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NEW ARCHAEOLOGICAL DATA AND PALEOLANDSCAPE RECONSTRUCTIONS OF THE BASIN OF AN EARLY AND MIDDLE HOLOCENE LAKE NEAR KUNDA, NORTH-EASTERN ESTONIA

Abstract

The settlement site of Kunda Lammasmägi and its surroundings have been studied extensively since the 19th century. Nevertheless, a number of questions on the nature of the settlement and its surrounding environment remain unanswered. In this paper, we will present paleolandscape reconstructions based on geology, palynology, micro- and macrofossil analysis and radiocarbon datings published by various researchers. We will also include recent LiDAR data, results of the fieldwork carried out by the authors at Kunda Lammasmägi and along the paleolake shoreline, as well as the results of the analysis of archaeological material accumulated from 1933 to 2016 with an emphasis on lithic finds and pottery. Recent fieldwork, digital elevation modelling and typo-chronological review of the finds have clarified issues, such as the extent of stratigraphical mixing, association between the settlement stages and the paleolake development, and the human activity in other parts of the paleolake depression. Three distinct phases can be observed in the development of environmental conditions of the Kunda depression: 1) until the beginning of the Atlantic pollen assemblage zone, Lammasmägi existed as an island in the southern part of a postglacial lake; 2) during the first half of the Atlantic, the water level dropped, a remnant lake was left in the northern part, and Lammasmägi existed as a seasonal island or higher place in the marsh; 3) by the beginning of the second half of the Atlantic, the remnant lake was partly overgrown and Lammasmägi was surrounded by dry land. The analysis of archaeological material enabled the differentiation of four settlement phases: 1) in the Early Mesolithic I and II; 2) in the Late Mesolithic I; 3) in the Late Mesolithic II; and 4) in the Neolithic until the beginning of the Bronze Age. The first two settlement stages can be associated with the paleolake, while the subsequent two are associated with the present-day Kunda River and other streams.

Keywords: Comb Ware, Estonia, Kunda, Mesolithic, Narva Ware, paleolandscape, settlement sites.

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INTRODUCTION

The Stone Age settlement site of Kunda Lammasmägi is the best-known archaeological site in Estonia. Most European archaeologists have probably heard of the settlement site after which the Mesolithic Kunda Culture was named. Despite a research history spanning more than a century, many questions about the site and its surroundings have yet to be satisfactorily answered. It has become evident that the archaeological record formed over a long period and that

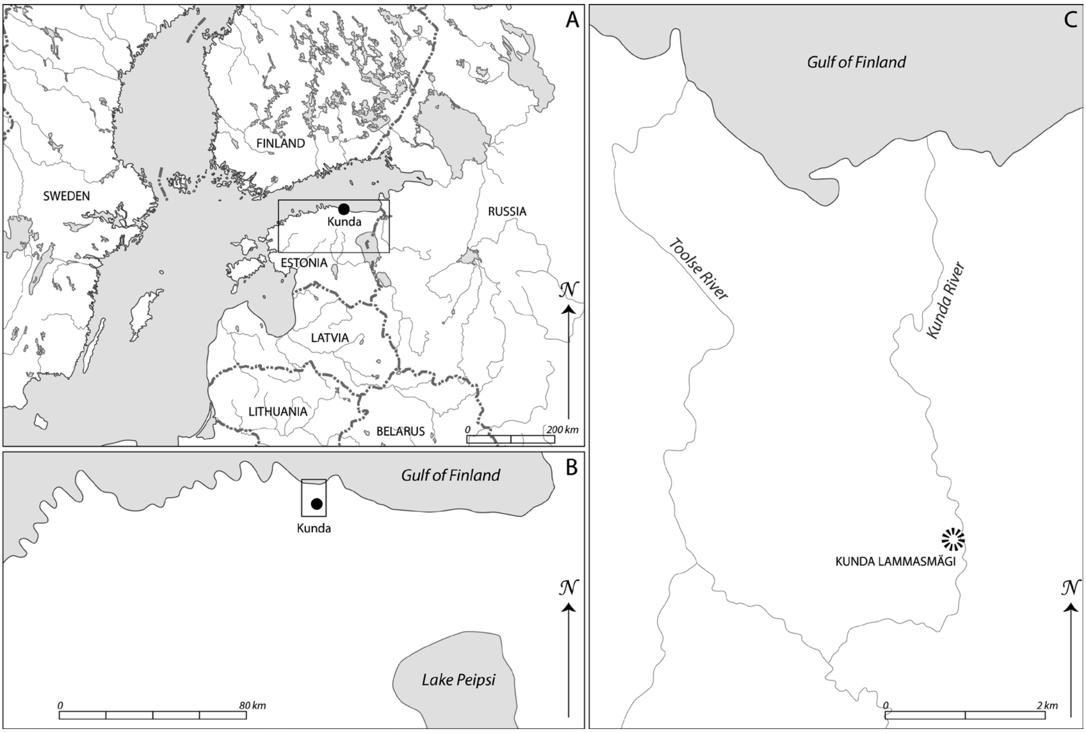

Fig. 1. Location of Kunda archaeological sites in the Baltic Sea region (A) and in northern Estonia (B–C). Illustration: A. Kriiska & K. Roog.

the finds cannot be used as a reference material to date other sites. Quite the opposite, the material itself requires comparative typo-chronological analysis.

Kunda Lammasmägi is a small hillock situated at c 3 km from the town of Kunda in north-eastern Estonia (Figs. 1 & 2). The immediate surroundings of the hillock form a rather flat depression, which, together with the hillock, has been used as fields or pastures for centuries; some of the surroundings were already subjected to various land improvement and drainage projects in the 19th century. In addition, the mining of lake marl started in the northern part of the depression in the 1870s (Orviku 1948) and turf mining industry in the Kunda Mire in 1882 (Trumm & Rozental 2012). Various parts of the depression and its slopes have been used to mine gravel and sand. However, most of the surface has been disturbed only by traditional agricultural use.

The surroundings of Kunda are one of the few parts of Estonia that have been subjected to intensive geoarchaeological research and paleogeographic reconstructions (e.g. Grewingk 1882; 1884; Thomson 1928; Indreko 1936; 1948; Orviku 1948; Karukäpp et al. 1996; Moora & Moora 1996; Moora et al. 1996; Moora 1998; Sander & Kriiska 2015). Since the soil conditions are favourable for bone and antler preservation, the area has yielded valuable material for zooarchaeological research (Grewingk 1882: 29–34; Paaver 1965: 352–5; Lõugas 1996).

Kunda Lammasmägi itself is among the most extensively studied Stone Age sites in Estonia (Fig. 2), and as mentioned above, the Kunda culture was named after it. The spread of this Mesolithic technocomplex has been defined in various ways. Some interpretations limit it to the Eastern Baltics and Finland (L. Jaanits et al. 1982: 34; Kriiska & Tvauri 2007: 20) while others have even extended it to the Ural Mountains in Russia (Indreko 1948: 373–409; 1954: 140; 1964: 39; Kozłowski & Kozłowski 1975: Map 16). First excavated as early as 1886 by Constantin Caspar

Fig. 2. The excavations of Kunda Lammasmägi. Illustration: K. Sander; base map by the Estonian Land Board.

Andreas Grewingk, the founder of Estonian scientific archaeology, the site has been excavated a number of times (Kriiska 2006: 54). From 1933 to 1937, Richard Indreko conducted investigations at a considerably larger scale than Grewingk. During these years, over 500 square metres were excavated (Indreko 1936; 1948). In 1949 and 1961, the site was excavated by Lembit Jaanits (1965), and in 1981 by Tanel Moora and Kaarel Jaanits (K. Jaanits 1989; Moora 1998). In 1992, a part of the 1981 excavation was reopened to gather samples for radiocarbon dating and other analyses (Åkerlund et al. 1996). While most of these studies focused on Lammasmägi, four other settlement sites were discovered on the shore of the ancient lake in 1978 and in the early 2000s.

In spite of the impressive scale of the earlier excavations, several problems persisted until the fieldwork carried out by the authors of this article: 1) the scale of stratigraphic mixing remained unclear; 2) the finds from the previous excavations were collected and registered selectively; 3) the finds were mostly interpreted as a single complex; and 4) there was only a small number of known settlement sites in the surrounding landscape and previous systematic efforts to locate them had been largely unsuccessful (L. Jaanits 1991: 29). Initiating a new stage of the investigations, small test excavations were carried out at Lammasmägi from 2013 to 2016, complemented by a surface survey (Sander & Kriiska 2015).

As shown above, the discussion regarding the paleoenvironmental conditions of the area has continued for more than 130 years. However, all earlier studies were published before LiDAR data and post-glacial rebound tilting gradients became available. The aim of this article is to provide LiDAR-based paleoreconstructions of Early and Middle Holocene Lake Kunda, enhanced by the latest results based on the test excavations, landscape surveys and a thorough review of the previous findings.

System	Period	Sub-period	Stage / type of ceramics
Sub-epoch of the Holocene (Walker et al. 2012)	Early Holocene 9700–6200		
	Middle Holocene 6200–2200		
	Late H. From 2200		
Pollen assemblage zone (PAZ) (Raukas et al. 1995)	Preboreal (PB) 9700–8200		
	Boreal (BO) 8200–6900	BO1 8200–7600	
		BO2 7600–6900	
	Atlantic (AT) 6900–3700	Early AT (AT1) 6900–5400	
		Late AT (AT2) 5400–3700	
	Subboreal (SB) 3700–600		
Stone Age period / type of ceramics (Kriiska et al. 2017a)	Early Mesolithic 9000–7000	E.M. I	Pulli stage 9000–8500
		Early Mesolithic II	Kunda stage 8500–7000
	Late Mesolithic 7000–3900	Late Mesolithic I	Sindi-Lodja stage 7000–5200
		Late Mesolithic II	Narva stage, Narva Ware 5200–3900
	Neolithic 3900–1800	Comb Ware 3900–1800	Corded Ware 2800–2000

Year calBC 10000 9000 8000 7000 6000 5000 4000 3000 2000

Table 1. Periodization systems used in this paper. Illustration: K. Sander.

MATERIALS AND METHODS

The paleolandscape reconstructions in the present study were made possible due to the availability of LiDAR measurements made by the Estonian Land Board (Maa-amet 2012–17). The Estonian Soil Map, which was also used, is maintained by the same agency (Maa-amet 2009).

Starting with William Thomson (1928), a number of test pits or excavations have been made in various parts of the ancient lake, which have provided data based on geology, palynology, micro- and macrofossil analysis, radiocarbon dating and other means (for more about the extensive body of literature related to the geological history of the surroundings of Lammasmägi, see Moora 1998 and references therein). For the sake of clarity and compatibility with earlier research, the earlier system of pollen assemblage zones (PAZ) (Raukas et al. 1995) has been used throughout the current work, based on which the lake existed during the Preboreal (PB), Boreal (BO) and Atlantic (AT) PAZ. The periodization systems used are summarised in Table 1. The stratigraphical data obtained from 14 excavations and test pits (Fig. 3; Tables 2 & 3) is presented with an emphasis on the development of the ancient lake in the Early Holocene as defined by Walker et al. (2012).

Today, the Arusoo raised bog (Fig. 3) covers the western part of the former lake. A 30-cm layer of gyttja, which accumulated on lake marl during the first half of the BO1 PAZ, rests under a 3.35 m peat layer (Orviku 1948: 30; Karukäpp et al. 1996: 225). Therefore, the subtraction of the peat layer from the LiDAR-based digital elevation model (DEM) results in a DEM for the end of the BO1 PAZ. Reconstructions for different dates can be obtained by correcting the amount to subtract with the relevant sediment elevations in test pits, thus combining the peat thickness mapped by the Estonian Land Board with the stratigraphy of coring sites. The geoinformatical aspects of using the peat layer data of the Estonian Soil Map will be discussed in detail in an upcoming article.

Before subtracting the peat layer, artefacts such as large buildings, motorways and ditches were removed by elevation filtering, or manually using CloudCompare v2 software. Large portions of the map were excluded from the reconstruction as the original landscape has been destroyed by mining, the buildings and factories in the town of Kunda and other modern activities.

The resulting point cloud was interpolated using the Whitebox GAT 3.2 Nearest Neighbour method.

Since the area under investigation is small, the dispersion of the results of the various models of post-glacial rebound exceeds the maximum tilting effect (Steffen, pers. comm.). Therefore, the absolute elevations presented in the reconstructions were not corrected by taking post-glacial rebound into account. Instead, the present elevations were used, corrected with appropriate summary tilting (Saarse et al. 2007; Rosentau et al. 2011: 181).

No (in Fig. 3)	Test pit or excavation (name given in publication if specified; investigator and year of fieldwork if available)	Present elevation	Elevation of sediments associated with pollen assemblage zone (PAZ) lower boundary, approximate datings of PAZ boundaries				Elevation of the latest lake sediments; corresponding PAZ and/or the latest 14C dating
			PB 9700–8200	BO1 8200–7600	BO2 7600–6900	AT 6900–3700	
1	Langei farm; T. Moora 1980–81	42.50	-	41.85	-	-	41.90[1]; before 4729-4499[2]
2	Arusoo bog 1; T. Moora 1980–81	49.80	47.30	47.68	-	48.43	47.80[1]; end of BO1[3]
3	Arusoo bog 2; T. Moora 1980–81	51.13	46.85	47.33	47.63	47.81	47.78[1]; end of BO1
4	Arusoo bog 3; T. Moora 1980–81	50.40	-	-	-	-	47.70
5	Arusoo bog; A. Poska	50.50? (50.00–51.00)	46.81	47.20	47.60	48.20	-
6	West of Lammasmägi; L. Jaanits 1955[4]	46.75? (46.40–47.00)	45.65	46.05	-	46.55	-
7	R. Pirrus 1976	48.00	46.75	46.30	47.70	-	47.75[1]; BO1/BO2 transition
8	Thomson's pit A; P.W. Thomson 1927	47.90? (47.80–48.10)	-	47.35	-	47.65	47.65[1]; BO2/AT transition
9	Profile K–S; T. Moora 1980	50.20	48.65[5]	48.80	-	49.30	48.72; end of PB; 8695-8349[6]
10	Lammasmägi sq. 237; T. Moora & K. Jaanits 1981	46.80	-	-	-	45.40[7]	-
11	Lammasmägi Lm1; T. Moora & K. Jaanits 1981	46.75? (46.40–46.75)	-	-	-	-	46.25[1]
12	Lammasmägi site 1981 B; K. Jaanits, V. Sevelyov & A. Åkerlund 1992	48.50	-	-	-	-	47.70[8]; AT1; 7179–6693 (see Table 4: 7)
13	K. Orviku	47.00? (46.50–47.00)	-	-	-	-	46.30[1]
14	R. Indreko 1933	44.00? (43.70–44.00)	42.65	42.80	43.15	43.40	43.60?[1]; AT1/AT2 transition

Table 2. Elevations of sediments associated with climate stage transitions in test pits or excavations; all elevations m a.s.l., datings calBC. Datings in this table and throughout the paper are calibrated by OxCal v4.3 (Bronk Ramsey 2018); r5; IntCal13 atmospheric curve (Reimer et al. 2013). Notes: [I] gyttja, depth approximate; [II] 5780±50 BP (Tln-989; Karukäpp et al. 1996: 226; Moora 1998: 70, 77), at the depth of c 50 cm; [III] dating 9180±300 BP (Tln-500, 9232–7647 calBC; Karukäpp et al. 1996: 226; Moora 1998: 70) covers most of the PB and BO1, being of little use; [IV] location and date of fieldwork previously unpublished: c 10 metres west of Lammasmägi, May 1955 (L. Jaanits n.d.); [V] later sediments are those of a slope wetland; [VI] 9295±40 BP (Tln-937, tree trunk in sand; Moora 1998: 68); [VII] riverbed/oxbow sediments, lower than the surrounding plane; [VIII] lake plant macrofossils.

No (in Fig. 3)	Test pit or excavation (name in publication if specified, investigator, year of fieldwork if available)	PAZ	Elevation of sediments	Land uplift (m)	Approx. past min. water level at Lammasmägi	Accumulation of organics on the lake bottom (m)	Approx. past min. water depth at Lammasmägi (m)
9	Profile K–S; T. Moora 1980	End of PB	48.72	-0.30	48.50	0.90	2.80
2	Arusoo bog 1; T. Moora 1980–81	End of BO1	47.80	-0.29	47.60	0.30	1.20
3	Arusoo bog 2; T. Moora 1980–81	End of BO1	47.78	-0.39	47.50	0.30	1.20
7	R. Pirrus 1976	BO1/BO2 transition	47.75	-0.30	47.55	0.30	1.25
8	Thomson's pit A; P.W. Thomson 1927	BO2/AT transition	47.65	-0.27	47.50	0.25	1.10
12	Lammasmägi B; A. Åkerlund 1992	Beginning of AT	47.70	0.00	47.70	0.25	1.35
14	R. Indreko 1933	AT1/AT2 transition	43.60	-0.17	43.50	0.20	-2.90

Table 3. Uppermost lake sediments by the pollen assemblage zones (PAZ) and the respective lake depths at Lammasmägi (m a.s.l.).

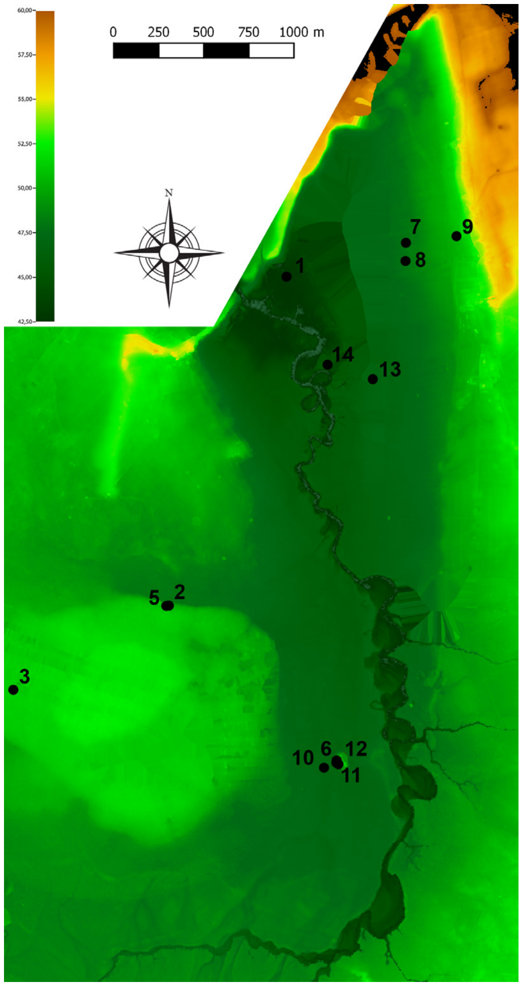

Fig. 3. Locations of coring sites used for landscape reconstruction on the present-day digital elevation model provided by the Estonian Land Board. Coring site 4 is not shown, as its precise location is not known. Illustration: K. Sander.

The archaeological material discussed in the article was collected by Richard Indreko (1933–38), Lembit Jaanits (1949, 1961), Tanel Moora and Kaarel Jaanits (1981), Kaarel Jaanits and Agneta Åkerlund (1992), and the authors of this article (2013–16). Some of the material is published here for the first time. Differences in the excavation methodology are discussed in detail by Sander (2014). Typo-chronology of the material is compared to that of settlement sites situated in Estonia and the neighbouring countries.

No	Layer (excavations, layer name; corresponding layer in 2014, see Fig. 7)	Lab-index	BP	±	calBC (2σ)	δ^{13}C (‰)	Material	Reference
1	1992: silt, dark humic (2); 2014: layer 2	Ua-3004	3805	130	2619–1887	-21.00	Animal bone	Åkerlund et al. 1996
2	1961: mixed upper layer; 2014: layer 1	TA-12	6015	210	5463–4458	-	Elk bone	Liiva et al. 1965
3	1992: silt, stratifed (3); 2014: layer 3	Ua-3001	8485	90	7713–7331	-21.60	Elk bone	Åkerlund et al. 1996
4	1992: silt, stratifed (3); 2014: layer 3	Ua-3002	8515	100	7792–7324	-20.74	Elk bone	Åkerlund et al. 1996
5	1992: silt, stratifed (3); 2014: layer 3	Ua-3003	9085	100	8568–7968	-20.77	Elk bone	Åkerlund et al. 1996
6	1992: silt, sandy, humic (4); 2014: layer 4	Ua-3053	3555	55	2036–1703	-26.62	White-tailed eagle bone	Åkerlund et al. 1996
7	1992, silt, sandy, humic (4); 2014: layer 4	Ua-3052	8040	75	7179–6693	-21.89	Elk bone	Åkerlund et al. 1996
8	1992, silt, sandy, humic (4); 2014: layer 4	Ua-3000	8260	90	7501–7075	-22.26	Elk bone	Åkerlund et al. 1996
9	1961: undisturbed Mesolithic layer; 2014: layer 4	TA-14	8340	280	8196–6646	-	Charcoal	Liiva et al. 1965
10	1992: silt, sandy, humic (4); 2014: layer 4	Ua-3005	9330	120	9120–8288	-20.77	Elk bone	Åkerlund et al. 1996
11	2013: surface of the natural moraine; 2014: layer 5	Poz-64419	3425	35	1876–1633	-	Elk bone	Sander & Kriiska 2015
12	Unclear	KIA-35735	7385	35	6381–6106	-	Wild horse bone	Sommer et al. 2011

Table 4. Radiocarbon datings of the Kunda Lammasmägi Stone Age settlement site.

All the available conventional radiocarbon and AMS datings are presented for the Kunda Lammasmägi site (Table 4). Organic material datable by the radiocarbon method has yet to be obtained from the other nearby sites.

THE ENVIRONMENTAL CONDITIONS OF THE SURROUNDINGS OF LAMMASMÄGI

The environmental conditions around Kunda Lammasmägi changed from a paleolake to a dry land cut by streams and the canyon of the Kunda River over thousands of years. This can be observed in the palynological data obtained from the test pits and excavations. For each test pit or excavation, the absolute altitudes from the current sea level corresponding to the PAZ boundaries based on palynological data are mapped against the latest (uppermost) occurrences of the lake sediments. If available, the radiocarbon dating is presented (Table 2).

It has been suggested by Karukäpp et al. (1996: 227) that the PB PAZ water level between 47.5 and 49.5 m a.s.l. dropped at the beginning of the BO PAZ and thereafter the area of the Arusoo bog became a separate lake, with Lammasmägi existing only seasonally as an island surrounded by wetland in the later part of the BO PAZ. Moora (1998: 41, 44) proposes that the average water level during the PB PAZ might have been around 48 m a.s.l., and that it dropped by about 1.5 metres at the beginning of the BO PAZ.

This is incompatible with the uppermost traces of gyttja in several excavations and test pits, and with the results of relevant pollen analysis. The highest altitudes of the lake sediments at the different climate stages are shown in Table 3.

The approximate water depth at Lammasmägi can be calculated as follows:

$$d = e + t + w + p - L$$

wherein *e* denotes the current elevation of lacustrine sediments above sea level in the test pit or excavation; *t* is the summary land uplift of the test pit or excavation relative to that of Lammasmägi from the respective PAZ; *w* is the assumed minimal water depth of sediments; *p* is the summary accumulation of organics on the paleolake bottom near Lammasmägi by Lissitsyna

(1958); and *L* is the current average elevation of the plain around Lammasmägi (46.60 m a.s.l.). Conservatively, the minimum water depth (*w*) is estimated to be at least 10 cm higher than the accumulation zone of gyttja or *Equisetum* rhizome macrofossils, in the case of the 'profile K–S' described by Moora (1998: 124).

It must be stressed that the water levels and depths thus obtained are the minimum values. For instance, since *Equisetum fluviatile* can grow at a depth of 50 cm or more (Peng et al. 2009), the water level at Lammasmägi corresponding to the PB PAZ sediments in test excavation 9 might have been close to 49 m a.s.l. However, the elevation of the lower parts of the Hiiemägi ridge (about 50 m a.s.l.) which acts as a natural dam (Karukäpp et al. 1996: 227; Moora & Moora 1996: 236–40 and references therein; Moora 1998: 104–10) constitutes an obvious limit. During the 2014 excavation, a feature resembling a miniature coastal landform, which probably indicates the PB PAZ waterfront, was documented by the authors of this article at 48.15–48.55 m a.s.l.

Combining the data of several test pits reveals a remarkably stable water depth at around 1.30 metres at Lammasmägi during the BO2 and at the beginning of the AT1 PAZ, and the marginal fluctuations are due to measurement errors (Fig. 4; Table 3). Two major drops in the water level are evident: about 1 m during the BO1 PAZ and more than 3 m by the transition to the AT2 PAZ (Figs. 5 & 6; Table 3).

The entire process of drainage seems to have occurred later than proposed in the works cited above, and more gradually than Orviku's estimates (1948). The likeliest cause was the bottom erosion of a natural outlet through the Hiiemäe ridge. Today, the ridge is cut by the deep canyon of the Kunda River at a considerably greater depth than the ancient lake bottom. Near the top of the ridge, large quantities of moraine have eroded off thereby destroying all traces of possible Early Holocene streams.

The general process and speed of drainage is well in line with the findings by Saarse (1990: 213) regarding 'lakes dammed by glacial deposits formed in river valleys' in northern Estonia. The nearby Lake Pehka dried up even later (Moora 1998: 114). The possible role of a violent local geological event (Nikonov & Miidel

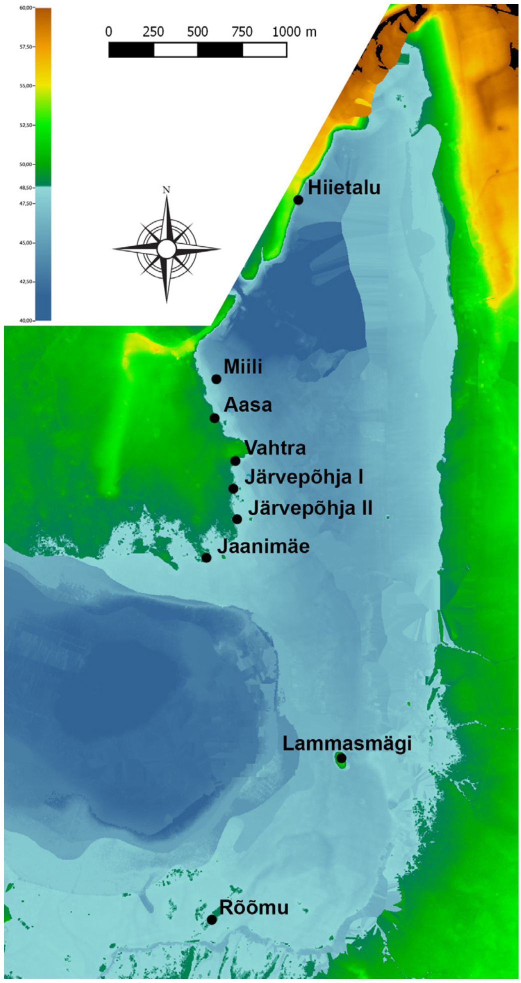

Fig. 4. Digital elevation model of the paleolake at the beginning of the BO PAZ. Black dots denote settlement sites. Illustration: K. Sander.

2003 propose an earthquake) still remains unclear.

The timing of the final drainage of the lake has yet to be determined. In the excavation of the deepest part of the ancient lake bed by Indreko in 1933, the peat appeared at approximately 43.60 m a.s.l. (dated to the AT1/AT2 PAZ transition by palynological data). By then, the surroundings of Lammasmägi were already almost three metres above the water level of the disappearing lake remnant.

Moora et al. (1996) published a thorough analysis of the palynological data and mollusc

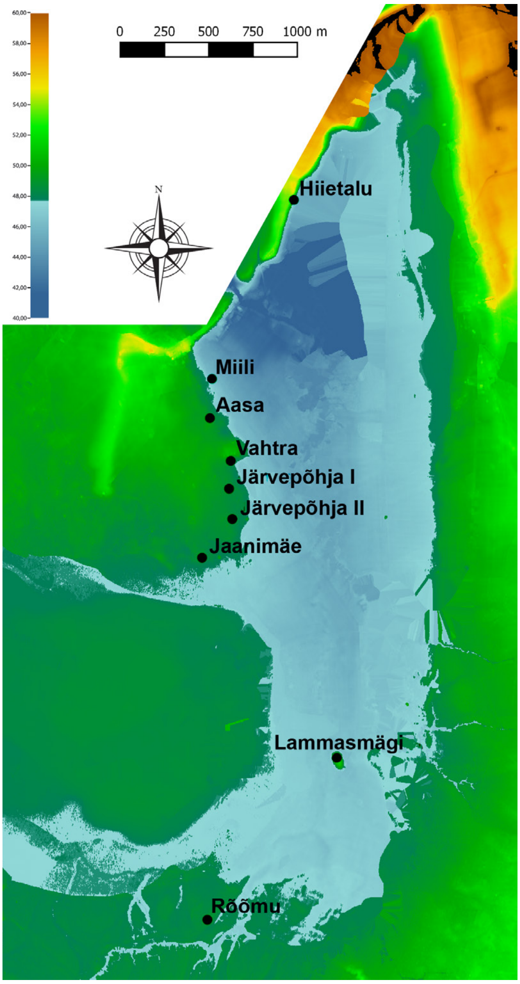

Fig. 5. Digital elevation model of the paleolake at the beginning of the AT PAZ. Black dots denote settlement sites. Illustration: K. Sander.

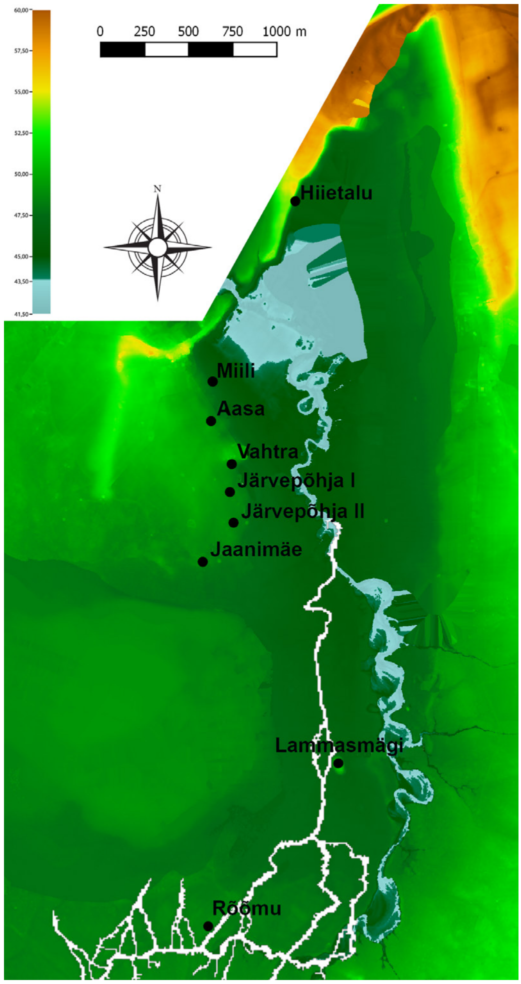

Fig. 6. Digital elevation model of the paleolake in the middle of the AT PAZ. Black dots denote settlement sites, smaller streams marked with white. Illustration: K. Sander.

shells from an excavation located some 68 metres west of the hillock (excavated in 1981, square 237) and demonstrated how the riverbed sediments are replaced by oxbow sediments. While the formation of oxbow must certainly have happened after the surroundings dried up, it is not possible to date the process more precisely than the AT1 PAZ.

Moora et al. (1996) also present radiocarbon dating for the riverbed sediments, and assume that it corresponds to the lotic phase of the body of water. This dating (7950±60 BP; Tln-552) is problematic for several reasons. Firstly, it is practically identical to the radiocarbon dating obtained from Lammasmägi (Table 4: 7; Åkerlund et al. 1996), about which there is little doubt that the sampled layer formed in the coastal zone of a lake (see below). Secondly, it is difficult to prove that any organic matter obtained from the bottom of a body of running water was originally deposited in the same place. Thirdly, there is an apparent confusion about the dated matter. Karukäpp et al. (1996: 226) mention 'wood in fluvial sands', while Moora (1998: 70) writes about a 5-cm thick piece of turf, and confirms that the piece of wood was not dated.

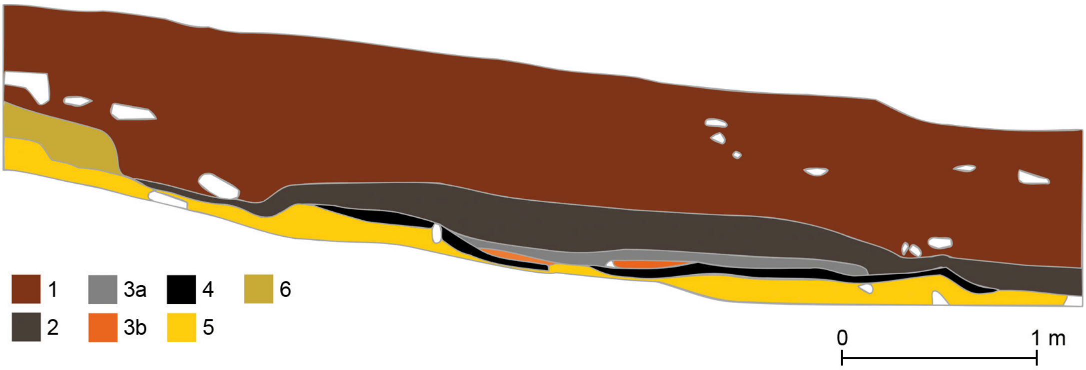

Fig. 7. Stratigraphy of the test excavation of 2014; 1) dark brown humic layer (stratigraphic unit 1), 2) humic layer rich in charcoal (unit 2), 3a) grey layer of sandy silt (unit 3), 3b) sandy patches (unit 3), 4) black layer of sandy silt rich in charcoal (unit 4), 5) natural sand, 6) sandy humic layer. Numeration of layers 1–4 corresponds to that of Trench B described by Åkerlund et al. (1996: 259). Drawing: K. Sander.

Summing up the previous multidisciplinary studies, three distinct phases of the development of the environmental conditions in the Kunda depression can be observed. During the PB and BO PAZ, a paleolake with a rather stable water level existed, at least until the beginning of the AT PAZ. Lammasmägi was an island in the shallow southern part of the lake. The present-day elevation of the Lammasmägi hillock is 51 m a.s.l. or slightly more. The hillock has been subjected to slope erosion by natural processes and human activity (the upper parts of the cultural layer have been thoroughly mixed; see Sander & Kriiska 2015 and references therein). Therefore, during the PB and BO PAZ, the island must have been somewhat higher (for the same reason, the resemblance of the present-day surface features of the hillock to coastal formations should be viewed with caution). If the water flow through the ancient Lake Kunda was comparable to the present-day flow via the Kunda River, the seasonal water level change might have been comparable to that of present-day Lake Vagula in south-eastern Estonia (1–2 m), which is of roughly similar size and depth (Varep 1968: 383). Under the drier conditions of the BO PAZ it was most probably less. Even at the theoretical highest water level of 49.50 m, a large part of the islet would still have been dry, and was most probably usable year-round.

During the first half of the AT PAZ, the water level dropped, and a remnant lake was left in the northern part of the basin. The southern part of the lake turned into a wetland and the Arusoo raised bog formed in the western part. Thereafter, Lammasmägi existed as a seasonal island or a higher place in the marsh.

By the beginning of the AT2 PAZ, the remnant lake was partly overgrown and Lammasmägi was surrounded by dry land. During the process, a stream had formed some 70 metres west of the Lammasmägi hillock, which provided fresh water. There is little doubt that all these changes were reflected in the people's use of the landscape.

THE LAMMASMÄGI SITE

Stratigraphic overview

Although a large number of archaeological finds has been registered throughout the islet, a zone of abundant archaeological material (worked and unworked bone and antler, lithic artefacts, some bits of amber and wood) has been observed on the slopes of the hillock at an elevation of 47–48 m a.s.l. In this rather narrow (about 3–6 m wide) zone, the cultural layer has been documented as consisting of four stratigraphic units in all the excavations. The lowest of these (unit 4; Fig. 7) is probably the undisturbed Mesolithic cultural layer (Indreko 1948: 46; L. Jaanits et al. 1982: 37; Åkerlund et al. 1996: 259; Sander & Kriiska 2015; for more details, see Sander 2014 and references therein), deposited over a relatively long time. A bird bone obtained from this layer in 1992 was dated to approximately 1900 calBC (median value; Table 4: 6), leaving open the possibility of later disturbance. However, it is probable that this sample was contaminated (Åkerlund et al. 1996: 265–6 discuss the low $\delta^{13}C$ value, carbon content and physical properties of collagen different from other samples) and that the deepest cultural layer formed *in situ*.

The earliest cultural layer is covered with a layer of the same geological properties, but much lower find density and less charcoal (stratigraphic unit 3). The content of phosphates, lipids, proteins and organic matter in general is also much lower (Åkerlund et al. 1996: 260, 263–4; on find density, see Sander 2014 and references therein). In other words, both units 4 and 3 were probably formed by the extensive natural erosion of silt particles from the higher parts of the hillock. However, unit 3 almost completely lacks finds and organics associated with human activity. The simplest explanation for this is a break in the use of the site.

Above unit 3, two more stratigraphic units have been described (Fig. 7: 1–2). These two upper layers appear to be extensively mixed, containing Neolithic ceramic sherds or amber and flint finds next to typical Mesolithic artefacts (see below).

In addition to the Early Mesolithic (the PB and BO PAZ) and the Neolithic (the end of the AT PAZ and SB PAZ) discussed by earlier authors, a typo-chronological analysis of the archaeological material reveals two more clearly distinct settlement phases: the Late Mesolithic I (at the beginning of the AT PAZ) and at the Late Mesolithic II (the second half of the AT PAZ). All these will be discussed in detail below.

Early Mesolithic I and II

A comparison of the archaeological finds obtained from Kunda Lammasmägi to that of other settlement sites in Estonia or neighbouring countries by artefact type, technology of manufacture and used material (e.g. L. Jaanits & K. Jaanits 1975; 1978; Koltsov & Zhilin 1999; Ostrauskas 2000; Jussila et al. 2007; 2012) suggests that a number of flint blades and some tools (Fig. 8) originate from the beginning of the Mesolithic (corresponding to the PB PAZ). However, a comparison of the early material of Kunda Lammasmägi to that of the Early Mesolithic settlement of Pulli (south-western Estonia) reveals an important difference. While the lithic material of Pulli is dominated by Cretaceous flint of southern origin (L. Jaanits et al. 1982: 32), the finds of other kinds of flint are far more numerous in Lammasmägi, with Cretaceous flint amounting to only a few percent of the entire lithic inventory. For example, out of the 18 lithic finds from the lowest stratigraphic unit (unit 4) of the 2014 test excavation, ten were of Carboniferous

Fig. 8. Early Mesolithic flint finds from the Kunda Lammasmägi site; 1) a blade fragment of Carboniferous flint (TÜ 2268:337), 2–3) retouched blade fragments of Cretaceous flint (AI 3308:271, 379), 4) an arrowhead of Carboniferous flint (AI 3359:138), 5) a Helvetinhaudanpuro-type point of Cretaceous flint (AI 4284:384). TÜ – University of Tartu; AI – Archaeological Research Collection of Tallinn University. Photos: A. Kriiska.

flint, seven of Silurian flint and one of quartz. The question of possible similarities with Early Mesolithic settlement sites with large quantities of imported Carboniferous flint previously described in Finland (e.g. Takala 2004: 107; Jussila et al. 2012: 18 and references therein) remains open, pending further excavations on a larger scale. However, most of the finds cannot be dated more precisely than the Mesolithic. As the area was also settled during the Comb Ware period, the Carboniferous flint, as a characteristic find type of Comb Ware settlements, cannot be considered to be a marker of early deposition outside stratigraphically isolated contexts.

As indicated by plant macrofossils (especially abundant algae of *Chara* sp.) and 'the high value of phosphates, proteins and lipids, together with high organic content', the stratigraphic unit 4 'would correspond to a drift gyttja that had accumulated close to the former shoreline' (Åkerlund et al. 1996: 264, 267).

All available radiocarbon datings from the same layer (Table 4: 6–10) coincide with the PB and BO PAZ, corresponding to the Stone Age periodization of Early Mesolithic I and II. The study of microfossils from one of the test pits reveals increasing human impact before the lake becomes overgrown and turns into wetland (Table 2: 11; Sakson 1996). A human impact study of the nearby Arusoo bog also shows a high charcoal concentration in the Early Boreal PAZ (Poska & Köningsson 1996: 304–5).

Because the undisturbed Mesolithic layer has accumulated below the average waterline, no conclusions about the nature of settlement can be drawn from its thinness or the missing traces of fireplaces or remnants of buildings. As the cultural layer is extensively mixed at higher elevations (Kriiska & Sander 2015: 33), there is little hope that hard evidence of early dwellings can be found in the future.

Late Mesolithic I

The upper strata above stratigraphic unit 3 were already partly mixed during the Stone Age. Finds of fish gear, Silurian and Carboniferous flint and quartz are abundant. Finds of ceramics are rather scarce (see below) but some were situated in the lower part of stratigraphic unit 2 or even in the upmost part of stratigraphic unit 3 next to artefacts typical of the Mesolithic (Sander 2014; Sander & Kriiska 2015 and references therein).

Mesolithic finds in the upper strata, together with an abundance of Silurian flint (somewhat less than half of the lithic finds from the whole site; Sander 2014: 35–42) and fishing gear, cannot be explained by human activity at end of the Mesolithic (Narva stage) or beginning of the Neolithic (Comb Ware culture) for three reasons.

Firstly, during the 7th millennium calBC, a change in stone usage occurred throughout coastal Estonia: Silurian flint was mainly replaced by quartz (Kriiska 2002: 36). Near the northern coast, this change is well observable in the settlement sites of Narva Joaorg and Jägala-Jõesuu II, dated c 6500 calBC (L. Jaanits et al. 1982: 47; Kriiska & Sikk 2014: 51–2).

Secondly, the proportion of flint blades (including fragments and tools made from blades) for the entire site (including the Early Mesolithic layer, stratigraphic unit 4) is rather high and exceeds 22%. This figure is in line with other Estonian Early Mesolithic Pulli and Kunda stage settlement sites (e.g. Pulli, Umbusi, Lepakose, Siimusaare, Ihaste, Sindi-Lodja II, and Jälevere where it ranges from 10% to 40%; K. Jaanits & Ilomets 1988: 54; Kriiska et al. 2003: 36; Tvauri & Johanson 2006: 42–3; Kriiska & Lõugas 2009: Fig. 26.5). The share of blades is generally lower in the Late Mesolithic Narva stage sites (e.g. in the north-Estonian Vihasoo II and Kroodi sites in a range of 1–6%; Kriiska 1997: 9).

Thirdly, by the beginning of the 5th millennium calBC, the surrounding lake had been drained and the finds of fishing gear should have become less frequent. This is not the case and the authors of this article have found no difference between harpoons and bone spear points collected from layers 4 or 1–2. In general, the Kunda bone artefacts are similar to the Early and Late Mesolithic material of the northern and eastern European forest zone (e.g. Oshibkina 1997: 171–4; K. Jaanits 2000; Lozovskaya & Lozovski 2013: 88–99; Zhilin 2015).

For these reasons, the second stage of the use of the settlement site must have begun after the latest radiocarbon dating from units 3 and 4 (7179–6693 calBC; Table 4: 7), but before the datings of the Narva Joaorg and the Jägala Jõesuu II mentioned above (around 6500 calBC), which correspond to the beginning of the AT PAZ. A

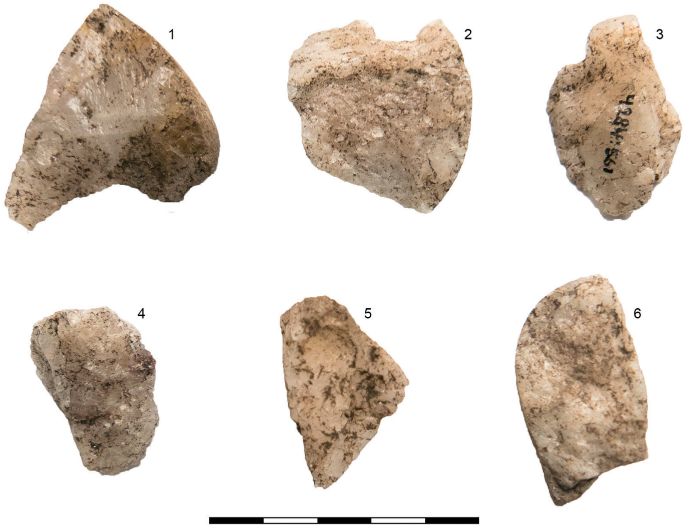

Fig. 9. Bipolar quartz flakes from the Kunda Lammasmägi site (AI 4284:561). Photos: A. Kriiska.

tendency towards more open landscapes and an increase in charcoal, interpreted as intensified human impact, is observable at the same time in the sediments of the nearby Arusoo bog (Poska & Köningsson 1996: 304–5). The largest proportion of finds were most probably deposited during this stage of human activity. A fireplace with stones described by Indreko (1948: 65–6) with a number of nearby finds (including a bone harpoon) from the lower part of stratigraphic unit 2 (the largest stone resting directly on unit 3) was probably from the same period.

During the second half of the BO and the beginning of the AT PAZ, Lammasmägi also became more easily accessible. About 100 m east of Lammasmägi, a positive landform is observable that must have been part of the eastern shore of the paleolake before the formation of the Kunda River canyon, which consists of similar sand and gravel based on the Estonian Soil Map (Maa-amet 2009). The eastern part of this remnant has been destroyed by erosion, but the western slope rises slightly above the water level at the end of the BO1 PAZ (Fig. 5). This leaves about 100 metres of waist-high water between Lammasmägi and the eastern shore of the lake. A fragment of a grinding stone was found there by the authors of this article in 2016.

The upper boundary of this period remains unclear for the time being. The peak in the human impact diagram by Poska & Köningsson (1996: 304–5) covers the first half of the AT PAZ. Indreko (1948) proposed a recess in habitation in the AT and Lõugas (1996) even suggested that human activity was absent during the whole AT PAZ, due to the lack of animal bones of species frequently found at sites from this period. However, a radiocarbon dating corresponding to the 2nd half of the 7th millennium calBC (Table 4: 12) was obtained from a wild horse bone later (Sommer et al. 2011). As explained above, a major part of the lithic material should be interpreted as originating from the early 7th millennium calBC. However, that does not rule out the continuation of human activity on a lower scale and it is quite possible that a part of the abundant worked quartz (Fig. 9) found from Lammasmägi was deposited there during the whole AT1 PAZ.

Interpretation of fishing gear as a marker of immediately surrounding environmental conditions has obvious drawbacks, such as the possibility that broken harpoons or spears were deposited during manufacture. However, the transformation of the lake into a wetland during the first half of the AT PAZ and further afforestation must nonetheless have had an effect on the attractiveness of the site, besides fishing also influencing conditions for hunting migratory water birds (Lõugas 1996: 285). The association between the decline of human activity during the AT PAZ and the disappearance of the lake remains plausible until further studies. As the duration of reduced human activity is not precisely known, the impact of other factors (such as the '8.2 kyr calBP cooling event' discussed in the extensive body of literature on the Late Mesolithic; e.g. Manninen 2014 and references therein) remains unclear.

Fig. 10. Narva Ware pottery fragments (1–4) and Comb Ware pottery fragments (5–9), arrowheads of Carboniferous flint (10–11), and an amber 'button' with a V-shaped hole (12); 1) AI 3575:29, 2) TÜ 2268:25, 3) AI 4282:240, 4) AI 4282:190, 5) AI 4284:59, 6) AI 4284:566, 7) AI 4284:?, 8) AI 3359:58, 9) AI 3308:408, 10) AI 4284:493, 11) TÜ 2268:676, 12) TÜ 2268:675. Photos: A. Kriiska.

Late Mesolithic II and Neolithic

The third and fourth groups of typologically datable archaeological finds belong to the final part of the Mesolithic (the Narva stage) and to the Neolithic Comb Ware culture. Radiocarbon datings cover the period until the beginning of the Bronze Age (Table 4: 1, 2, 11). The period roughly corresponds to the second half of the AT and the first half of the SB PAZ.

As the lake had drained away by the middle of the AT and the nearest body of water, the Kunda River, is nowadays about 250 m distant, the Lammasmägi site was described as a 'forest site' by Jussila and Kriiska (2006), somewhat stretching the designation meant for settlement sites situated about 300 m away from a body of water. However, a nearby smaller stream discussed above (Fig. 6) might have provided the site with fresh water. Some Neolithic pottery sherds were also discovered somewhere between Lammasmägi and the stream in 1981, but were not documented (Moora 1998: 45).

Sherds of two types of pottery – Comb Ware and Narva Ware – are present among the finds (Fig. 10: 1–9). The Comb Ware sherds were first documented by Indreko (1948) and the Narva Ware sherds by the authors of this article (Sander & Kriiska 2015: 33). The Narva-type sherds (Fig. 10: 1–4) originate from large vessels made of clay with organic admixture. Most of the sherds are unornamented. Several examples of the Narva Ware sherds display the U-shaped contact surface of clay bands. In general, the sherds of Narva-type belong to the group characteristic of northern Estonia (Kriiska 1997: 19). Among the Comb Ware sherds, both mineral and organic admixtures can be observed. Some of them are ornamented with small pits or comb prints (Fig. 10: 5–9).

However, the rather small number of pottery finds (in total of almost 80 sherds of Narva and Comb Wares so far; Sander 2014 and references therein; Sander & Kriiska 2015: 33–4) suggests either sporadic seasonal occupation or a modest use of ceramics. Most probably some of the quartz, flint and bone finds originate from the same period but they are indistinguishable from the others.

Settlement sites of various sizes with very few or even no pottery finds dated to the Narva or Comb Ware periods, based on the typology of lithic artefacts, radiocarbon dating or shore displacement chronology, are common in the

Estonian coastal regions and on the islands. They have been interpreted as short-time camping sites where ceramic vessels were not used (e.g. Jussila & Kriiska 2004: 3–4; Muru et al. 2017: 923). The observation of similar inland sites in the present paper is novel and suggests a common model of hunter-gatherer landscape use.

Of the 29 ^{14}C-dated Narva Ware sites in Estonia and Ingermanland (Russia) (see Kriiska et al. 2017b: Table 1, Fig. 7), only one site has been dated to the first quarter of the 4th millennium calBC (Kuzemkino 1, 3970–3790 calBC) and all the others are earlier. This does not support the general idea of a continuity of settlements from the Narva stage to the Comb Ware stage. A radiocarbon dating obtained from Kunda Lammasmägi (Table 4: 2) is well in line with most of the datings from the Narva Ware sites (in Kriiska et al. 2017b).

In Estonia, Comb Ware sherds with mineral admixture have been dated to approximately 3900–3200 calBC, and sherds with organic content are considered to postdate 3750 calBC (see also, Kriiska & Nordqvist 2012: 30; Kriiska et al. 2017b: 76). If the latest radiocarbon datings obtained from Kunda Lammasmägi (Table 4: 1, 11) can be associated with the Comb Ware culture, they are among the latest Comb Ware culture datings throughout its entire range.

Since the Comb Ware culture datings from Kunda Lammasmägi are about 2000 years later than the Narva Ware dating and the settlement continuity between the Narva and Comb Ware sites is unusual in the entire region, the possibility of two distinct settlement stages corresponding to the Narva Ware and Comb Ware finds is also highly probable for Kunda Lammasmägi. As the cultural layer is mixed, the temporal boundaries of these settlement stages will remain unclear until radiocarbon dating of the organic remains on the sherds is performed.

OTHER SETTLEMENT SITES AND STRAY FINDS IN THE VICINITY OF KUNDA LAMMASMÄGI

To date, eight settlement sites have been discovered, three of them by the authors of this paper in 2013-16 (Figs. 4–6; Table 5). From each site, three to ten surface finds have been collected (Fig. 11). No excavations have been carried out on sites other than Lammasmägi. The environmental conditions of the settlement sites differ.

The Hiietalu site is situated on the lower part of the steep slope of Hiiemägi and the erosion of the finds cannot be ruled out (thus the unclear elevation in Table 5). The Aasa, Järvepõhja I, Järvepõhja II, and Jaanimäe sites are situated on the lower north-western shore of the lake depression, presumably near the seasonal waterfront. There is no apparent reason to believe that the surface finds might have been moved farther than a few metres from their original place of deposition.

No	Site (collection)	Approx. elevation (m a.s.l.)	Archaeological material
1	Hiietalu (TÜ 1448)	46.00–51.00	Four quartz flakes, remains of a stone bead
2	Miili (TÜ 1340)	46.50	Four quartz flakes, a blade of Carboniferous flint
3	Aasa (TÜ 1790)	48.50–50.00	A fragment of Cretaceous flint blade, two quartz flakes
4	Vahtra (AI 4996; TÜ 2411)	48.50–50.00	Four flakes of Silurian (or Carboniferous) flint, three quartz flakes and a quartz core
5	Järvepõhja I (TÜ 2639)	48.00–48.50	Three quartz cores, seven quartz flakes, an unworked piece of imported flint
6	Järvepõhja II (TÜ 2640)	48.00–48.50	A core of Silurian flint, two cores of quartz, a flake of Silurian flint, a flake of Carboniferous flint, six flakes of quartz, a proximal end of a stone blade
7	Jaanimäe (TÜ 2641)	48.50	Two flakes of Carboniferous flint, a flake of Silurian flint
8	Rõõmu (TÜ 2412)	48.50	Four flakes of Silurian flint

Table 5. Stone Age settlement sites near Kunda Lammasmägi.

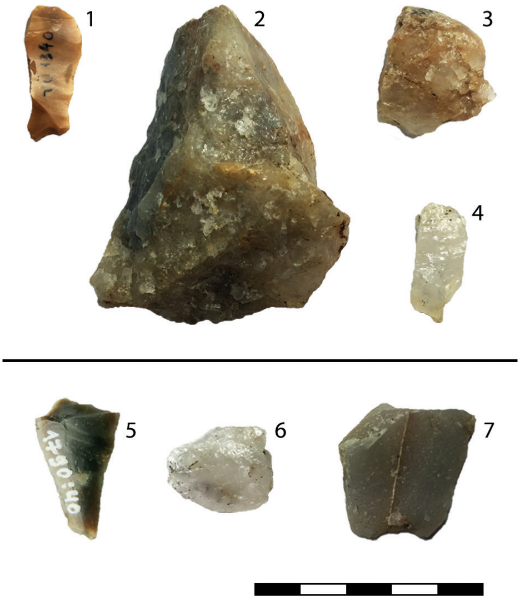

Fig. 11. Lithic artefacts from the Miili (1–4) and Aasa (5–7) settlement sites; 1) a blade fragment of Carboniferous flint (TÜ 2268), 2) a quartz core (TÜ 2268), 3, 4, 6, 7) quartz flakes (TÜ 2268, 1790: AI 4284:41, 42), 5) a blade fragment of Cretaceous flint (TÜ 1790: 40). Photos: A. Kriiska.

The surroundings of the Vahtra site are more noteworthy. The finds were situated on the lower part of a small hill that must have formed a little peninsula at the time of the paleolake (Figs. 4 & 5). The top of the hill rises about as high as Lammasmägi and it might have provided equally good conditions. In addition, a couple of large boulders make it visually pronounced. Unfortunately, most of the original ground surface has been removed by construction or gardening. In addition to that, both the Aasa and Vahtra sites are located on the same Iron Age settlement site. The Miili site is situated just across the road from the Aasa site, but at a considerably lower elevation.

The Rõõmu site is located on the very low southern slope of the lake depression by the bed of an ancient stream. The selection of that particular place might have been due to the proximity to both of the bodies of water.

Regarding archaeological material collected from the sites, no ceramics have been found from the surface of any settlement site except for Lammasmägi and its immediate vicinity. The lithic material is rather scarce. Therefore, it can be assumed that the sites listed above were probably not used for long-term settlement (with the possible exception of the Vahtra site).

Dating of the sites is impossible without excavations. As Carboniferous flint, together with Comb Ware sherds, is abundant in the upper strata of Lammasmägi, its presence alone cannot be considered as a marker of early usage. However, the Jaanimäe site, where two flakes of Carboniferous and one of Silurian flint have been found, was situated by the body of water only during the BO PAZ (Fig. 4).

The archaeological material of two of the sites (Hiietalu and Miili) is supposedly more recent, consisting mainly of worked quartz. That is well in line with the location of the Miili site, as it is clearly situated much lower than the others and must have become usable during the AT PAZ (Figs. 4 & 5).

The research history of the Kunda basin begins with stray finds from lake marl deposits during the mining conducted at the end of the 19th century (mainly bone fishing gear, ice picks and arrowheads). The finds have been preserved and have been published repeatedly, starting with Grewingk (1882). However, as far as their location is concerned, only the general area in the north-eastern part of the basin has been identified.

The stray finds discovered by Indreko in 1933, famous for a fully preserved pike skeleton together with a harpoon point (Indreko 1948: 52), cluster at two depths: 110 cm (the pike skeleton) and 55–75 cm (two ice pick points and an arrowhead). The pike skeleton was certainly deposited at the lake bottom and the upper finds do not necessarily indicate a settlement site. However, the location is described well enough for the palynological description of the excavation to be used in this paper (Table 2: 14).

The excavations carried out by L. Jaanits in 1949 on the eastern slope of the depression (in the villages of Kunda and Siberi, approximately 46 and 49 m a.s.l.) added three fragments of grinding stones to the stray finds in the area (L. Jaanits 1949). The natural environment in the location of the 1949 excavation in the village of Siberi has been destroyed by sand mining. The grinding stone fragment from the village of Kunda could actually originate from the Hiietalu site. A fragment of a grinding stone was also found by the authors of this paper in 2016 on an aforementioned remnant of the eastern shore of the lake east of Lammasmägi (47.5–48 m a.s.l.). None of these finds have been previously published.

CONCLUSIONS

Digital elevation modelling together with palynological and radiocarbon datings from test pits or excavations enable the reconstruction of past water levels of the paleolake. Three distinct phases can be observed in the development of environmental conditions of the Kunda depression (Figs. 3–6). Until the beginning of the AT PAZ, Lammasmägi existed as an island in the southern part of a lake. During the AT1 PAZ, the water level dropped, a remnant lake was left in the northern part, and Lammasmägi became a seasonal island or a higher place in the marsh. In the AT2 PAZ, Lammasmägi was surrounded by dry land. The gradual replacement of the lake by wetland during the first half of the AT PAZ (AT1) (Fig. 6) is later than suggested by previous authors (e.g. Karukäpp et al. 1996: 227; Moora 1998).

The currently available archaeological material and radiocarbon datings allow four separate settlement phases in the Lammasmägi site to be identified: 1) the Early Mesolithic I and II; 2) the Late Mesolithic I; 3) the Late Mesolithic II; and 4) the Neolithic until the beginning of the Bronze Age. The first two settlement stages can be associated with the paleolake, the two subsequent two with the present-day Kunda River and other streams. The archaeological material of the Kunda Lammasmägi Late Mesolithic settlement stage had not been clearly differentiated before it was studied by the authors of this paper.

Most of the cultural layer of the Lammasmägi settlement site is extensively mixed, and only the lowest stratigraphic unit (Fig. 7: 4) is presumably intact. It accumulated as drift gyttja near the lake shore (Åkerlund et al. 1996: 264, 267) and finds (Fig. 8) from this layer have been dated to the Early Mesolithic I and II periods (9^{th} and 8^{th} millennia calBC; the PB and BO1 PAZ) by several radiocarbon datings (Table 3). The presence of similar artefact types (Fig. 8), technology of manufacture, and raw materials in vast areas in eastern and northern Europe during the Early Mesolithic I (L. Jaanits & K. Jaanits 1975; Koltsov & Zhilin 1999; Ostrauskas 2000; Takala 2004; Jussila et al. 2007; 2012) allow a number of the finds from Lammasmägi to be dated to the same period. Stratigraphy of the site suggests that this early settlement stage was followed by a short pause in human activity. Above the paleolake shoreline, no unmixed layers are stratigraphically discernible.

Comparative analysis of the lithic finds collected from the Lammasmägi settlement site leads to the conclusion that the most active usage of the site can be dated to the Late Mesolithic I period (the first half of the 7^{th} millennium calBC; the beginning of the AT PAZ). The environmental conditions of Lammasmägi do not rule out permanent habitation nor limit the use of the islet to certain seasons. This is well in line with the animal bone analysis by Lõugas (1996: 287–8), according to which the island must have been used at least from February to March and from August to November. With the possible exception of the spring high-water period, the island was habitable almost year-round. A natural drainage of the lake occurred during the first half of the AT PAZ (AT1) and roughly coincided with a temporary abandonment of the site. The association between the end of the second period of human activity and the replacement of the lake with wetland remains plausible until further studies.

The Lammasmägi settlement site came into use again at the end of the Mesolithic period (during the 5^{th} millennium calBC) as indicated by finds of Narva Ware (Fig. 10: 1–4). In general, the Narva-type pottery sherds from Kunda Lammasmägi belong to the local group characteristic of northern Estonia (Kriiska 1997: 19).

The last settlement phase is related to the Neolithic Comb Ware culture. Comb Ware sherds and contemporaneous artefacts of Carboniferous flint and amber ornaments (Fig: 10: 5–11) are present, and the latest radiocarbon datings are from the very end of the Stone Age (Table 4). However, the scarcity of both types of ceramic sherds (Narva and Comb Ware) suggests only sporadic seasonal occupation. During this last stage of site use by prehistoric people, the nearest water bodies were the Kunda River (about 250 m east) and a smaller (currently disappeared) stream (about 70 m west of the hillock).

Eight settlement sites (Table 5) have been found on the slopes of the depression left by the paleolake, most probably situated on the shore of the lake or by a stream running into the lake. Five of these are being published here for the first time. No ceramics were found at any of them, even where elevation necessitates Neolithic dating (Miili). The scarcity of finds suggests that the shores of the ancient Kunda Lake were used mostly for short-term campsites.

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