Teemu Mökkönen

NEOLITHIC HOUSEPITS IN THE VUOKSI RIVER VALLEY, KARELIAN ISTHMUS, RUSSIA – CHRONOLOGICAL CHANGES IN SIZE AND LOCATION

Abstract
Since the discovery of the first housepits on the Karelian Isthmus in 1999, intensive surveys in the research area of the Vuoksi River Valley have revealed 82 housepits dispersed among 24 dwelling sites. Most of the housepits date to the Neolithic Stone Age. During the time the housepits were in use, the sites were located on the shores of Ancient Lake Ladoga.
The first part of this article deals with pattern recognition: chronological variation in housepit size and shape, and in the placement of pithouses. The clearest change in tradition in pithouse placement is observed in the Typical Comb Ware Period, when pithouses appeared in large numbers in the archipelago. This change is accompanied by an unprecedented increase in pithouse size and numbers.

The second part of this article attempts to infer what motivated the observed changes. This paper argues that there was an increase in sedentism during the first half of the 4th millennium cal BC, in the Middle Neolithic. This is reflected in the development of pithouses and pithouse sites, in shifts in site placement to settings favouring other than winter-only habitation, and in logistical mobility based on water transportation.

The article is based on survey data mostly gathered during the Kaukola-Räisälä Project (2004–2005).

Keywords: Neolithic, Stone Age, housepits, ancient Lake Ladoga, Karelian Isthmus, Finland, Russia, hunter-gatherers, survey data, sedentism, water transport

Teemu Mökkönen, Institute for Cultural Research, Archaeology, P.O. Box 59, FI-00014 University of Helsinki, Finland, E-mail: teemu.mokkonen@helsinki.fi

INTRODUCTION

This article is the first comprehensive presentation of the Stone Age housepits discovered over the last ten years in the Kaukola–Räisälä region in the northeastern part of the Karelian Isthmus, Russia (Fig. 1). Archaeologically, this is the most intensively studied area of the Karelian Isthmus, with a history of research extending back more than a hundred years.[1] Regardless of the long research history, the majority of the data used in this study was gathered during the Kaukola–Räisälä Project[2], which included several surveys and small-scale excavations. As a result of the surveys, the number of known Stone Age and Early Metal Period sites doubled.[3] Sites are referred to here by their Finnish names[4], a convention also followed in previous articles (see Lavento et al. 2001; 2006; Mökkönen et al. 2006).

The first housepits in the research area were discovered in 1999 (Lavento et al. 2001). At the moment, known housepits number 82, divided among 24 dwelling sites[5] (Appendix 1). Most of the housepits date to the Neolithic[6] Period, with a few exceptions (see Mökkönen et al. 2007). During the Stone Age these sites were located by Ancient Lake Ladoga (ca. 7800/7000–1350 cal BC), the water level of which lay at ca. 21 meters above sea level, i.e., about 16 meters higher than at present.

The central question of this paper deals with chronological variation in the housepits. The

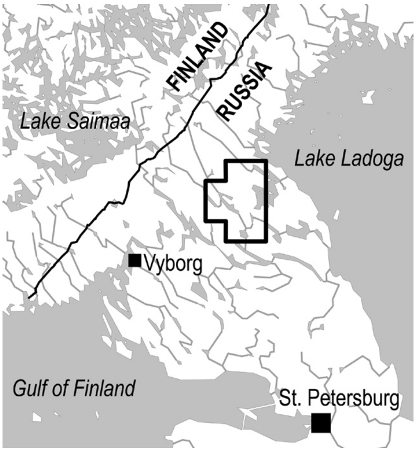

Fig. 1. The research area is located in the River Vuoksi Valley, Karelian Isthmus, Russia. The maximum size of the research area is 30 x 40 kilometers.

absence of excavated housepits has directed the analysis towards information available through archaeological surveys. In boreal forest that has never been agricultural land, housepits are still clearly observable. Therefore, it is possible to measure the size and depth and examine the shape and alignment of the housepits without excavation.

Other issues also examined here are the distribution of housepits with respect to environmental zones, the housepit sites' immediate environment, and the pottery types associated with housepits. The development of housepits and changes in site location provide information, for example, about the degree of sedentariness and the mobility strategies of the groups that inhabited the shores of Ancient Lake Ladoga.

This article commences with a discussion of the problems with chronological accuracy regarding the Neolithic material found on the Karelian Isthmus and the general development of housepits with emphasis on the areas in the vicinity of the study area. The article then focuses on the housepits in the lower Vuoksi River Valley and describes the observed changes: the chronological trends in housepit shape and size as well as changes in the housepit sites' environmental and topographic setting. Finally, the observations are discussed with emphasis on questions relating to the degree of sedentism, mobility, and the housepit sites' suitability for year-round habitation.

LIMITATIONS OF CHRONOLOGICAL TOOLS

When the number of excavated sites is low, the presumed chronological distribution of the sites is usually not based on radiocarbon dates. Chronological tools often employed in such cases include shoreline displacement chronology and pottery typology.

Land uplift is an active natural force on the Karelian Isthmus. However, sites in the research area cannot be dated accurately by shoreline displacement chronology. Likewise, the pottery typology of the area is still poorly studied and presents a number of unique characteristics. The limitations of these tools are presented in the following.

Shoreline displacement

The Ancient Lake Ladoga Phase covers the span from the isolation of the lake from the Baltic Sea Basin (ca. 7800–7000 cal BC) to the formation of the River Neva (ca. 1350 cal BC). During this period the lower Vuoksi River Valley was a large bay of Ancient Lake Ladoga, reaching far into the interior of the Karelian Isthmus (see Fig. 10). The research area is located approximately on the same land uplift isobase as the former outlet channel at the Heinijoki threshold east of the town of Vyborg (Saarnisto & Grönlund 1996; Saarnisto 2003; 2008).

The Heinijoki threshold, which was active during the whole Ancient Lake Ladoga period, split the ancient lake into two areas: (1) the north-western area with a higher land uplift rate and regressive water level, and (2) the south-eastern area with a lower land uplift rate and transgressive water level. The water level in the research area, which is located on the same land uplift isobase as the threshold, was nearly stable.

Around 4000 cal BC, the formation of the Vuoksi River, a new outflow channel of Lake Saimaa running into Lake Ladoga, accelerated the rise of the water level in the latter, including, of course, the research area. The maximum water level was reached just before the formation of the current outflow channel, the River Neva (ca. 1350 cal BC), the opening of which caused a ca. 10-meter drop in the water level. Nevertheless, the fluctuation of the water level in the research area during the Ancient Lake Ladoga Phase was minor, within a limit of two meters[7] (Saarnisto & Siiriäinen 1970).

In addition to slight water level fluctuations, there is another factor that complicates the dating of dwelling sites on the basis of their elevation. During the Stone Age there was a clear tendency to occupy locations with a steep shore profile (Mökkönen et al. 2006: 116). These sites were not affected at all by small water level fluctuations and could consequently have been occupied throughout the Ancient Lake Ladoga Phase.

Pottery typologies

A detailed pottery typology for the Karelian Isthmus does not exist as of yet. On the basis of typologies created for nearby areas, it can be assumed that the Early Neolithic on the Karelian Isthmus was rather similar as regards dating and ceramic types (see Piezonka 2008). Later, during the late Middle Neolithic and the Late Neolithic[8], regional variation in ceramics increases (Fig. 2). This is evident when comparing the chronologies of areas adjacent to the Karelian Isthmus (see Carpelan 1999; Zhul'nikov 1999; 2003; 2005; Lang & Kriiska 2001; Pesonen 2004). Therefore, it is probable that none of the pottery chronologies used in the nearby areas will automatically work on the Karelian Isthmus.

Discrepancies in dating certain types of ceramics are suggested by comparisons of AMS-dates from the Karelian Isthmus with Finnish dates. For example, Kierikki Ware found in Finland dates to ca. 3350–2900 cal BC (Pesonen 2004) while an AMS-dated piece of Kierikki Ware from the Johannes Väntsi site, located by the seashore on the Karelian Isthmus, dates notably older, ca. 3770–3530 cal BC (1 sigma)[9] (Huurre 2003: 198–9, 512).

As an inverse example, Late Comb Ware from the Viipuri Häyrynmäki site, also once located by the sea, dates to 3500–3030 cal BC (1 sigma) (Pesonen 2004: 91–2). This is nearly 300 years younger than the youngest Late Comb Ware dates obtained from Finland (Pesonen 2004). Recent dates of similar age from south-eastern Finland (Mökkönen 2008: 122–4) demonstrate that Late Comb Ware stays longer in use in the eastern Gulf of Finland than in most other parts of Finland (for Estonian dates see Kriiska 2001; Lang & Kriiska 2001: 92).

To sum up the limitations of the chronological tools: The use of shoreline displacement for dating is hazardous because of the minor water level fluctuation and the ancient population's habit of occupying locations with steep shore profiles. At the moment, our knowledge of Middle and Late Neolithic ceramics on the Karelian Isthmus is insufficient for understanding the chronological variation in all its details. There are numerous similarities with the Stone Age ceramics found within the current borders of Finland, but on the other hand, similarities with materials found in nearby Russian areas are highly likely, although at the moment this is poorly understood. I suppose that the Finnish pottery typology and chronology, for the lack of something better, can be used on the Karelian Isthmus as a directional device, yet keeping in mind the limitations of its accuracy.

CHRONOLOGICAL TRENDS IN NORTHERN EUROPEAN HOUSEPITS

Another approach to understanding the chronology is to analyse the sizes and shapes of the housepits. A certain developmental trend may be observed taking place quite simultaneously in the Northern European forest belt. A preference for larger, deeper, and more oblong housepits (a.k.a. semi-subterranean houses) appears during the late 4th millennium cal BC, continues universally during the 3rd millennium cal BC and sporadically in some areas up to the early 2nd millennium cal BC (Norberg 2008: 159–60).

In Finland, the larger and deeper housepits with surrounding embankments and with entrances or antechambers visible on the surface predominantly date from ca. 3500 cal BC to the beginning of the Bronze Age ca. 1800 cal BC (Halinen et al. 2002; 2003; Katiskoski 2002; Mökkönen 2002; 2008; Ojanlatva & Alakärppä 2002; Núñez & Okkonen 2005; Vaneeckhout 2008; 2009). Multi-room housepits, including terrace houses, appear during the 4th quarter of the 4th millennium cal BC (Mökkönen 2008).

Housepits of smaller size, shallower depth, and nearly equal length and width have a longer period of occurrence. In Finland they date from the beginning of the Typical Comb Ware Period ca. 4000 cal BC to the Early Metal Period (1800 cal BC–50 cal AD) (Mökkönen 2002: 58; Pesonen 2002: 29; Halinen et al. 2003). So far, known housepits from the Mesolithic Period are so few in Finland (see Núñez & Uino 1997; Pesonen 2002), that it is not possible to draw conclusions as to their chronological variation.

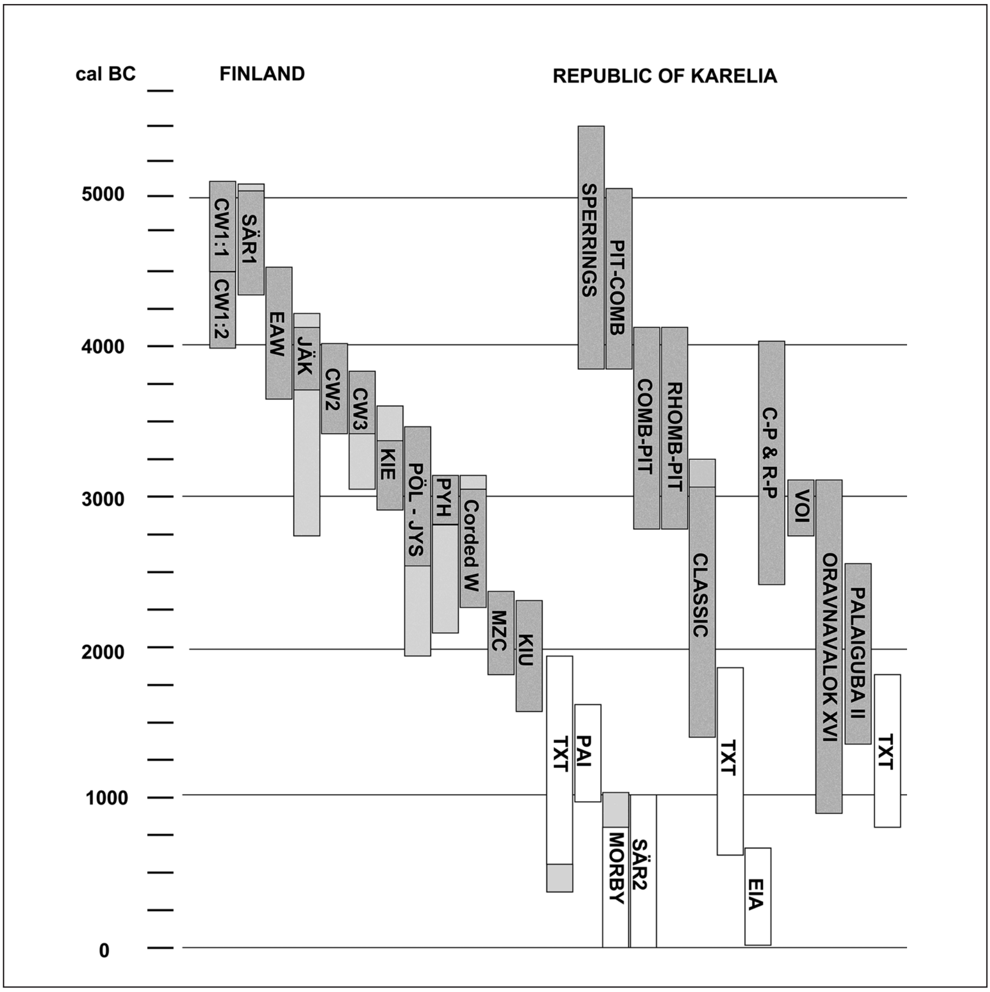

Fig. 2. A suggestive chronological diagram of the pottery styles in Finland and the Republic of Karelia, Russia. Stone Age ceramics in grey. Early Metal period/Bronze Age – Early Roman Iron Age ceramics in white. A lighter grey colour towards the end of the column indicates a paucity of dates.

Abbreviations:

Finland *(after Asplund 1997; 2004; Carpelan 1999; Edgren 1999; Lavento 2001; Pesonen 2004)*

CW1 = Early Comb Ware (aka Sperrings), SÄR1 = Säräisniemi 1 Ware, EAW = Early Asbestos Ware, JÄK = Jäkärlä Ware, CW2 = Typical Comb Ware, CW3 = Late Comb Ware, KIE = Kierikki Ware, PÖL–JYS = Pöljä and Jysmä Wares, PYH = Pyheensilta Ware, Corded W = Corded Ware, MZC = Middle Zone ceramics, KIU = Kiukainen ware, TXT = Textile pottery, PAI = Paimio ware, MORBY = Morby Ware, SÄR2 = Sär[äisniemi]2 ceramics.

Republic of Karelia

Left columns after Kosmenko (2004): Sperrings = Early Comb Ware, PIT-COMB = Pit-Comb Ware, COMB-PIT = Comb-Pit Ceramics, RHOMB-PIT = Rhombic Pit Ceramics, CLASSIC = "Classic" ceramics (organic and asbestos tempered), TXT = Net ("Textile") Ware, EIA = Early Iron Age, Net Ware-Ananino mixed type ceramics

Right columns after Zhulnikov (1999): C-P & R-P = Comb-Pit and Rhomb-Pit Ceramics, VOI = Voinavolok XXVII ceramics, TXT = Textile pottery

In the Republic of Karelia, which lies northeast of the Karelian Isthmus in Russia, the oldest pithouses also date to the Mesolithic Period. These pithouses were either rectangular or round in their ground plan, with a structure supported by upright posts. Around Lake Onega, the first rectangular pithouses with a frame of horizontal logs are associated with Pit-Comb Ware. They date to the first half of the 5th millennium cal BC. The first interconnected housepits also appear at this time (Zhul'nikov 2003: 101–2).

In the Republic of Karelia, as in Finland, pithouses were most numerous as well as largest in size during the latter part of the Middle Neolithic. According to the chronology established for the Republic of Karelia, this peak corresponds to the beginning of the Eneolithic Period, ca. 3300–2500 cal BC. Later, but still before the beginning of the Bronze Age ca. 1800 cal BC, the number of pithouses declined and their size decreased. No housepits dating to the Bronze Age are known from this area.

The chronologies reflecting the development of housepits are not fully comparable. The Finnish chronology is based on several sources (conventional radiocarbon dates, AMS dates, shore displacement chronology, and other dating methods, e.g. optically stimulated luminescence and thermoluminesence dating) while the Russian chronology relies mainly on conventional radiocarbon dates on charcoal. Regardless of the differences in dating methods, it appears that the building of semi-subterranean houses is an older phenomenon in the Republic of Karelia than in Finland. However, in the Finnish inland Lake District the almost total absence of housepits

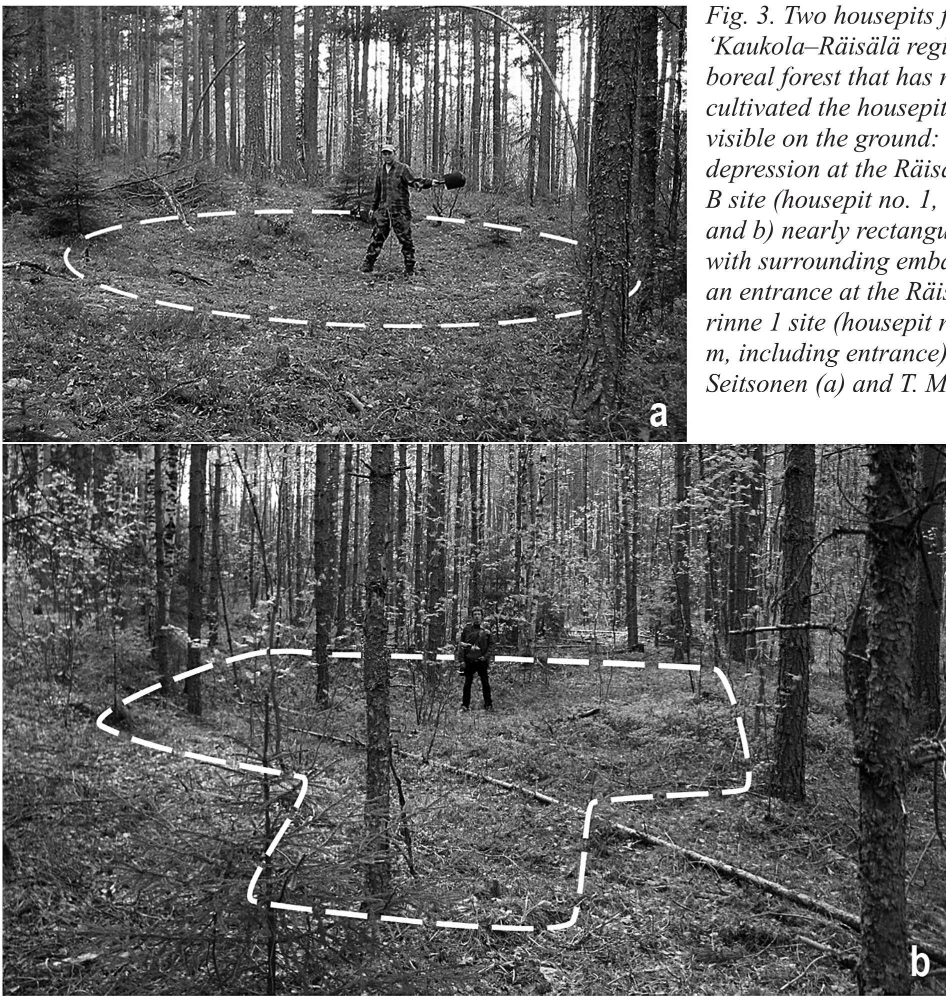

Fig. 3. Two housepits from the 'Kaukola–Räisälä region'. In boreal forest that has never been cultivated the housepits are clearly visible on the ground: a) Roundish depression at the Räisälä Peltola B site (housepit no. 1, 8.3x9.6 m), and b) nearly rectangular housepit with surrounding embankment and an entrance at the Räisälä Mäenrinne 1 site (housepit no. 2, 10x8.5 m, including entrance). Photos: S. Seitsonen (a) and T. Mökkönen (b).

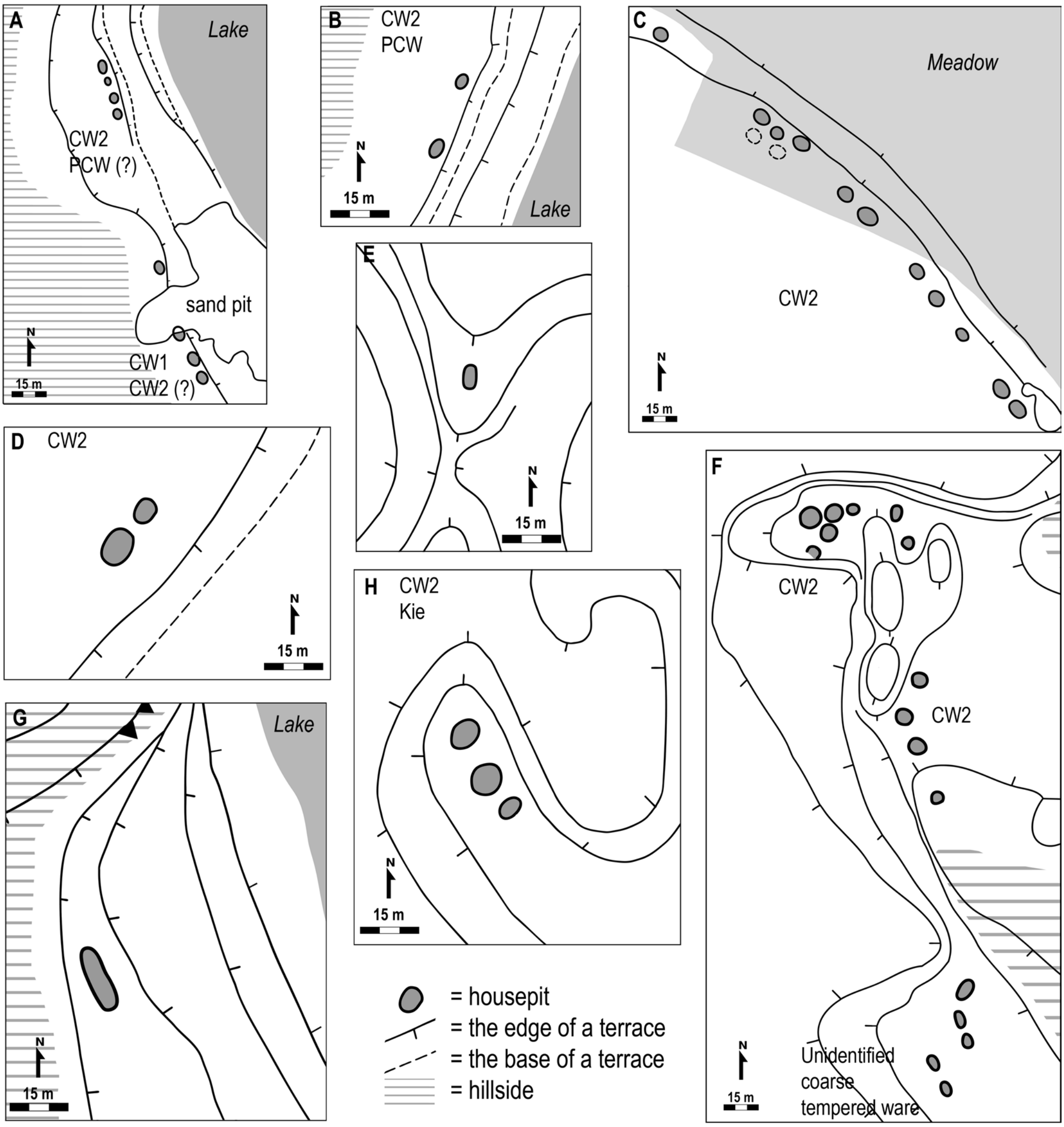

Fig. 4. Some housepit sites in the Kaukola–Räisälä region and the associated ceramics.
Sites: A – Juoksemajärvi Westend (below) and Juoksemajärvi, B – Juoksemajärvi West, C – Mäenala, D – Mömmönsalmi 1, E – Repokorpi, F – Peltola A, B, and C (the clusters are named from south to north), G – Sylijärvi SW2, and H – Seppälä 4. All sites are located in the former municipality Räisälä.
Ceramics: CW1 = Early Comb Ware, CW2 = Typical Comb Ware, PCW = Pit-Comb Ware, Kie = Kierikki Ware.
Sites A and B are located in Environmental Zone 3. Other sites are located in Environmental Zone 2. Redrawn by the author after originals by V. Deckwirth & N. Närväinen, P. Halinen, K. Nordqvist, O. Seitsonen, and S. Seitsonen in reports Halien et al. 1999, Halinen & Mökkönen 2004 and Mökkönen et al. 2005.

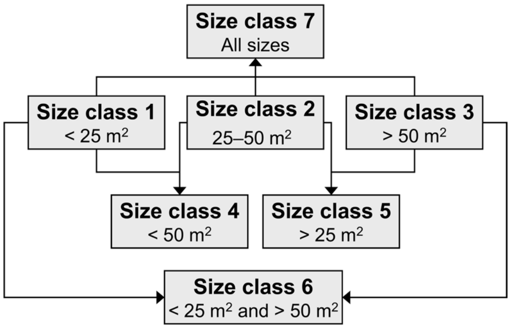

Fig. 5. Site classification according to housepit sizes.

older than Typical Comb Ware may at least partly be due to natural causes, such as transgressive lakes.[10]

In the Republic of Karelia the largest housepits date to ca. 3300–2500 cal BC (Zhul'nikov 2003: 101). This is fairly synchronous with the occurrence of the largest housepits in Finland (Núñez & Okkonen 2005; Mökkönen 2008; Vaneeckhout 2009). Therefore, as a hypothesis, it is assumed that similar developments took place quite contemporaneously also on the Karelian Isthmus.

HOUSEPIT SIZE VARIATION IN THE VUOKSI RIVER VALLEY

In boreal forest that has never been cultivated or otherwise subjected to earth moving or ploughing, Stone Age pit structures are still clearly discernible on the surface. In such circumstances, size as well as certain structural features like embankments and corridors may be defined without any excavations (Figs. 3 and 4). Consequently, the housepits discussed in this study are examined on the basis of size measurements and structural details derived mainly from survey data.

In order to study chronological changes in size, the housepit sites are divided into seven size classes (Fig. 5). The housepits are measured from the dip point of the housepit's edge, which has been shown to correspond closely to the original house wall (Pesonen 2002: 27). The ratio of pit area to original floor area naturally varies with the type of soil into which the pithouse was excavated and with the depth of the original pit, but as a rule the floor areas of the excavated housepits have turned out to be somewhat smaller than the measurements made from the dip point have indicated (e.g., Alexander 2000: 38; Halinen et al. 2002; Kankaanpää 2002). The errors between measurements made on the surface and those made during excavation range between 5 and 30 percent in scale. Hence, the size of the pit measured on the surface provides a rough approximation of the pithouse's original size.

Variation in size

The smallest housepits included in the data are under 20 m^2 and the largest approximately 100 m^2 in size (Fig. 6). The average housepit size is 42.4 m^2, while the median is slightly smaller at 35 m^2. The longest housepit, from the Räisälä Sylijärvi SW2 site, measures 19.4 meters in length and 4.5 meters in width (see Fig 4G).

Plotting the size class against the number of housepits at individual sites gives interesting results (Table 1, Fig. 7). There is a tendency for the co-occurrence of a low number of housepits and minimal variation in housepit size at the same site (size classes 1, 2 and 3). The largest number of housepits is found among the sites in size classes 5 and 7, which also represent maximal variation in pit size. Among these sites the number of housepits peaks at the Räisälä Valkialampi site with 12 housepits[11].

A closer examination of the sites with four or more housepits reveals that most of the housepits are relatively small (Fig. 8). In three cases the largest housepits measure over 80 m^2 – at the Räisälä Peltola A site ca. 100 m2, at the Räisälä

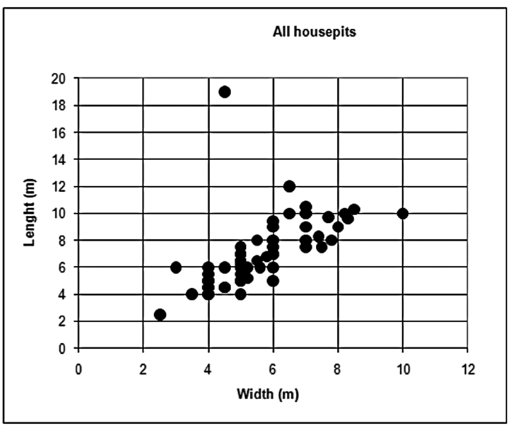

Fig. 6. Housepit sizes on the Kaukola–Räisälä region.

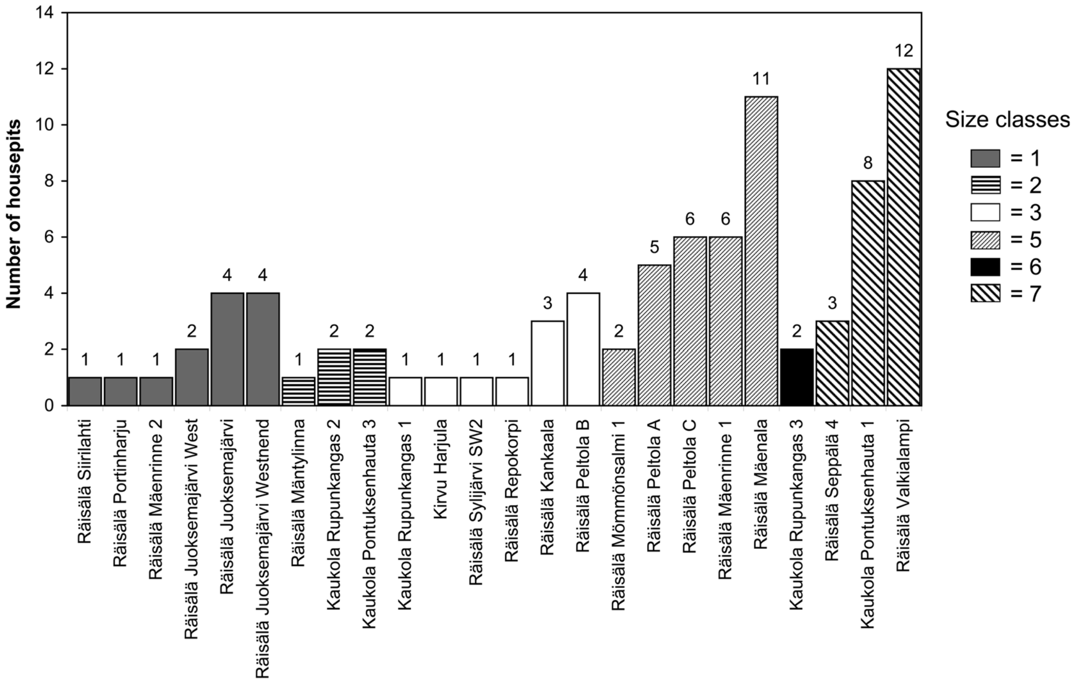

Fig. 7. The number of housepits per site divided into Size Classes.

Peltola C site ca. 82 m^2, and at the Räisälä Valkialampi site ca. 100 m^2. The latter is associated with a fragment of a completely polished slate arrowhead dating to the late Middle Neolithic – Late Neolithic (Halinen et al. 1999).

In five out of the eight cases, the sites include one or two housepits that are clearly larger than the others (Fig. 8). However, at two sites the size range is much more limited. At the Räisälä Juoksemajärvi Westend site all the housepits are smaller than 30 m^2, while at the Räisälä Peltola B site all the housepits are between 60 and 80 m^2 in size.

Chronological trends in size and shape

As noted above, pottery typology is the only relatively practicable device available for chronological studies in the research area. This sec-

Table 1. Housepits of different sizes from the research area.

#	Size m^2	Sites	HPs	HPs/site	Shapes	Details	Ceramics	Other dating
1	<25	6 *25 %*	13 *15 %*	2.6 (1/4)	ov, rd	-	CW1, CW2, CPW	Mesolithic (finds + C14)
2	25–50	3 *13 %*	5 *6 %*	1.7 (1/2)	ov, re, rd	emb	CW2, KIE, KIE/PÖL	-
3	>50	6 *25 %*	11 *13 %*	1.8 (1/4)	ob, ov	ent	CW2, CW3, ORG, TXT	-
4	<50	-	-	-	-	-	-	-
5	>25	5 *21 %*	30 *36 %*	6.0 (2/11)	ov, rd, re	ent	CW2, CW3, unidentified[1)]	-
6	<25+>50	1 *4 %*	2 *7 %*	2 (-/-)	re, rd	emb	-	Mesolithic (finds + C14)
7	all sizes	3 *13 %*	23 *27 %*	7.7 (3/12)	ov, re, rd	emb, ent	CW2, KIE	Mesolithic (?)

#= Size Class; HPs= housepits; HPs/Site (minimum/maximum); Shapes: ob= oblong, ov= oval, re= rectangular, rd= round; Details (structural details): emb= embankment, ent= entrances; Ceramics: CW1= Early Comb Ware, CPW= Comb-Pit Ware, ORG= Organic tempered ware, TXT= Textile ceramics, [1)]coarse tempered ware (CW)

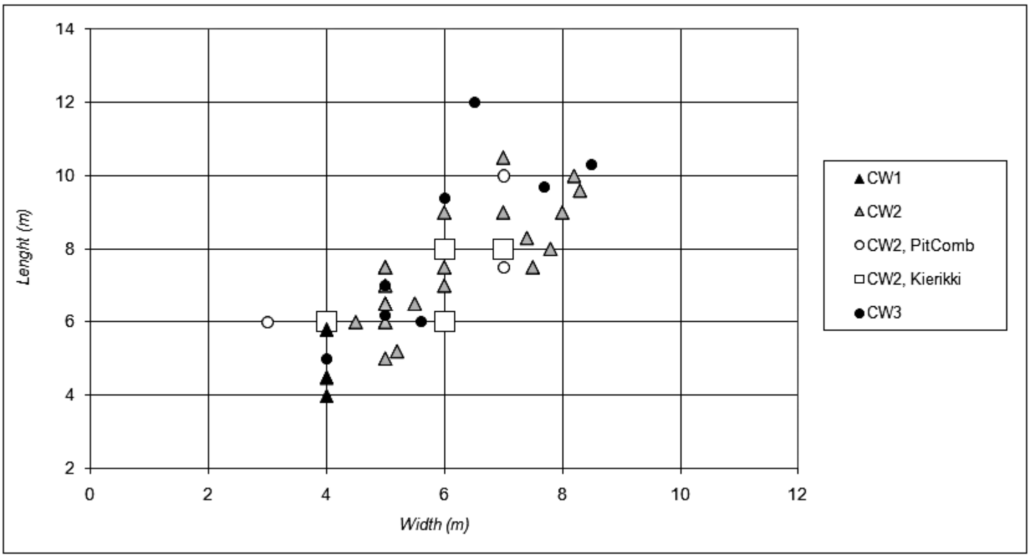

Fig. 8. Size distribution of housepit sizes at individual sites with four or more housepits. Sites are grouped according to the find material. The sites included in the scatter plot diagram in Kaukola municipality are following: Rupunkangas 1 and Rupunkangas 2. Site included from Kirvu parish: Harjula. Sites included from Räisälä municipality: Juoksemajärvi West, Juoksemajärvi Westend, Kankaala, Mäenala, Mäenrinne 1, Mömmönsalmi 1, Peltola B, Peltola C, Repokorpi and Seppälä 4.

tion discusses different kinds of housepits and housepit sites and their association with different ceramics types.

Looking at the ceramics from the sites in the different size classes (Table 1), the first thing to note is that Typical Comb Ware is found in sites with both larger and smaller housepits. More detailed information is provided by a scatter diagram showing the size distribution of individual housepits and pottery types associated with them. This diagram reveals that the smallest housepits are, indeed, associated with Early Comb Ware (Fig. 9, Table 2). It also shows that the housepits associated with Typical Comb Ware have a wide size range. A parallel, even slightly wider size range is to be found in the housepits containing Late Comb Ware, with which the largest housepits are associated. The late Middle Neolithic/Late Neolithic dating for the largest housepits would be even more evident if the 10 x 10 m housepit with a polished slate arrow-head from the Räisälä Valkialampi site were included in the scatter diagram.

Not only the size but also the shape of the housepits changed over time. Table 2 illustrates the shift towards a larger average housepit size as well as towards a more oblong shape that takes place over the course of the Neolithic. However,

Table 2. Sizes and shapes of the housepits associated with different ceramic assemblages. The housepits associated with Early Comb Ware are those at the Räisälä Juoksemajärvi Westend site. The Mesolithic examples from the Rupunkangas 3 site date to ca. 8200–7600 cal BC (Mökkönen et al. 2007).

	Average L/W	Range L/W	Average m^2	Range m^2	*N*
Mesolithic	1.27	1.00–1.50	42.63	20–61	2
Early Comb Ware	1.18	1.00–1.45	18.80	16–23	4
Typical Comb Ware	1.24	1.00–1.50	47.32	27–80	21
Late Comb Ware[1)]	1.33	1.07–1.85	51.41	31–78	7
Typical Comb Ware + Pitted Ware	1.50	1.07–2.00	46.83	18–70	3
Typical Comb Ware + Kierikki	1.24	1.00–1.50	41.00	24–56	4
Late Neolithic/Textile ceramics (?)[2)]	1.57	-	56.40	-	1
Polished slate arrow head	1.00	-	100.00	-	1

Abbreviations: L= length, W= width. [1)- 2)]) houses with entrances included, slightly exaggerating the maximum area: [1)]2 examples, [2)]1 example.

the longitudinal growth as well as the areal increase connected with Late Comb Ware as seen in table 2 is in part a consequence of the occasionally appearing entrances/antechambers.

A partly excavated housepit from the same site is associated with Early Comb Ware or coarse Typical Comb Ware. The Räisälä Juoksemajärvi Westend site is in Size Class 1. Another excavated site with Typical Comb Ware is the Räisälä Peltola C site, which dates to 3750–3650 cal BC (Halinen & Mökkönen, in this volume). The housepits there are larger, varying from 20–40 m² (5 cases) to over 80 m² (1 case). These are the only two excavated sites but, in any case, the results are in accordance with the observations drawn from the survey data.

The data shows that the development of pithouses on the Karelian Isthmus is rather analogous to the development observed in Finland and the Republic of Karelia. Housepits associated with Early Comb Ware are lacking in Finland, but this could be at least partly caused by the lacustrine transgression of Ancient Lake Saimaa. The largest housepits most probably occur in all areas fairly concurrently, i.e., roughly from 3300 to 2500 cal BC. The increase in pithouse size, however, began

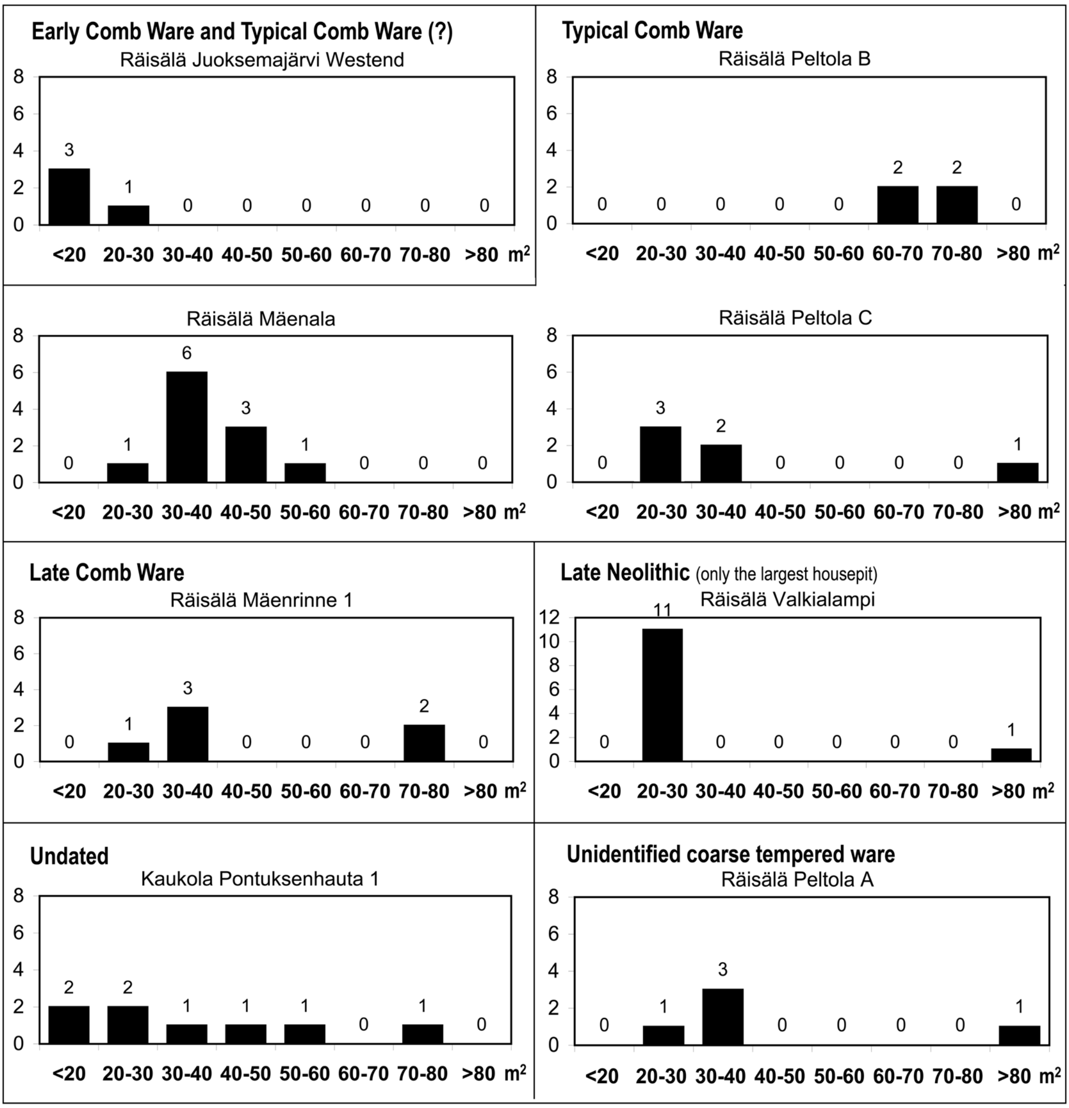

Fig. 9. Distribution of housepit sizes associated with different pottery styles.

in the research area already at the sites associated with Typical Comb Ware (ca. 4000–3400 cal BC). The sites with the highest number of housepits are also those with Typical Comb Ware.

HOUSEPITS AND THE ENVIRONMENT

As described above, there is a certain regularity regarding the housepits' size and shape and the ceramics associated with them. This chapter focuses on site location with respect to the environment. The housepit sites are analysed with the help of wider environmental zones and a topographic shelter index, which describes the sites' degree of vulnerability to winds (see also Halinen & Mökkönen, in this volume). The housepits located in one cluster in the outer archipelago in the Rupunkangas area are excluded in detailed analyses. These sites are exceptional in environmental sense and are interpereted as seasonally occupied hunting stations (Mökkönen et al. 2007, see also Halinen & Mökkönen, in this volume).

The geographical distribution of housepits over environmental zones

The environmental zones used in this study are defined on the basis of changes in the ratio between land and water areas in the hydrological reconstruction of the period preceding the formation of the River Neva (ca. 1350 cal BC). The environmental zones are the following: Zone 1 – Outer archipelago and open water area, Zone 2 – Inner archipelago and the mouths of bays, and Zone 3 – Shores of narrow fjord-like bays and inland areas.[12] These zones are roughly equivalent to geographical and ecological zones (Fig. 10).

The overall distribution of housepits within environmental zones indicates that most of the housepits were located in the inner archipelago and around the mouths of bays (Zone 2). However, there are some well-defined housepit clusters (Fig. 10). At first glance, it appears that the densest clusters consist of housepits of all sizes, but closer scrutiny shows that there is a noticeable change in site location with relation to size class.

Beginning with Size Class 1 (<25 m^2), the only cluster in the inland zone (Zone 3) at the head of a bay in Lake Juoksemajärvi has only housepits of less than 25 m^2 size (Fig. 10A). As far as waterways are concerned, this cluster was located at a dead end. On the other hand, these sites are situated adjacent to a nearly ten kilometre long moraine esker, which is the easiest natural route through the forests for one preferring to use land routes.

The sites with housepits of widely varying size, i.e., Size Classes 5 and 7, lie among the clusters in the 'Räisälä inner archipelago' and in the Papinkangas area (Zone 2). These clusters lay in the inner archipelago characterized by narrow stretches of water speckled by islands of various sizes. Particularly the 'Räisälä inner archipelago' is characterised by varying small-scale topography. During the Ancient Lake Ladoga Phase these sites were located by waterways with easy access in all directions. These sites are clearly attainable by water, whether by boat during ice-free periods or by sledge when the lake was frozen over. Also, suitable land routes provided by moraine eskers are found nearby.

The sites with only large housepits, i.e., Size Class 3 with housepits over 50 m^2 in size, have a different distribution than other housepit sites (Fig. 10A). They are located on the outer fringes of the densest housepit clusters or in areas devoid of other housepits, mainly in Zone 2. The general distribution of the large housepits is environmentally, in wider sense, more terrestrially oriented than most of the housepit sites. During the Ancient Lake Ladoga Phase these sites were located by waterways in areas with a monotypic topography, often at the heads of capes by narrow straits. These particular locations were also of great strategic significance if one wished to keep an eye on the best water routes of the area.

Site placement and protection against the wind

The topographic shelter index describes a site's topographic location in terms of how well-sheltered or vulnerable to the winds the locus is (see Halinen & Mökkönen, in this volume). This index is composed of three variables regarding the degree of vulnerability from the direction of (1) the background of the site, (2) the shoreline, i.e., the rate of exposure to the open sea, and (3) the immediate environment as a whole, i.e., the topographic location of the site as a protected or vulnerable locus. Each variable is evaluated on a three-digit scale where the number 3 stands for maximal and number 1 for minimal shelter. The higher the index value, the better sheltered the site.[13]

Table 3. Topographic shelter index values at the sites with and without housepits. Environmental zones: Zone 1: Outer archipelago and open water area, *Zone 2:* Inner archipelago and the mouth of bays, *and Zone 3:* Shores of narrow fjord-like bays and inland.

	N	min	max	mean	median
All sites	135	1.3	3.0	2.05	1.82
Without housepits	111	1.3	3.0	2.02	1.82
With housepits	24	1.3	3.0	2.32	2.12
With housepits in Zone 1	5	1.3	2.3	1.73	1.33
With housepits in Zone 2	14	1.7	3.0	2.19	2.15
With housepits in Zone 3	5	1.7	3.0	2.38	2.30

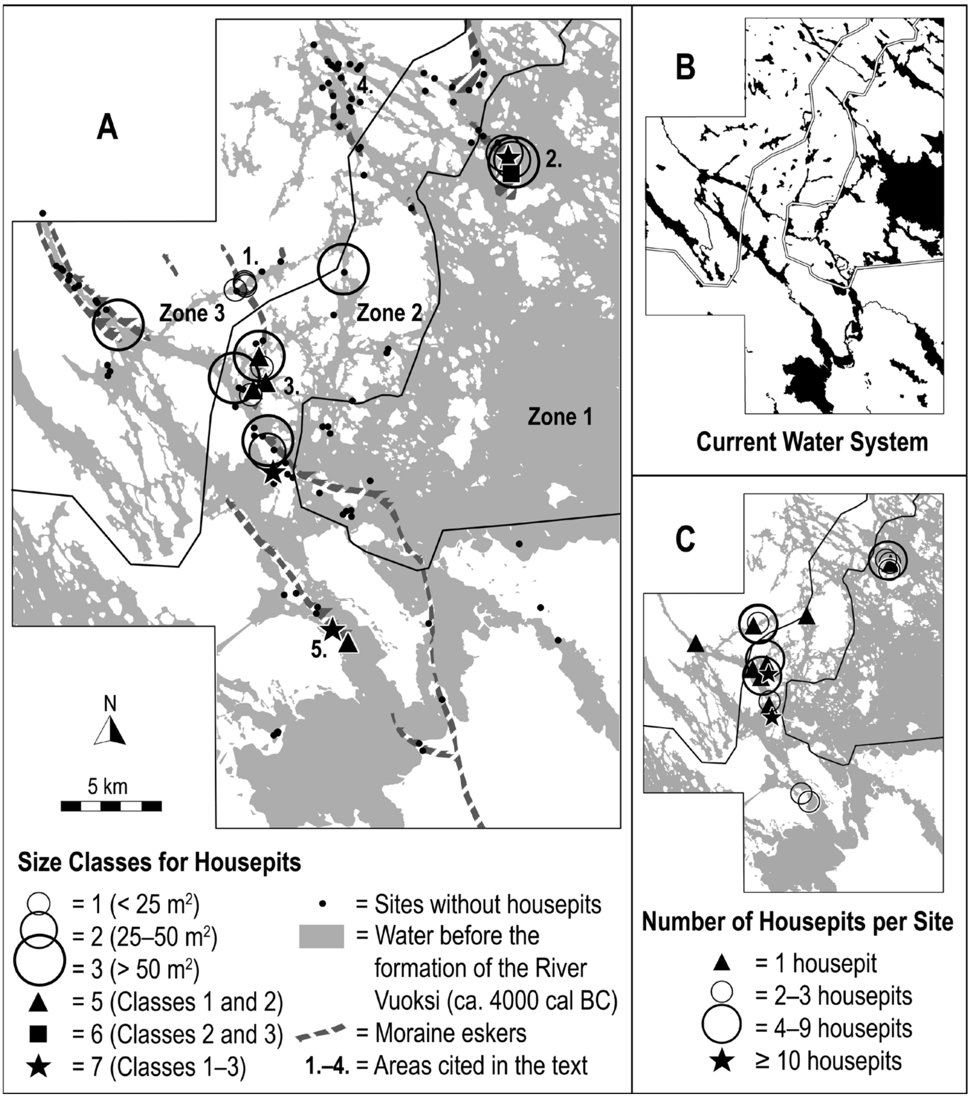

Fig. 10. The distribution of housepits over environmental zones: A. The distribution of different sized housepits, B. Current water system at the research area, C. Number of housepits per site. Areas cited in the text: 1. Lake Juoksemajärvi area, 2. Rupunkangas area, 3. 'Räisälä inner archipelago', 4. Riukjärvi-Piiskunsalmi area, and 5. Papinkangas area.

In general, housepit sites are better sheltered than archaeological sites without housepits (Table 3, see Halinen & Mökkönen, in this volume). As an exception, the housepit sites located in the outer archipelago (Zone 1) are located in very vulnerable places. The sites in the Rupunkangas area, presumed to be permanent campsites used for exploiting seasonal resources of the outer archipelago (Mökkönen et al. 2007), are not included in this section.

The variation in the degree of vulnerability to winds of housepit sites is considerable (Tables 3 and 4). The sites in Size Class 1 (<25 m^2) have remarkably high values in the topographic shelter index. High values are observed also at the sites with only large housepits (Size Class 3, >50 m^2), while the sites with housepits of various sizes (size classes 5 and 7) have shelter index values in approximately the same range as the values of sites without housepits. Comparing size classes 1 and 3 with the other sites with housepits and sites without housepits, it is clear that the sites with only small and those with only large housepits are located in well-sheltered places.

Summary of observations

Before discussing the phenomena relating to housepits, the observations concerning the material need to be summed up. In short, the observations are the following: Pithouse size tends to grow over the course of the Neolithic in the Vuoksi River Valley. However, smaller pithouses are present all the time.

The hypothesis that the evolution of pithouses in the study area is similar to and coeval with pithouse evolution in the Republic of Karelia and Finland is partly supported by the data. At least the largest housepits are associated with Middle Neolithic (4000–2300 cal BC) material. However, the expansion of the pithouse sizes begins already during the early Middle Neolithic on sites associated with Typical Comb Ware and dating to ca. 4000–3400 cal BC. The sites associated with Typical Comb Ware also have the largest number of housepits per site.

The smallest housepits are located in Environmental Zone 3, in highly sheltered loci with better connections to land routes than to water routes. These sites are associated with Early Comb Ware, Pitted Ware, and Typical Comb Ware.

With respect to other areas, both the number of housepits per site and the variation in the size of housepits within a site reach their maximum in the 'Räisälä inner archipelago'. There, the sites are clearly attainable by water and poorly sheltered. The environment of the area was a patchy one – a labyrinth of land and water with varying topography. With respect to site location and immediate environment, these sites have much in common with sites without housepits, which were most probably used for non-winter habitation. Most of the sites are associated with Typical Comb Ware, although Kierikki Ware, Late Comb Ware and Pit-Comb/Comb-pit Ware are also present at some sites.

The sites with exclusively large housepits were located by the most strategic waterways, often by narrow straits. These sites are relatively well-sheltered. Regionally, these sites are located differently from the other housepits. The materials associated with these sites are very similar to those associated with smaller housepits, i.e., Typical Comb Ware, Late Comb Ware and Kierikki Ware.

DISCUSSION

The changes in site placement associated with different size classes of housepits provide grounds for arguing that there is also a change in the conditions defining the nature of occupation. These changes could have something to do with changes in subsistence strategies, technological innovations, social organization, as well as in other cultural concepts defining the settlement (see, e.g., Rafferty 1985; Gilman 1987; Binford 1990; Kelly 1992; Ames 1994; 1996; 2004).

This section discusses the possible explanations for the recognized changes in the housepit sites. Firstly, the limitations of the data are discussed. Then aspects of the ethnographic data on housepits concerning settlement patterns and subsistence are presented and the causes and effects of sedentism are briefly discussed. The discussion continues with an examination of logistical mobility, which is important for the question of the degree of sedentism. The housepit sites' degree of vulnerability to wind has advantages and disadvantages with respect to the season of occupation. This is discussed regarding the sites themselves and the pithouses constructed in certain environments. Lastly, the questions of what the observed

Table 4. Topographic shelter index values of housepit sites in various size classes. The sites located on the former outer archipelago on the Rupunkangas area are excluded. Number 3 stands for the best shelter against wind and number 1 for the worst.

	Immediate environment				
	BG	WA	TL	Avg.	Sites
Size class 1	1	3	3	2.30	Juoksemajärvi West
	2	3	1	2.00	Juoksemajärvi
	3	3	3	3.00	Juoksemajärvi Westend
	1	3	3	2.30	Siirilahti
	2	3	3	2.70	Portinharju
	3	3	3	3.00	Mäenrinne 2
Avg.	2.00	3.00	2.67	2.55	
Median	2.00	3.00	3.00	2.50	
Size class 2	3	2	2	2.30	Mäntylinna
Avg.	3.00	2.00	2.00	2.30	
Median	-	-	-	-	
Size class 3	3	3	1	2.30	Harjula
	2	3	2	2.30	Sylijärvi SW 2
	1	3	1	1.70	Repokorpi
	2	3	1	2.00	Peltola B
	2	2	3	2.30	Kankaala
Avg.	2.00	2.80	1.60	2.12	
Median	2.00	3.00	1.00	2.30	
Size class 5	1	3	1	1.70	Mäenala
	3	3	3	3.00	Mäenrinne 1
	2	3	1	2.00	Peltola A
	2	3	1	2.00	Peltola C
	1	2	2	1.70	Mömmönsalmi 1
Avg.	1.80	2.80	1.60	2.08	
Median	2.00	3.00	1.00	2.00	
Size class 7	2	2	3	2.30	Valkialampi
	1	3	1	1.70	Seppälä 4
Avg.	1.50	2.50	2.00	2.00	
Median	1.50	2.50	2.00	2.00	

Immediate environment: BG= background, WA= water areas, TL= topographic location

changes indicate and what might have caused the changes are presented briefly.

Limitations of the data

The survey data has certain limitations. The distribution of known housepits is, naturally, affected by the obliteration of sites by recent agriculture. This is especially true of the northern part of the research area. However, the presence of housepit concentrations is not merely an artefact of preservation, nor of the survey methods used (see Lavento et al. 2006; Mökkönen et al. 2006). Consequently, I believe that the housepit clusters do in fact provide a rough approximation of past reality.

The long occupation periods of the sites and the re-use of the pit structures over a long timespan (see Mökkönen et al. 2007) make it difficult to understand the chronology of the area. Another weakness of the data is that the possible contemporaneity of the housepits has not been established: were the largest and the smallest pithouses at one site contemporaneous, and how many pithouses in one cluster were occupied at the same time? Likewise, the chronological correlation of the housepits and the ceramics found at individual sites during survey is not self-evident.

None of the data is totally objective. The measurements and classifications could have been done differently. In the data the measurements of the housepits are almost exclusively the work of a field crew of less than ten persons in the Kaukola–Räisälä Project and are fully comparable. On the other hand, the topographic shelter index (see also Halinen & Mökkönen, in this volume) used in this study is highly subjective since the used variables are not based on actual measurements.

The long occupation periods of the sites and the re-use of structures pose problems when trying to associate finds with visible structures without a larger excavation. Therefore, it is rather unexpected that the data exhibits so obvious clustering. This is not a coincidence, since the various combinations of certain kinds of housepit sites and pottery types have different geographical distributions and display a preference for different environmental settings. Hence, it is highly probable that the smallest housepits are, indeed, associated with older pottery types (Early Comb Ware, Typical Comb Ware and Pitted Ware), while the sites with larger housepits lack the Early Neolithic component.

The final weakness of the data is that this study focuses only on housepit sites. Due to difficulties with dating, the sites without housepits could not be used.

Housepits, subsistence, and settlement patterns

According to the Ethnographic Atlas by Murdock (1967) there are three conditions that are nearly always present when semi-subterranean pit structures are used as dwellings. These are (1) non-tropical, i.e., cold climate during the season of use, (2) reliance on stored food while the dwelling is inhabited and (3) permanent winter sites or a more sedentary settlement pattern15 (Gilman 1987: 541–3). Basically, pithouses are winter dwellings because the structures tend to be damp and susceptible to vermin infestation during warmer periods (Gilman 1987: 542–3). In the present research area soil moisture cannot have been a severe problem since the pithouses were mostly built on moraine soils which serve as natural drains for the dwellings.

Following ethnographic data, hunter-gatherers building semi-subterranean dwelling structures practise residential mobility as follows: 2 % fully nomadic, 49 % semi-nomadic, 29 % semi-sedentary, and 20 % fully sedentary (Binford 1990: 124). Murdock's Ethnographic atlas (1967) shows that 77 % of pithouse dwellers are exclusively hunter-gatherers, although the remaining 23 % includes societies that practise either intensive or small-scale cultivation (Gilman 1987: 545–6).

As concerns the Karelian Isthmus, it can be proposed that pithouses were inhabited at least during winter and that the settlement systems to which the housepits belong ranged between semi-sedentary and sedentary. This assumption, which is in accordance with the interpretations drawn from archaeological data in the nearby areas (e.g. Lundberg 1997; Katiskoski 2002; Kotivuori 2002; Norberg 2008: 177), will serve as a basis for this discussion.

As indicated by the ethnographic sources mentioned above, pithouse dwellers have mostly been hunter-gatherers, but there are also examples of pithouse use by agriculturalists. Pithouses have been used at least for winter habitation, although a longer occupation period is also possible. As noted above, the mere presence of housepits does not allow us to draw any far-reaching conclusions concerning settlement patterns or subsistence (e.g. Binford 1990; Ames 1994: 219). Instead, changes in site location can be used to explain the nature of the variation.

Sedentism

The most commonly used definition of sedentism focuses on year-round habitation at one dwelling site by at least part of the population (see Rafferty 1985: 115; Kelly 1992; 2007: 148–9 with references). Still, sedentism is often thought to be a relative rather than an absolute condition, which means that settlement can become more sedentary, i.e., less mobile than before (Kelly 1992). Many archaeologists, including myself, use the categorization modified by Murdock (1967) in the Ethnographic Atlas. In this categorization societies are divided into fully nomadic, semi-nomadic, semi-sedentary, and fully sedentary. This is a more fine-grained categorization than the bipolar classification into mobile or sedentary. However, it is not easy to define archaeologically whether a society is semi- or fully sedentary. Changes in mobility are, undoubtedly, the results of long-term processes (Binford 1980; Marshall 2006: 158), but the finer details of the change process are often difficult to distinguish in the archaeological record.

Sedentariness is a result of decreased residential mobility. Stationary year-round habitation at one dwelling site, however, does not decrease the overall mobility but reorganizes it into increasing logistical mobility (Binford 1980; Kelly 2007: 149).

Sedentism has various causes as well as various consequences, but it is not always easy to point out which category a phenomenon belongs to. Causes of sedentism include abundant food resources that encourage reduced mobility (the "pull" hypothesis), subsistence stress leading to an intensification of subsistence efforts and resulting in sedentism (the "push" hypothesis), group packing caused by population growth, situations where the cost of moving is high compared to the cost of remaining in the current camp, and a domino effect where one sedentary society encourages neighbouring groups to become sedentary (Rafferty 1985; Kelly 1992; 2007: 152, 160).

Sedentism is followed by several effects: population growth, territoriality, more tightly controlled social boundaries, the intensification of long distance trade, and an increased reliance on stored food entailing an increased investment of labour (Kelly 1992; 2007: 152, 311–3).

Numerous archaeological indicators have been used to define sedentism. Changes in the settlement pattern, new kinds of settlements, the presence of substantial houses (often rectangular), pottery, heavy artefacts, luxury goods, agriculture, cemeteries, ceremonial structures and storage are the most common ones (Rafferty 1985; Kelly 1992; 2007: 152, 160). However, the core elements in identifying sedentism are associated with the nature of the dwellings and the dwelling sites (Rafferty 1985: 128; Marshall 2006: 157).

Proximal resources and mobility patterns

The way people have settled the landscape relates to a number of cultural and ecological factors. The factors effectively setting the limits for cultural variation are the environmental conditions and the abundance and seasonality of food resources, the effects of which can, however, be reduced by storage capability and solutions relating to logistical mobility. In an aquatic environment the logistical mobility provided by boats also has a wide-ranging effect on the exploitable resources and thereby also on the areas to be settled (see e.g. Binford 1990; Ames 2002).

Site placement in relation to larger environmental zones highlights which resources are the easiest to exploit from the site. In this respect the smallest Early Neolithic housepits, located in Environmental Zone 3, are ideally located for utilizing terrestrial resources by land routes. Yet, surprisingly, 30% of the identified mammal bones at the Räisälä Juoksemajärvi Westend site were seal (Halinen et al. 2008), which indicates that the winter resources located in the archipelago were also utilized at the site, most probably with the help of sledges.

The densest clusters of housepit sites are, however, located in the archipelago. Sites situated in the inner archipelago and at the mouths of bays are located in an aquatic environment. It is important to notice that these sites are obviously meant to be reached by boats, which indicates logistical mobility based on water transport.

As compared with pedestrian hunter-gatherers, the availability of water transport makes it possible to take advantage of resources spread over larger areas and to carry larger bulk over longer distances (Binford 1990; Ames 2002; 2003). Groups with logistical transportation based on boats tend to be more sedentary, and because of the effective transportation, the dwelling sites do not need to be located adjacent to certain individual resources, but rather in a central position with respect to all exploitable resources (Ames 2002). Other traits often connected with aquatically oriented hunter-gatherers as opposed to terrestrially oriented ones include a potential for higher population density, larger camps, longer residential moves, long distance trade, and the possibility of developing a more complex society (Binford 1990; Ames 1994; 2002; 2003).

Of the said traits connected with aquatically oriented hunter-gathers, two – the development of larger camps and the central position of the sites (most probably sedentary ones) with respect to all resources – are also apparent in the primary data of this study. In the material from the Kaukola–Räisälä region, it is not only the housepits that are distributed in the archipelago during the period when Typical Comb Ware was in use. A similar trend is also observed in the geographic distribution of Typical Comb Ware and other pottery styles of comparable or younger ages. These are evenly distributed in various dwelling sites over the archipelago, while the older pottery styles have a more terrestrially oriented distribution (Halinen & Mökkönen, in this volume). This supports the hypothesis that logistical mobility based on boats arose at the time Typical Comb Ware was in use.

The existence of water transport together with the village-like clustering of housepits in the inner archipelago most probably marks a decrease in residential mobility and an increase in logistical mobility. As will be demonstrated below, these housepits sites also have other features suggesting occupation was not limited to the winter season. This can be interpreted as a sign of increasing sedentariness.

On the windy capes or by the sheltering hills

A site's environment gives a hint of the possible occupation season. The larger environmental zone in which the site is situated indicates both the resources most easily exploited from the site and the prevailing transportation used. The immediate environment of the site provides more site-specific information about conditions that were vital and significant for the people who once erected their dwelling in the location. One such condition is the degree of protection against wind, which is described here by the Topographic Shelter Index.

There are advantages and disadvantages as regards a site's degree of protection against winds. In the case of winter-only sites, a well-sheltered locus may be presumed (see Lundberg 1997: 111–2). On the other hand, in the case of summer sites, other aspects such as the amount of insects and protection against forest fires direct the selection of dwelling sites (Jordan 2001:93).

The topographic shelter index shows that the most terrestrially oriented sites are also the most sheltered ones. The sites located by Lake Juoksemajärvi are situated on NE-E facing shores. There are high shading eskers in the background, and therefore the sites do not receive much drying sunlight. Most probably the pit structures at the site were extremely vulnerable to dampness when the ground was not frozen. Thus, these sites, with the smallest housepits associated with Early Comb Ware, are perfect for winter habitation (see also Halinen et al. 2008: 259) but not very suitable for use during the more humid seasons.

The larger sites, as regards both the number and the size of the housepits, are located in more poorly sheltered locations that seem to be more suitable for summer than winter habitation. It is noteworthy that windy locations have some advantages for a housepit dweller planning to live on the site also during warmer seasons. During other seasons than winter, pithouses tend to be damp, which is probably the main reason for not using pithouses as summer dwellings (Gilman 1987: 542–3). On windy locations the drying effect of wind may have kept the pit structures drier for longer periods and enabled longer occupation of the pithouses (see below). Also the storage of foods benefits from drying breezes, and during summer the stronger winds provide relief from the swarms of mosquitoes.

The housepits located in the archipelago and by the water routes are typically located in a patchy environment or at the heads of capes in an otherwise monotypic environment. These sites are consequently in places that are not susceptible to forest fires, and additional protection against fire could have been easily gained by cutting down a few trees or by digging a trench.

Thermal regulation of housepits

The thermal regulation of a dwelling structure is always a compromise between thermal efficiency and thermal adjustability in relation to outdoor climatic conditions, since both of these cannot be maximized at the same time (Wilkins 2009). A pithouse with heavyweight structures, for example, a cladding of sod or earth, is thermally effective but poorly adjustable. There are, however, several technical options that can render the thermal regulation of a structure more effective.

A small pithouse with only one door is good for keeping heat inside (thermally very effective), but at the same time it lacks the capability to react to variation in outdoor temperatures (poorly controllable). The best solution to finding a balance in this contradiction is to increase structural complexity. In a dwelling with heavyweight structure, this balance is acquired by increasing the number of closable openings, increasing the number of spaces at different levels, and creating separate means of heating and ventilation for each space. This increases the thermal flexibility and adjustability within the structure. Such an arrangement allows the occupant to regulate the thermal microclimate of the dwelling (Wilkins 2009).

The housepit data used in this study includes both small and large housepits. The smallest ones undoubtedly represented high thermal efficiency and poor thermal control, while the largest ones – especially those with antechambers/entrances – most probably offered the occupants better thermal control. As concerns the smaller housepits (less than ca. 50 m² in size), controlling the pithouse's inner temperature with respect to outdoor temperature was an impossible task, with few options for ventilation. A structure with limited means of thermal regulation can be made more or less adjustable by a judicious choice of location (see Wilkins 2007). Better thermal control of such a structure can be acquired through optimising ventilation, which can be achieved by placing the structure in a windy location. The adjustable ventilation allows the occupants to control the moisture balance of the structure.

Combining the ideas of thermal regulation and the evolution of the housepits in the Kaukola–Räisälä area produces interesting results. As interpreted above, the small pithouses associated with Early Neolithic ceramics and located in Environmental Zone 3 were situated in places very suitable for winter habitation. They were structures with high thermal efficiency and poor thermal control located in highly sheltered locations, which makes them ideal winter dwellings.

The relocating of pithouses into the archipelago at the time Typical Comb Ware was in use makes sense from the point of thermal regulation. The locating of pithouses in windy places rendered them more thermally controllable through ventilation, and as a consequence the housepits' microclimate (including moisture balance) could be made more suitable also for non-winter habitation. The unsheltered windy location may have rendered these types of dwelling structures more functional for longer or even year-round occupation.

The sites with only large housepits (Size Class 3, > 50 m²) are located more terrestrially and in more sheltered places than the sites with both large and small housepits. Could the largest pithouses have been more amenable to thermal control than the small ones, and could these structures have been comfortably used year round without a strong wind to maintain thermal control through ventilation during non-freezing seasons? Is this the reason for the more sheltered and terrestrially oriented location of the sites with only large structures?

What do the changes in housepits indicate

A change in architecture is always a response to new requirements. The changes might be driven by modifications taking place in the subsistence base, residential mobility, or social relations (e.g. McGuire & Schiffer 1983). Whatever the reason for changes in architecture, the change often occurs with some time lag in relation to the emergence of the causes (McGuire & Schiffer 1983; Rafferty 1985: 130; Ames 2003: 64).

The relation between the shape of a dwelling's ground plan and residential mobility, again following ethnographic data, shows rather clearly that circular shapes are more typical of nomadic groups and rectangular forms characterize the ground plans of buildings used by more sedentary groups (McGuire & Schiffer 1983: 284; Binford 1990: 122–3). In cases where settlement has become more sedentary, the change in house shape has usually occurred, if it has occurred at all, with some time lag after the advent of sedentariness (McGuire & Schiffer 1983; Rafferty 1985: 130).

The sizes of individual houses, together with the overall distribution of house sizes, are data that enable us to draw conclusions about the society that built the structures. Beyond the nearly self-evident positive correlation between the size of the houses and the probable number of habitants, the co-existence of both larger and smaller houses is seen as evidence of an uneven distribution of wealth or social hierarchy (McGuire & Schiffer 1983: 282–3, 289–90; Fitzhugh 2003: 31–2; Prentiss et al. 2003; Ames 2004: 62–4). This interpretation naturally presupposes that the larger and smaller structures were in simultaneous use, a stipulation that cannot be confirmed through survey data.

Although the presence of substantial houses does not directly indicate the termination of residential movements, in the case of the study area the larger pithouses, being built of non-transportable materials (most probably logs and sod/earth) with a larger labour investment than the smallest pithouses, are arguable related to low residential mobility (see, e.g., Gilman 1987).

It has been suggested that rectangular dwellings are more flexible regarding variation in space as compared to dwellings with circular ground plans. They are easier to divide internally and to extend by adding new rooms (McGuire & Schiffer 1983: 285–6). In the Kaukola–Räisälä region elongated rectangular ground plans increase together with larger size. There are several reasons for the adoption of larger sized dwellings. Larger houses with larger households are a response to increased demands for labour, expanded storage, and a growing number of tasks required by food production (Ames 1996: 132–3; 2003: 27–8), at least on the Northwest Coast of North America. In the American Southwest the appearance of large pithouses is seen as a response to economic intensification and a manifestation of individual households as autonomous units of production (Wills 2001).

What caused the changes?

I have interpreted the changes in housepits and housepit sites as markers of an increasing degree of sedentism during the Neolithic. The increase of sedentism is likely to be coupled with several other changes. In his monograph on hunter-gatherer lifeways, Kelly writes: "I take a reduction in residential mobility, eventually resulting in sedentism, to be the significant 'kick' that sets dramatic socio-political changes in motion" (Kelly 2007: 310). In Kelly's scenario, environments with a constant and reliable resource base encourage the development of sedentism, which is in turn followed by population growth, territoriality, more tightly controlled social boundaries, and an increased use of stored food. The last of these also requires more labour in order to succeed (Kelly 2007: 151, 310–3).

Kelly's scenario of sedentism is shortened above into a list. This article argues for a growing degree of sedentism during the period when winter dwellings were erected in the inner archipelago at locations favouring longer than winter-only habitation. Therefore, it is worth revisiting the common elements in the data and Kelly's scenario. In the Kaukola–Räisälä region the relocating of housepits in the archipelago – in locations more suitable for summer than winter habitation – marks the beginning of more permanent settlement as seen in the archaeological record. This shift is followed by an increase in the size and number of housepits, and also in their rectangular ground plans. Although there is no direct evidence for the increased storage of food, the growing size of the houses probably indicates larger households and, at the same time, an increase in labour and storage capacity. The location of sites with only largest-size housepits by the most strategic waterways may result from a growing need to oversee the traffic and, at the same time, to restrict the access of other groups to resources considered the local group's private property. This might be one manifestation of growing territoriality.

Is this just a general development of habitation (see Kelly 2007: 159–60, 259, 313–9), or do the changes also allow other lines of interpretation? The Neolithic cultures in Finland, on the Karelian Isthmus, and in the Eastern European coniferous forest zone are usually labelled Subneolithic, i.e., cultures that have other traits in common with real Neolithic cultures but have not practised agriculture. However, recent studies in Estonia have proved that cereal cultivation was known there already in the beginning of (sub)Neolithic Stone Age and that it became more common at the time Typical Comb Ware was in use (Kriiska 2003; Poska et al. 2004). Similarly, on the eastern shore of Lake Onega the first signs of cereal cultivation date to 3800–3700 cal BC (Vuorela et al. 2001). These signs are associated with Comb-Pit and Rhomb-Pit Ceramics and correspond chronologically to Typical Comb Ware. Although there is no evidence of Stone Age cereal cultivation from the Karelian Isthmus so far, the evidence from Lake Onega and Estonia raises the possibility, if not even the probability, that agricultural practices were known also on the Karelian Isthmus during the Typical Comb Ware period (see Mökkönen in press).

The idea of cereal cultivation being involved in the process of the changes in housepits and housepit sites that commenced during the Typical Comb Ware Period is not impossible. Similar changes in site location have been recorded in Eastern Sweden. There, in southern Norrland, the relocation of sites from riverine estuaries to the archipelago began around 3400 cal BC. This process was simultaneous with the spread of agriculture, and therefore the changes in sites and site locations have been connected with the adoption of agriculture (Björk 2003; Björk & Larsson 2007).

I suppose that the domino effect, in which one group adopting sedentism also encourages its neighbours to become sedentary (Kelly 2007: 152), could be one cause for the increase of sedentism in the research area. At the time Typical Comb Ware was in use, the long-distance trade networks supplying, e.g., Baltic Amber to the East European forest zone were activated for the first time (Edgren 1999: 68–70; Carpelan 1999; Zvelebil 2006; Zhul'nikov 2008). Societies already practising agriculture also took part in this network. Therefore, it is possible that the introduction of agriculture and the domino effect causing sedentism might have coincided in the sphere of this network system.

SUMMARY AND CONCLUSIONS

A number of distinct chronological changes may be observed taking place in housepits and housepit sites. The chronological development of housepits in the research area and some of the interpretations are summarized in Table 5.

The housepits associated with the Early Neolithic (5100–4000 cal BC) are small in size. In the beginning of the Middle Neolithic (4000–2300 cal BC), characterized by Typical Comb Ware (4000–3400 cal BC), the size of pithouses grew. The increase in size mainly affected the largest pithouses, while the smallest ones remained roughly the same size as before. Concurrently, the number of housepits per site increased.

The later development of pithouses during the Middle Neolithic and Late Neolithic is not very easy to follow. Larger housepits that occur together with smaller ones date most likely to the later part of the Middle Neolithic, i.e., presumably starting from ca. 3700 cal BC. The data does not allow more accurate dating. The occurrence of larger solitary pithouses is, likewise, a phenomenon that is difficult to date. I presume that they are younger than 3300 cal BC. This assumption is based on the general occurrence of the largest housepits in northern Fennoscandia (Norberg 2008), which mainly dates after cultural contact following the arrival of the Corded Ware Culture or other agrarian cultures (Mökkönen 2008). The limited number of finds associated with the solitary large housepits in the research area, however, also supports this date.

The environmental location of housepit sites changed quite simultaneously with the changes observed in size and clustering. The small Early Neolithic housepits have terrestrially oriented catchment areas and their locations are extremely well-sheltered against winds, but the sites do not receive much sunlight. Controlling the moisture balance of pithouses in such locations in non-freezing temperatures is challenging. Sites like this are ideal for winter-only habitation.

Table 5. The chronological development of housepits on the research area summarized.

cal BC	Period	Ceramics	Observations on housepits	Interpretation
5100–4000	Early Neolithic	Early Comb Ware Pit-Comb Ware	Small housepits on highly sheltered locations by the mainland. Poor dwelling sites during moist seasons.	Winter-only habitation
4000–2300	Middle Neolithic	Typical Comb Ware Late Comb Ware Comb-Pit Ceramics Asbestos tempered wares (Kierikki-Pöljä) organic tempered wares (not well-studided)	*1st half:* Housepit clusters are appearing to the archipelago, to the places vulnerable to the winds. The size of the largest housepits grows, and the number of housepits per site increases. These sites are aquatically oriented and made to be reached by boats. Good sites concerning fire safety and the control of houses moisture balance.	Year-round habitation at the villages, logistical mobility based on boats
			2nd half: The growing of housepit size peaks, the number of housepits decreases. Large solitary housepits are occuring at the sites, which are by the most prominent water routes but, at the same time, more terrestrially oriented than before.	Year-round habitation, in a villages, but also on large multifamily houses
2300–1800	Late Neolithic	Textile pottery organic tempered wares	Not known	Not known

In the beginning of the Middle Neolithic, housepit sites associated with Typical Comb Ware (4000–3400 cal BC) spread over the archipelago. At this time the number of housepits per site increased, and the size of the housepits started to grow. The sites in the archipelago are clearly intended to be reached by a boat, which indicates logistical mobility based on water transport. These sites are poorly sheltered against winds, a feature that favours non-winter habitation due to, among others, better control of the pithouses' thermal and moisture balance through maximum ventilation. These sites are also protected from fire, which makes them safe investments.

During the later Middle Neolithic, the large solitary housepits, which are probably younger than 3300 cal BC, are found in more terrestrially oriented sites. The larger pithouses, which often had entrances/antechambers, were thermally more easily controllable and therefore habitable in non-freezing temperatures without the maximal ventilation generated by a windy location.

I suppose that Early Neolithic pithouses were built in winter villages and used as winter-only dwellings. In the beginning of the Middle Neolithic, settlement became more sedentary and even fully sedentary habitation may have been possible. During this time the winter dwellings, i.e., pithouses, began to be built in the archipelago at location that were more similar to summer dwelling sites. The other concurrent changes – the growth of housepit size, the increasing number of housepits per site, logistical mobility obviously based on water transport, and other characteristics of the sites as well as cultural aspects favouring year-round habitation – all speak for a growing degree of sedentism. I presume these sites were small villages inhabited over most of the year or even year-round.

It would appear to me that that the degree of sedentism did not change during the latter part of the Middle Neolithic, at the time when the large and solitary housepits emerge. The number of housepits per site decreases and the habitation increasingly concentrates in single large, probably multifamily houses instead of several smaller pithouses. For me, the occurrence of large solitary houses is very similar – as concerns both the concept of the dwelling structure and the dwelling site itself – to the dispersed single farmstead settlements of the Corded Ware culture.

In my opinion there are not one but several reasons for the changes seen in housepits and housepit sites. I am positive that the beginning of agriculture probably plays a role in this change, whether through contacts with agricultural groups encouraging the spread of sedentism or in the form of actual early small-scale agriculture. The growing degree of sedentism, presumably even a fully sedentary settlement pattern, arises during the Typical Comb Ware Period. This is indicated also by other cultural phenomena such as the intensification of long-distance trade during the early Middle Neolithic (Carpelan 1999; Edgren 1999: 68–70; Zvelebil 2006; Zhul'nikov 2008), the emergence of a number of cemeteries with red ochre graves (e.g. Halinen 1999) and the appearance of village-like pithouse clusters.

The question of the specific dates of these changes in settlement is impossible to answer without more excavated material and radiocarbon dates. Similar changes have been observed in a case-study carried out in eastern Finland. In the Lake Saimaa area around one hundred kilometres north of the Kaukola–Räisälä region, the placement of housepits changes during the Typical Comb Ware period (ca. 4000–3400 cal BC). The older pithouses were built at the heads of bays in highly sheltered loci, while the younger pithouses were built on windy capes and islands. Afterwards, these very same unsheltered sites were frequently occupied by people using asbestos-tempered pottery (Kierikki and Pöljä Wares) and also building larger rectangular pithouses (Mökkönen 2002).

My argument concerning the growing degree of sedentism is based on the changes observed in housepits and in the environmental settings of the housepit sites. Interestingly, the changes in the archaeological record following the 'colonization of the inner archipelago' include traits shared with Kelly's (2007: 310–3) scenario concerning the development of sedentism. However, it is not known what really caused the change towards residentially more stationary settlement. The cause of sedentism could have been, as in Kelly's scenario, merely normal development within a society or a domino effect resulting from contacts with sedentary societies also practising agriculture.

Whatever the cause, the change in housepit shape and size takes place quite simultaneous over large areas of Northern Fennoscandia. Likewise, the rather contemporaneous change in placing pithouses in locations vulnerable to winds takes place in at least two major lake regions. This article puts forward a few ideas concerning this change in settlement, but at present this process is still poorly understood.

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NOTES

[1] For more information on early research see Uino 1997; 2003; Lavento et al. 2001; Huurre 2003; Nordqvist & Lavento 2008; Nordqvist et al. 2009; and Halinen & Mökkönen, *in this volume*; on recent research see Lavento et al. 2001; 2006; Gerasimov 2006; Mökkönen et al. 2006; Lavento 2008; Nordqvist et al. 2009; and Halinen & Mökkönen, *in this volume*.

[2] The Kaukola-Räisälä Project is named after two former Finnish municipalities forming the core of the research area (now Russian *Sevast'janovo* and *Mel'nikovo*). The official name of the project is *Subsistence strategies and changes of communities between 9000–1 BC: an archaeological intensive-investigation in the western part of Lake Ladoga, Karelian Isthmus*. The project was carried out as a cooperative Finnish-Russian-Estonian effort. The field work – surveys and small scale excavations – was carried out in 2004–2005. The project was lead by professor Mika Lavento (University of Helsinki). The English versions of the survey and excavation reports are available at the University of Helsinki Department of Archaeology.

[3] Some of the results have already been published. A number of these publications deal with the preliminary results of the surveys (Gerasimov *et al.* 2006; Lavento *et al.* 2006; Mökkönen *et al.* 2006) and others present the excavation results (Gerasimov *et al.* 2006; Mökkönen *et al.* 2007). See also Halinen & Mökkönen, *in this volume*).

[4] The Finnish names are used because the most detailed and accurate maps available for use in the surveys were Finnish topographic maps from the 1930's (in 1:20 000 scale). Russian names for sites discovered before the 21st century may be found in Nordqvist *et al*. 2008 and for the sites discovered during 2004–2005 in Gerasimov 2006.

[5] There are two sites, namely Räisälä Pitkäjärvi (see Seitsonen 2005) and Kaukola Kyöstälänharju, excavated during early 20th century both of which are having possible or probable housepits. Due to inexact nature of the data these sites are excluded from this study.

[6] It must be noted that in the prehistory of the East European coniferous forest zone, the Neolithic Stone Age is defined by the occurrence of pottery rather than agriculture and is therefore often labelled "Subneolithic".

[7] In the most southern part of the research area the water level has fluctuated more than in the northern part.

[8] In this article the Finnish periodization of the Neolithic is used: Early Neolithic (5100–4000 cal BC), Middle Neolithic (4000–2300 cal BC) and Late Neolithic (2300–1800 cal BC) (see, e.g., Carpelan 2002).

[9] This particular date – Hela-465, 4870 ± 85 BP – was published by Huurre (2003: 198–9, 512). This date is incorrectly referred in another article (Timofeev et al. 2004) to a sherd of Typical Comb Ware instead of Kierikki Ware. Another date of nearly comparative age derives from Kierikki Ware from the Inari Saamen museo – Vuopaja site in North Finland (see Pesonen 2004).

[10] For example, in the Lake Saimaa area the older

housepits could be covered by flooded sediments during the transgressive Ancient Lake Saimaa prior to the formation of the Vuoksi River, the latest outflow channel, ca. 4000 cal BC, or destroyed by cultivation (for discussion on the absence of housepits in certain areas see Pesonen 2002).

[11] In this study the Räisälä Peltola site, with 15 housepits in total, is divided into three separate sites following the three housepit clusters (areas A, B, and C). These clusters are located side by side, but separated from each other by hillocks. The reason for this division, in addition to topographic features separating the clusters, is the fact that while two of the clusters were associated with Typical Comb Ware, one yielded different, notably coarse tempered ware. For a general map, see Fig. 4F.

[12] The term Pitted Ware used here refers to both Pit-Comb Ware and Comb-Pit Ceramics.

[13] This division follows a typological division of ecological and geographic zones used in the archipelago of the Gulf of Finland. Put simply, it relies on the ratio between land and water areas (see Hanhijärvi & Yliskylä-Peuralahti 2006: 9–11). In Zone 2 – the inner archipelago and the mouths of bays – the amount of water and land areas is roughly equal. In Zone 1 – the outer archipelago and open water area – water areas dominate. And, conversely, in the Zone 3 there is clearly more land than water (see also Halinen & Mökkönen, *in this volume*).

[14] As an example, a site located on the point of a cape without any topographic shelter in the background and surrounded by vast areas of open water is located in a poorly sheltered locus and therefore has a topographic shelter index value of 1.

[15] There are, however, a few exceptions. These are housepit sites located in ecologically and environmentally marginal environments, where the sites were used repeatedly as seasonal campsites (e.g. Renouf & Murray 1999; Smith 2003;). In this respect, the housepit sites in the outer archipelago posses a different character as compared to other housepit sites (see Mökkönen et al. 2007), and therefore the housepits clustered in the Rupunkangas area in Zone 1 – seen as 'exceptions to the rule' – are excluded from this analysis. Even though the interpretation presented here concerning the duration of the occupation period of housepit sites in the outer archipelago were to prove invalid, these sites are, in terms of their environmental location, clearly something different from most housepit sites located in other environmental zones.

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APPENDIX 1

Municipality/site	Survey[1)]	HPs	Ceramics site	N	Shp	SC[1)]	#	LxW	D	Features
Kaukola Pontuksenhauta 1	1999	-	-	8	re,	7	1	7x10	0.8–1	ENA,
					ov/		2	7x8	0.8–1	EMB
					rd		3	6x7	0.6–0.8	
							4	5x5	ca. 0.6	
							5	4.5x4.5	0.4	
							6	5x5.5	0.35	
							7	4x4	0.3	
							8	2.5x2.5	0.35	
Kaukola Rupunkangas 1	2004[2)]	CW3,	CW3,	1	ov	3	1	9,4x6	0.4 m	ENA,
		TXT,	TXT, ORG,							EMB?
		ORG	LNeo, ASB							
Kaukola Rupunkangas 2	2004	-	CW2, KIE,	2	rd	2	1	6x6	0.4	-
			KIE/PÖL				2	6x6	0.15	
Kaukola Rupunkangas 3	2004	-	-	2	rd,	6	12	4.5x4.5	0.6	EMB
					re			6.5x10	0.6	
Kaukola Pontuksenhauta 3	2004	-	-	2	re	2	1	8x6	0.5	EMB
							2	6x5	0.5	
Kirvu Harjula	2004[3)]	-	CW3	1	ov	3	1	6.5x9 w/	NDA	ENA,
								entrance		NDA
								6.5x12		
Räisälä Juoksemajärvi	1999>	CW1,	CW1, CW2	4	ov	1	1	5–4x4–4.5	NDA	-
Westend		CW2					2	5–4x4–4.5		
							3	5–4x4–4.5		
							4	3x3		
Räisälä Juoksemajärvi	1999	-	CW2, PitC	2	oval	1	1	3x6	NDA	-
Westend							2	3x6		
Räisälä Juoksemajärvi	1999[4)]	CW1,	CW1,	4	rd,	1	1	4x5.5	0.2–0.3	-
Westend		CW2?	CW2?,		ov		2	4x4	NDA	
			VOL?				3	4x4.5	NDA	
							4	4x4.5	NDA	
Räisälä Sylijärvi SW2	1999	-	-	1	ob	3	1	4.5x19	ca. 0.4	-
Räisälä Valkialampi	1999	-	-	12	rd, ov	7	1	10x10	NDA	-
							2	5x5		
							3	5x5;		
							…	others		
							12	ø 5–4		
Räisälä Siirlahti	1999	-	-	1	ov	1		5x4 m	0.4	-
Räisälä Mäenala	1999	CW2	CW2	11	rd,	5	1	5x7.5	all	-
					ov		2	5x7.5	ca.	
							3	5x6	0.2–0.4	
							4	7.5x6		
							5	5x7		
							6	6x9		
							7	5x6.5		
							8	7.5x6		
							9	5x6		
							10	6x7		
							11	4.5x6		
Räisälä Portinharju	1999	-	CW?	1	ov	1		4x3,5	NDA	-
Räisälä Mäenrinne 1	2004	CW3	CW3	6	rd,	5	1	5x7	0.2	ENA,
					ov,		2	8.5x10.3	0.5	EMB
					re		…	w/entrance	entrance	
							…	3x3.8	0.2	
							3	5.6x6	0.2	
							4	5x6.2	0.3	
							5	7.7x9.7	0.3	
							6	4x6	0.3	
Räisälä Mäenrinne 2	2004	-	-	1	rd	1		4.5x4	ca. 0.3	-
Räisälä Peltola A	2004	-	UnID'd	5	ov	5	1	5x6.2	0.3	-
			coarse ware				2	5.2x6	0.2	
			(CW)				3	5.8x6.	0.2	
							4	5.1x5.5	0.2	
							5	10x10	0.45	
Räisälä Peltola B	2004	CW2	CW2	4	rd	3	1	8.3x9.6	0.45	-
							2	7.8x8	0.3	
							3	8x9	0.35	
							4	7.4x8.3	0.3	
Räisälä Peltola C	2004[3)]	CW2	CW2	6	rd	5		8.2x10	0.3	-
								5x5	0.2	
								7.5x7.5	0.4	
								5.5x6.5	0.2	
								5.2x5.2	0.3	

Municipality/site	Survey[1)]	Ceramics HPs	Ceramics site	N	Shp	SC[1)]	#	LxW	D	Features
Räisälä Repokorpi	2004	CW2	CW2	1	ov	3		7x10.5	ca. 0.3	-
Räisälä Seppälä 4	2004	CW2, KIE	CW2, KIE	3	ov	7	1	6x8	NDA	-
							2	7x8	NDA	
							3	4x6	NDA	
Räisälä Mömmönsalmi 1	2004	CW2	CW2	2	ov	5		5x6.5	ca. 0.3	EMB
								7x9	ca. 0.6	
Räisälä Mäntylinna	2005	-	-	1	ov	2		5.5x8	NDA	-
Räisälä Kankaala	2005	CW2/ PitC	CW2/ PitC	3	ov	3	1	NDA	NDA	-
							2	7x10	0.6	
							3	7x7.5	0.4	

Survey: [1)] the year the site was found, [2)] excavated by Mökkönen in 2005, [3)] excavated by Halinen in 2005, [4)] excavated by Halinen, Lavento & Timofeev in 2002; Ceramics: HPs= housepits, CW1= Early Comb Ware, CW2= Typical Comb Ware, VOL= Volosovo pottery, PitC= Pit-Comb Ware, CW3= Late Comb Ware, KIE= Kierikki Ware, PÖL= Pöljä Ware, ASB= asbestos tempered ware, ORG= organic tempered ware, LNeo= Late Neolithic pottery, TXT= Textile pottery. Shapes (Shp): ob= oblong, ov= oval, re= rectangular, rd= round; Size Class (SC)= see fig. 5; Number of housepits (#); Length (L), width (W) and depth (D); Features: ENA= entrances/antechambers, EMB= embankment NDA= no data available