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Liber Augustus, Vižinada, 2 stoljeće / 2nd century
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Tjaša TOLAR, Anton VELUŠČEK

DISCOVERY OF FLAX (*LINUM USITATISSIMUM*) AT LJUBLJANSKO BARJE, SLOVENIA

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During the excavation of the Eneolithic pile-dwelling settlements from the second half of the 4th millennium BC at Stare gmajne at the Ljubljansko barje in 2007, domestication of flax (*Linum usitatissimum*) was approved for the first time in Slovenia. Flax remains (capsule fragments and seeds) were found due to the use of an appropriate method. The new archaeobotanical method M3 consists of: systematically taken samples (soil from cultural layers), keeping the soil in wet condition before sieving, carefully and gently washing over the material with flotation, keeping the sieved fractions (1 mm and 0.355 mm mesh sizes of sieves) wet, examination and identification of plant remains in wet conditions under stereomicroscope.

Key words: Archaeobotany, Flax, Ljubljansko barje, Pile-dwelling, Eneolithic

Ljubljansko barje and its pile-dwelling settlements

The Ljubljansko barje is a marshland situated on the outskirts of the South-Eastern Alps in Central Slovenia. It is known by its pile-dwelling settlements. The earliest among them are dated to the 5th millennium BC, while the best researched originate from the 4th and the 3rd millennium. Two of them were detected at the Stare gmajne site.¹

The Stare gmajne site was discovered more than 10

years ago and it became famous by the discovery of a wooden wheel and an axle. However, dendrochronologists have revealed two separate building phases, in fact two different villages. The oldest settlement is dated to the second half of 34th century BC, while the second phase of the occupation should be set to the 32nd century.²

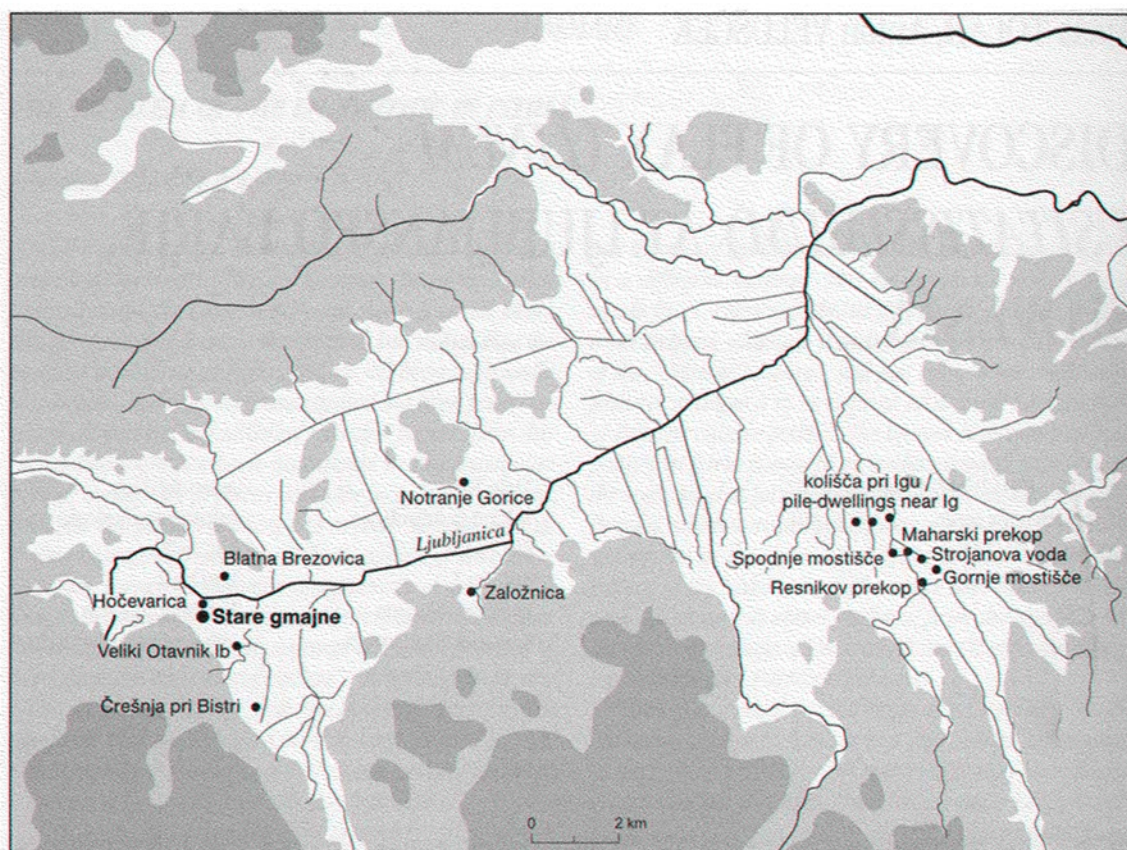
This article focuses on flax (*Linum usitatissimum*) remains which were found in the layers of both pile-dwelling settlements that once existed at Stare gmajne site.

¹ VELUŠČEK 2009, in press

² VELUŠČEK 2009, in press

Fig. 1. Better researched pile-dwelling settlements of the Ljubljansko barje. Prepared by T. Korošec.

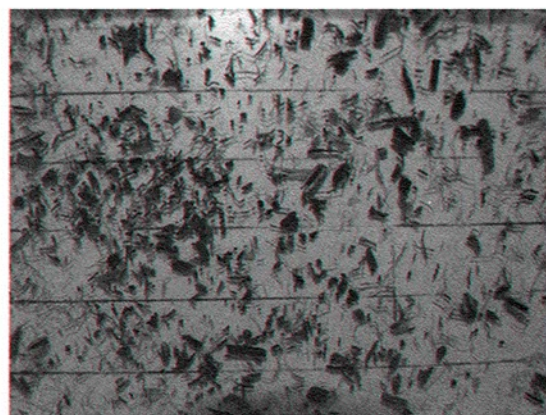
Fig. 2. Very rich wet archaeobotanical samples.



The importance of archaeobotany at pile-dwelling (waterlogged) settlements

The preservation of the settlement layers at pile-dwellings is excellent, due to waterlogging.^{3,4,5,6} Therefore, the knowledge of the economy and daily life in general between c. 4300 and 2500 cal BC is rather good, compared with other sites.^{7,8} Pile-dwellings are well known for their excellent waterlogged preservation of the plant materials, that also include carbonised remains,^{9,10} while from the sites located on mineral soils only carbonised plant material is available. Cereals and pulses are generally well represented even in the absence of preservation by waterlogging because there is a greater likelihood that they will come into contact with fire and become carbonised. The contrary is the case with flax and opium poppy seeds; they burn easily because they contain oil and are preserved only rarely in a recognizable form.^{11,12} More significantly, their remains are very fragile and likely become damaged during processing procedures (e.g.^{13,14}). There are many millions of seed remains preserved under waterlogged conditions (Fig. 2).

However, the state of research of waterlogged settlements is not always as excellent as it seems to



be at the first sight because the methods used are not appropriate.^{15,16,17} The pile-dwelling site Stare gmajne was the first investigated waterlogged site in Slovenia where comparable archaeobotanical method, that was found to be the most appropriate for Swiss and German lakeshore settlements, was used.^{18,19,20,21}

The new method was tested for the first time during the 2007 excavation at Stare gmajne site at Ljubljansko barje.²² Such an investigation (testing different recovery techniques) was made because it was not known which parts of plant taxa and remain types were lacking or completely underrepresented due to the application of an inappropriate method (for details see ref.²³). We

³ JACOMET 2004., XI
⁴ JACOMET 2007., XIV
⁵ JACOMET 2009., p. 47-59
⁶ TOLAR ET AL. 2009., on-line first
⁷ JACOMET 2004., XI
⁸ JACOMET 2009., p. 47-59
⁹ JACOMET 2004., XI
¹⁰ JACOMET 2007., XIV
¹¹ JACOMET ET AL. 1989., 348 pp.
¹² JACOMET 2004., XI
¹³ JACOMET - KREUZ 1999., VI
¹⁴ TOLAR ET AL. 2009., on-line first
¹⁵ JACOMET - KREUZ 1999., VI
¹⁶ JACOMET 2004., XI
¹⁷ TOLAR ET AL. 2009., on-line first
¹⁸ JACOMET - KREUZ 1999., VI
¹⁹ MAIER 2001., p. 9-384
²⁰ JACOMET 2004., XI
²¹ TOLAR ET AL. 2009., on-line first
²² TOLAR ET AL. 2009., on-line first
²³ TOLAR ET AL. 2009., on-line first



Fig. 3. The applied methods: a) rough washing in the field (M1, M2), b) dried material after sieving (M1) with hard and lignified (dried) seed of *Rubus*, c) gentle washing with flotation (M3), d) wet material (M2, M3) with fragile and soft (waterlogged) seed of *Oenanthe*.

compared three methods for the investigation of botanical macroremains (Fig. 3): Method 1 (M1) included rough wet-sieving and subsequent drying, method 2 (M2) rough wet sieving and keeping the fractions wet, and method 3 (M3) washing over (flotation) and keeping the fractions wet. M3 with gentle washing, systematic subsampling, examination, and sorting of macroremains in wet condition gave the best results (for details see ref. ²⁴).

The recommended smallest mesh size is 0.355 mm.²⁵ When using M2 or M1, seeds of taxa like *Linum*, *Papaver* and *Brassica*, uncarbonized chaff of *Cerealia*, pericarps of *Maloideae* and *Quercus*, which are all thin and fragile, were underrepresented or lacking. On the contrary, taxa like *Cornus*, *Corylus*, *Rubus*, *Quercus-cupulae*, *Chenopodium*, *Physalis*, *Shoenoplectus* with lignified seed/fruit walls were overrepresented when using M2 and particularly M1 method.²⁶ When using a mesh sieve with the smallest fraction of 1 mm, taxa with smaller seeds/

fruits were underrepresented (e.g. *Papaver*, *Brassicaceae*) or even lacking (e.g. *Urtica cf. dioica*, *Mentha arvensis/aquatica*, *Lythrum*, *Eupatorium cannabinum*, *Characeae*, *Verbascum/Scrophularia*, *Camelina microcarpa*, *Arenaria serpyllifolia*).²⁷ The application of M3 instead of M1, which has been traditionally used in Slovenian archaeobotany until now,²⁸ helped us to determine the uncarbonized remains of *Linum* for the first time within the prehistoric wetland settlements of Slovenia.

Discovery of Flax (*Linum usitatissimum*) and its significance

The discovery of flax (*Linum usitatissimum*) is very important, while flax is known to be one of the most important first cultivated plants, besides cereals (barley and wheat).²⁹ Flax remains are present in very large amounts in many Neolithic waterlogged settlements, also

²⁴ TOLAR ET AL. 2009., on-line first

²⁵ TOLAR ET AL. 2009., on-line first

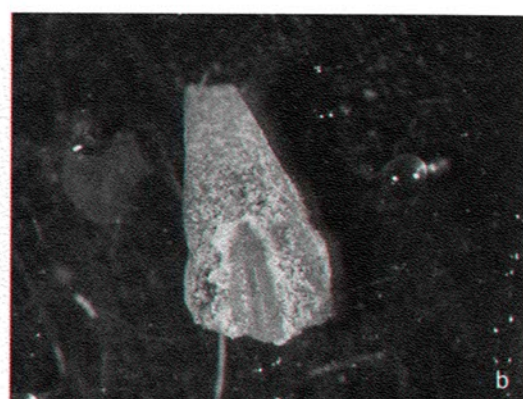
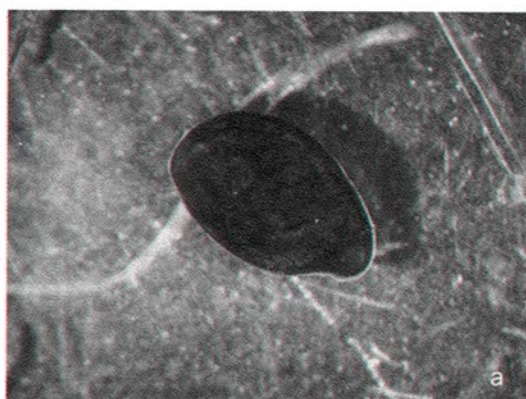
²⁶ TOLAR ET AL. 2009., on-line first

²⁷ TOLAR ET AL. 2009., on-line first

²⁸ JERAJ ET AL. 2009., p. 78-79

²⁹ JACOMET 2004., XI

Fig. 4. The remains of *Linum usitatissimum*: a) seed and b) capsule remain from Stare gmajne site (excavation 2007).



due to the good preservation in the waterlogged layers (e.g. Ödenahlen, Arbon Bleiche 3).^{30,31,32,33,34,35,36}

From the lakeshore dwellings north of the Alps several cereal species (*Triticum monococcum* (einkorn), *Triticum dicoccum* (emmer), *Hordeum vulgare* (barley)) and three other domestic plant taxa are known: *Pisum sativum* (pea), *Papaver somniferum* (opium poppy) and *Linum usitatissimum* (flax).^{37,38} All these plants were also discovered at Stare gmajne site, due to the use of an appropriate method.^{39,40,41}

Between 3500 and 2400 cal. BC considerable changes are observed in the abundance of cultivated plants in the northern Alpine foreland.⁴² The importance of tetraploid naked wheat (*Triticum durum*) and opium poppy (*Papaver somniferum*) declines whereas that of glume wheat (mainly *Triticum dicoccum*) and flax (*Linum usitatissimum*) increases progressively.^{43,44} In the north it even appears to have been specialised flax-growing settlements, as it was proposed for the Federsee region.^{45,46} Flax remains are not only in the form of seeds, but also capsule and stem fragments.

The state of research in the regions south of the Alps is much poorer,⁴⁷ but the discovery of flax remains in Slovenian Eneolithic pile-dwelling settlements allows us to hypothesize that the flax was also important in this area.

The use of Flax

Flax (*Linum usitatissimum*) was the principal oil and fibre source in the Old World and probably the earliest cultivated plant used for weaving clothes.^{48,49} Flax fibres are stronger than cotton or wool and were the principal vegetable fibre used for weaving textiles in Europe and western Asia.⁵⁰ The seed contains about 40 percent oil and was used as a source for edible oil and high-grade lighting oil.⁵¹

Flax is represented in archaeological excavations both by seed and, occasionally, capsules, and by remnants of stems or textiles.⁵² In the latter, fibres can be identified microscopically,^{53,54} if they are not carbonised.

Flax was apparently used by man before its domestication. The oldest linseed remains retrieved from excavation sites in the Near East come from Epi-Palaeolithic pre-farming contexts (9200-8500 BC).⁵⁵ Soon after, seeds of flax were found in many of the Pre-Pottery Neolithic farming villages that appeared in the near East (Turkey, Iran, Jordan) in the second half of the 8th millennium BC and in the 7th millennium.⁵⁶ The seeds are still small, similar in size to those of wild forms and are often associated with domesticated wheats and barley.⁵⁷ When fragments of capsule and seeds with 3.0 to 4.0 mm in length are found one can assume to cultivated flax.⁵⁸ Therefore, there is a good indication for flax cultivation before 6000 BC (in several Neolithic and Bronze Age sites in the Near East).⁵⁹ Flax is associated with the spread of Neolithic agriculture from the Near East to Europe and Nile Valley. Linseed has been recovered from several Early Neolithic sites in Greece (6th millennium BC).⁶⁰ Further north, in Central and Western Europe, the earliest cultivated flax finds are from relatively more recent periods (4400-4000 BC); however, they belong to the earliest food production culture (Germany, Poland, Switzerland).^{61,62,63} In Switzerland it occurs among plant remains in many lakeshore settlements.^{64,65,66} Flax is similarly common in lakeshore settlements in south Germany such as Ödenahlen at the Federsee.⁶⁷ It is also known from the Late Neolithic and Early Bronze Age sites in the northern Italy.⁶⁸

Remains of flax textiles also appear early. The best examples come from dry parts of the Near East, where due to low humidity, woven material survived without carbonisation. They are dated to the beginning of the 7th millennium BC.⁶⁹

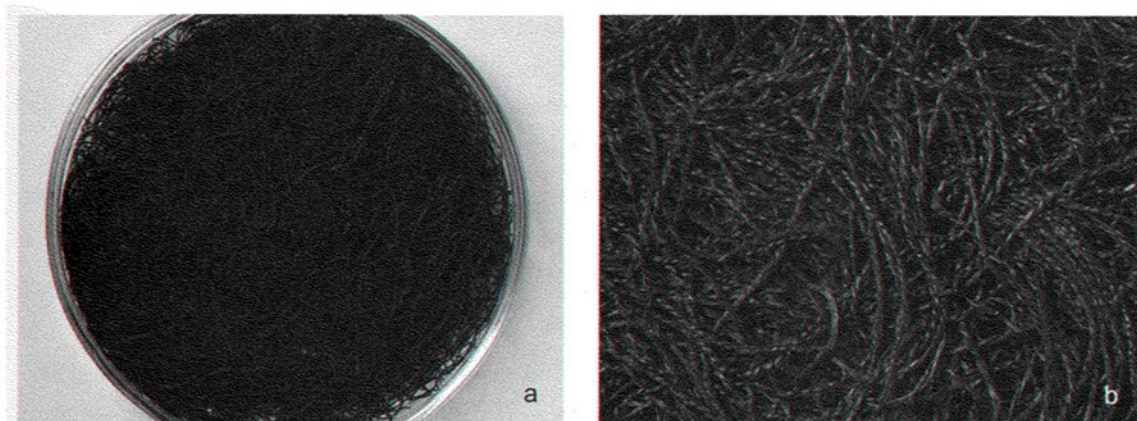


Fig. 5. Yarn from Stare gmajne (late 32nd century BC) after restoration (a) and detail (b). Photo: T. Lauko.

The use of flax at Stare gmajne has not been confirmed yet, but we can hypothesize that it was the same as in other contemporary settlements in central Europe. However, a great surprise was the discovery of remains of yarn (Fig. 5) that was found at Stare gmajne and was produced from the fibres of grasses (*Poaceae*).⁷⁰

Conclusion

The available archaeological evidence clearly suggests that flax belongs to the first group of crops that introduced agriculture in the Near East. The gradual increase in seed size and the use of linen indicate that flax cultivation was, very likely, already practised in the Near East before 6000 BC.⁷¹ In Europe, flax-growing seems to have been fairly important after 4000 cal BC onwards.^{72,73}

Flax is very well represented in the lake-dwelling sites due to excellent waterlogged preservation of the layers. Plant remains are strongly under-represented when they are

preserved only in carbonised state or when inappropriate method is used what has been clearly shown by the results from the wetland sites (for example ref. ^{74,75,76,77}).

The new recovery technique, which was recommended for waterlogged material⁷⁸ and was tested for the first time in Slovenia at the Stare gmajne site, gave astonishing results. During the excavation in 2007, two occupation phases (the first during 34th and the second during 32nd century BC) were detected and many botanical species were determined for the first time. It seems that the most important are uncarbonised remains of flax (*Linum ussitalisimum*) what confirms again⁷⁹ that plant remains from Slovenian Eneolithic settlements (it means in the regions South of the Alps) show some similarities to other circumalpine lakeshore settlements of the same age. However, the investigation of the level of resemblance between different regions remains the aim for the further researches in the future.

⁷⁰ VELUŠČEK 2009, in press

⁷¹ ZOHARY - HOPF 2004, p. 126-132

⁷² JACOMET 2004, XI

⁷³ JACOMET 2007, XIV

⁷⁴ JACOMET ET AL. 1989, 348 pp.

⁷⁵ JACOMET - KREUZ 1999, VI

⁷⁶ JACOMET 2004, XI

⁷⁷ TOLAR ET AL. 2009, on-line first

⁷⁸ JACOMET - KREUZ 1999, VI

⁷⁹ JERAJ ET AL. 2009, p. 75-89

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SAŽETAK

OTKRIĆE LANA (LINUM USITATISSIMUM) U LJUBLJANSKOM BARJU, SLOVENIJA

Tjaša TOLAR, Anton VELUŠČEK

Tijekom iskopavanja brončanodobnih sojeničkih naselja iz druge polovice četvrtog tisućljeća prije Krista kod Stare gmajne u Ljubljanskem barju 2007. godine, po prvi put je potvrđeno uzgoj lana (Linum usitatissimum) u Sloveniji. Ostaci lana (djelići čabure i sjemenke) pronađeni su uporabom odgovarajuće metode. Nova arheobotanička metoda M3 sastoji se od sustavnog uzimanja uzoraka (tla iz kulturnih slojeva), održavanja tla u vlažnom stanju

prije procjeđivanja, pažljivog i nježnog ispiranja-plutanja preko materijala, održavanja procijedenih djelića (veličina cjedila od 1 do 0,355 mm) vlažnima, proučavanja i prepoznavanja ostataka biljaka u vlažnim uvjetima pod stereomikroskopom.

Prijevod s engleskog: Nenad Patrun