or stone structures, which had consistently high frequencies of cereals.

Indeed, many sites in mainland Scotland showed a considerable continuity with the preceding Mesolithic way of life, in both structural forms and subsistence strategies. The small circular structures and the concentrations of pits, post-holes and hearths that characterise many Neolithic sites have clear parallels with earlier Mesolithic structures (Armit & Finlayson 1992, 668; 1996, 281; Alexander 2000, 65) and appear to represent short-term occupations of mobile or transhumant populations (Armit & Finlayson 1992, 670; Brophy 2006, 25; Noble 2006, 59). There is an association between these ephemeral structural types and wild plant foods – though domestic plants also formed part of the economy of these sites (illus 2c; Table 3). Also, it is arguable that many of the pit sites, which contained few cereal remains, were indicative of transient domestic settlement (Ashmore 1996, 59; Alexander 2000, 65). This suggests that wild plant collection was still a common aspect of the subsistence strategy in some parts of Neolithic Scotland and may support Sharple's (1992, 329) suggestion that indigenous Mesolithic inhabitants may have adopted aspects of the Neolithic package in south-west Scotland.

There may also be a functional division between the pit sites and domestic settlements. Many of the pit sites may actually represent specialised plant processing sites, perhaps used on a seasonal basis by communities occupying the timber 'halls' and ephemeral domestic sites. In support of this is the fact that apart from the timber structures and stone structures, cereal chaff is only present at pit sites (Table 3). There are no pit sites in the Northern and Western Isles, so perhaps cereal processing took place within the stone domestic structures in these islands. In particular the site of Dubton Farm, in north-east Scotland provides the clearest evidence for a specialised plant-processing site. The largest concentration of cereal chaff, crab apple remains and whole hazelnuts, together with the third largest concentration of weed seeds in Neolithic Scotland, was recovered from pits at this site. The cereal chaff and weed seeds indicate cereal processing; the crab apple remains and whole hazelnuts may have



ILLUS 8 Proportion of cereals at the large rectangular timbers structures. The dating classification and the number of grains is indicated in brackets after the class on the x-axis



ILLUS 9 Proportion of cereals at Early Neolithic sites (excluding large rectangular timber structures shown in illus 8), sites with more wheat than barley (a), and sites with more barley than wheat (b). The number of grains is indicated in brackets after the class on the x-axis

become charred during drying for storage. The composition of the assemblage was also very similar to the timber 'halls' in the area: mostly emmer wheat (43%), some naked barley (19%), and a little bread wheat (3%), together with crab apples and hazelnuts (compare illus 8 & 9a). Considering this and the fact that the site is contemporary with the rectangular timber structures, Dubton Farm may represent an initial processing area for food used within one of the timber 'halls'.

The mainland Scottish Neolithic sites clearly contrast with the permanent stone settlements in Orkney, Shetland and the Outer Hebrides, where settled agricultural communities appear to have been present, and where plant assemblages were almost entirely composed of cereals (illus 2b, 2c & 4a). Interestingly, even the ephemeral circular timber structures at Wideford, Orkney, lacked wild plants remains (Table 3). The scarcity of hazelnut shell in the Northern Isles assemblages also contrasts with the mainland Scottish assemblages. Hazelnut shell was only present at four sites in Orkney (Braes of Ha'breck, Knap of Howar, Pool and Barnhouse). This is not surprising given that hazel was probably relatively scarce in Neolithic Orkney – as a result of both natural decline and anthropogenic clearances (Keatinge & Dickson 1979; Davidson & Jones 1993, 25–6; Bunting 1994; de la Vega Leinert et al 2000). The preferential preservation of hazelnut shell in archaeobotanical assemblages compared to cereals, together with the presence of hazel charcoal in assemblages containing cereals but lacking hazelnut shell, such as Wideford and Stonehall (Miller & Ramsay forthcoming) suggests that hazelnuts were a relatively unimportant food source for most social groups in Orkney. While the settlement evidence from the Outer Hebrides may suggest that settlement was not as permanent as in the Northern Isles (Armit 1992, 319), the archaeobotanical evidence suggests that there was no significant difference in subsistence practices between these two areas, since only one of the three settlements in the Western Isles had a greater proportion of wild than domestic plants.

However, in contrast to other areas of Atlantic Scotland where numerous stone-built structures are present, it appears that there was considerable continuity in economic practices between Mesolithic and Neolithic communities in the west coast of mainland Scotland and the Inner Hebrides. There are no known examples of cereal grain in the Neolithic of this area (Table 3), and there is evidence for the continued occupation of Mesolithic shell middens into the Neolithic period (Armit & Finlayson 1992; 1996; Mithen et al 2007, 516–7; Sharples 1992, 327; Telford 2002, 300). For example, the shell midden at Carding Mill Bay, near Oban, contained only wild plant species and artefacts normally associated with the Mesolithic period, but the radiocarbon dates place this activity within the Neolithic period (Connock et al 1992, 36). It is possible that cereal cultivation was not introduced into this area until the Bronze Age (Mithen et al 2007, 521).

While most Atlantic Scottish communities focused on domestic plants and some southern Scottish/north-east Scottish groups were more focused on wild plants, it is probable that a mixed-plant subsistence economy based on both gathering and agriculture was the predominant subsistence pattern in many areas of mainland Scotland (Boardman 1993b, 376; Barclay 2003a, 148; Stevens 2007, 382). Hunter-gathering and agriculture are not mutually exclusive strategies and many societies have mixed economies (Layton et al 1991, 260; Armit & Finlayson 1992, 670; 1996, 274). In mainland Scotland, there is consistent evidence for the cultivation of cereals and the gathering of wild species on most sites (Table 3). As Barclay (2003a, 148) contends, a 'model of a small-scale, intensive, subsistence economy using a wide range of resources may be more helpful than comparisons with later prehistoric agricultural systems in Wessex'.

The differing levels of investment in arable agriculture in different parts of Scotland may be a reflection of the differing density of settlement

in different areas in the Mesolithic (Armit & Finlayson 1992, 672; Sharples 1992, 326; Telford 2002, 289) and the natural availability of wild resources in the environment. For instance, in Orkney, Shetland and the Outer Hebrides, where there is at present limited evidence for Mesolithic settlement (Cantley 2005; Gregory et al 2005; Lee & Woodward 2009) it is probable that only small Mesolithic populations existed. Consequently, it is likely that a greater initial investment in an agricultural economy was necessary than elsewhere to make settlement viable for a larger population, especially considering the relative scarcity of wild plants, such as hazel and crab apple, available for exploitation in these areas. In contrast, there is abundant evidence for Mesolithic occupation and the exploitation of both marine resources and wild plants in the West Coast of mainland Scotland and the Inner Hebrides (eg Mercer 1970–1; Mercer 1971–2; Mercer 1972–4; Mercer 1978–80; Mellars 1978; Affleck et al 1988; Searight 1990; Wickham-Jones 1990; Mithen 2001; Mithen et al 2001; Wickham-Jones & Hardy 2004). This, together with the absence of Neolithic cereal remains and the continued occupation of Mesolithic shell middens into the Neolithic (Armit & Finlayson 1992; Sharples 1992, 327; Armit & Finlayson 1996; Telford 2002, 300; Mithen et al 2007, 516–17), may suggest continuity between the Mesolithic and Neolithic communities in this area. In north-east and southern Scotland abundant wild resources were available for exploitation and there is consistent evidence for Mesolithic settlement (eg Coles 1971; Wordsworth et al 1985; Boyd & Kenworthy 1991–2; Alexander et al 1997; Johnston 1997; Wickham-Jones & Dalland 1998; Macgregor et al 2001; Atkinson 2002; Mackenzie et al 2002). Considering both the variability in both Neolithic settlement and archaeobotanical evidence in southern and north-east Scotland, it seems probable that there was a mixture of indigenous adoption of agricultural practices into successful Mesolithic economic systems, together with the movement of some established agricultural communities from elsewhere into the area. For instance, the similarities between the structural forms, artefactual evidence and archaeobotanical remains from the Early Neolithic timber 'halls' (Fairweather & Ralston 1993; Ashmore 1996, 32–3; Sheridan 2004, 12; 2007) may suggest that these sites were established by incoming farming groups (see below for further discussion).

THE SCOTTISH NEOLITHIC ARABLE ECONOMY

The two main crops cultivated in Neolithic Scotland were naked barley and emmer wheat, although hulled barley outnumbered naked barley in a number of specific assemblages. Many assemblages contained a mix of both naked and hulled barley. This was perhaps a reflection of the mixed nature of the imported crop and of the ability of the naked and hulled varieties to interbreed – the naked trait is controlled by a single recessive gene (Zohary & Hopf 2000, 60). On the basis of the Pool and Tofts Ness assemblages, Bond (2007a, 183; 2007b, 157) has suggested that the transition from naked to hulled barley, which generally occurred sometime during the Bronze–Iron Age in Britain (Hillman 1981b, 124; Van der Veen 1992, 74; Miller & Ramsay forthcoming), occurred in the Neolithic period in Orkney. Against this idea is the predominance of naked barley at several Neolithic (Barnhouse, Isbister, Knap of Howar, Ness of Brodgar, Skara Brae, Stonehall, Wideford) and Late Neolithic/Bronze Age sites (eg Crossiecrown, Ness of Gruting) in Orkney and Shetland (Table 3; Milles 1986b; Miller & Ramsay forthcoming). Considering the high proportion of indeterminate cereal grains and grains identified as barley at Pool and Tofts Ness (Table 3), the proportion of naked:hulled barley grain is difficult to assess, and it is not possible to say whether there was an increase in hulled barley from the early to later phases of Pool. Consequently, it seems that hulled barley

was only to become dominant in the Bronze Age or later in Orkney, as in the rest of Scotland.

All other cereal species were rare in Neolithic Scotland and probably represent contaminants of the emmer wheat and naked/hulled barley crops or small-scale experimentation with new crop types. Though cultivated oat was present in 18 of the 93 site blocks, it was only present in very small quantities and was probably never grown as a crop in its own right. Spelt wheat was only present at two sites and rye at just one site (Table 3). Apart from these examples, grain of these species has only been recovered from the late Bronze Age onwards in Britain (Helbaek 1971, 268; Renfrew 1973, 83; Godwin 1975, 406, 413, 415; Barclay & Fairweather 1984; Boyd 1986; van der Veen 1992, 75), and rye may not have become an important crop until the Medieval period and possibly later in Scotland (Barclay & Fairweather 1984; Boyd 1988, 105; Dickson & Dickson 2000, 236–7). Also, none of the spelt wheat or rye grains has been radiocarbon dated, and it remains possible that these grains represent intrusive material.

It seems likely that the shift from wheat to barley in mainland Scotland in the later Neolithic was a result of environmental factors. Towards the later Neolithic, climatic conditions were wetter and possibly slightly cooler in Scotland (Tipping 1995; Anderson 1998; Anderson et al 1998; Bonsall et al 2002; Tipping & Tisdall 2004, 76). Therefore conditions were less favourable for the cultivation of wheat which prefers drier soils and warmer summers (Renfrew 1973, 65 & 81; Coppock 1976, 55) and is more sensitive to changes in soils and climate (Zohary & Hopf 2000, 68). It is probable that Neolithic farmers observed this natural selection against wheat, and that as the climate grew wetter, the more successful species – barley – was chosen as the dominant crop. Equally, the more marginal environmental conditions in Atlantic Scotland were probably far less favourable for wheat production than elsewhere in Neolithic Scotland, due to high winds and rainfall (Coppock 1976, 14–16; Davidson & Jones 1993, 19). Modern agricultural maps show that the northern economic limit of wheat is around the Dornoch Firth (Coppock 1976, 55) – which is at the northern extent of the north-east Scotland geographical category in this review. Wheat would therefore have been better adapted to the conditions in southern and north-east Scotland (Coppock 1976, 55; Maclean & Rowley-Conwy 1984, 71; Milles 1986a, 119; Dickson & Dickson 2000, 67; Church 2002b, 61). The decline in the size of emmer grains between the Early Neolithic site of Boghead and the later Neolithic site of Skara Brae supports this conclusion (Maclean & Rowley-Conwy 1984, 70). Indeed, considering the low proportions of wheat in the assemblages from Orkney and Shetland throughout the Neolithic, it seems likely that wheat was a contaminant of the barley crop in these areas (Milles 1986a, 119; Bond 2007a, 183; Miller & Ramsay forthcoming).

However, these environmental factors do not explain the variation in the proportions of wheat and barley at the different site types. Not only were all of the assemblages from the Early Neolithic rectangular structures composed almost entirely of wheat, but there was also a remarkable similarity in the composition of these assemblages (illus 8). The samples from Lockerbie, Balbridie and Claish Farm were dominated by emmer wheat (40–80%), together with slightly lesser amounts of naked/hulled barley (18–30%), and low frequencies of bread wheat and oats (<5%). The structure at Warren Field, on the other hand, contained more bread wheat (*c* 65%) than emmer wheat (*c* 2%), but similar levels of naked/hulled barley (33%). Bread wheat is a rare find on Scottish Neolithic sites and it is only present in ten of the other site blocks. In contrast, the plant macrofossil assemblage from the Carsie Mains structure was composed entirely of barley. This is probably a consequence of the Late Neolithic date of this site, though it may be a reflection of the fact that it was an unroofed and possibly non-domestic structure, which may differentiate it from the

other large timber halls (Brophy & Barclay 2004, 19; Brophy 2007). Overall, the proportions of cereals from the Early Neolithic timber 'halls' were extremely unusual for Neolithic Scotland.

Other rare and unusual finds at these sites were crab apple remains and flax seeds. Crab apple was present at just four other Scottish Neolithic sites. Flax was present at both Balbridie and Lockerbie, forming the two largest concentrations of Neolithic flax in Scotland. Only one other possible flax fragment has been found in the whole of Neolithic Scotland, at Achnasavil in Kintyre. Flax is also a rare discovery in Neolithic England, with the remains coming from Windmill Hill, Wiltshire (Godwin 1975, 167), Lismore Fields, Buxton (Jones & Rowley-Conwy 2007) and from The Stumble, Essex (Grieg 1991, 300).

To some extent the abundance of wheat in the cereal assemblages from the timber 'halls' can be accounted for by their Early Neolithic date and southern/north-east Scotland distribution. However, this does not fully explain the unusual compositions of these assemblages because not all of the Early Neolithic sites located in these areas conform to the same pattern.

One possibility is that these timber rectangular structures served a ritual rather than domestic purpose (Thomas 1996, 12; Topping 1996, 166; Thomas 2003, 71; Noble 2006, 59) and that the cereals were specifically chosen for use within ritual contexts. Alternatively, it is possible that these structures were high-status domestic sites and that the unusual compositions of plants may relate to the importance of these species within Scottish Neolithic society (Miller & Ramsay 2002, 95). The association of the rare and more labour-intensive flax with timber 'hall' sites in Britain (Balbridie, Lockerbie, Lismore Fields) could support both these suggestions. However, these arguments seem less plausible since similar combinations of cereals have been recovered from several other Early Neolithic sites of different function. These sites include an ephemeral structure and domestic evidence at Biggar Common, the groups of pits from Dubton Farm, Forest Road and Inchture (illus 9a), and ditches, pits and post-holes from Larkhall Academy (Table 3). None of these sites provides evidence for clear ritual activity and all of these sites can be interpreted as having a relatively low-status domestic function.

A further possibility is that this suite of cereals was introduced together by a group of culturally similar people during the same phase of colonisation. This idea is supported by the similarities in the structural form of the timber 'halls' and the associated artefactual evidence (eg carinated bowl pottery) with continental material (Fairweather & Ralston 1993; Ashmore 1996, 32–3; Sheridan 2004, 12; 2007). This may represent either the introduction of a specific method of cereal cultivation that had been successful elsewhere, or the acquisition of cereal grain by indigenous peoples from a specific group at a similar period of time. While the artefactual evidence from Warren Field suggests that this particular site may not have been the first settlement of incoming farmers (Murray et al 2009, 66–7), this suite of introduced plants may have continued to be used by descendents of the first farmers using this range of plants. The fact that there appears to be another group of Early Neolithic Scottish sites with a very different combination of cereal species supports this suggestion (illus 9b). These site assemblages all contain over 80% barley, with only small concentrations of emmer/bread wheat. This second group could represent another phase of colonisation, or indigenous acquisition of cereals from a different cultural group. However, caution must be exercised when using archaeobotanical remains in isolation when interpreting the nature of Neolithic colonisation and society.

CONCLUSIONS

The most common plant subsistence strategy in Neolithic Scotland was the cultivation of naked barley, supplemented by the collection of hazelnuts and some wild fruits. However, plant

exploitation was geographically, socially and chronologically diverse. Though naked barley was the main barley crop, many plant assemblages contained a mixture of hulled and naked barley, and hulled barley was the most significant cereal in a number of specific assemblages. Emmer wheat was also an important crop on many Early Neolithic sites in southern and north-east Scotland, but was probably only ever a contaminant of the other crops in Orkney and Shetland, due to the more marginal environment in this area. Wheat was no longer a significant crop in the Late Neolithic, and was probably only a crop contaminant by this period. The wetter climate in the later Neolithic was probably responsible for this, because wheat is less tolerant of wet conditions than barley. Bread wheat was only found on 14 sites and was represented by a few grains only at each site, except at the large rectangular timber structures where larger concentrations were present. These Early Neolithic timber 'halls' were associated with a distinct suite of plant material: mostly emmer wheat, some naked barley and bread wheat, together with flax, hazelnuts and crab apples. Five other Early Neolithic sites had a similar range of cereal species to the timber 'halls', and this suite of plants may have been introduced during the same phase of colonisation.

The relative importance of wild and domestic plants in the Scottish Neolithic economy was very variable. The permanent stone settlements in Orkney, Shetland and the Western Isles were associated with plant assemblages composed almost entirely of cereals and seem to represent settled agricultural communities. Hazelnut shell was very rare in Neolithic Orkney and Shetland despite the presence of hazel charcoal at some sites, suggesting that wild plants were an insignificant part of the economy in this area.

In contrast, in most of mainland Scotland, a mixed-plant subsistence economy based on both wild plant collection and cereal cultivation was the predominant pattern. Hazelnuts were present at the majority of sites in this area. Additionally, ephemeral structures, pit sites and ritual sites included a mixture of both wild and domestic plants, but considering the preferential survival of hazelnuts in archaeobotanical assemblages it is difficult to be certain whether wild or domestic plants were of greater significance. However, it appears that wild species made a far more significant contribution to the assemblages in southern than in north-east Scotland, and there appears to have been a continuation of a Mesolithic subsistence strategy on the West Coast of mainland Scotland and the Inner Hebrides. On the local scale, however the picture is more complex, with some apparently contemporary groups living in both larger timber structures and growing crops on a large scale, and other groups living in smaller more ephemeral structures and focusing on wild resources.

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