**Supplementary Material 1 for Emergence of hilltop settlements in the southeastern Baltic: new AMS 14C dates from Lithuania and revised chronology**

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S1. **Previously dated sites and the background information pertaining sample collection**

***NW Belarus***

Northwestern Belarusian hilltop settlements in Ratjunki and Zazony has been the only 14C dated sites of the inland cluster of SE Latvia, NW Belarus and NE Lithuania before this study. Mostly charcoal samples were selected for dating, except for 2 samples of human bones from Ratjunki. The sample context had been described with insufficient detail (Egoreichenko 2006) and thus cas doubts whether dated charcoal samples was connected with settlement context. The only charcoal sample from reliable context was collected from the pit in Zazony. All other samples were collected in different levels of cultural layer. None of the samples were studied in regards of wood species identification and age estimation and bone samples were not measured for δ13C and δ15N stable isotopes.

***Inland Estonia***

Kõivuküla site is a single case of Estonian Bronze Age pure inland hilltop settlement in Estonia. Sitting ca. 150 km from Baltic Sea coast to N and W, located 8 km to SE from Tartu city centre, on the S bank of Mõra River (a tributary to Emajõgi River), site is located on a 70 m long promontory between two valleys. Hilltop settlement has been discovered during 2009 and 2011 excavations and two separate horizons has been revealed. The lower containing Bronze Age finds under the rampart and upper attributed to Roman Iron Age / Migration period with the fortification of low rampart, ca. 1 m high (Valk et al. 2012). No other enclosures, previous to the Roman Iron Age, had been uncovered. The Bronze Age horizon was disturbed by later human activities in the Iron Age and only 5–10 cm thick greyish sand layer under the rampart remained. The charcoal sample from the latter had been selected by the researchers for 14C dating.

***Coastal Lithuania***

Kukuliškiai hilltop settlement represents the single dated site to the Late Bronze Age in coastal Lithuania. Settlement was established on the terrace of Littorina Sea, its remains currently lies ca. 320 m from Baltic Sea. Discovered in 2016, settlement was archaeologically investigated in 2017 (Urbonaitė-Ubė and Ubis 2018). Amongst striated, smooth surfaced and early rusticated pottery, part of a clay crucible, unworked amber and animal bones, archaeobotanical remains were collected as well. The analysis of the latter was supplemented by AMS C14 dating of 8 grains (Minkevičius et al. 2019). 4 grains had been selected from postholes, 3 grains form hearth and 1 from cultural layer. The archaeobotanical collection revealed one of the first more complete grain package in the SE Baltic. The collection was dominated by *Hordeum Vulgare*, smaller amounts of *Triticum dicoccum* and *Triticum aestivum* was identified. Moreover, the earliest oat (*Avena* sp.) grains and several pulses (*Vicia faba*, *Pisum sativum* and *Lens culinaris*) were found during the archaeobotanical investigations (ibid.). Thus, aforementioned study makes an important argument for intensive agriculture in the subsistence economy practiced by hilltop settlement communities.

***Lower Daugava / W Latvia***

The Ķivutkalns hilltop settlement situated on Dole Island in the lower reaches of Daugava River could had positioned itself in one of the most important areas in Southeastern Baltic. Daugava River, being the longest tributary to the Baltic Sea in study area, extended towards Valdai Hills in the east. Latter hills mark a division between the drainage basins of Baltic, Black and Caspian seas, thus Daugava River joined Volga and Dniepr Rivers in the same territory and became the most important route via inland Southeastern Baltic. Route usage is represented by the hilltop settlement pattern in the Bronze Age (fig. 1) as well as other archaeological remains of different prehistoric processes from Stone to Viking Ages.

Ķivutkalns hilltop settlement represents a cluster of Bronze Age sites in the Daugava River mouth. Site was excavated to almost full extent in 1966–1967. During these investigations, an undisturbed cemetery layer, lying 1.60–3 m deep, was uncovered below the settlement horizon (Graudonis 1989). The human remains from cemetery had been dated by two different studies (Oinonen et al. 2013; Mittnik et al. 2018) and presented a strong argument for the earliest chronological limit of hilltop settlement as a stratigraphical argument, i.e. sequence that hilltop settlement was established only after cemetery usage had siezed, could not been refuted (contra Oinonen et al. 2013; cf. Vasks and Zariņa 2014). Dating results of human bones indicated a high probability that Ķivutkalns hilltop settlement was established not earlier than VIII–VI cent. cal BC. Archaeological collection of 2 700 artefacts, 38 000 pottery fragments and 11 600 animal bones collected during the excavations constitutes one of the largest Bronze Age hilltop settlement collection in Southeastern Baltic. The hilltop settlement history was distinguished into the 4 stages from a settlement enclosed by wooden fences to ones fortified by ramparts as high as 1.2–3 m. Ķivutkalns hilltop settlement was C14 dated by 7 charcoal samples from the different areas of cultural layer. 5 of them collected in 0.8–1.1 m depth had been dated to Bronze Age. Additionally, 3 animal bones from cultural layer that lied from 0.75 to 1.9 m deep have been dated in 2013 (Oinonen et al. 2013).

Krievu kalns hilltop settlement is farther from the sea, ca. 50 km inland, but regionally were most likely influenced by coastal contact zone (fig. 1). Archaeologically investigated in 2012–2013, research yielded one of the best described sample contexts (Doniņa et al. 2014) in the review of the previously acquired dates. 0.8–0.9 m thick Bronze Age cultural layer covered postholes extending down to 1.9 m deep. The lines of two palisades uncovered separated by 2–3 m towards the slope have represented two stages of hilltop settlement development. Alongside palisade a building was distinguished by postholes covered by 3–4 m wide charcoal rich areas. In the area interpreted as building zone, two large pits were uncovered: first, 0.8 m deep 1.2x1.4 m wide, and second, 0.5 m deep and 1.2 m in diameter. Researchers interpreted them as storage pits. Furthermore, 5 hearths were found in the excavated areas and were also associated with buildings. Charcoal samples from posthole and pits were selected for 14C dating.

The second case that was likely influenced by coastal contact zone in W Latvia was Padure (Beltes) hilltop settlement. 0.6–1.3 m thick cultural layer is represented by two horizons: Late Bronze Age and second half of I millennium–12th c. AD. In the course of archaeological investigations during 2003, 2005–2007 number of settlement features had been uncovered. One charcoal sample from a hearth at the depth of 0.5 m was dated to Bronze Age (Vasks et al. 2011).

***Coastal Estonia***

Asva hilltop settlement represents a single case from Saarema Island in this paper. Site currently is located ca. 5 km from the Baltic Sea, however due to the land elevation Bronze Age settlement is reconstructed as possibly situated near the coast of small bay (Sperling 2014). Here, a rich in finds archaeological layer has been extensively investigated by several groups of researchers (Indreko 1939; Vassar 1955; Lõugas 1967, 1970; Sperling et al. 2013, 2015). It constituted of two Bronze Age horizons (so called younger Asva IIa and older Asva IIb) and one of mostly disturbed Pre-Viking Age settlement layer (Asva I). Both Bronze Age layers had been succeeded by burned layers. Chronology has been studied extensively (Lang 2007; Sperling 2014; Sperling et al. 2015; Rannamäe et al. 2016) dealing samples of charcoal, carbonized surface residue on pottery and animal bone from different areas of the site. The results of 14C dating constitute the largest number (10[[1]](#footnote-1)) of dates per site alongside Ratjunki (Belarus) hilltop settlement in the SE Baltic. Samples were excavation finds collected during in 1949, 1965–1966, 2013–2014. Notable contexts were zones of metallurgical activities or its waste. There were small areas rich in charcoal and casting moulds. There are also dates on the context of collapsed houses and burned horizon between the two Bronze Age layers (Sperling, pers. communication). Context of several samples had not been specified by the researchers, but it is plausible that the attention was concentrated on the finds from lower horizons. From all the samples distinguished by its type was *Ovis aries* metacarpus found in the SE part of hilltop settlement (area F). The remains of two houses and a wooden enclosure was uncovered in this area. Moreover, same area was dated by sampling carbonized surface residue on pottery fragments. In addition to it, the sample was taken from the another pottery fragment collected in the NE part of hilltop settlement (area E), where the earliest remains of metallurgical activity in the settlement is indicated by a clay casting mould for Mälar type axe (Sperling 2014). The first dated samples that were collected in Asva had not been presented with accompanying information on context (Lang 2007).

Northern Estonian coast is represented by hilltop settlements situated near the bay of Tallinn and NE Estonia. Firstly, Iru site is located ca. 10 km to E of central Tallinn, in a bend of Pirita River. Archaeological evidence indicates several periods of human activity there: the clearest and richest in finds were Late Bronze Age and V/VI–XIth cent. AD hillfort horizons (Vassar 1939; Lõugas 1970; Lang 1996). In addition, remains of a short-term activities dating to pre-Roman Iron Age were uncovered as well (Lang 2007). The features dated to the Bronze Age were the remains of 4 rectangular house floors and several fireplaces in the excavated areas. Archaeological collection from Iru excavations constitute a large amount of pottery (ca. 4150 fragments), bronze spearhead, fragments of neck-rings, awls, bone and horn artefacts (e.g. harpoon, pins, arrowheads, awls, spoon) and collection of clay casting moulds with crucibles. Samples selected for chronological studies were not specified, but it seems that charcoal had been used.

Last case of hilltop settlement in the Estonian coastal zone is a rather a transitional area to inland as Narva hilltop settlement sat ca. 16 km from the bay of Finland, on the left bank of Narva river. Archaeological investigations into the site had revealed ambiguous contexts where Bronze Age remains were mixed up with material from other periods, such as textile pottery and Stone Age finds. The study that is referred here attempted to date the textile pottery, but in absence of dating material researchers turned to pottery fragments that was found in their vicinity (Kriiska and Lavento 2006). The samples selected for the dating were carbonized surface residue on pottery. No stable isotopic measurements have been executed.

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List of the localities marked in figure 1

**NE Poland**: Szurpiły, Tarławki, Zubronajcie

**Russia**: Osyno

**Lithuania**: Antaniškės, Antilgė, Asavytai, Bikūnai II, Dūkštas, Garniai I, Gugiai, Jaurelis, Jurkakalnis, Juodonys, Kalnočiai, Kereliai, Kiemionys, Kukliai, Kuktiškės, Kukuliškiai, Kupiškis, Kurmaičiai, Malkėstas, Marciūniškės, Mielėnai, Mineikiškės, Moškėnai, Narkūnai, Nevieriškė, Pakačinė, Papiliakalnė, Petraučizna, Petrešiūnai, Skineikiai, Sokiškiai, Spitrėnai, Sviliškės, Šišponiškės, Šiukščiai, Ūžėniškės, Velykuškės, Velykuškės “Sala”, Vorėnai, Vosgėliai.

**Belarus**: Bancerovsčina, Dvorisče, Gatoviči, Gorany, Gorodisče, Kasčelici, Labensčina, Ratjunki, Tarilovo, Zanoroč, Zazony,

**Latvia**: Aizkraukle, Arāji, Asote, Baltkāji, Beržine, Bondari, Batarejas kalns, Blaževici, Brikuļi, Daugmale, Dievukalns, Dignāja, Jersika, Kaķiški, Klosterkalns, Krievukalns, Ķivutkalns, Klaņģukalns, Kaldabruņa, Koknese, Kņāvukalns, Kūliņi, Ķenteskalns, Krupenišķi, Matkule, Mūkukalns, Madalāni, Padure, Paplaka, Puišakalns, Piliškas, Puze, Rušenica, Saulieši, Sārumkalns, Stanoviški, Sudmaļi, Stupeļu kalns, Sudrabkalns, Šokolādes kalns, Tanīskalns, Tērvete, Vīnakalns, Zamečka, Żaunareni.

**Estonia**: Asva, Iru, Kõivuküla, Narva, Ridala

1. 6 more dates corresponding with the rest of the dates from Asva are known, but unpublished (Sperling, pers. communication). [↑](#footnote-ref-1)