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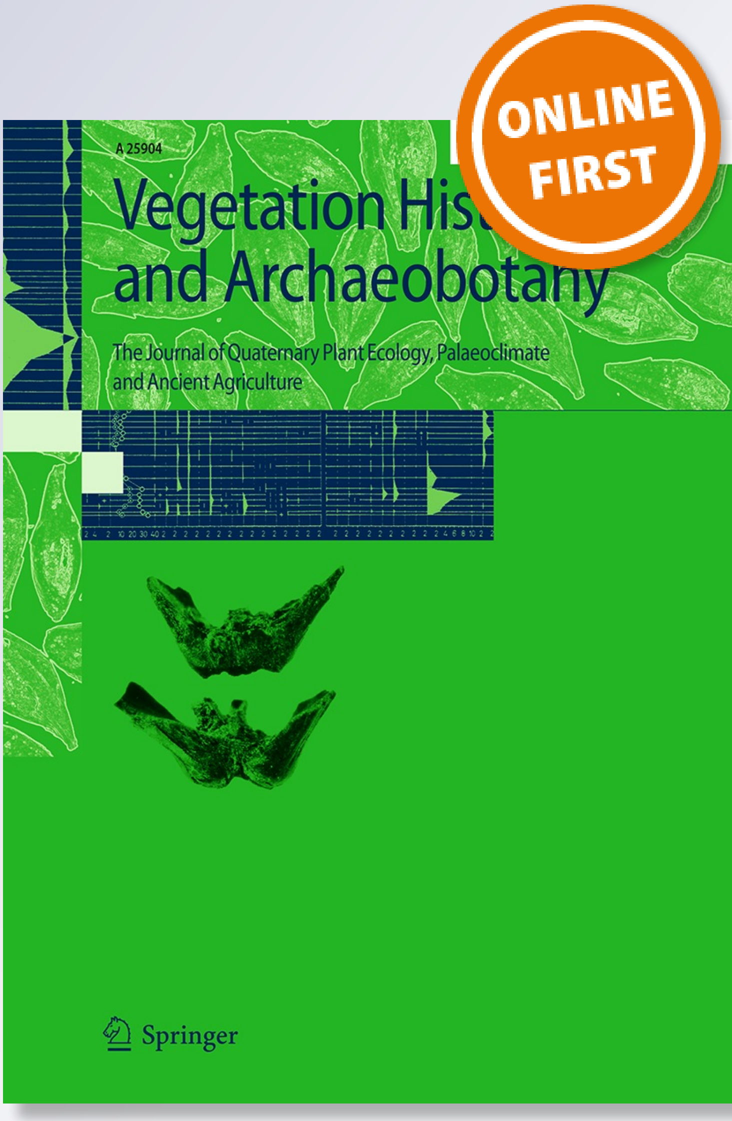

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ORIGINAL ARTICLE

Deconstructing the concept of Subneolithic farming in the southeastern Baltic

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Abstract The paper presents a critical review of the zooarchaeological, macrobotanical, palynological and archaeological data from Lithuania and their previous interpretations, which formerly served as the basis for the concept of development of pre-Neolithic or Subneolithic low intensity farming and/or livestock breeding in the eastern Baltic region. Moreover, it presents the first direct AMS dates from the crop remains and domestic animal bones discovered in Lithuanian Subneolithic and Neolithic settlements. An investigation proved that most of, or possibly all, the early farming "evidence" came from the wrong identification of the plant and animal species and incorrect dating of crop remains and domestic animal bones. The errors of dating were caused by the fresh water reservoir effect being ignored when dating the bulk lacustrine sediment samples, by the failure to evaluate the impact of the palimpsest and bioturbation phenomena on the formation of an archaeological layer, and by insufficient attention to stratigraphy and spatial documentation of the finds during very extensive archaeological excavations in the second half of the 20th century. To date, no credible evidence is available in Lithuania that domestic animals had been kept and crops grown before the Neolithic Globular Amphora and Corded Ware cultures in 3200/2700 cal BC. However, this does not mean such evidence may not appear in the future, provided direct AMS dating of animal and crop residues from Subneolithic contexts continues, and systematic macrobotanical studies finally start not only in the lake settlement and fishing sites, but also in higher altitude areas.

Keywords AMS dates · Neolithisation · Archaeozoology · Archaeobotany · Pollen · Lithuania

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Introduction

To date, for the eastern Baltic region, the view is predominately that low intensity farming and/or livestock breeding appeared between 6000 and 4000 cal BC, in the so called Subneolithic (here, instead of the traditional periodisation of the Lithuanian Stone Age - Early Neolithic 5500–4300, Middle Neolithic 4300–3000, Late Neolithic 3000–1800 cal BC; after Antanaitis-Jacobs and Girininkas 2002—we shall use the one proposed by GP—Subneolithic 5000/4000–3200/2700 cal BC, Neolithic 3200/2700–2000 cal BC, Piličiauskas in press. Pottery will be considered as the criterion for the beginning of the Subneolithic, and agriculture for the Neolithic) or the Ceramic Mesolithic, i.e. before the emergence of the first Neolithic cultures, the Globular Amphora (GAC) and Corded Ware (CWC) cultures, around 3000 cal BC (Daugnora and Girininkas 1996, 1998; Antanaitis 1999; Loze 2001; Stančikaitė et al. 2002; Rimantienė 2005; Lõugas et al. 2007; Kriiska 2003, 2009; Alenius et al. 2013; Nordqvist and Herva 2013). In the present paper, this approach will be referred to as the "concept of Subneolithic farming" (hereinafter CSF). The CSF is based on archaeological,

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zooarchaeological, macrobotanical and palynological data in Lithuania and Latvia, on archaeological and palynological data in Estonia, and in Finland merely on palynological evidence. In Finland, distinct changes in the material culture and the increasingly complex social organisation immediately after the adoption of the ceramic production technology is sometimes seen as indirect evidence of early agriculture (Herva et al. 2014). The CSF tends to explain the neolithisation by means of a cultural transmission model (e.g. Antanaitis-Jacobs and Girininkas 2002) which suggests an extremely slow, thousands of years-long, gradual development of agriculture and husbandry and explains the process not by large-scale migration of people, but by cultural exchanges between hunter-gatherers and farmers and other peaceful and long-term contacts (Zvelebil 1996). Moreover, the importance of the eastern Asian neolithisation centres for the spread of the first crops, e.g. hemp, buckwheat and millets, is also argued (Rimantienė 2005; Alenius et al. 2013).

The CSF is in sharp contrast with the data from numerous other European regions, including the western Baltic, that testify to sudden and dramatic changes in economy and diet concurrent with the cultural transformations when hunting-fishing-gathering was replaced by agriculture and husbandry, the basis of which was a package of SW Asian crops and domestic animals (e.g. Richards et al. 2003; Sørensen and Karg 2014). Although some argue for more gradual change (e.g. Craig et al. 2011), a question arises, and remains unanswered, as to why the western Baltic did not experience pre-Neolithic farming, although similar material cultures witness that in the fifth millennium cal BC all the areas of the Baltic region were closely interrelated. Nevertheless, the eastern Baltic CSF received very little criticism. Only once has the reliability of the pollen studies been called into question (Lahtinen and Rowley-Conwy 2013).

The authors of the present paper believe that the absence of scientific criticism does not actually prove the strength and validity of the CSF. It is rather the outcome of language barrier-determined seclusion of scientific research. The primary eastern Baltic archaeological sources are practically inaccessible for researchers abroad, as all the reports and most of the papers in the eastern Baltic area were, and still are, published in native languages, particularly in Lithuania and Latvia. Moreover, in the not so numerous archaeologist communities of small countries, scientific discussion is also hindered by intolerance of criticism, inherited from the Soviet totalitarian past. In Lithuania, the reviewing of publications, and especially monographs, is most frequently formal, superficial, and uncritical. Such an atmosphere is ideal for the birth of archaeological myths, which are constantly repeated in local publications until their eventual penetration into the international realm.

In 2013–2014, the authors of the paper decided to check out the archaeological, zooarchaeological, pollen and macrobiological data that served as the basis for the CSF construction in Lithuania. The outcomes were supplemented by recent research data and are presented in this paper.

Materials and methods

The authors of the paper focused on Lithuanian archaeological and bioarchaeological materials due to their easy accessibility. We reviewed the collections of archaeological finds, animal bones and macrobotanical residues from Subneolithic and Neolithic archaeological sites stored in the National Museum of Lithuania, other scientific institutions and private collections (Fig. 1). Moreover, we had access to field work reports and to the unpublished materials on Piličiauskas' recent excavations at Nida and Šventoji Subneolithic and Neolithic sites (Table 1).

When determining the types of animal bones, G. Piličiauskienė's personal comparative collection was used.

For accurate characterisation of plant remains, description keys, atlases and remain descriptions (Grigas 1986; Berggren 1969, 1981; Cappers et al. 2006) were used, together with comparative collections of contemporary plants and samples of excavated specimens stored in the Quaternary Research Laboratory of the Nature Research Centre.

Direct AMS dates of cultigens and domesticates were provided by Poznań Radiocarbon Laboratory. Charred grain was pre-treated using the acid-alkali-acid (AAA) method as described by Brock et al. (2010). For the bones,

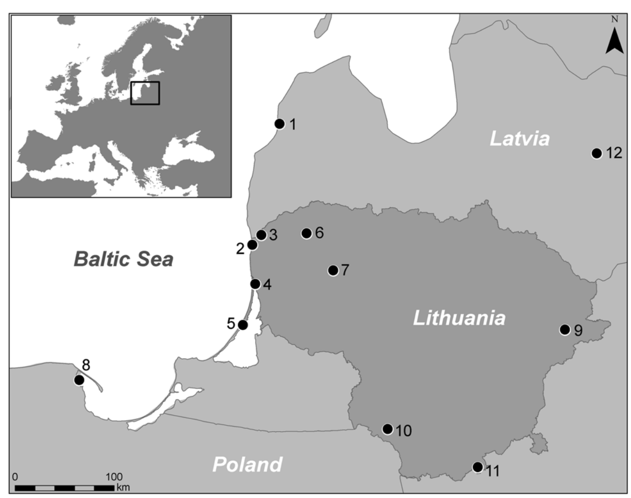

Fig. 1 Map of sites mentioned within the text: *1* Sārnate, *2* Šventoji, *3* Benaičiai, *4* Smeltė, *5* Nida, *6* Šarnelė, *7* Biržulis Lake, Daktariškė 5, and Donkalnis, *8* Rzucewo, *9* Kretuonas 1 and Žemaitiškė 2, *10* Turlojiškė, *11* Dūba and Pelesa Lakes, Gribaša 4, *12* Zvidze

Table 1 General information about the sites investigated for the present study

Site	City/district	Years of excavation	Excav. area (m^2)	Chronology	References	Present research
Daktariškė 5	Telšiai	1986–89	648	Subneolithic-Early Bronze Age	Butrimas (1988)	Direct AMS dating of animal bones
Donkalnis	Telšiai	1981–82	1,024	Mesolithic-Iron Age	Butrimas et al. (1985)	Reanalysis of animal tooth pendants
Nida	Neringa	1974–1978, 2011–2013, 2016	4,744	Subneolithic-Neolithic	Rimantienė (1989), Piličiauskas and Heron (2015)	Zooarchaeological analysis
Šarnelė	Telšiai	1973, 1981–1982	568	Subneolithic-Early Bronze Age	Rimantienė (1984), Butrimas (1996)	Direct AMS dating of animal bones
Šventoji 4	Palanga	1986–1995, 1997–98, 2002–2003, 2006, 2014	1,650	Subneolithic-Neolithic	Rimantienė (2005), Piličiauskas in press	Plant macroremains and zooarchaeological analyses
Šventoji 6	Palanga	1982–1988, 1997	2,000	Subneolithic-Neolithic	Rimantienė (2005)	Analysis of plant macroremains and direct AMS dating of charred grain
Šventoji 12	Palanga	1970	Surface finds	Subneolithic-Neolithic	Rimantienė (2005)	Direct AMS dating of animal bones
Šventoji 43	Palanga	2014	61	Subneolithic	Piličiauskas in press	Direct AMS dating of animal bones
Žemaitiškė 2	Švenčionys	1979, 1980, 1983, 2000–2001	403	Mesolithic-Early Bronze Age	Girininkas (2004)	Direct AMS dating of animal bones

extraction of collagen was performed using the procedures originally described by Longin (1971), with further modifications (Piotrowska and Goslar 2002). The extracted collagen was ultrafiltered using pre-cleaned Vivaspin™ 15 MWCO 30kD filters (Bronk Ramsey et al. 2004). All dates in this study were calibrated by using OxCal 4.2 software and the IntCal13 atmospheric curve (Bronk Ramsey 2009; Reimer et al. 2013). Calibrated dates are quoted with 68.2 % probability.

Results and discussion

Zooarchaeological data

A statement can be found in the archaeological literature about the first domestic animals having reached the eastern Baltic as early as in the Mesolithic, around 5900 cal BC. This allegedly could be shown by animal teeth-pendants found in graves 4 and 5 of the Donkalnis Mesolithic cemetery in Western Lithuania (Kriiska 2009). The author of this statement, an Estonian archaeologist, quoted a paper by the Lithuanian archaeologist I. Antanaitis (1999), which referred to an unpublished report by the zooarchaeologist L. Daugnora. Somewhat later, Daugnora referred to the tooth-pendant as possibly coming from a specimen of livestock '*Bos bovis*?' (Table 1 in Daugnora and Girininkas 2004). After re-examination of the original finds one can conclude that there is no evidence to support the suggestion of livestock. Sixty-nine pendants from grave 4 belonged to elk, deer, aurochs, roe and dog/wolf. Forty-four pendants from grave 5 belonged to deer, aurochs/bison and elk (Fig. 2).

The Smeltė findspot on the Lithuanian coast is another place where a Mesolithic age for domestic animal bones seemed to be a possibility. During the excavations of a small coastal swamp during 1970 to 1973, a cattle skull was found along with antler and bone tools typical of the Mesolithic. However, its direct dating proved it had got into the bog from a recent village site (Table 2; Piličiauskas et al. 2015).

Various authors in numerous publications have written that in the Kretuonas 1B mid-Neolithic (4,400/4,200–3,100/2,900 cal BC; Subneolithic in our periodisation) settlement in northern Lithuania, the bones of domestic animals accounted for from 4 to 7 % of the total archaeological material (cf. Rimantienė 1984; Daugnora and Girininkas 1996, 2004; Antanaitis-Jacobs et al. 2009). 'Kretuonas 1B' refers to the lower archaeological layer in the northern sector of the excavated settlement. The excavations were carried out under the guidance of A. Girininkas. Bones of cattle, pigs, sheep/goats, horses and dogs were discovered. In merely one paper of the research

Fig. 2 Red deer (*row 1*) and aurochs'/bison' (*row 2*) teeth pendants from grave 5 of the Donkalnis Mesolithic cemetery

author we found a warning that "…an error is possible, as in particular places of the settlement the cultural layer was mixed with later layers" (Daugnora and Girininkas 2004, p. 105). Moreover, another archaeologist, a participant in the excavations, mentioned that in the northern sector, all styles of Narva pottery, including that of the late period dating to the beginning of the Bronze Age, were found, and different pottery types "were mechanically mixed" (Brazaitis 2002). It is therefore very possible that the bones of domestic animals belonged not to the Subneolithic, but to a later period. However, we did not have access to the Kretuonas 1B zooarchaeological collection, and were therefore not able either to check out the species identification or to directly date the bones of domestic animals. We were only able to date a cattle mandible from the Žemaitiškė 2 settlement near Kretuonas 1 which turned out to be from the Bronze Age (Poz-61567: 3,195 ± 35 BP; 1498-1437 cal BC), even though the contextual dates covered the period of 7500-1700 cal BC (Piličiauskas 2012). The cattle bones from the Kretuonas 1C settlement also dated back to the beginning of the Bronze Age (see Table 2).

Ungrounded assignment of zooarchaeological materials from multicomponent unstratified settlements or from stratigraphically undocumented collections to the Subneolithic or Neolithic is not a rare case in Lithuania. Thus for example, in the Donkalnis settlement, coarse Iron Age pottery predominated; however, some Neolithic CWC and the beginning of the Bronze-Age post-CWC pottery were also found. There was no stratigraphy; however, all the animal bones were sometimes assigned to the Neolithic, but not to the Iron Age (Butrimas et al. 1985; Daugnora and Girininkas 1996). The zooarchaeological material has not so far been directly dated; we did not have access to it.

In the Šarnelė settlement, excavated in 1973 and 1981–1982, proportions of 39.5 or 17 % respectively of domestic animal bones were described. All of them were assigned to the Neolithic, i.e. CWC (Butrimas 1996; Rimantienė 1984), although in fact only a few CWC fragments were found. Post-corded ware pottery of the early Bronze Age predominated, which was comparable to the ceramics found at the Šventoji 9 site dating back to 2000–1700 cal BC (Piličiauskas in press). The Šarnelė settlement was lacustrine and stratified in a number of

Table 2 Direct ^{14}C dates of domestic animal bones and cultivated plant seeds from Mesolithic to Early Bronze Age sites in Lithuania

Site	Lab.code	Date BP	Calibrated age (1σ)	Sample	Reference
Daktariškė 5	Poz-71525	3,305 ± 35	1622–1531 BC	Sheep/goat mandible	This study
Šarnelė	Poz-71526	330 ± 30	AD 1495–1635	Cattle mandible	This study
Šventoji 12	Poz-61595	135 ± 35	AD 1680–1939	Sheep/goat tooth	This study
Šventoji 43	Poz-61701	95 ± 30	AD 1695–1918	Cattle tooth	This study
Šventoji 6	Poz-64676	122.8 ± 0.26 pMC	Post-bomb	*Secale cereale*, charred grain	This study
Žemaitiškė 2	Poz-61567	3,195 ± 35	1498–1437 BC	Cattle tooth	This study
Smeltė	Poz-61593	225 ± 30	AD 1646–1943	Cattle skull	Piličiauskas et al. (2015)
Kretuonas 1C	Ki-11087	3,600 ± 37	2018–1910 BC	Cattle bone	Daugnora and Girininkas (2009)
Kretuonas 1C	Ki-11086	3,600 ± 50	2023–1896 BC	Cattle bone	Daugnora and Girininkas (2009)
Kretuonas 1C	Ki-11085	3,620 ± 50	2107–1889 BC	Cattle bone	Daugnora and Girininkas (2009)
Kretuonas 1C	Ki-11084	3,580 ± 50	2015–1787 BC	Cattle bone	Daugnora and Girininkas (2009)
Kretuonas 1C	Ki-11043	3,610 ± 70	2119–1881 BC	Cattle bone	Daugnora and Girininkas (2009)

segments, however, the finds had not been collected by layer, as was also proved by the very recent date of the cattle mandible received by us (Poz-71526: 330 ± 30 BP; 1495–1635 cal AD).

Another lacustrine Subneolithic settlement from western Lithuania, Daktariškė 5, was excavated in 1986–1989 (Butrimas 1988). Here, Subneolithic pottery prevailed, although some GAC, CWC, and post-CWC items were also discovered. In some trenches, stratified layers were found; however, zooarchaeological material had not been collected by individual horizon. Its links with any specific period out of the many periods of the settlement are not clear, therefore, it is difficult to understand why the bones of domestic animals, accounting for 14 % of all the bone material, are sometimes assigned specifically to the Neolithic (Daugnora and Girininkas 1996, 1998). The sheep/goat's mandible dated by us turned out to be of the Bronze Age (Poz-71525: 3,305 ± 35 BP; 1622–1531 cal BC).

The Šventoji archaeological complex in NW Lithuania consists of about 60 archaeological sites, the majority of which date back to the Subneolithic and Neolithic (3900–2500 cal BC; Piličiauskas in press). In the Šventoji coastal Subneolithic-Neolithic sites, intermittently excavated in the period 1966 to 1998, 1,609 mammalian bone fragments were identified, including 11 assigned to domestic animals (cattle and sheep/goat) (Stančikaitė et al. 2009). Regrettably, not a single one of them was directly dated by the AMS method. We were not able to re-analyse the materials and had access only to the zooarchaeological material excavated between 2003 and 2015, as well as to a small part of the material from 1966–1998. This was mostly bone-antler tools and unprocessed bone and teeth fragments previously assigned to them. Among the 1,174 identified mammalian bone fragments, we discovered just two that definitely belonged to domestic animals. However, a sheep/goat molar tooth from the Šventoji 12 site after the direct AMS dating turned out to come from a recent village site (Poz-61595: 135 ± 35 BP; cal AD 1680–1939). A cattle molar tooth from the ploughed layer of the Šventoji 43 Subneolithic settlement also turned out to have nothing in common with the Stone Age, the AMS date also proving to be modern (Poz-61701: 95 ± 30 BP; cal AD 1695–1918). We would argue that a small number of domestic animal bones in the Šventoji Subneolithic-Neolithic sites appeared due to identification errors and mechanical transfer (bioturbation, ploughing etc.) from the subsequent layers. It is also worth noting the fact that in the Šventoji sites 2, 4, 6 and 26, where the total excavated area amounted to >6,000 m^2, not a single domestic animal bone has been found! (Stančikaitė et al. 2009). Possible errors in determining animal species can be illustrated by a shot-through harp seal's scapula, presented in Rimantienė's monograph as belonging to a wild boar (Fig. 26 in Rimantienė 2005).

Domestic animal bones were discovered in the Neolithic Nida settlement in SW Lithuania (Hollack 1895; Rimantienė 1989; Piličiauskas and Heron 2015). Here the bones and teeth of sheep/goats and cattle were sometimes found in the contexts protected from post-depositional contamination, in buried soils below the groundwater level. Unfortunately, the collagen of the majority of bones, including those of domestic animals, survived in a very poor condition which made direct dating impossible. Domestic animals in Nida can be associated with the contexts of the Neolithic Rzucewo culture and can only be dated very broadly: 3200–2400 cal BC. Bones of cattle, pigs and sheep/goats have also been detected in other Rzucewo culture settlements in the SE Baltic (Lasota-Moskalewska 1997). Here they were found in much larger numbers than at Nida. Animal husbandry therefore undoubtedly had a certain role within the economy of Neolithic coastal people.

The bones and teeth of the cattle, sheep/goat and pigs, as well as tools made from them, have been found in the CWC graves in the eastern Baltic, and especially frequently in Estonia. The Estonian CWC graves with the bones of domestic animals date back to 2800–2200 cal BC (Lõugas et al. 2007). In the Lithuanian and Latvian CWC graves, bones of wild animals and tools made from them predominate, although in grave 3 of the Benaičiai burial ground in NW Lithuania, a goat bone with cutting marks was discovered. It was dated by liquid scintillation in Kiev (Ki-10632: 2,690 ± 70; 906-801 cal BC; Merkevičius 2005); however, the AMS date of a human bone from the same grave is much older—Poz-61591: 4,040 ± 30; 2618–2491 cal BC (Piličiauskas et al. in press). We would think that the first date is likely to be wrong due to insufficient collagen cleaning, as similar AMS and conventional date discrepancies from the same contexts have also been observed in other cases (Piličiauskas and Heron 2015).

The grave goods in the CWC graves in Estonia prove that in the E Baltic in 2800–2200 cal BC, livestock was undoubtedly bred, even though the earliest direct bone dates in Lithuania belong to later periods and go back to the beginning and the first half of the second millennium cal BC (see Table 2). In Finland, the oldest direct sheep/goat date is 2200–1950 cal BC (Bläuer and Kantanen 2013).

Macrobotanical data

Remains of cultivated plants, and especially their processing waste, would be direct and irrefutable evidence of agriculture in the Subneolithic or Neolithic. Macrobotanical data from the Stone Age sites in Lithuania are still scarce. That is not surprising, as in the second half of the 20th century, when excavations of huge areas took place, no systematic investigations of the plant macroremains were carried out, and no systematic recovery was applied.

During the excavations seeds were collected by hand, and possibly some of them washed through sieves, although that was not documented. Therefore, the old collections are rather scanty and unrepresentative.

R. Rimantienė (1979, 2005) reported that several kinds of hemp seeds (*Cannabis ruderalis*, *Cannabis sativa*, *Cannabis indica?*) were discovered in the sites of the Šventoji 1A, 3, 9 and 23 Subneolithic/Neolithic and Early Bronze Age settlements. She noted that the discovered seeds differed from the contemporary hemp: "some rather primitive semi-cultivated seeds occur". She also wrote that in the Šventoji 6 Subneolithic-Neolithic site seeds of *Setaria italica* (foxtail millet) and *Triticum dicoccum* (emmer) were discovered (Rimantienė 1996). Moreover, among the finds in the Šventoji 23 settlement a hemp string was described, and its photograph presented in the publication (Rimantienė 1979, Fig. 53). The seeds, or at least a part of them, were identified by the biologist and pharmacist, medicinal plant specialist Dr. Eugenija Šimkūnaitė (Rimantienė 2005). Regrettably, the identification criteria of the cultivated plants discovered in Šventoji were not described, the reference materials were not specified, and also the accurate findspots of the seeds, the depths, layers or horizons were not noted.

In 2014, we failed to find a hemp (?) string in the National Museum of Lithuania where all the Šventoji archaeological materials are stored. The seeds from the Šventoji excavations were found carefully placed into several glass vials. We expected to find the most valuable ones, i.e. the seeds of cultivated plants, to have been collected and stored. However, it turned out that most of the seeds belonged to wild plants, and the only charred *Secale cereale* (rye) grain was found in the Šventoji 6 site (see Table 3). *Secale* grains were not mentioned in the publications; however, the found grain was charred and therefore difficult to identify, and it was perhaps possible to make a mistake and to call it hulled wheat (Rimantienė 1996). After the direct dating of the *Secale* grain, it turned out to belong not to the Subneolithic or Neolithic but to modern times, grown in the 20th century after the first atomic explosions (Poz-64676: 122.8 ± 0.26 pMC). The dating confirmed that cultivated plant seeds could get into an archaeological layer from the surface layers due to bioturbation or due to gyttja cracking from over drying. That is especially likely in the case of the Šventoji 23, 1A and 6 sites, where archaeological finds did not lie that deep, at a depth of 0.5 to 0.7 meters only and very close to the ploughing horizon. The possibility of errors in the identification of cultivated plants also should not be dismissed. Foxtail millet *Setaria italica* does not belong to the package of plants domesticated in SW Asia. It was first grown in northern China and arrived in central Europe as late as 2000–1500 cal BC. *Cannabis* came from Central Asia and appeared in Europe during the first millennium BC, and in northern Europe, in the Roman period (Zohary et al. 2012). Thus, in the European context, the finds mentioned above from Šventoji seem to be extremely old.

The doubts about the previous macrobotanical investigations in the Stone Age settlements are further enhanced by the case of the Šarnelė settlement. As reported, during the excavations of 1973, *Cannabis* seeds were discovered in the Neolithic layer (Butrimas 1996); however, the two seeds discovered in the test tube in the National Museum of Lithuania belonged to a wild water plant—*Nuphar lutea* (yellow water-lily).

We have to admit that at present in Lithuania we do not have reliably identified and dated crop remains from the Stone Age. The charred *Panicum miliaceum* (broomcorn millet) grains collected in the Turlojiškė settlement of the late Bronze Age seem to be the oldest find: Ua-16681: 2,590 ± 75 BP; 830–550 cal BC (Antanaitis and Ogrinc 2000). However, the first cultivated plants may have appeared earlier, together with domestic animals and the onset of the CWC. As mentioned in archaeological literature, charred barley grain was found in the CWC pottery of the Yru settlement in northern Estonia (Kriiska 2001). On the Curonian Spit, or, more exactly, in Nida and at Pilkopa, *Hordeum* (barley) and *Triticum dicoccum* grain imprints in pottery were described (Heydeck 1909). The Rzucewo culture pottery in the SE corner of the Baltic is very close to the GAC pottery in Central Europe; these regions are closely related by the amber trade, therefore it would not seem strange that the Rzucewo people were getting grain from the neighbouring or even more distant lands. However, the question of whether they were growing their own crops on the spit is more complex; it is necessary to find not only the grains, but also grain processing waste.

Table 3 The species analysis outcomes of plant seeds collected in the Šventoji 4 site in the period of 1986 to 1995 and in the Šventoji 6 site in the period of 1982 to 1988 and stored in the National Museum of Lithuania

Site	Plant species	Number
Šventoji 4	*Galeopsis tetrahit*-type	171
	Schoenoplectus lacustris (L.) Palla	21
	Nuphar lutea Sm.	13
	Persicaria lapathifolia (L.) Gray	9
	Ceratophyllum demersum L.	7
	Humulus lupulus L.	4
	Nymphaea alba L.	1
	Sparganium cf. *emersum* Rehmann	1
Šventoji 6	*Secale cereale* L.[a] (charred)	1
Šarnelė	*Nuphar lutea* Sm.	2

[a] Proved to be contemporary after the direct AMS dating

Pollen data

Pollen data seem to form a crucial basis to the CSF in the eastern Baltic. In fact, one can find a considerable collection of palynological records across the region that testify to agriculture in the Subneolithic (Poska 2001; Stančikaitė et al. 2002; Antanaitis-Jacobs and Stančikaitė 2004; Alenius et al. 2013). However, Lahtinen and Rowley-Conwy (2013) pointed out that the supposed earliest farming was usually suggested by only single pollen grains which could have been wrongly identified, transported by storms from distant regions, or had got into the sample through contamination. Moreover, the authors also pointed out that the pollen core chronologies might be increased in apparent age by several hundred to several thousand years due to the freshwater reservoir effect (FRE), if bulk samples of the lacustrine sediments were dated. This latter argument seems to us of particular relevance, as the dating of bulk samples of lake gyttja totally predominates in the work of Lithuanian palynologists. Single plant remains were dated in extremely rare cases, and even then it was not quite clear whether those were aquatic or terrestrial plants (cf. Stančikaitė et al. 2006).

Thus, what are the arguments of palynologists for Subneolithic agriculture in Lithuania? First of all, we discuss the pollen diagrams of SE Lithuania from the former Pelesa and Dūba Lakes (Stančikaitė et al. 2002). A number of settlements are known on the shores of both lakes, dating back to the period from the end of the Palaeolithic to the Iron Age. The palynological samples were taken from borehole cores every 5 or 10 cm. The sediments of Pelesa Lake with single Cerealia-type pollen date back to ca. 5500, 4900, 3900 cal BC, and with a single *Avena*-type pollen grain from the Dūba Lake, ca. 4800 cal BC. In the latter, *Avena*-type pollen was undetectable in any later sample from the same borehole. In both sections, more Cerealia pollen only appears from ca. 2200 cal BC onwards. Lahtinen and Rowley-Conwy (2013) have already argued that single pollen grains cannot be regarded as evidence of early agriculture. Moreover, the chronology of the boreholes at the Dūba and Pelesa Lakes was based on radiocarbon dates of bulk samples of the lacustrine sediments (dates 3 and 4, respectively). Some of them were obtained for carbonaceous gyttja. All dates of bulk samples, especially of carbonaceous gyttja, can be increased in apparent age due to the FRE by several hundred or even several thousand years, as proved by a variety of freshwater reservoir research in Great Britain, northern Germany, Latvia and Lithuania (Keaveney and Reimer 2012; Fernandes et al. 2013, 2014; Philippsen and Heinemeier 2013; Meadows et al. 2014; Piličiauskas and Heron 2015). Single cereal-type pollen grains were also sometimes assigned to the Subneolithic layers in other lakes in SE Lithuania, namely Pelesa, Glūkas and Varėnis (Fig. 3.5 in Kabailienė and Stančikaitė 2001). However, radiocarbon dating was not applied to those sections (Kabailienė et al. 2001) and therefore they cannot be used in search of the oldest evidence of agriculture.

How the FRE could contribute to the creation of the CSF myth when bulk samples of the lacustrine sediments were dated was perfectly illustrated by an example from the Šventoji 4 lacustrine fishing site. *Triticum*- and *Hordeum*-type pollen was discovered in the upper part of the archaeological B horizon, at a depth of approximately 1.6 m (Stančikaitė et al. 2009). For the dating of the pollen column, two dates of the bulk organics were obtained: T-13523a: 4,545 ± 80 BP (0.62–0.64 m depth) and T-13524a: 4,930 ± 55 BP (1.8–1.82 m depth). The date of the fish bones collected at a similar depth of 1.8 m (TUa-2076: 4,875 ± 65 BP) turned out to be statistically the same as the sediment date. On the basis of these dates, the first cereal pollen was dated back to the Subneolithic, around 3600 cal BC (Stančikaitė et al. 2009). However, as proved by the recent studies of the Šventoji 4 site, Šventoji lagoonal lake was characterised by FRE ageing of between 320 ± 42 and 510 ± 72 years (Piličiauskas and Heron 2015), which undoubtedly increased the age of the gyttja and fish bones radiocarbon dates that served as a basis for the pollen sample column dating. We also know that, in accordance with the terrestrial plant dates, the Šventoji 4B layer dated to 3110/3000-3020/2930 cal BC (Piličiauskas in press), which means that the oldest cereal pollen grains, provided they were identified correctly and were contemporaneous with the gyttja layer where they were found, should belong to a period not earlier than 3000 cal BC. Although the general change from the Subneolithic pottery into the Neolithic at Šventoji dates back to only 2700 cal BC, judging by the archaeological data from the surrounding territories (e.g. Biržulis Lake, Nida), the first Neolithic GAC, or possibly also CWC, groups might have appeared in the region earlier, around 3000 cal BC.

Biržulis Lake is another Lithuanian freshwater reservoir, and we have some data about its FRE. By comparing ^{14}C AMS dates from the herbivorous animals and from people, whose diet largely consisted of aquatic food, from the same graves, it was established that the FRE of Biržulis Lake in the Mesolithic was minimal (Piličiauskas and Heron 2015). During the palynological analysis, the Cerealia-type pollen was discovered in the layer which was dated on the basis of the macroremain of an unidentified plant to TUa-2018: 4,385 ± 75 BP (3260–2905 cal BC) (Stančikaitė et al. 2006). Even if that was a former water plant, a minimal FRE was to be expected. It is important that in this region the Cerealia-type pollen is also contemporaneous with the appearance of the Neolithic, but not the Subneolithic, pottery (in this case GAC) that dates back to 3015–2920 cal BC (Fig. 7:1 in Piličiauskas 2012).

Archaeological data: farming tools

Identification of tools used in agriculture is a complicated task in Stone Age studies, as tools similar to contemporary ones or to those of historical times could have been used in pre-history for totally different activities.

Strong evidence of agriculture would be flint sickles and stone hoes with a hole for the handle. However, sickle blades with a characteristic gloss from crop reaping are extremely rare in Lithuania. Only two flint sickle blades are known, discovered in the Gribaša 4 settlement in SE Lithuania (Fig. 18:10–11 in Grinevičiūtė 2002). The settlement was an unstratified multicomponent site, and the chronology of the sickle blades was not clear, possibly Bronze Age as was suggested by the pottery types found there. Stone hoes were usually found by chance, and the majority possibly also belonged to the Bronze Age (Bagušienė and Rimantienė 1974). Moreover, they could have been used not only for agricultural purposes, but also for gathering wild plants or digging. One of the most important agricultural tools would be stone mortars and pestles, however, in Lithuania they are only known in Bronze Age contexts, as are bronze sickles (Grigalavičienė 1995).

Wooden digging sticks and hoes from Lithuanian and Latvian Subneolithic lacustrine sites are considered to be evidence of early agriculture (Vankina 1970; Loze 1988; Rimantienė 2005). Three digging sticks were found only in the Šventoji 6 Subneolithic-Neolithic site. They had points with wear marks, as well as a step in the lower part, possibly to rest a foot when pressing the stick into the ground (Fig. 3). Most likely the tools were really used to dig the ground, however, their relationship to agriculture remained unclear. They were found at fishing sites unsuitable for agriculture, far from the shore. Perhaps one may speculate that they were used for cultivating *Trapa natans* (water chestnut) whose plentiful fruit, including some charred examples, were found in the Subneolithic and Neolithic horizons of the Šventoji fishing sites.

Wooden hoes were made from a branch of a tree by rounding and flattening the stem part (Fig. 4). They were found in the Šventoji 23 Subneolithic settlement, as well as in the Subneolithic horizons of the Šventoji 1, 3, 4 and 6 fishing sites. The same type was discovered in the Subneolithic contexts in Sārnate and Zvidze, Latvia (Vankina

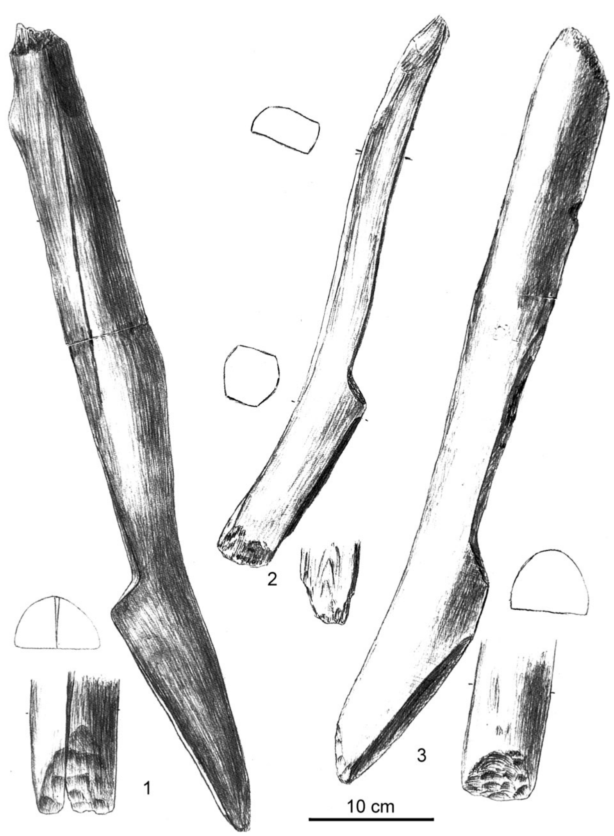

Fig. 3 Wooden digging sticks found at Šventoji 6 Subneolithic-Neolithic site. After Rimantienė (2005)

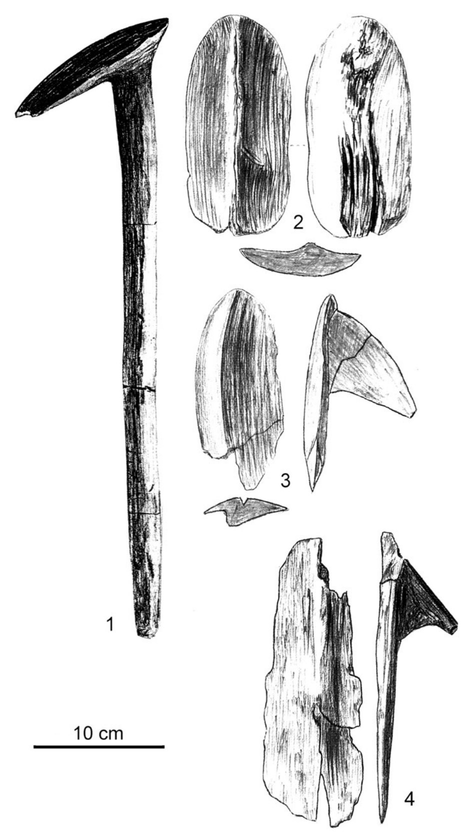

Fig. 4 Wooden hoes found at the lower Subneolithic horizon at Šventoji 1 site (1) and at Šventoji 6 Subneolithic-Neolithic site (2–4). After Rimantienė (2005)

1970; Loze 1988; Rimantienė 2005). The heads of the hoes formed a relatively acute angle (around 50°) with the handles; therefore, it was impossible to hoe with them in a standing position. Moreover, the heads of the hoes were often thin and did not have any macro-wear signs, which made one doubt whether they had ever been used to dig the ground. The interpretation of the 'oxen yoke model', proposed for a wooden artefact from the Šventoji 2/4 fishing site, does not seem convincing (Fig. 152:1 in Rimantienė 2005). The archaeological analogies presented come from distant lands to the south; moreover, they were much smaller stylised ceramic and bronze figures of harnessed oxen, but not yoke models (Rimantienė 2005). Unfortunately, we cannot offer any alternative interpretation for the same reason: the absence of archaeological, historical and ethnographic analogies.

Conclusions

After the review of the 'facts' testifying to Subneolithic or pre-Neolithic low intensity agriculture and husbandry in the territory of Lithuania, it becomes clear that the smaller part of them cannot be verified (macroremains of cultivated plants have not been preserved in the collections?), and the larger part have appeared due to incorrect identification of the plant and animal species or incorrect dating of cultivated plant remains and domestic animal bones. Dating errors occurred due to neglect of the fresh water reservoir effect when dating bulk samples from lacustrine sediments, due to neglect of the phenomena of palimpsest and bioturbation in the formation of a cultural layer, and due to insufficient attention to stratigraphy and spatial find documentation during large scale archaeological excavations in the second half of the 20th century.

No credible evidence exists to attest animal husbandry and/or crop growing in Lithuania before the appearance of Neolithic cultures around 3200/2700 cal BC, however, this does not mean that such evidence will not appear in the future. It is necessary to continue direct dating of the bones of assuredly domestic animals from Subneolithic contexts, as at present only a small part of them have been checked out. To date, domestic animal bones from the Kretuonas 1B and some Šventoji settlements have not been dated.

The possibilities of macrobotanical analysis have been especially poorly used to understand the process of neolithisation. Mostly wetland sites, and frequently fishing sites, have been investigated to a degree, yet it was difficult to expect agricultural residues from them. As proved by archaeological excavations in Central and Western Europe, as well as by the distribution of single stone axes typical of the Neolithic GAC and CWC cultures, the Stone Age agricultural settlements could have existed in higher areas, further away from wet lakeshores favoured by hunter-gatherers. They could be detected by means of detailed surface survey or mechanised removal of the vegetation layer during large infrastructural projects, while the filling of the recessed structures should be analysed macrobotanically. Regrettably, to date, no such studies have been carried out in Lithuania and Latvia.

The outcomes of palynological analyses will continue to be worthless for understanding the process of neolithisation in eastern Baltic region, provided bulk lacustrine sediment samples continue to be dated, while the FRE that can significantly age the dates remains unknown. In future, high resolution pollen diagrams are needed, with AMS-^{14}C dating of terrestral macroremains from the sediments and careful consideration of the Cerealia-type pollen as proposed recently by Feeser et al. (2016).

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References

Alenius TH, Mökkönen TO, Lahelma A (2013) Early farming in the Northern Boreal Zone: re-assessing the history of land use in south-eastern Finland through high-resolution pollen analysis. Geoarchaeology 28:1–24

Antanaitis I (1999) Concerning the transition to farming in the East Baltic. Documenta Praehistorica 26:89–100

Antanaitis I, Ogrinc N (2000) Chemical analysis of bone: stable isotope evidence of the diet of Neolithic and Bronze Age people in Lithuania. Istorija 45:3–12

Antanaitis-Jacobs I, Girininkas A (2002) Periodization and chronology of the Neolithic in Lithuania. Archaeologia Baltica 5:9–39

Antanaitis-Jacobs I, Stančikaitė M (2004) Akmens ir bronzos amžiaus gyventojų poveikis aplinkai ir jų ūkinė veikla Rytų Baltijos regione archeobotaninių tyrimų duomenimis. Lietuvos archeologija 25:251–266

Antanaitis-Jacobs I, Richards M, Daugnora L, Jankauskas R, Ogrinc N (2009) Diet in early Lithuanian prehistory and the new stable isotope evidence. Archaeologia Baltica 12:12–30

Bagušienė O, Rimantienė R (1974) Akmeniniai gludinti dirbiniai. In: Rimantienė R (ed) Lietuvos TSR archeologijos atlasas 1 Akmens ir žalvario amžiaus paminklai. Mintis, Vilnius, pp 84–205

Berggren G (1969) Atlas of seeds and small fruits of Northwest-European plant species with morphological descriptions. Part 2: Cyperaceae. Berlingska Boktryckeriet, Lund

Berggren G (1981) Atlas of seeds and small fruits of Northwest-European plant species with morphological descriptions. Part 3: Salicaceae–Cruciferae. Berlings, Arlöv

Bläuer A, Kantanen J (2013) Transition from hunting to animal husbandry in Southern, Western and Eastern Finland: new dated osteological evidence. J Archaeol Sci 40:1,646–1,666

Brazaitis D (2002) Narviškos keramikos stiliai rytų Lietuvoje. Lietuvos archeologija 23:51–72

Brock F, Higham T, Ditchfield P, Bronk Ramsey C (2010) Current pretreatment methods for AMS radiocarbon dating at the Oxford Radiocarbon Accelerator Unit (ORAU). Radiocarbon 52(1):103–112

Bronk Ramsey C (2009) Bayesian analysis of radiocarbon dates. Radiocarbon 51:337–360

Bronk Ramsey C, Higham T, Bowles A, Hedges R (2004) Improvements to the pretreatment of bone at Oxford. Radiocarbon 46:155–163

Butrimas A (1988) Daktariškės 5-osios neolito gyvenvietės tyrinėjimai. Archeologiniai tyrinėjimai Lietuvoje 1988 ir 1989 metais:7–9

Butrimas A (1996) Šarnelės neolito gyvenvietė. Lietuvos archeologija 14:174–191

Butrimas A, Kunskas R, Česnys G, Balčiūnienė I, Jankauskas R (1985) Duonkalnis: vėlyvojo neolito gyvenvietė, alkas ir kapinynas. Lietuvos Archeologija 4:25–66

Cappers RTJ, Bekker RM, Jans JEA (2006) Digital seed atlas of the Netherlands. Barkhius Publishing and Groningen University Library, Groningen

Craig OE, Steele VJ, Fischer A, Hartz S, Andersen SH, Donahue P, Glykou A, Saul H, Jones DM, Koch E, Heron C (2011) Ancient lipids reveal continuity in culinary practices across the transition to farming in Northern Europe. Proc Natl Acad Sci USA 108:17,910–17,915

Daugnora L, Girininkas A (1996) Osteoarcheologija Lietuvoje. Savastis, Vilnius

Daugnora L, Girininkas A (1998) Stock breeding in the Baltic Culture area. Archaeologia Baltica 3:223–234

Daugnora L, Girininkas A (2004) Rytų Pabaltijo bendruomenių gyvensena XI–II tūkst. pr. Kr. Kaunas, Lietuvos veterinarijos akademijos leidykla

Daugnora L, Girininkas A (2009) Butchery in the Early Bronze Age. Archaeologia Baltica 12:46–56

Feeser I, Dörfler W, Czymzik M, Dreibrodt S (2016) A mid-Holocene annually laminated sediment sequence from Lake Woserin: the role of climate and environmental change for cultural development during the Neolithic in Northern Germany. Holocene 26:947–963

Fernandes R, Dreves A, Nadeau MJ, Grootes PM (2013) A freshwater Lake Saga: carbon routing within the aquaticfood web of Lake Schwerin. Radiocarbon 55:1,102–1,113

Fernandes R, Rinne C, Nadeau M-J, Grootes P (2014) Towards the use of radiocarbon as a dietary proxy: establishing a first wide-ranging radiocarbon reservoir effects baseline for Germany. Environ Archaeol. doi:10.1179/1749631414Y.0000000034

Girininkas A (2004) Žemaitiškės 2-oji polinė gyvenvietė. Istorija 62:26–32

Grigalavičienė E (1995) Žalvario ir ankstyvasis geležies amžius Lietuvoje. Mokslo ir enciklopedijų leidykla, Vilnius

Grigas A (1986) Lietuvos augalų vaisiai ir sėklos. Mokslas, Vilnius

Grinevičiūtė G (2002) Gribašos 4-oji akmens amžiaus gyvenvietė. Archaeologia Lituana 3:5–33

Herva V-P, Nordqvist K, Lahelma A, Ikäheimo J (2014) Cultivation of Perception and the Emergence of the Neolithic World. Nor Archaeol Rev 47:141–160

Heydeck J (1909) Kultur- und Wohnstätten der Steinzeit in Ostpreussen. Sitzungsberichte der Altertumsgesellschaft Prussia 22:202–206

Hollack E (1895) Bericht des Herrn Lehrer Hollack über seine Untersuchungen und Ausgrabungen auf der Kurischen Nehrung. Sitzungsberichte der Altertumsgesellschaft Prussia 19:146–161

Kabailienė M, Stančikaitė M (2001) Akmens amžiaus žemdirbystės ir gyvulininkystės raida pagal paleobotaninių tyrimų duomenis. In: Baltrūnas V et al (eds) Akmens amžius pietų Lietuvoje. Geologijos Institutas, Vilnius, pp 218–225

Kabailienė M, Stančikaitė M, Ūsaitytė D (2001) Paleoekologinių tyrimų rezultatai. In: Baltrūnas V et al (eds) Akmens amžius pietų Lietuvoje. Geologijos Institutas, Vilnius, pp 146–167

Keaveney EM, Reimer PJ (2012) Understanding the variability in freshwater radiocarbon reservoir offsets: a cautionary tale. J Archaeol Sci 39:1,306–1,316

Kriiska A (2001) Stone Age settlement and economic processes in the estonian coastal area and islands. Dissertation, University of Helsinki. https://helda.helsinki.fi/bitstream/handle/10138/19475/tekstid/01.html. Accessed 28 Nov 2015

Kriiska A (2003) From hunter-fisher-gatherer to farmer—changes in the Neolithic economy and settlement on Estonian territory. Archaeologia Lituania 4:11–26

Kriiska A (2009) The beginning of farming in the eastern Baltic Area. In: Dolukhanov PM et al. (eds) The east European plain on the eve of agriculture. BAR International Series 1964. Archaeopress, Oxford, pp 159–179

Lahtinen M, Rowley-Conwy P (2013) Early farming in Finland: was there cultivation before the Iron Age (500 B.C.?). Eur J Archaeol 16:660–684

Lasota-Moskalewska A (1997) Animal remains from the Neolithic settlement at Rzucewo. In: Król D (ed) The built environment of coast areas during the Stone Age. Regional Centre for Studies and Preservation of Built Environment in Gdańsk, Gdańsk, pp 162–166

Longin R (1971) New method of collagen extraction for radiocarbon dating. Nature 230:241–242

Lõugas L, Kriiska A, Maldre R (2007) New dates for the Late Neolithic Corded Ware Culture burials and early husbandry in the East Baltic region. Archaeofauna 16:21–31

Loze IA (1988) Poseleniya kamennogo veka Lubanskoj niziny. Mezolit, rannij i srednij neolit Zinatne, Riga (in Russian)

Loze I (2001) Neolīts 4500.–1500. g. pr. Kr.. In: Mugurēvičs Ē, Vasks A (eds) Latvijas senākā vēsture: 9. g. t. pr. Kr. – 1200. g.. Latvijas vēstures institūta apgāds, Rīga, pp 74-115

Meadows J, Lübke H, Zagorska I, Bērziņš V, Ceriņa A, Ozola I (2014) Potential freshwater reservoir effects in a Neolithic shell midden at Riņņukalns, Latvia. Radiocarbon 56:823–832

Merkevičius A (2005) Benaičių kapinynas ir senovės gyvenvietė. Archeologiniai tyrinėjimai Lietuvoje 2002 metais:10–12

Nordqvist K, Herva V-P (2013) Copper use, cultural change and Neolithization in north-eastern Europe. Eur J Archaeol 16:401–432

Philippsen B, Heinemeier J (2013) Freshwater reservoir effect variability in northern Germany. Radiocarbon 55:1,085–1,101

Piličiauskas G (2012) Lietuvos neolito ir ankstyvojo metalų laikotarpio chronologija naujų radiometrinių datų šviesoje. Lietuvos archeologija 38:11–52

Piličiauskas G (in press) Lietuvos pajūrio subneolitas ir neolitas. Žemės ūkio pradžia [Subneolithic and Neolithic of coastal Lithuania. The beginning of farming]. Lietuvos Archeologija 42

Piličiauskas G, Heron C (2015) Aquatic Radiocarbon Reservoir Offsets in the Southeastern Baltic. Radiocarbon 57:539–556

Piličiauskas G, Luik H, Piličiauskienė G (2015) Reconsidering Late Mesolithic and Early Neolithic of the Lithuanian coast: the Smeltė and Palanga sites. Est J Archaeol 19:3–28

Piličiauskas G, Piličiauskienė G, Jankauskas R, Dupras T (in press) Reconstructing Subneolithic and Neolithic diets of the inhabitants of the SE Baltic coast (3200–2500 cal BC) using stable isotope analysis. Archaeological and Anthropological Sciences. In: Fernandes R (ed) Isotopes in archaeology

Piotrowska N, Goslar T (2002) Preparation of bone samples in the Gliwice radiocarbon laboratory for AMS radiocarbon dating. Isot Environ Health Stud 38:1–9

Poska A (2001) Human impact on vegetation of coastal Estonia during the Stone Age (Comprehensive summaries of Uppsala dissertations from the Faculty of Science and Technology). Uppsala Universitet, Uppsala

Reimer PJ, Bard E, Bayliss A et al (2013) IntCal13 and Marine13 radiocarbon age calibration curves 0–50,000 years cal BP. Radiocarbon 55:1,869–1,887

Richards MP, Schulting RJ, Hedges REM (2003) Sharp shift in diet at onset of Neolithic. Nature 425(6956):366

Rimantienė R (1979) Šventoji. Narvos kultūros gyvenvietės. Mokslas, Vilnius

Rimantienė R (1984) Akmens amžius Lietuvoje. Mokslas, Vilnius

Rimantienė R (1989) Nida: senųjų baltų gyvenvietė. Mokslas, Vilnius

Rimantienė R (1996) Šventosios 6-oji gyvenvietė. Lietuvos archeologija 14:83–173

Rimantienė R (2005) Die Steinzeitfischer an der Ostseelagune in Litauen. Litauisches Nationalmuseum, Vilnius

Sørensen L, Karg S (2014) The expansion of agrarian societies towards the north a new evidence for agriculture during the Mesolithic/Neolithic transition in Southern Scandinavia. J Archaeol Sci 51:98–114

Stančikaitė M, Kabailienė M, Ostrauskas T, Guobytė R (2002) Environment and man around Lakes Dūba and Pelesa, SE Lithuania, during the Late Glacial and Holocene. Geol Q 46:391–409

Stančikaitė M, Baltrūnas V, Šinkūnas P, Kisielienė D, Ostrauskas T (2006) Human response to the Holocene environmental changes in the Biržulis Lake region, NW Lithuania. Quat Int 150:113–129

Stančikaitė M, Daugnora L, Hjelle K, Hufthammer AK (2009) The environment of the Neolithic archaeological sites in Šventoji, Western Lithuania. Quat Int 207:117–129

Vankina LV (1970) Torfyanikovaya Stoyanka Sarnate. Zinatne, Riga **(in Russian)**

Zohary D, Hopf M, Weiss E (2012) Domestication of plants in the Old World, 4th edn. University Press, Oxford

Zvelebil M (1996) The agricultural frontier and the transition to farming in the circum-baltic area. In: Harris D (ed) The origin and spread of pastoralism in Eurasia. UCL Press, London, pp 323–345