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"THE GOOD, THE BAD, THE WEIRD": STONE AGE AND EARLY METAL PERIOD RADIOCARBON DATES AND CHRONOLOGY FROM THE KARELIAN ISTHMUS, NORTH-WEST RUSSIA

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Abstract: In this paper all the Stone Age and Early Metal Period (ca. 8600 cal BC - 300 AD) radiocarbon dates from the Karelian Isthmus, Russia, are compiled and their archaeological usability assessed using a set of evaluation principles. The quality of radiometric dates from such a large area has rarely been methodologically examined in Finnish or North-West Russian archaeology, and is applied here for the first time on the present material. Special attention is given to the discussion on the deficiencies and limitations of the current data. Based on the 81 dates evaluated as useful, a tentative radiocarbon chronology is presented for the study area. This is generally in sequence with the chronologies of the nearby areas, but suggests some differences especially towards the end of Stone Age, as well as the presence of biases caused by taphonomic and research-related factors.

Keywords: Archaeology, ^{14}C dates, radiocarbon chronology, Holocene, Karelian Isthmus, Finland, Russia.

1. INTRODUCTION

The Karelian Isthmus, located in North-West Russia between Lake Ladoga and Gulf of Finland, was the stage of extensive Stone Age studies in the early 20th century (e.g. Pälsi, 1920a; also Uino, 2003; Nordqvist *et al.*, 2009). A vast amount of archaeological material was unearthed then, but as the studies pre-dated the invention of radiocarbon method, dating relied mostly on typological schemes and later also on shoreline displacement chronology. The period when radiocarbon dating started to become a standard tool for constructing archaeological chronologies coincides in the study area with the post-World War II standstill of research, and most of the area remained thinly studied until the collapse of Soviet Union (see e.g. Uino, 2003; Nordqvist *et al.*, 2009; **Fig. 1**).

Stone Age and Early Metal Period research in the northern part of Karelian Isthmus has intensified again only during the last decade as a result of several Finno-Russian joint research projects (e.g. Lavento (ed.), 2008; Nordqvist *et al.*, 2009)[1]. Also the parts of study area

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[1] The research has mostly taken place within the projects of the Department of Archaeology, University of Helsinki, Finland and two organs of the Russian Academy of Sciences in St. Petersburg, namely the Institute for the History of Material Culture and Peter the Great's Museum of Anthropology and Ethnography (Kunstkamera) (e.g. Lavento (ed.), 2008; Sapelko *et al.*, 2008; Nordqvist *et al.*, 2009). Some studies have

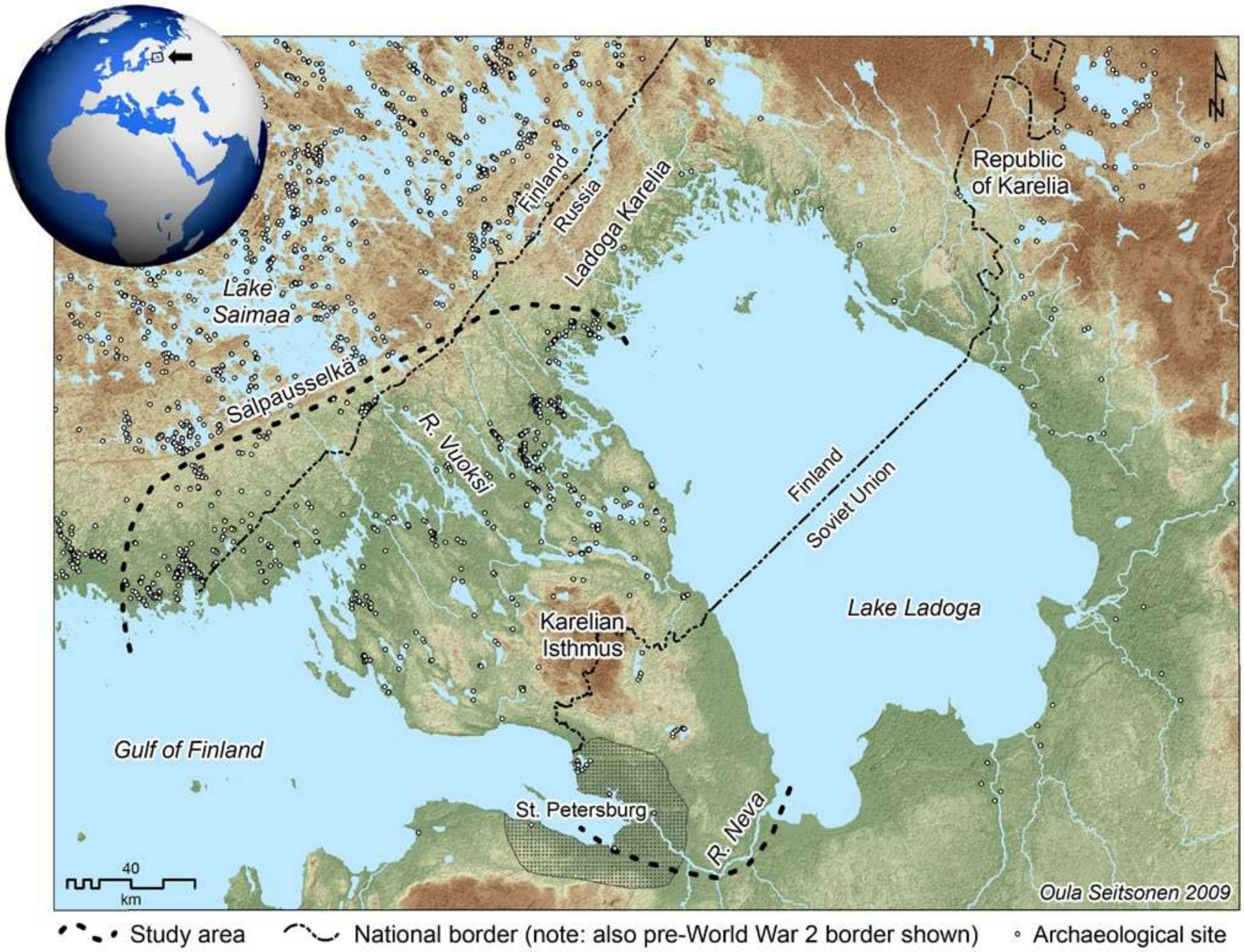

Fig. 1. *The study area (bordered with dotted line) comprises the Karelian Isthmus and south-western parts of Ladoga Karelia, Russia, and the south-eastern corner of Finland up to the watershed formed by Salpausselkä end moraine – the whole area is referred as Karelian Isthmus for brevity's sake. Also the Stone Age and Early Metal Period sites known up to 2010 are shown (white dots; based on the KarAS database) (Map: O. Seitsonen).*

belonging to Finland have recently faced increased research activity (e.g. Jussila *et al.*, 2007; Mökkönen and Seitsonen, 2007; Mökkönen, 2008). Conversely, the southern part of the study area has so far remained meagerly studied, with a few exceptions (see Vereščagina, 2003; Sorokin *et al.*, 2009).

The first attempt to date Stone Age contexts in the Karelian Isthmus with radiocarbon method was carried out by S.I. Rudenko in the 1960s, but the dates proved to be problematic (Rudenko, 1970). Both archaeological studies and the number of radiometric dates remained low till the end of 1990s: recent increase in fieldwork has also meant a rapid and substantial upswing in the number of archaeological ^{14}C dates. This enables for the first time the construction of a preliminary regional radiocarbon chronology for the study area. The pace is illustrated if we compare the previous compilations of Stone Age and Early Metal Period radiocarbon dates from the Karelian Isthmus (Uino, 1997; Saarnisto (ed.), 2003; Timofeev *et al.*, 2004a; Timofeev *et al.*, 2004b[2]) with the current situation: earlier compilations included altogether 39 dates from 16 Stone Age and Early Metal Period sites, while in this paper we present 94 conventional and AMS dates from 40 sites, over 10% of them previously unpublished.

In the first half of this paper all the radiometric dates from Stone Age and Early Metal Period contexts availa-

also been made as collaboration of Lahti City Museum, Finland and the above-mentioned Russian institutions (e.g. Takala and Sirviö, 2003; Takala, 2004). The authors have participated in these projects since their very beginning, and currently direct the ongoing field research in the area of Karelian Isthmus (e.g. Gerasimov *et al.*, 2007; 2008; Seitsonen *et al.*, 2009).

[2] In their article Timofeev *et al.* (2004a) published 30 dates from 13 locations. For some reason not all the dates available at that time were included, and due to the delimiting of study area also nine dates presented in Saarnisto ((ed.) 2003: 512) were left out – the latter account includes 19 Stone Age and Early Metal Period dates from 11 sites.

ble from the study area by the end of 2009 are compiled and their usability for building an archaeological radiocarbon chronology evaluated. The evaluation of radiometric dates has become more common over the past decade (e.g. Kuzmin and Tankerslay, 1996; Pettitt *et al*., 2003; Graf, 2009), but has not been consistently practiced in the study area earlier – also from a more wide-ranging viewpoint the assessment of radiometric dates in Holocene contexts has largely depended on each researcher's personal interests and motivation (e.g. Gkiasta *et al.,* 2003: 48).

In the second half of the paper the dated samples and their contexts are presented according to the major chronological periods, and a tentative ^{14}C chronology presented for the Karelian Isthmus. We also examine the possibilities proposed chronology and present dwelling site data possess for making interpretations of the spread and scale of prehistoric settlement and population dynamics in the Karelian Isthmus over time (see e.g. Kuzmin and Orlova, 2000; Dolukhanov *et al*., 2005; Zaitseva and Dergachev, 2009; Tallavaara *et al*., 2010), and the constraints set by the current, on no account optimal, research situation, as well as other factors, such as the environmental history (see Surovell and Brantingham, 2007; Surovell *et al*., 2009).

2. EVALUATION OF THE RADIOCARBON DATES

Numerous researchers have lately reminded that "Dates are not just data" (e.g. Kuzmin and Keates, 2005). Methodically sound and reproducible evaluation principles are needed when working with archaeological radiocarbon dates, and accordingly assessment criteria has been suggested on occasions since the 1970s (e.g. Waterbolk, 1971; Spriggs, 1989; Kuzmin and Tankerslay, 1996).

In this paper, all ^{14}C dates available from the study area by the end of 2009 are evaluated with a ranking system based on the criteria presented by Pettitt *et al.* (2003) and Graf (2009), and adapted to fit our KarAS database[3]. We developed our assessment criteria on the basis of an interpretative viewpoint related to the archaeological context of each sample, with focus on three major themes: the association of the sample and the dated hominin-influenced event; the compatibility of the date with other data from the site; and the quality of the sample and date itself (**Table 1**). Since all dates have been processed by acknowledged radiocarbon laboratories, we did not feel a need for assessing the chronometric issues connected to the formal analyses (Pettitt *et al*., 2003: criteria 1-5).

[3] Seitsonen has assembled from numerous sources, including our primary fieldwork data, a constantly growing KarAS (Karelian Archaeological Sites) database, which includes relevant data of all the known prehistoric sites. Researchers interested in this information can contact him. KarAS database is also going to be published online in the future.

All the Stone Age and Early Metal Period radiocarbon dates from the study area are compiled in **Table 2**[4]. A case-by-case approach was chosen to evaluate the quality of the dates: each date was scored from 0 to 4 for all the criteria (**Table 1**), and the overall score summed (**Table 2**). Finally the dates were divided into three categories according to the score: 20-28 "Good", 10-19 "Weird" and 0-9 "Bad" (**Fig. 2**), equivalent to the characters in the South Korean Western movie "The Good, the Bad, the Weird" (Kim Ji-woon, CJ Entertainment; cf. Graf, 2009).

Fig. 2. *"The Good, the Bad, the Weird": an evaluation framework for the archaeological radiocarbon dates from the Karelian Isthmus (Illustration: O. Seitsonen).*

[4] In this paper the Finnish names of sites and administrative areas located in the northern Karelian Isthmus, part of Finland prior to World War II (**Fig. 1**), are used, because the main corpus of the extensive material collected here is catalogued under and discussed according to these names in the archival material and archaeological literature – the Russian names can be found in the referred literature (see also e.g. Gerasimov *et al*., 2003; Nordqvist *et al*., 2008).

The dates entitled "Good" (N=42) originate from a number of meticulously sampled, recently excavated sites, with multiple dates from each context. The "Weird" dates (N=39) consist mostly of solitary dates; Although in many cases these show a relatively good fit with the excavated materials on a face value, it should be remembered that "one date is no date" (e.g. Pettitt *et al.*, 2003), as they cannot be cross-checked. The dates which received the evaluation "Bad" (N=11) for their archaeological usability, are omitted from further examinations. Most of these evidently date some other incidents than human activities, e.g. periodical forest fires (Jussila *et al.* 2007). There are also two "Good" dates which date later events, from Muolaa Silino 1 and Kaukola Rupunkangas 1 sites; these too are excluded from the following assessment.

Table 1. *Criteria used in the evaluation of radiocarbon dates (1-4 based on Pettitt* et al. *(2003), 5-7 based on Graf (2009), and modified to fit the data from the study area).*

1. Certainty of association of dated sample with human activity

Score

0. Low possibility (sample recovered from e.g. geological horizon).
1. Reasonable possibility (archaeology scattered and/or fragmentary, low numbers).
2. Probability (no demonstrable relationship but number of items and spatial patterning suggest association).
3. High probability (direct functional/contextual relationship).
4. Full certainty (anthropogenic object dated).

2. Relevance of dated sample to specific archaeological entity of concern

Score

0. Sample material is unknown.
1. Sample has no traces of human modification, or if charcoal, "old wood" effect cannot be ruled out.
2. Sample has high association with diagnostic archaeology, through incorporation in same horizon/level, but is in itself undiagnostic.
3. Sample has very high association, through incorporation into cultural feature, e.g. hearth or pit, albeit undiagnostic itself.
4. Sample culturally diagnostic, or has a high probability of association, or has traces of human modification.

3. Quantity and nature of dates for archaeological horizon

Score

0. The date is one of several for a given horizon that differ statistically at 2σ range.
1. The date is the sole measurement for a given horizon.
2. The date is one of 2 dates for a given horizon which are statistically the same age at 2σ range.
3. The date is one of 3 dates for a given horizon which are statistically the same age at 2σ range.
4. The date is one of 4 or more dates for a given horizon which are statistically the same age at 2σ range.

4. Stratigraphic issues

Score

0. Sample is a small fragment which may be stratigraphically mobile, with no spatial indication of its stratigraphic integrity.
1. Sample is <5 cm in maximum dimension with no clear indication of its stratigraphic integrity.
2. Sample is <5 cm in maximum dimension with a high probability of stratigraphic integrity.
3. Sample is >5 cm in maximum dimension with a high probability of stratigraphic integrity.
4. Sample is >5 cm in maximum dimensions and clearly stratified within an identifiable cultural feature.

5. Sample type choise and own age of the material

Score

0. Dispersed material whose stratigraphic context is not clear.
1. Charcoal from a clear archaeological horizon, "old wood" effect cannot be ruled out.
2. Burnt bone from a clear archaeological horizon.
3. Charcoal or burnt bone from a hearth or other cultural feature, or human modified material with which "old wood" effect cannot be ruled out.
4. Charred crust, resin, cut-marked burnt bone or other human modified material, "old wood" effect ruled out.

6. Standard deviation

Score

0. > ±100
1. ±71-100
2. ±51-70
3. ±40-50
4. < ±40

7. Fittingness with the archaeological find material and stratigraphy

Score

0. No obvious correlation between the date and find context or context unknown
1. The date does not fit the find context but overlaps at 2σ range with 1 or more other dates in a given horizon.
2. The date fits the find context but is the sole measurement or does not overlap with other dates at 2σ range.
3. The date fits the find context and overlaps at 2σ range with 1 other date.
4. The date fits the find context and overlaps at 2σ range with atleast 2 other dates.

Table 2. *Archaeological radiocarbon dates from the study area; calibrated with OxCal 4.0, (Bronk Ramsey, 2001), using the IntCal09 calibration curve for the Northern Hemisphere (Reimer* et al.*, 2009).*

Site nr.	Site	Date nr.	Context[a]	Material	Lab. nr.	BP	SD	Cal (68.2%) max	Cal (68.2%) min		Cal (95.4%) max	Cal (95.4%) min		Rating	References
1	Antrea (Vuoksenranta) Korpilahti	1	EM, net float, NM 6688[b]	pine bark	Hel-1303	9310	140	8730	8340	BC	9130	8270	BC	22	1, 2, 3, 4
		2	EM, net float, NM 6688	pine bark	Hel-269	9230	210	8790	8230	BC	9210	7940	BC	22	1, 2, 3, 4
		3	EM, net cord, NM 6688	willow cord	Hela-404	9140	135	8560	8240	BC	8740	7960	BC	23	4, 5, 6, 7
2	Antrea Suuri Kelpojärvi	4	EM, cultural layer	burnt bone	Hela-931	9275	120	8640	8320	BC	9110	8250	BC	13	8, 9
3	Heinjoki Latukangas 1 (Veschevo 1)	5	EN, CW1, charcoal concentration	charcoal	Le-6511	5770	130	4780	4460	BC	4940	4350	BC	17	10, 11
		6	EMP, cultural layer	charcoal	Le-6559	2400	50	720	390	BC	760	390	BC	18	10, 11
		7	MIA?, cultural layer	charcoal	Le-6509	1470	140	414	680	AD	250	870	AD	7	10, 11
4	Heinjoki Tarhojenranta	8	EN, charcoal patch	charcoal	N/A	5815	50	4730	4590	BC	4790	4540	BC	14	12
5	Heinjoki Valklampi 1	9	EM, cultural layer	burnt bone	Hela-743	8765	65	7960	7680	BC	8190	7600	BC	14	8, 9
6	Heinjoki Valklampi 2	10	EM, cultural layer	burnt bone	Hela-744	8720	70	7830	7600	BC	8170	7580	BC	13	8, 9
7	Hepojärvi	11	LM/EN, hearth	charcoal	Le-1412	6480	60	5490	5370	BC	5550	5320	BC	20	11, 14, 15
		12	LM/EN, hearth	charcoal	Le-1411	6380	60	5470	5310	BC	5480	5220	BC	20	11, 14, 15
		13	LN, org, hearth	charcoal	Le-1410	4100	60	2860	2570	BC	2880	2490	BC	20	11, 14, 15
		14	LN, org, pit feature	charcoal	Le-1408	4020	70	2840	2460	BC	2870	2340	BC	19	11, 14, 15
8	Johannes Loikas	15	LN, cord?, hearth	charcoal	Hela-663	3860	45	2460	2230	BC	2470	2200	BC	16	16, 17
9	Johannes Tokarevo 1:1	16	MN, CW2, potsherd	charred crust	Ki-10298	4790	210	3930	3340	BC	4040	2940	BC	19	16, 17, 18
10	Johannes Väntsi	17	MN, Kierikki, potsherd, NM 9406:188	charred crust	Hela-465	4870	85	3770	3530	BC	3940	3370	BC	20	11, 16, 17
11	Joutseno Saarenoja 2	18	EM, cultural layer	burnt bone	Hela-728	9310	75	8710	8450	BC	8750	8320	BC	15	34
		19	EM, cultural layer	charred plant remains	Hela-470	7720	115	6680	6440	BC	7030	6370	BC	3	35
12	Joutseno Hiekkasilta-Hiekkakuoppa	20	EM?, cultural layer	charred pine cone fragments	Hela-472	6430	75	5480	5340	BC	5540	5220	BC	5	35
13	Joutseno Saarenoja-Muilamäki	21	EM?, cultural layer	charred pine cone fragments	Hela-471	4050	70	2840	2470	BC	2880	2450	BC	5	35
14	Kanneljärvi Kanneljärvi 2	22	LN, charcoal concentration	charcoal	Le-2549	3890	40	2470	2340	BC	2480	2210	BC	17	10, 15
		23	EMP, charcoal concentration	charcoal	Le-2550	3500	40	1890	1770	BC	1940	1690	BC	18	10, 15
15	Kaukola Juho Paavilaisen Rantapelto (Kankaanmäki)	24	EMP, potsherd, NM 7117:24	charred crust	Hela-467	3085	70	1430	1260	BC	1500	1130	BC	20	11, 17, 19, 31
16	Kaukola Piiskunsalmi Lavamäki	25	LN, cord, potsherd NM 6385:21	charred crust	Hela-468	4130	60	2870	2620	BC	2890	2500	BC	21	11, 17, 19, 33
17	Kaukola Riukjärvi (Kyöstälänharju)	26	MN, CW3, potsherd NM 5699:9	birch bark tar	Hela-359	4780	70	3650	3380	BC	3700	3370	BC	20	11, 17, 19, 32
18	Kaukola Rupunkangas 1A	27	EM, inside a house-pit	charcoal	Hela-1182	8770	85	8170	7650	BC	8210	7600	BC	17	8, 20
		28	EM, inside a house-pit	charcoal	Hela-1197	8130	65	7290	7040	BC	7350	6830	BC	13	8, 20
		29	LM, inside a house-pit	charcoal	Hela-1196	7550	75	6480	6260	BC	6570	6230	BC	10	8, 20
		30	LM, inside a house-pit	charcoal	Hela-1195	6595	55	5610	5480	BC	5630	5470	BC	11	8, 20
		31	historical, tar-burning pit	charcoal	Hela-1183	205	40	1650	1960	AD	1640	1960	AD	x	8, 20
19	Kaukola Rupunkangas 3	32	EM, cultural layer	burnt bone	Hela-1165	8740	80	7940	7610	BC	8190	7590	BC	11	8, 20
20	Kirvu Harjula	33	LN, org, hearth	burnt bone	Hela-1176	3995	40	2570	2470	BC	2630	2350	BC	16	21
21	Kirvu Juhola 2	34	EM, bone pit	burnt bone	Hela-1164	8970	75	8280	7980	BC	8310	7840	BC	16	21
22	Kirvu Kivimäki 2	35	EN, CW1, cultural layer	charcoal	Hela-1158	2380	35	510	390	BC	730	380	BC	7	21

Table 2. *Continuation.*

Site nr.	Site	Date nr.	Context[a]	Material	Lab. nr.	BP	SD	Cal (68.2%) max	Cal (68.2%) min		Cal (95.4%) max	Cal (95.4%) min		Rating	References
23	Kurkijoki	36	MN, cultural layer	charcoal	Su-2651	4620	60	3520	3340	BC	3630	3100	BC	10	19
	Kuuppala Kalmistomäki	37	EMP, cultural layer	charcoal	Le-4145	2920	190	1380	910	BC	1630	670	BC	10	19
24	Kurkijoki Kylliäisenlahti W-2	38	LM/EN, pit feature	charcoal	Le-6928	6400	600	5980	4690	BC	6600	4040	BC	15	17, 22, 23
25	Kurkijoki Lahdenryhmä	39	LM, pit feature	charcoal	Le-6929	7900	80	7030	6640	BC	7050	6600	BC	16	17, 22, 23
		40	EMP?, pit feature	charcoal	Le-6930	2230	30	380	210	BC	390	200	BC	16	17, 22, 23
26	Lavansaari Suursuonmäki	41	EMP, cairn	charcoal	Su-3297	1660	50	260	510	AD	250	540	AD	13	19
		42	EMP, cairn 1, NM 9229:2	resin	Ua-2545	1975	70	60 BC	130	AD	170 BC	220	AD	24	19
		43	EMP, cairn 2, NM 9229:8	resin	Ua-2546	1960	70	50 BC	130	AD	160 BC	230	AD	24	19
		44	EMP, cairn 3, NM 9229:11	resin	Ua-2547	2165	60	360	110	BC	380	50	BC	25	19
27	Luumäki Mustaniemi	45	EM, hearth	burnt bone	Hel-4395	8580	140	7830	7480	BC	8200	7330	BC	18	37, 38
28	Metsäpirtti Vjun 1	46	Geological profile of river ravine, depth 4,3 m	wood	Le-561	5980	100	5000	4720	BC	5210	4610	BC	7	24, 15
		47	Geological profile of river ravine	wood	N/A	5310	100	4260	4000	BC	4350	3950	BC	5	24
		48	Geological profile of river ravine, depth 2,5 m	wood	Le-559	3650	80	2140	1920	BC	2290	1770	BC	7	24, 15
		49	MN, cultural layer	charcoal	N/A	1860	120	170 BC	430	AD	10	330	AD	5	24
29	Muolaa Silino 1	50	LM, hearth	charcoal	Hela-524	6975	80	5980	5770	BC	6010	5720	BC	20	11, 22, 26
		51	LM, charcoal concentration	charcoal	Hela-526	6860	75	5840	5660	BC	5970	5620	BC	19	11, 22, 26
		52	LM, hearth	charcoal	Hela-525	6815	80	5770	5630	BC	5890	5560	BC	20	11, 22, 26
		53	EN, CW1, potsherd	charred crust	Hela-554	5830	80	4790	4590	BC	4900	4490	BC	20	11, 22, 26
		54	MN, CW2, potsherd	charred crust	AAR-7129	5050	100	3960	3710	BC	4050	3640	BC	22	11, 22
		55	MN, CW2:1, potsherd	charred crust	Hela-553	4965	80	3910	3650	BC	3950	3640	BC	23	11, 22, 26
		56	MN, CW2, hearth	charcoal	Hela-591	4965	60	3800	3660	BC	3950	3640	BC	20	11, 22, 26
		57	LN asb, potsherd	charred crust	AAR-7130	4430	65	3330	2920	BC	3340	2910	BC	21	11, 22
		58	MIA, potsherd	charred crust	Hela-555	1275	65	660	810	AD	640	900	AD	x	11, 22, 26
30	Pyhäjärvi Kunnianniemi	59	LM, hearth	burnt bone	Hela-1842	7195	45	6090	6000	BC	6210	5980	BC	21	27
		60	LM, bone concentration	burnt bone	Hela-2048	7077	49	6020	5900	BC	6050	5840	BC	21	28
		61	LM, hearth	burnt bone	Hela-1843	7025	45	5990	5870	BC	6010	5800	BC	21	28
		62	EN, CW1:2, potsherd	charred crust	Hela-1817	5635	45	4530	4370	BC	4550	4350	BC	22	27
		x	EN, CW1, potsherd	charred crust	Hela-1818	N/A								x	28
		63	MN, CW2, potsherd	charred crust	Hela-1816	4930	35	3760	3650	BC	3780	3640	BC	23	28
		64	MN, netsinker	birch bark	Hela-1554	4450	35	3330	3020	BC	3340	2930	BC	23	28
		x	MN, Kierikki, potsherd	charred crust	Hela-1820	N/A								x	28
		65	LN, Pöljä, potsherd	charred crust	Hela-1819	4030	35	2580	2480	BC	2840	2470	BC	25	28
		66	LN, ,Pöljä, bone pit	burnt bone	Hela-1844	3955	35	2570	2350	BC	2580	2340	BC	20	28
		67	EMP, cultural layer	charcoal	Le-8021	1720	40	250	390	AD	230	420	AD	14	27
31	Pyhäjärvi Porsaanmäki 1	68	LN, org, pit feature, on the wall of a house-pit	charcoal	Hela-1821	4390	35	3090	2920	BC	3270	2910	BC	18	28
32	Pyhäjärvi Ristilä 1	69	LM, hearth	charcoal	Hela-1822	7095	45	6020	5910	BC	6060	5890	BC	17	28
33	Räisälä Hiekka 1	70	LM, next to a hearth	burnt bone	Hela-1163	6840	60	5780	5660	BC	5870	5620	BC	17	21
		71	LM, next to a hearth	burnt bone	Hela-1256	6950	60	5890	5750	BC	5990	5720	BC	17	21

Table 2. *Continuation.*

Site nr.	Site	Date nr.	Context[a]	Material	Lab. nr.	BP	SD	Cal (68.2%) max	Cal (68.2%) min		Cal (95.4%) max	Cal (95.4%) min		Rating	References
34	Räisälä Juoksemajärvi Westend	72	LM, cultural layer	charcoal	Le-6556	7750	180	6990	6420	BC	7080	6240	BC	11	10, 11, 22, 29, 30
		73	MN, cultural layer	charcoal	Le-6641	4550	180	3520	3020	BC	3710	2770	BC	18	10, 11, 22, 29, 30
		74	LN, cultural layer	charcoal	Le-6512	4150	50	2880	2630	BC	2890	2580	BC	18	10, 11, 22, 29, 30
		75	LN, cultural layer	charcoal	Le-6601	3740	90	2290	2020	BC	2460	1930	BC	19	10, 11, 22, 29, 30
		76	LN, cultural layer	charcoal	Le-6557	3700	320	2570	1690	BC	3020	1320	BC	19	10, 11, 22, 29, 30
		77	LN, charcoal concentration next to a hearth in the eastern half of a house-pit	charcoal	Le-6602	3660	30	2130	1970	BC	2140	1950	BC	24	10, 11, 22, 29, 30
		78	LN, cultural layer	charcoal	Le-6642	3450	100	1890	1630	BC	2030	1520	BC	20	10, 11, 22, 29, 30
		79	EMP, charcoal concentration (hearth) in the western corner of a house-pit	charcoal	Le-6600	3370	30	1730	1620	BC	1750	1530	BC	23	10, 11, 22, 29, 30
		80	EMP, cultural layer	charcoal	Le-6643	2620	70	900	600	BC	930	530	BC	8	10, 11, 22, 29, 30
		81	MIA?, cultural layer	charcoal	Le-6640	1400	50	600	670	AD	540	770	AD	9	10, 11, 22, 29, 30
		x	LN?, cultural layer	charcoal	Le-6558	N/A								x	29
35	Räisälä Hovi Kalmistomäki	82	EMP, potsherd, NM 2556	charred crust	Hela-8	2360	70	740	370	BC	760	230	BC	20	12, 19
		83	EMP, potsherd, NM 6675:42	charred crust	Hela-466	2640	70	900	760	BC	980	540	BC	23	19, 31
		84	EMP, potsherd, NM 6675:50	charred crust	Hela-469	2540	75	800	540	BC	820	410	BC	23	19, 31
36	Räisälä Kuusela	85	LM, cultural layer	burnt bone	Hela-1175	7945	60	7030	6700	BC	7050	6660	BC	10	21
37	Räisälä Peltola C	86	MN, CW2, wall of a pithouse	resin "chewing gum" [c]	Hela-1159	4905	45	3720	3640	BC	3790	3630	BC	13	21
38	Viipuri Häyrynmäki	87	MN, CW3, potsherd, NM 5620:CCXLIV	birch bark tar	Hela-358	4550	60	3370	3100	BC	3500	3020	BC	21	12, 19
39	Viipuri Ozernoe 3	88	LM, cultural layer	charcoal	Le-7538	7580	50	6480	6400	BC	6570	6270	BC	20	13
		89	LM, cultural layer	charcoal	Le-7539	7220	50	6210	6010	BC	6220	6010	BC	20	13
		90	LM, cultural layer	charcoal	Le-7540	7680	50	6590	6460	BC	6630	6440	BC	20	13
		91	LM, cultural layer	charcoal	Le-7541	7640	50	6570	6430	BC	6600	6420	BC	20	13
40	Virolahti Meskäärtty	92	MN, CW3, potsherd, NM 37112:1	charred crust	Hela-1613	4535	35	3360	3110	BC	3370	3100	BC	23	36
		93	MN, CW3, potsherd, NM 37112:3	charred crust	Hela-1615	4520	40	3350	3110	BC	3370	3090	BC	23	36
		94	LN, cord, potsherd; NM 37112:2	charred crust	Hela-1614	3820	45	2350	2150	BC	2460	2140	BC	20	36

[a]*EM = Early Mesolithic, LM= Late Mesolithic, EN= Early Neolithic, MN= Middle Neolithic, LN= Late Neolithic, EMP= Early Metal Period, MIA= Middle Iron Age*

[b]*NM = National Museum of Finland catalogue number*

[c]*Erroneously reported as burnt bone by Halinen and Mökkönen (2009).*

All the presented dates have been calibrated with OxCal 4.0 (Bronk Ramsey 2001), using the IntCal09 calibration curve for the Northern Hemisphere (Reimer et al. *2009).*

References: 1) Jungner 1979: 44; 2) Siiriäinen 1974; 3) Matiskainen 1989: 71; 4) Carpelan 2008; 5) Miettinen et al. *2008; 6) Takala 2004: 151; 7) Ylikoski 2004: 25; 8) Lisitsyn and Gerasimov 2008; 9) Takala 2004: 161; 10) Gerasimov* et al. *2003; 11) Timofeev* et al. *2004a; 12) Takala 2004: 156; 13) Sapelko* et al. *2008; 14) Vereščagina 2003; 15) Timofeev and Zaitseva 1991; 16) Carpelan* et al. *2008; 17) Nordqvist* et al. *2008; 18) Lisitsyn 2003; 19) Saarnisto (ed) 2003: 512; 20) Mökkönen* et al. *2007; 21) Halinen and Mökkönen 2009; 22) Gerasimov and Kul'kova 2003; 23) Seitsonen and Gerasimov 2008; 24) Rudenko 1970; 25) Timofeev* et al. *2004b; 26) Takala and Sirviö 2003; 27) Seitsonen* et al. *2009; 28) this paper; 29) Halinen* et al. *2008; 30) Timofeev* et al. *2003; 31) Lavento 2001: 102; 32) Pesonen 2004; 33) Huurre 2003: 234; 34) Jussila & Matiskainen 2003; 35) Jussila* et al. *2007; 36) Mökkönen 2008; 37) Luoto & Laakso 2001; 38) Hakulinen 2003*

3. ARCHAEOLOGICAL RADIOCARBON DATES

In the following the radiocarbon dates assessed as "Good" or "Weird" are presented according to the major chronological periods. The used archaeological sequence and chronological contexts are shown in **Table 3**, compiled on the basis of various studies in Finland and North-West Russia, and adapted to the local conditions; we especially consider it more appropriate to date the start of Late Neolithic at 3000 cal BC (see also Lang & Kriiska, 2001), since there are more changes around that time, than at the often used 2300 cal BC (e.g. Carpelan 1999; Mökkönen 2011). The beginning of (Sub)Neolithic period in the area is traditionally connected to the appearance of ceramic manufacture; however, recent studies suggest that the introduction of agriculture might actually date older than previously thought, at least to the Middle Neolithic, and needs revision in the future (Mökkönen 2010).

Table 3. *Chronological contexts of the ^{14}C dates; in the local terminology Neolithic refers to the appearance of ceramic manufacture.*

Period	cal BC/AD	^{14}C dates	
		Total	%
Early Mesolithic	8600-7000	12	15%
Late Mesolithic	7000-5100	18	22%
Early Neolithic	5100-4000	7	9%
Middle Neolithic	4000-3000	14	17%
Late Neolithic	3000-1800	16	20%
Early Metal Period	1800-AD 300	14	17%

Early Mesolithic (8600-7000 cal BC)

The earliest presence of humans in the study area relates to the post-glacial pioneer settlement, dated in South Finland to ca. 8850-8400 cal BC (e.g. Takala, 2004). The oldest known dwelling site is Joutseno Saarenoja 2, dated to 8710-8450 cal BC[5] (Hela-728: 9310±75 BP) (Jussila *et al.*, 2007) (**Fig. 3**). A coeval ^{14}C dating, 8640-8320 cal BC, comes from Antrea Suuri Kelpojärvi site (Hela-931: 9270±120 BP) (Takala, 2004; Jussila *et al.*, 2007), located a few kilometers away from the find location of the famous Antrea Korpilahti Net Find, excavated in 1914 (Pälsi, 1920b). The most recent ^{14}C sample from the willow braid of this net gave a date 8560-8240 cal BC (Hela-404: 9140±135 BP), slightly younger than the previous ones obtained from the pine bark floats (Hel-1303: 9310±140 BP, Hel-269: 9230±210 BP); these were most likely affected by the "old wood" effect, suggesting the pine(s) used for the floats had a considerable own age already at the time when the net was weaved (Carpelan, 2008; Miettinen *et al.*, 2008).

Early Mesolithic habitation subsequent to the initial pioneer settlement is evidenced from six dated sites. The oldest of these is Kirvu Juhola 2, where a sample from a pit full of burnt bone fragments was dated to 8280-7980 cal BC (Hela-1164: 8970±75 BP) (Halinen and Mökkönen, 2009). Two sites excavated in the Heinjoki area, Valklampi 1 and 2, date slightly younger (Hela-743: 8765±65 BP, Hela-744: 8720±70 BP) (Takala, 2004). From Luumäki Mustaniemi, located by the nowadays dry ancient Lake Selänalajärvi, a burnt bone sample was dated to 7830-7480 cal BC (Hela-4395: 8580±140 BP) (Luoto and Laakso, 2001; Hakulinen, 2003).

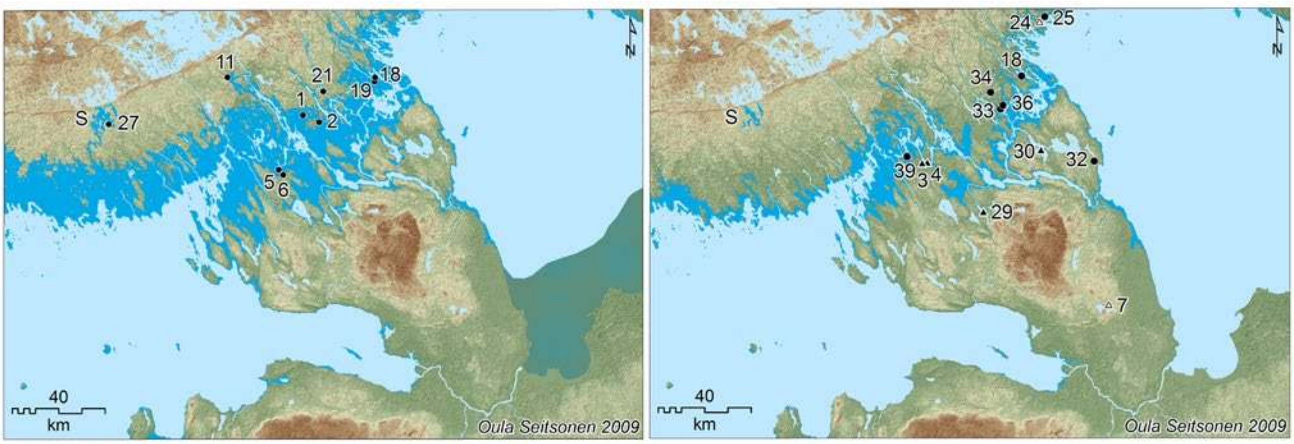

Fig. 3. *Distribution of ^{14}C dated sites; Left: Early Mesolithic sites, darker blue water levels are reconstructed to the Ancylus transgression maximum ca. 8400-8300 cal BC, rasterizing in the southern Lake Ladoga shows the area now submerged by the lake; Right: Late Mesolithic and Early Neolithic sites (black dot = Late Mesolithic, black triangle = both Late Mesolithic and Early Neolithic, open triangle = Late Mesolithic and possible Early Neolithic), water levels reconstructed to ca. 5000 cal BC; S=ancient Lake Selänalajärvi (also in* ***Figs. 5-6****). Site numbers in all maps refer to* ***Table 2*** *(Map: O. Seitsonen).*

5 One sigma (68.2%) distributions are used in the text (e.g. Michczyński, 2007).

Contemporaneous Early Mesolithic dates were obtained from two adjacent sites in Kaukola: burnt bones collected from Kaukola Rupunkangas 3 (Hela-1165: 8740±80 BP) (**Fig. 4**: 1-3) and the oldest habitation phase of Kaukola Rupunkangas 1A (Hela-1182: 8770±85 BP) (**Fig. 4**: 4-7) date to the interval 8170-7610 cal BC (Mökkönen *et al.*, 2007: 20). The latter date derives from charcoal sampled in the lowest cultural deposits inside a house-pit, and hence dates the oldest known dwelling of this kind in the Karelian Isthmus. This house-pit was reused several times in the Mesolithic, based on one more Early Mesolithic (Hela-1197: 8130±65 BP) and two Late Mesolithic radiocarbon dates (Hela-1196: 7550±75 BP, Hela-1195: 6596±55 BP), as well as during the Middle Neolithic and Early Metal Period based on the find material (Mökkönen *et al.*, 2007).

Late Mesolithic (7000-5100 cal BC)

Besides Rupunkangas 1A, reliable Late Mesolithic dates have been obtained from eight sites (**Fig. 3**). Charcoal from the cultural layer at Räisälä Kuusela site gave a dating 7030-6700 cal BC (Hela-1175: 7945±60 BP) (Halinen and Mökkönen, 2009), and a pit feature at the multi-period site Kurkijoki Lahdenryhmä was dated to 7030-6640 cal BC (Le-6929: 7900±80 BP); the Mesolithic

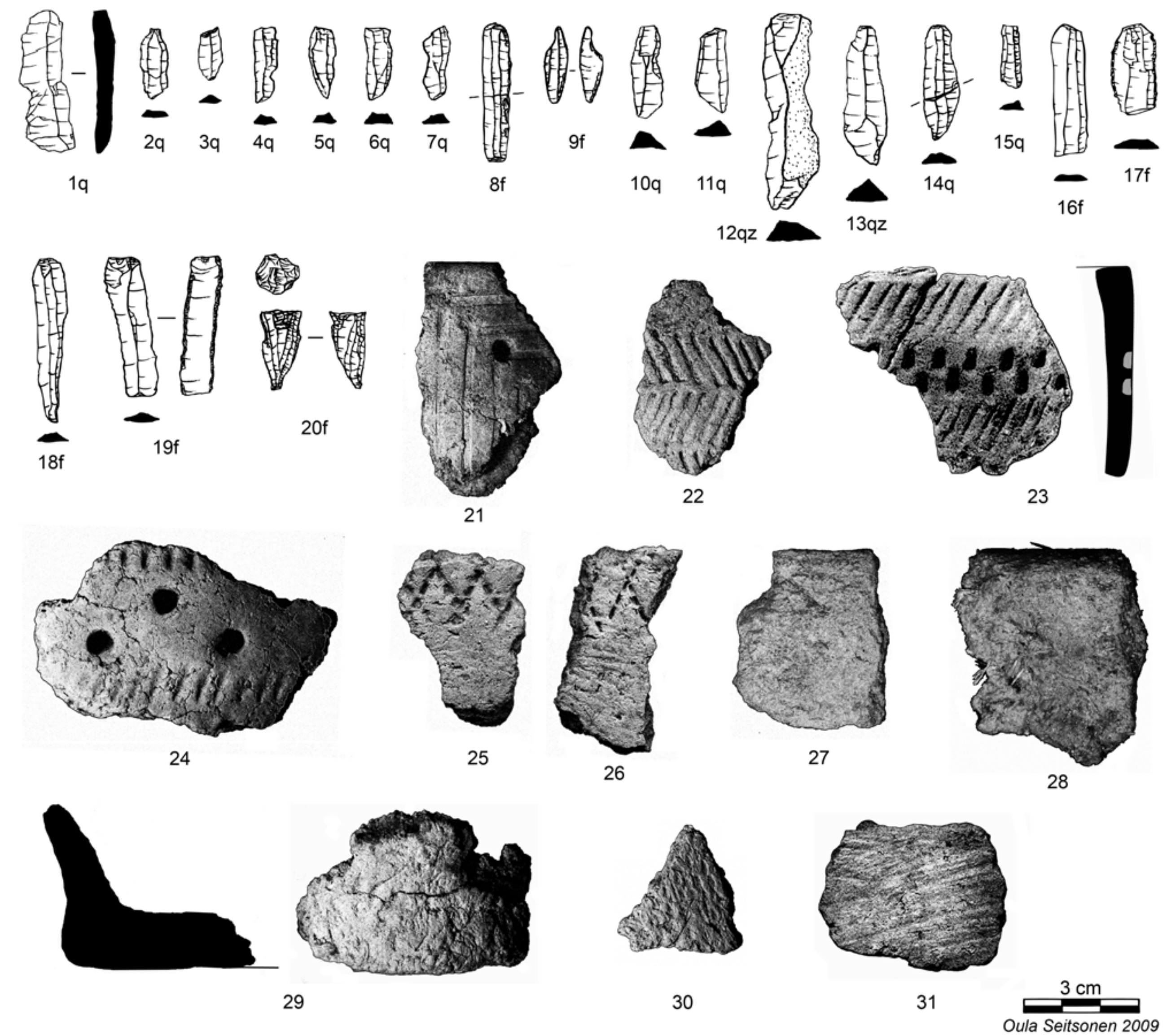

Fig. 4. *Finds from radiocarbon dated sites: Mesolithic: 1-17) blades and microblades, 8, 9 and 17 retouched; Mesolithic (?): 18-19) microblades, 19 retouched, 20) conical microblade core; CW1: 21-22; CW2: 23-24; CW3: 25-26; Kierikki/Pöljä ceramics: 27-28; Late Neolithic organic-tempered ceramics: 29-30; Early Metal Period ceramics: 31. Site numbers in parentheses refer to **Table 2**: 1-3 (19), 4-7 (18), 8-9 (34), 10-13 (30), 14-15 (29), 16-17 (33), 18-20 (7), 21-22 (30), 23 (29), 24 (30), 25-26 (31), 27-28 (30), 29-30 (30), 31 (30) (q=quartz, qz=quartzite, f=flint) (Illustration: O. Seitsonen).*

finds at this site are covered by Neolithic and possibly Early Metal Period cultural layers (Seitsonen and Gerasimov, 2008). Excavations at the multi-period site Räisälä Juoksemajärvi Westend produced a large number of ^{14}C dates: the oldest of these, 6990-6420 cal BC (Le-6556: 7750±180 BP) shows, in accordance with the find material (**Fig. 4**: 8-9), that the habitation started in the Mesolithic (Halinen *et al.*, 2008). From Viipuri Ozernoe 3 site comes a series of dates from Mesolithic context, ranging from 6590 to 6010 cal BC (Le-7540: 7680±50 BP, Le-7541: 7640±50 BP, Le-7538: 7580±50 BP, Le-7539: 7220±50 BP), covered by alluvial sediments and also by Neolithic layers (Sapelko *et al*., 2008).

One of the most interesting sites discovered lately in the Karelian Isthmus is the deeply stratified multi-period dwelling site Pyhäjärvi Kunnianniemi, with nearly three meters thick prehistoric deposits (Gerasimov *et al.*, 2007; 2008; Seitsonen and Nordqvist, 2009; Seitsonen *et al*., 2009). The uniqueness of the site lies in its four distinctive cultural layers, each sealed by a sterile transgression layer. From the lowermost cultural layer two Mesolithic fireplaces were dated, and the results evidence successive use of these hearths between 6090-5870 cal BC (Hela-1842: 7195±45 BP, Hela-1843: 7025±45 BP) (**Fig. 4**: 10-13) (Seitsonen *et al.*, 2009). Parallel date was obtained from burnt bone collected inside a possible Mesolithic house-pit in another trench (Hela-2048: 7077±49 BP). To the same time period belongs also a date obtained from charcoal sampled in a hearth at Pyhäjärvi Ristilä 1 site (Hela-1822: 7095±45 BP).

Besides Kunnianniemi, cultural layers separated by transgression layers have been studied at another deeply stratified site, Muolaa Telkkälä Silino. Three dates, alongside finds (**Fig. 4**: 14-15), show that the habitation began also here during the Late Mesolithic (Hela-524: 6975±80 BP, Hela-526: 6860±75 BP, Hela-525: 6815±80 BP) (Takala and Sirviö, 2003). Räisälä Hiekka 1 site produced also two contemporaneous dates from burnt bones (Hela-1256: 6950±60 BP, Hela-1163: 6840±60 BP) (Halinen and Mökkönen, 2009) (**Fig. 4**: 16-17).

Finally, a pit-feature excavated in 2003 at multi-period site Kurkijoki Kylliäisenlahti W-2 was dated close to the end of Late Mesolithic, 5980-4690 cal BC (Le-6928: 6400±600 BP) (Seitsonen and Gerasimov, 2008). However, due to the large standard deviation this date may as well be connected to the subsequent Early Combed Ware (CW1) habitation at the site.

Early Neolithic (5100-4000 cal BC)

The earliest, and somewhat dubious, dates mentioned in connection to Early Neolithic come from multi-period site Hepojärvi, where two hearths were dated to 5490-5310 cal BC (Le-1412: 6480±60 BP, Le-1411: 6380±60 BP) (Vereščagina, 2003: 149; Timofeev *et al.*, 2004a). The earliest certain Neolithic dates derive from charred crust on CW1 sherds: from Muolaa Silino, 4790-4590 cal BC (Hela-554: 5830±80 BP) (Takala and Sirviö, 2003), and from Pyhäjärvi Kunnianniemi, 4530-4370 cal BC (Hela-1817: 5635±45 BP) (Seitsonen *et al.*, 2009) (**Fig. 4**: 21-22). Two multi-period sites in the Heinjoki area also exhibit CW1 dates: Tarhojenranta (5815±50 BP [no laboratory number reported]) (Takala, 2004: 156), and Latukangas 1 (Le-6511: 5770±130 BP) (Timofeev *et al.*, 2004a).

Both the crust dates from Silino and Kunnianniemi and the context dates from Heinjoki sites fit well within the proposed dating of CW1: the appearance of earliest pottery in the Karelian Isthmus and Southern Finland has been commonly dated to ca. 5200-5100 cal BC (Carpelan, 1999; Carpelan *et al.*, 2008). However, the two context dates from Hepojärvi are relatively early for CW1. Some researchers have hypothesized that these dates suggest the diffusion of CW1 through the Karelian Isthmus to Finland from the present-day Republic of Karelia (Timofeev *et al.*, 2004a), where it appears by 5400 cal BC (e.g. German, 2004). There is also a synchronous radiocarbon date, 5550-5060 cal BC (Le-405: 6380±220 BP), tentatively linked to CW1 from the Ust'-Rybežna 1 site on the southern end of Lake Ladoga (Gurina, 1961; Gerasimov and Subetto, 2009). Still, direct evidence for an earlier appearance of ceramics in the Karelian Isthmus, such as crust dates, is missing so far. Conversely, the few hundred years older dates from CW1 contexts at Hepojärvi, Ust'-Rybežna 1 and possibly also at Kurkijoki Kylliäisenlahti W-2 might derive from the "old wood" effect, as these are all made from charcoal of indefinite taxa. It is also possible that the Hepojärvi dates relate to a Mesolithic habitation phase, as suggested by some finds (**Fig. 4**: 18-20) (also Vereščagina, 2003).

Middle Neolithic (4000-3000 cal BC)

^{14}C dates connected to the Typical Combed Ware (CW2) are present from four sites, including four crust dates of pottery (**Fig. 5**). The oldest dates, calibrated to the interval 3960-3650 cal BC, come from two CW2 sherds found at Muolaa Silino site (AAR-7129: 5050±100 BP, Hela-553: 4965±80 BP) (Takala and Sirviö, 2003; Timofeev *et al.* 2004a; **Fig. 4**: 23). Synchronous with these are a third date from Silino, from hearth charcoal (Hela-591: 4965±60 BP) (Takala and Sirviö, 2003), and a crust date from the second cultural layer at Pyhäjärvi Kunnianiemi, 3760-3650 cal BC (Hela-1816: 4930±35 BP; **Fig. 4**: 24). Practically contemporaneous is also a date from Räisälä Peltola C site, made of resin "chewing gum" found from the wall of a CW2 house-pit, 3720-3640 cal BC (Hela-1159: 4905±45 BP; Halinen and Mökkönen, 2009[6]). The last ^{14}C dated CW2 sherd from Johannes Tokarevo 1:1 site gave a dating 3930-3340 cal BC (Ki-10298: 4790±210 BP; Lisicyn, 2003); however, due to the large standard deviation the calibrated age range covers nearly the whole Middle Neolithic period. All these dates are in accordance with

[6] Erroneously reported as burnt bone by Halinen and Mökkönen (2010).

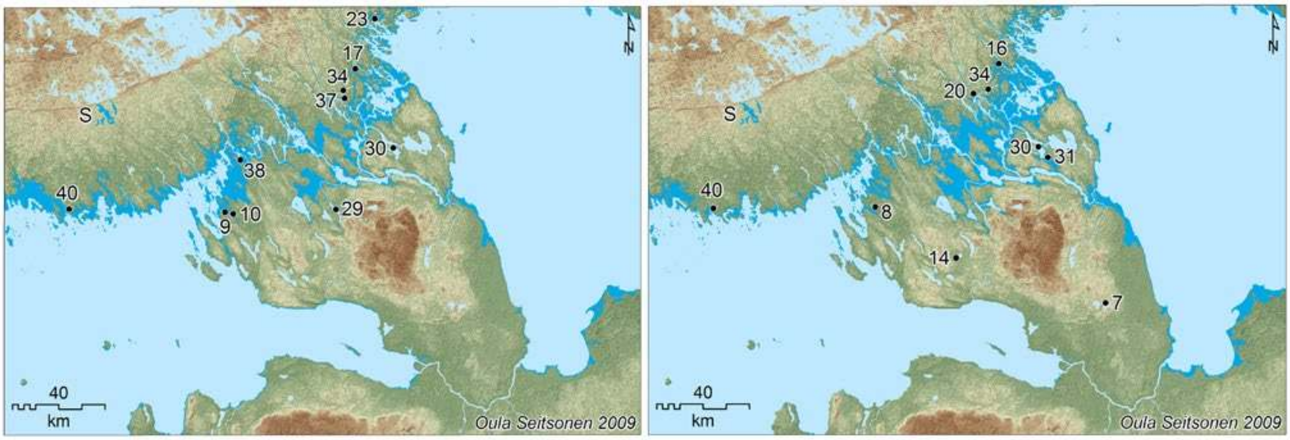

Fig. 5. *Distribution of ^{14}C dated sites; Left: Middle Neolithic sites, darker blue water levels are reconstructed to ca. 4000 cal BC; Right: Late Neolithic sites, water levels reconstructed to the Lake Ladoga transgression maximum period ca. 1350 cal BC (Map: O. Seitsonen).*

the CW2 period in Finland, dated to ca. 3950-3500/3400 cal BC (Pesonen, 2004; Tallavaara *et al*., 2010).

The number of dates connectable to Late Combed Ware (CW3), partly overlapping with CW2, is less clear-cut. Birch bark pitches on sherds of CW3 excavated already in the early 20th century at multi-period sites Kaukola Kyöstälänharju (Pälsi, 1920a) and Viipuri Häyrynmäki (e.g. Huurre, 2003; Seitsonen, 2004) gave dates 3650-3380 cal BC and 3370-3100 cal BC, respectively (Hela-359: 4780±70, Hela-358: 4550±60 BP; Pesonen, 2004). Two more crust dates of CW3 sherds, collected at Virolahti Meskäärtty site, are contemporaneous with the Häyrynmäki sample (Hela-1613: 4535±35, Hela-1615: 4520±40 BP; Mökkönen, 2008). Oldest radiocarbon date from the multi-period site Kurkijoki Kuuppala Kalmistomäki, made of charcoal collected from Stone Age context during excavation of Iron Age burials, belongs to the CW2-CW3 phase as also suggested by the finds (Su-2651: 4620±60 BP) (Saarnisto (ed.), 2003).

It is perhaps notable that apart from Kyöstälänharju date, all other CW3 ^{14}C age determinations are relatively late when compared with the Finnish material, ^{14}C dated to ca. 3750-3200 cal BC (Pesonen, 2004). According to a chronology not strictly based on radiometric dates, CW3 seems to have stayed in use until ca. 2800 cal BC (Carpelan, 1999), and on the grounds of data from Estonia CW3 might have been used even longer (Lang and Kriiska, 2001). This idea might be supported by even younger context dates from the study area connectable to ceramics resembling CW3 (see below).

Asbestos and organic tempers of ceramics become common from the Middle Neolithic on, although they are visible already in the Early Neolithic times, also in the current study area (e.g. Edgren, 1966; Pesonen, 1996). The oldest dating of asbestos-tempered pottery in the Karelian Isthmus comes from multi-period site Johannes Väntsi, studied before World War II (Carpelan *et al.*, 2008), where crust on a sherd of Kierikki Ware gave a result 3770-3530 cal BC (Hela-465: 4870±85 BP; Huurre, 2003). This date is slightly earlier than the dating of Kierikki Ware in Finland, ca. 3650-3100 cal BC (Pesonen, 2004; Tallavaara *et al*., 2010). The only other undisputed ^{14}C dated Kierikki context is at Pyhäjärvi Kunnianniemi, where the birch bark cover of a net sinker from a context with asbestos- and organic-tempered Kierikki-like ceramics was dated to 3330-3020 cal BC (Hela-1554: 4450±35 BP; **Fig. 4**: 27).

Late Neolithic (3000-1800 cal BC)

The earliest dating connected to the Late Neolithic Pöljä tradition in the Karelian Isthmus comes from Muolaa Silino, where charred crust on an asbestos-tempered sherd was dated to 3330-2920 cal BC (AAR-7130: 4430±65 BP) (Timofeev *et al*., 2004a) (**Fig. 5**). Like the Väntsi date for Kierikki, also this is a relatively early age for Pöljä, dated in Finland ca. 3250-2500/1900 cal BC (Pesonen, 2004; Tallavaara *et al*., 2010). More dates come from Pyhäjärvi Kunnianniemi, where crust on another sherd of Pöljä Ware, found on the floor-level of a Late Neolithic house-pit, was dated to 2580-2480 cal BC (Hela-1819: 4030±35 BP), with a synchronous date obtained from a concentration of burnt bones right outside this house-pit (Hela-1844: 3955±35 BP; **Fig. 4**: 28).

Besides the Mesolithic finds, artefacts suggestive of at least Middle and Late Neolithic occupation were unearthed from the house-pit studied *in toto* at Räisälä Juoksemajärvi Westend (Gerasimov and Kul'kova, 2003; Halinen *et al*., 2008). Kierikki/Pöljä period habitation is supported by a few pieces of asbestos-tempered ceramics collected next to the studied dwelling and two ^{14}C dates, 3520-3020 cal BC and 2880-2630 cal BC (Le-6641: 4550±180 BP, Le-6512: 4150±50 BP; Halinen *et al.*, 2008); both dates derive from charcoal collected in the Neolithic cultural layer outside the house-pit. The Late Neolithic-Early Metal Period use of the house-pit is supported by a series of radiocarbon dates (Le-6601:

3740±90 BP, Le-6557: 3700±320 BP, Le-6602: 3660±30 BP, Le-6642: 3450±100 BP, Le-6600: 3370±30 BP). Of these, two dates from its floor level, Le-6600 dating a hearth in the western corner of floor and Le-6602 dating a charcoal concentration next to a hearth in its eastern part, suggest the last use-stage of the house-pit dates most likely between 2130-1620 cal BC; the other dates derive from the cultural layer in- and outside the house-pit (Gerasimov and Kul'kova, 2003; Halinen *et al.*, 2008). Therefore dating the dwelling to the Early Neolithic, as hypothesized earlier by some researchers, seems conjectural (Timofeev *et al.*, 2004a; Mökkönen 2009)[7].

Corded Ware, as such a rather rare occurrence in the Karelian Isthmus, is represented by three dates. The oldest of these, 2870-2620 cal BC (Hela-468: 4130±60 BP; Saarnisto (ed.), 2003), comes from crust on a pottery sherd found at the multi-period dwelling site Kaukola Lavamäki in the early 20th century (Pälsi, 1920a), the second, 2460-2230 cal BC (Hela-663: 3860±45 BP), from hearth charcoal at Johannes Loikas site (Carpelan *et al.*, 2008), and the third, 2350-2150 cal BC (Hela-1614: 3820±45 BP) from crust on a sherd at Virolahti Meskäärtty (Mökkönen, 2008). It is perhaps significant, that the youngest dated sherd bears resemblance to the Late Corded Ware of Estonia (Mökkönen, 2008), where this ceramic tradition might continue until 1800 cal BC (Lang and Kriiska, 2001).

There is a number of Late Neolithic ^{14}C dates connected to organic-tempered ceramics. A date 3090-2920 cal BC (Hela-1821: 4390±35 BP) was obtained from charcoal collected in a pit feature on the wall of a large house-pit connected to organic- and sand-tempered, comb stamp decorated CW3-like pottery at the multi-period site Pyhäjärvi Porsaanmäki 1 (**Fig. 4**: 25-26). Also Hepojärvi site includes CW3-like organic-tempered ceramics, and a hearth and a pit feature from this context were dated to 2860-2570 cal BC and 2840-2460 cal BC, respectively (Le-1410: 4100±60 BP, Le-1408: 4020±70 BP) (Vereščagina, 2003; Timofeev *et al.*, 2004a). One more date apparently connected to a CW3-like context comes from a hearth at Kirvu Harjula site, 2570-2470 cal BC (Hela-1176: 3995±40 BP; Halinen and Mökkönen, 2009). Organic-tempered ceramics dated close to the end of Late Neolithic period were also collected at Kanneljärvi 2 site: two charcoal samples gave results 2470-2340 and 1890-1770 cal BC (Le-2549: 3890±40 BP, Le-2550: 3500±40 BP; Gerasimov *et al.*, 2003: 16; Timofeev *et al.*, 2004a).

Even though the above dates are late for CW3 when compared to the chronology used in Finland, both in Estonia and in the Republic of Karelia the use of Combed Ware has been reported to continue to 2500 cal BC, or even later (Žul'nikov, 2005; Lang, 2006; Kriiska and Tvauri, 2007; also Mökkönen, 2008). However, the question of chronological and typological position(s) of the ceramics dating to the Late Neolithic and Early Metal Period boundary in the Karelian Isthmus remains open (**Fig. 4**: 29-30). The local Late Neolithic ceramics are so far badly studied, and the material is yet too fragmentary for classification(s). At this point it suffices to say, that the postulated similarities with some ceramic types found in Finland, Estonia and North-West Russia, like the asbestos- and organic-tempered ceramics of the Republic of Karelia (e.g. Žul'nikov, 2005) and Volosovo-tradition of the Volga-Oka region (e.g. Krajnov, 1987; Vikkula, 1984), are under investigation by the authors.

Early Metal Period (1800 cal BC-300 cal AD)

The transition from Late Neolithic to Early Metal Period is so far poorly understood: to the transitional period belong the above-mentioned dates from Räisälä Juoksemajärvi Westend and Kanneljärvi 2. The subsequent Textile Ware period is represented by four radiocarbon dates. A crust date from multi-period site Kaukola Kankaanmäki, 1430-1260 cal BC (Hela-467: 3085±70 BP; Lavento, 2001; 2003; also Pälsi, 1920a), belongs to the older part of the tradition, as is customary for the ^{14}C dates of Finnish and Karelian Textile Ware (Lavento, 2001; **Fig. 6**). A charcoal sample from an Early Metal Period context at Kurkijoki Kuuppala Kalmistomäki gave a date of 1380-910 cal BC (Le-4145: 2920±190 BP; Saarnisto (ed.), 2003); however, it has a large standard deviation and might be affected by "old wood" effect. Thus it might belong to the temporal context presented by two more crust dates on Textile Ware sherds from Räisälä Hovi Kalmistomäki, one of the classical sites for the Early Metal Period studies (e.g. Meinander, 1954). These dates, 900-760 cal BC and 800-540 cal BC (Hela-466: 2640±70 BP, Hela-469: 2540±75 BP)[8], represent the later phase of the tradition (so called Kalmistomäki group), and are some of the youngest for Textile Ware (Lavento, 2001; 2003) – the Textile Ware is troublesome to date, but is given frames 1900/1700-500/0 cal BC (Lavento, 2001).

A crust date from a sherd of Luukonsaari Ware, 740-370 cal BC (Hela-8: 2360±70 BP) (Uino, 1997; Lavento, 2003), further evidences the Early Metal Period habitation at Räisälä Hovi Kalmistomäki. Luukonsaari Ware was in use during the 1st millennium BC, and possibly until 500/600 AD (Lavento, 2001). Analogous date was obtained of charcoal from the Early Metal Period cultural

[7] In our opinion the linking of the house-pit with CW1 habitation is based on over-emphasizing the role of one unambiguous and two uncertain CW1 sherds found inside the house-pit, and a CW1 vessel broken *in situ* on a lower terrace. Although the finds connectable to Late Neolithic occupation within the house-pit are also few, we see that the Late Neolithic–Early Metal Period dating is more plausible in the light of stratigraphy and the scrutiny of the contexts of ^{14}C dates, deriving from hearths on the floor level – of course it is possible that the house-pit was used already earlier, but there remains no visible indication of that.

[8] Possibly due to a mix-up caused by similar site names, these dates have been in some accounts (Lavento 2001: 102, Fig. 6.11; Saarnisto (ed.) 2003: 512) connected to Kurkijoki Kuuppala Kalmistomäki site – yet based on the catalogue number (National Museum of Finland; NM 6675), the dated sherds derive from Räisälä Hovi Kalmistomäki, as also reported by Lavento (2003: endnote 166).

layer at Heinjoki Latukangas 1 site (Le-6559: 2400±50 BP) (Timofeev and Gerasimov, 2003; Timofeev *et al.*, 2004a). Charcoal from the uppermost cultural layer of Kurkijoki Lahdenryhmä site was dated to 380-210 cal BC (Le-6930: 2230±30 BP); few tiny ceramic fragments encountered in this context were tentatively interpreted as Late Neolithic, but the context might as well be connected to the Early Metal Period, since only a small test pit has been opened this far (Seitsonen and Gerasimov, 2008). The youngest date evidencing Early Metal Period habitation derives from Pyhäjärvi Kunnianniemi, where charcoal from the uppermost cultural layer was dated to 250-390 AD (Le-8021: 1720±40 BP, Seitsonen *et al.*, 2009; **Fig. 4**: 31).

Finally, four dates from Lavansaari Suurisuonmäki, located in the middle of Gulf of Finland, originate from entirely different context than the other material presented in this paper: dates were obtained from the resin of burial urns and charcoal collected inside stone cairns excavated in 1930. These place the burials between 360 cal BC-510 AD (Ua-2547: 2165±60 BP, Ua-2545: 1975±70 BP, Ua-2546: 1960±70 BP, Su-3297: 1660±50 BP; Edgren, 1992; Lavento 2003).

4. TENTATIVE ^{14}C CHRONOLOGY

The temporal frequency of dates and sites

Of the 94 radiocarbon dates from Stone Age and Early Metal Period sites in the study area, 81 were evaluated as useful for building an archaeological radiocarbon chronology (**Table 3**). In the **Fig. 7** the distribution of dates is presented in two commonly used ways, as a relative probability of radiocarbon dates (summed with the CALPAL program), as well as grouped into a histogram in 500-year intervals by the calibrated median dates. Since there might be more than one date from the same context, causing bias, also the number of ^{14}C dated occupation episodes was counted (Kuzmin and Keates, 2005; Buchanan *et al.* 2008): the dates falling within the same 500 radiocarbon year interval from the same context were combined as single episodes using the R_Combine function of Oxcal program (Shennan and Edinborough, 2007), and plotted both as a relative probability and as a histogram by the median dates. The frequency of occupation episodes noticeably evens out the peaks shown by the frequency of dates. Also a histogram presenting the number of sites connected to each period is shown for comparison (**Fig. 7**).

As the study area still has a relatively meager number of radiometric dates, the whole distribution is subtle to changes with the addition of new dates. At present there is a relatively close match between the frequencies of sites, dates and dated occupation episodes. Whether this presents the current research situation or something else should be approached critically and scrutinized as new data accumulates.

Factors affecting the temporal frequency of dates and sites

Temporal frequency distributions of radiometric dates have been recently used to study various aspects of prehistory, e.g. population dynamics or neolithization (e.g. Kuzmin and Orlova, 2000; Lavento, 2004; Dolukhanov *et al.*, 2002; Derevianko *et al.*, 2004; Tallavaara *et al.*, 2010; Timofeev and Zaitseva, 1991). However, the logic of using simply the rate of radiocarbon dates or the number of sites, for making interpretations of past population developments seems rather one-dimensional. The reasons behind each scientist's decision to date something vary widely, starting from obtaining the funds for radiometric dating to scientists' personal interests (e.g. Oinonen *et al.*, 2010). Therefore the reasoning should always be backed up with other types of data and possible sources of error taken carefully into account (see Surovell *et al.*, 2009).

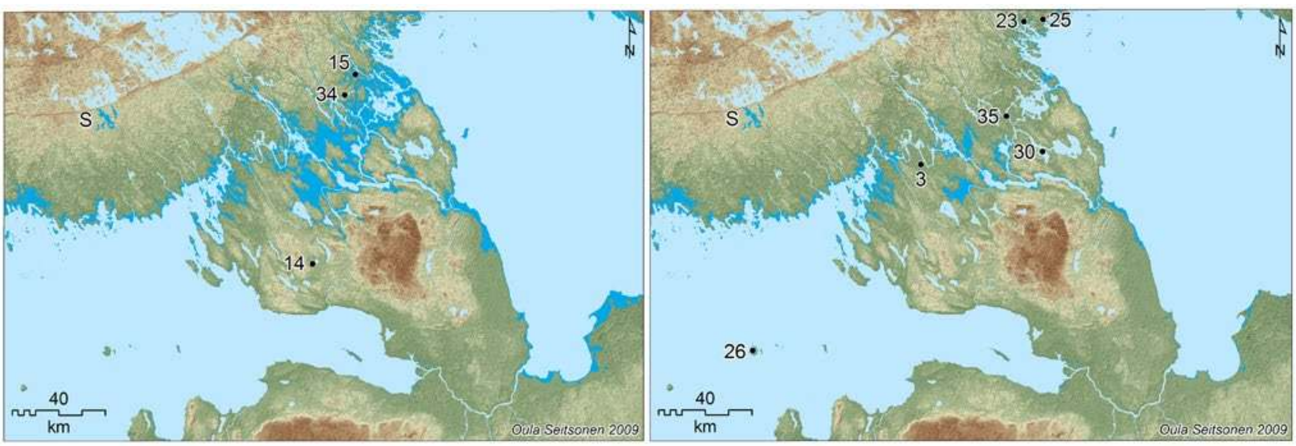

Fig. 6. *Distribution of ^{14}C dated Early Metal Period sites; Left: Sites dating before the Lake Ladoga transgression maximum ca. 1350 cal BC, darker blue water levels are reconstructed to the transgression maximum period. Right: Sites dating after the formation of River Neva about 1350 cal BC, water levels reconstructed to the situation a few hundred years later (Map: O. Seitsonen).*

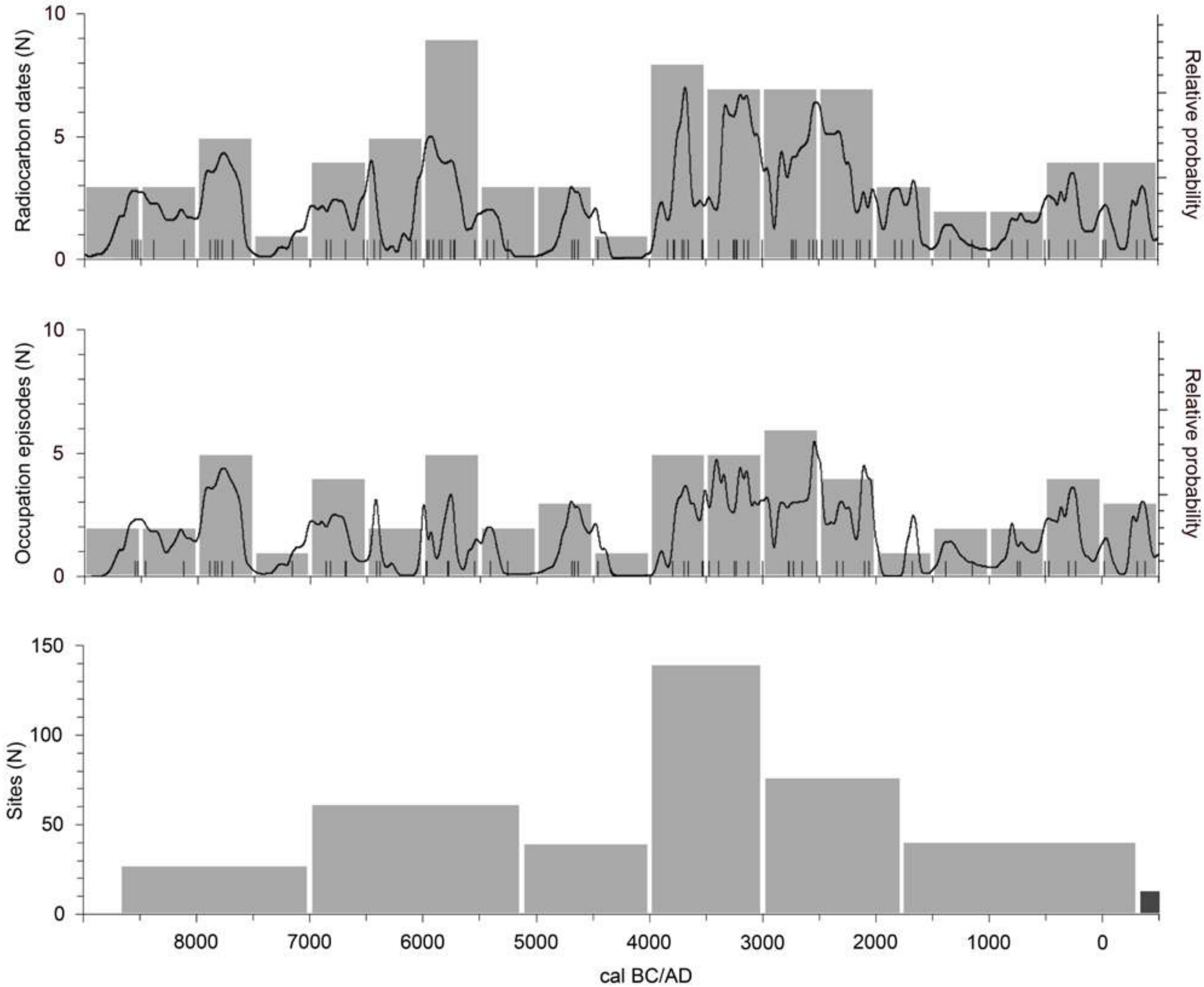

Fig. 7. *Left: Frequencies of ^{14}C-dates (top), and ^{14}C-dated occupation episodes (middle) plotted with the CALPAL as a relative probability (solid line, scale on the right), and presented in a histogram in 500-year intervals (median dates; scale on the left); histogram in the bottom illustrates the number of archaeological sites for each period, start of the Middle Iron Age is shown with darker grey (based on the KarAS database).*

As an obvious example, one could envisage that in our study area the excavation budgets have been saved when apparently recognizable context has been studied, and funds have been targeted for dating e.g. Mesolithic contexts with few typologically datable finds, or the poorly known Late Neolithic period. The former scenario is evident in the high number of Early Mesolithic dates, owing to the research projects targeted for locating the earliest pioneer sites (e.g. Jussila and Matiskainen, 2003; Takala, 2004).

The plain number of sites is neither a very good measure of population dynamics, since different kinds of locations have varying archaeological visibility through time. Therefore the questions related to the distribution and intensity of settlement should be inspected against diverse types of data, instead of the sheer number of sites or radiocarbon dates (see Gallivan, 2002; Surovell *et al.*, 2009). In the study area there are clear indications of heightened archaeological visibility of sites connected to some periods, especially to CW2: sites belonging to this period are typically more find-rich, have more house-pits visible to the surface, cover larger areas, and the ceramics preserve well and are easily recognizable (**Fig. 8**). Differences in the archaeological visibility suggest actual temporal changes in the settlement use and behavior, in the quality and quantity of material culture, and in the use-duration of sites, connected e.g. to sedentariness. These trends have to be closely examined before drawing any conclusions of the site frequencies through time, and will be discussed by the authors more closely elsewhere.

Also the extensive hydrological changes caused by the post-glacial interplay of isostatic rebound of Earth's crust and water level fluctuations affect the visibility of sites during certain periods. Although the dated sites are

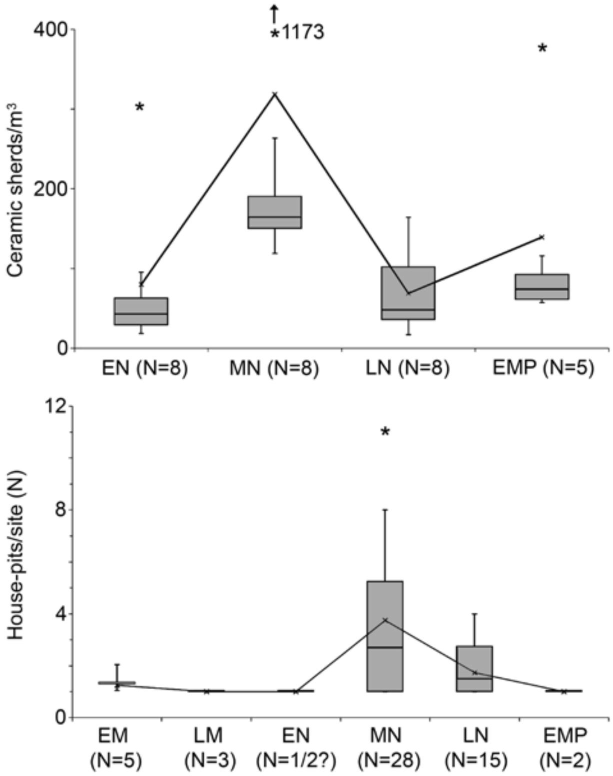

Fig. 8. *Top: Number of ceramics at some recently excavated sites (sherds/m³; outliers present vessels broken in-situ); Bottom: Number of house-pits at house-pit sites (based on the KarAS database; grey box presents the 1st and 2nd quartiles, whiskers the minimum and maximum, stars the outliers, and solid line the mean value).*

generally in accordance with the tilted palaeo-shoreline reconstructions suggested for Lake Ladoga and Gulf of Finland (see Gerasimov and Subetto, 2009; Saarnisto, 2008), new phenomena have started to emerge. As an example, the hydrological history might partly explain the dearth of Early Neolithic dates; Early Neolithic is concurrent with some of the lowest Stone Age water levels within the Lake Ladoga catchment, pre-dating the transgression-causing outbreak of Lake Saimaa waters through the Salpausselkä watershed. All the unambiguous CW1 dates derive from contexts covered by transgressions, and locating more inundated sites is thus a relevant task in the future. Also the Early Metal Period sites predating the formation of River Neva around 1350 cal BC seem to have been submerged by the Lake Ladoga transgression maximum (see **Fig. 6**). Conversely, due to the interplay of waterlevel changes and land uplift, the abundant Middle Neolithic finds are situated on some of the highest Stone Age-Early Metal Period shorelines encountered in the intensively studied northern shore of Lake Ladoga – this picture might be balanced when more data is gathered from the less well studied southern and western parts.

Also in parts of Finland the temporal water level fluctuations and changes in archaeological visibility are probably one reason for the increase in the number of sites and ^{14}C dates during the Middle Neolithic (Siiriäinen, 1981; Tallavaara *et al.*, 2010), as substantial transgressions took place also in the intensively studied and ^{14}C dated Lake Region of Eastern Finland (e.g. Saarnisto 1970). Further, thinking of the overall site distribution in Southern Finland and Karelian Isthmus, it should be kept in mind that the area south of Salpausselkä watershed was dotted in the past by currently dry lakes, shores of which offer excellent but so far little studied targets for archaeological surveys (e.g. Matiskainen and Ruohonen, 2004; Mökkönen and Seitsonen, 2007; Seitsonen, 2010). Also, the settlement patterns seem to become less shoreline connected from the Late Neolithic period onwards (e.g. Nordqvist and Seitsonen 2008; Mökkönen 2008) Thus it seems that modeling for various taphonomic bias (see Surovell *et al.*, 2009) is needed to get a fuller picture of the site and date frequencies.

Multi-period sites

Stone Age and Early Metal Period of the Karelian Isthmus are largely characterized by multi-period sites, i.e. locations recurrently occupied through several millennia (e.g. Pälsi, 1920a; Mökkönen 2009; Seitsonen *et al.*, 2009). This is mirrored in the radiometric dates: over one third of them come from three recently excavated multi-period sites.

At all three sites the dates and find material point to recurrent use from (at least) the Late Mesolithic to the Early Metal Period, if not even longer. The dates from Pyhäjärvi Kunnianniemi (11% of all dates) and Muolaa Silino (10% of all dates) cover evenly the time-span presented by archaeological material (plotted with the CALPAL program; **Fig. 9**). Conversely, the dates from Räisälä Juoksemajärvi Westend (12% of all dates) lean towards the Late Neolithic and Early Metal Period, although also Mesolithic as well as Early and Middle Neolithic material is present. This example shows how the apparently large number of radiocarbon dates can be deceptive, and underlines that the dates must be cross-checked against other data.

Also several other multi-period sites have been radiocarbon dated, although none to the same extent as the above-mentioned sites (e.g. Kaukola Rupunkangas 1, Heinjoki Latukangas 1, Viipuri Ozernoe 3, to name a few). Based on the find materials, these and other sites show similar temporal continuity as the three sites discussed above, ranging from the Late Mesolithic to the Early Metal Period (e.g. Huurre, 2003; Pälsi, 1918; 1920a; Seitsonen, 2004; 2006).

Spatial distribution of the dated sites

The regional distribution of ^{14}C dates is naturally dictated by the concentration of research: over half of the

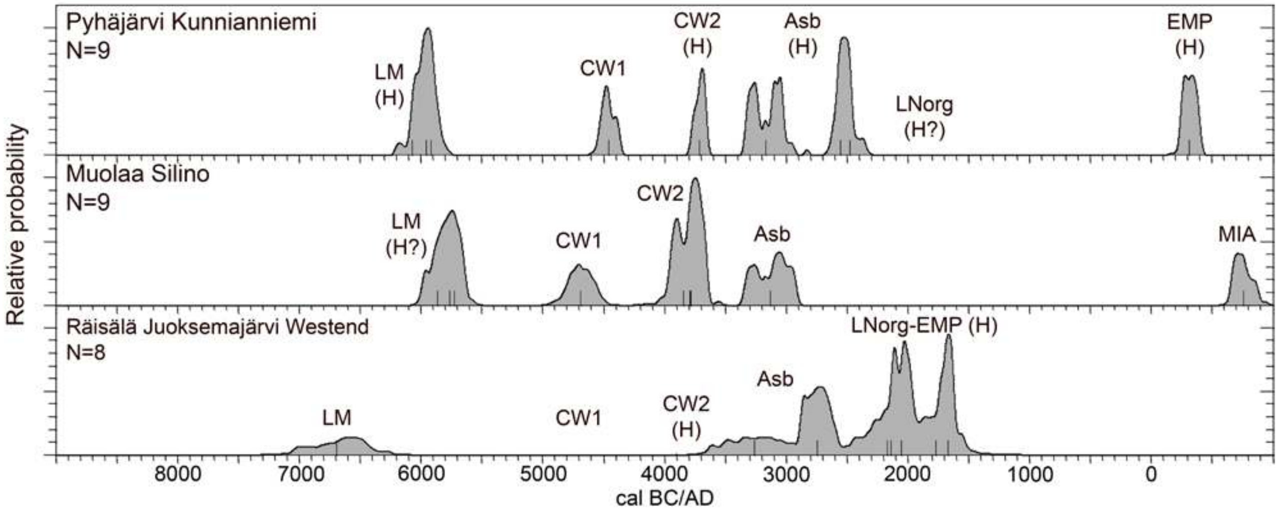

Fig. 9. *^{14}C dates and find contexts from the most comprehensively dated multi-period sites: Pyhäjärvi Kunnianniemi, Muolaa Silino, and Räisälä Juoksemajärvi Westend (plotted with the CALPAL program). Archaeological contexts as evidenced by the find material (from the whole sites, not only excavations): LM=Late Mesolithic, CW1=Early Combed Ware, CW2=Typical Combed Ware, Asb=Kierikki/Pöljä Ware, LNorg=Late Neolithic organic-tempered ceramics, EMP=Early Metal Period; MIA=Middle Iron Age; (H)=house-pit.*

dates come from four municipalities, Räisälä (19%), Pyhäjärvi (13%), Muolaa (10%) and Kaukola (10%), which also account for half of all the archaeological fieldwork conducted in the Karelian Isthmus (KarAS database). This distinction is even more evident when the different parts of the study area are compared: the research-wise neglected southern part exhibits only a few solitary dates and sites (see **Figs. 3**, **5-6**).

The temporal scale of dates is spatially hampered also in other respects. Only few parts of the study area exhibit radiocarbon dates from all the discussed periods, although find material from all these periods is encountered over the whole area. Even within the most studied municipalities the distribution of dates can be biased when mirrored against the excavated materials: as an example, in Kaukola the ^{14}C dates lean heavily towards the Mesolithic, despite the large, find-rich Neolithic multi-period dwelling sites known from the municipality since the early 1900s (Pälsi, 1920a).

Other problems in constructing a ^{14}C chronology

The difficulties in constructing a chronology are obviously greatest for periods with few dates and where the majority of dates are conventional. Conventional dates present certain difficulties, like the "old wood" effect (e.g. Schiffer, 1986; Carpelan, 2004) and correlation of the dated samples with archaeological finds. To avoid these problems the current trend is to move towards dating items of direct human manufacture or modification, such as charred crust on ceramics or burnt bone fragments, with the Accelerator Mass Spectrometry (AMS) method. Accordingly, over 60% of the dates presented in this paper are AMS dates, and nearly 50% of these derive from human modified materials.

Considering the dated materials, almost 50% of the samples are charcoal, while burnt bone and crust on ceramics cover ca. 40% of dated samples. Rest of the dates derive from anomalous materials, such as birch or pine bark, willow cord or resin "chewing gum" (**Table 2**). There are also differences in the dated materials between different periods: bone dates are more common in the Mesolithic contexts than in the Neolithic or Early Metal Period contexts, where charcoal dominates. The differences in the dated materials naturally have an effect in the accuracy: in some cases the "old wood" effect is a potential explanation for the discrepancies between dates and find materials.

Tentative ^{14}C chronology in the Karelian Isthmus

Although the number of radiometric dates from the Karelian Isthmus is still relatively small, we present a tentative ^{14}C chronology for the area (**Fig. 10**). However, as new radiometric dates accumulate, the proposed chronology needs constant re-evaluation and updating.

The role of radiometric dating has been already central for example in establishing the scope and age of the area's (Early) Mesolithic habitation. Also, based on the presented scheme no major decline is evident in the Early Metal Period habitation, contrary to what has been proposed earlier (e.g. Äyräpää, 1935; Lavento 2001; 2003). Currently Early Metal Period seems relatively well represented, albeit poorly studied; this discrepancy might derive e.g. from change towards more mobile settlement patterns, smaller site sizes, and changing material culture, as well as from fluctuating waterlevels. In addition, the divergences observed in the dating of some ceramic types as compared to the nearby areas might be significant.

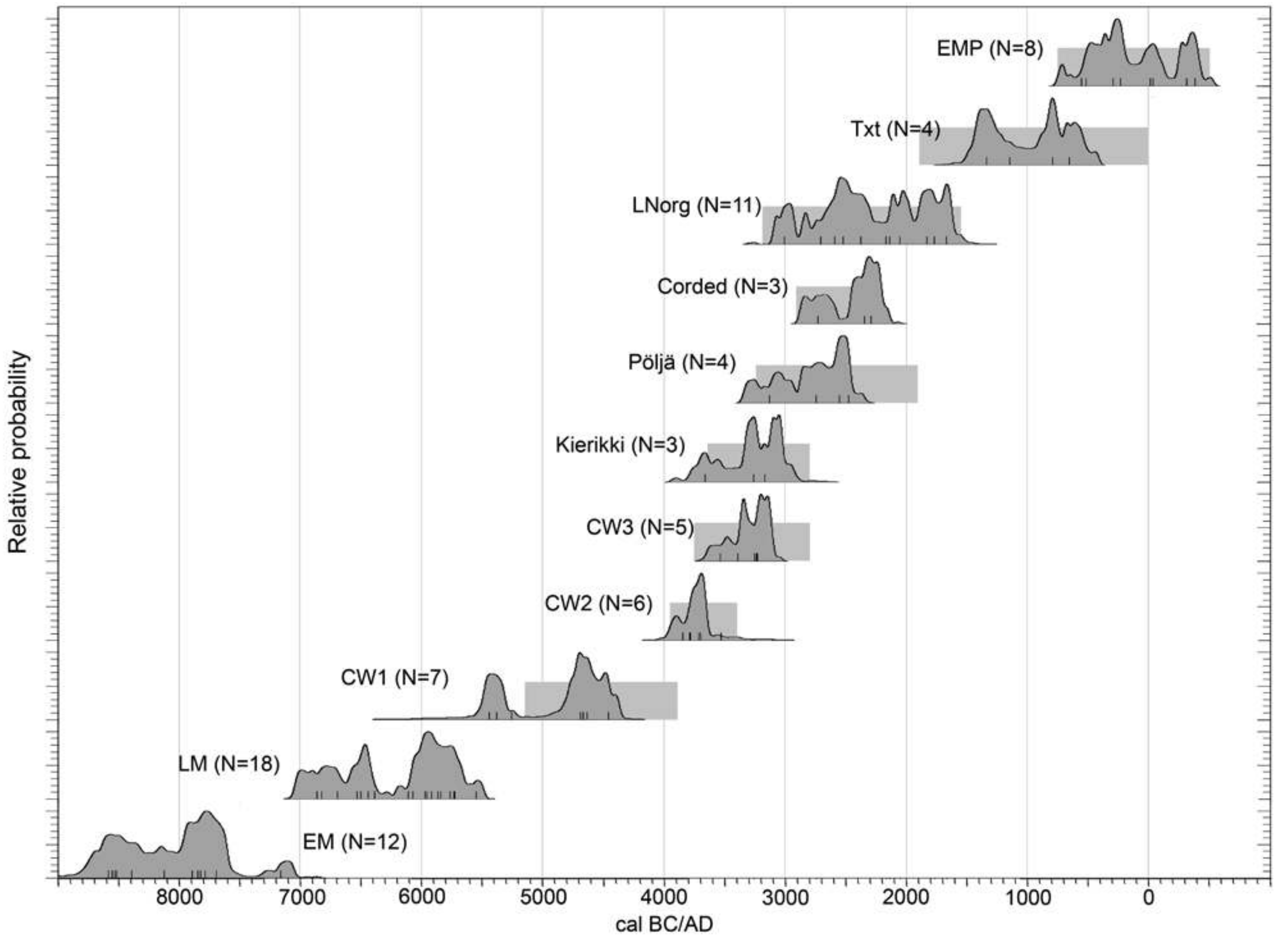

Fig. 10. *Stone Age and Early Metal Period ^{14}C chronology in the study area (plotted with the CALPAL program), and the datings of ceramics in Finland (grey baulks; based on Carpelan 1999; Pesonen 2004; Tallavaara* et al. *2010; Mökkönen 2011); EM=Early Mesolithic, LM=Late Mesolithic, CW1=Early Combed Ware (note: also the tentative early dates are shown), CW2=Typical Combed Ware, CW3=Late Combed Ware, Kierikki=Kierikki ceramics, Pöljä=Pöljä ceramics, Corded=Corded Ware, LNorg=Late Neolithic organic-tempered ceramics (cf. CW3/Pyheensilta/Kiukainen ceramics), Txt=Textile Ware, EMP=later Early Metal Period (note: grey baulk presents the dating of Luukonsaari Ware).*

Even though these observations are currently based on a few dates, they offer guidelines for future research.

In the future an effort should be made to tie the cultural sequences in Finland, the Karelian Isthmus, the Republic of Karelia, and the areas south of Gulf of Finland more comprehensively together, fusing or at least connecting the currently separate typologies and chronologies. In order to build up local as well as inter-regional ceramic chronologies, especially ceramic sherds with charred crust should be dated. Also, considering the future prospects, the traditional use of ceramics as *fossils directeurs* in the Stone Age and Early Metal Period research could be a subject for wider and more methodological discussion. A more holistic approach, combining e.g. the various traits of material culture, the faunal and floral remains, other traces of livelihoods, and the land-use patterns, might provide somewhat differing views of the chronology and cultural developments.

5. CONCLUSIONS

The number of radiocarbon dates currently available from the Karelian Isthmus starts to be sufficient for forming a ^{14}C chronology covering the Stone Age and Early Metal Period. In this study the evaluation of radiocarbon dates into the Good, the Bad, and the Weird categories proved to be worthwhile and the used principles fit for use. These criteria could be used and developed for assessing dates in an analogous, systematic manner also in the nearby areas to facilitate comparisons. Further, as new dates amass from the study area, the evaluation will be carried out to enable adjustments of the chronology.

Dates show that the pioneer settlers arrived to the area soon after the deglaciation. After this the number of dates and sites grows constantly for the rest of the Mesolithic period. Early Neolithic dates are few, probably due to the taphonomic bias caused by the hydrological history, and are followed by an increase in both dates and sites in the

Middle Neolithic. The observable rise in the number of sites and dates in the beginning of Middle Neolithic seems to be exaggerated by the differing archaeological visibility, e.g. by the increases in site size and find frequencies, apparently connected to actual differences in settlement behavior over time, and also by the typologically easily datable ceramic materials. The Late Neolithic period is also well represented, but towards the Early Metal Period the material evidence decreases. This is probably again biased by the hydrological fluctuations and affected by changes in the settlement patterns and material culture; however, the Early Metal Period remains visible in the light of ^{14}C dates.

The chronology formed by the available dates follows roughly the chronology used in Finland, both in the temporal distribution of dates and dating of ceramic types. However, for some ceramic types tentative divergences are discernible, and should be examined more closely in future. This is, besides defining the scope of Mesolithic and Early Metal Period habitations, among the most important observations considering the ^{14}C chronology of the Karelian Isthmus. Especially materials with little or no own age and directly related to the ceramics, such as charred crust, needs to be dated to refine the sequence.

The present ^{14}C database has also severe deficiencies. The so far limited number and skewed spatial coverage, caused by the research situation and taphonomic factors, introduces possible sources of error. Hence the suggested chronology is prone to changes with the addition of new dates. At the same time, this tendency towards alteration provides a key for further development and refinement of the chronology of Stone Age and Early Metal Period in the Karelian Isthmus, and also in the wider area.

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