

# RESEARCH IN ARCHAEOBOTANY

ASSOC. PROF. DR. TJAŠA TOLAR

STUDY MATERIAL FOR POSTGRADUATE STUDENTS OF ZRC SAZU (COURSE: SCIENTIFIC METHODS IN ENVIRONMENTAL AND REGIONAL STUDIES)

**Archaeobotanical work methods** within the doctoral programme *Environmental and Regional Studies* at the Postgraduate School ZRC SAZU

## Basic literature:

ANDRIČ, TOLAR, TOŠKAN (2016). Environmental archaeology and palaeoecology: palynology, archaeobotany and archaeozoology. Založba ZRC, ZRC SAZU, 317 pp.

<https://iza2.zrc-sazu.si/sl/strani/arheobotanika-stran-za-studente-arheologe-na-terenu>

ANDRIČ, TOLAR, RADOVIČ, TOŠKAN, GEROMETTA (2024). *Arheologija okoliša i paleoekologija : palinologija, arheobotanika, arheozoologija, geoarheologija*. Pula: Sveučilište Jurja Dobrile; Ljubljana: Založba ZRC, 456 pp.

<https://omp.zrc-sazu.si/zalozba/catalog/view/2140/8746/2491>

# INTRODUCTION

# ARCHAEOBOTANY AT ZRC SAZU

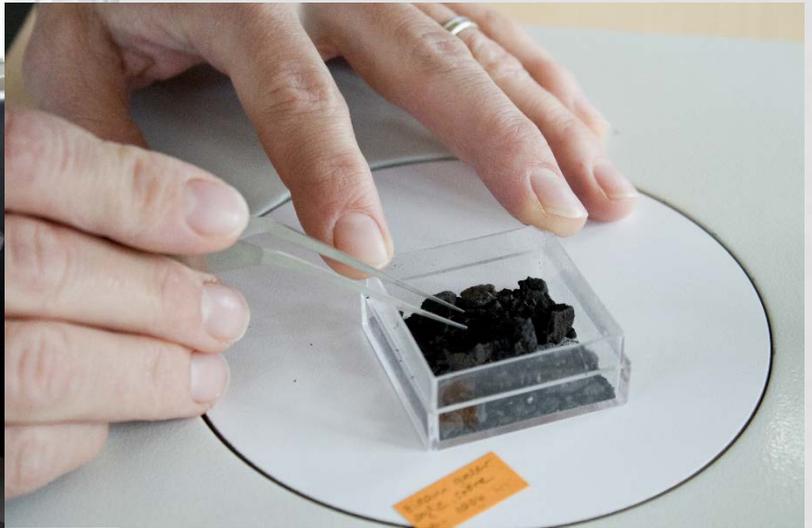
ZRC SAZU, Institute of Archaeology, Novi trg 5,  
Ljubljana (office)



tjasa.tolar@zrc-sazu.si  
01-4706 456 (Ljubljana)  
01-3207 365 (lg)

# ZRC SAZU, Barje Research Station, Zagorica 20, Ig (laboratory, cold room)





# ARCHAEOBOTANY

- botanical research at archaeological sites
- plant macro-remains ( $> 0,355$  mm)
- plant micro-remains ( $< 0,1$  mm)

# BIOARCHAEOLOGY

- ON-SITE DATA
- **Palaeo-economy** (past economy, activities, human behaviour and knowledge, and impact on the environment)
- OFF-SITE DATA
- **Palaeo-environment** (past flora, vegetation, ecological conditions)

# ARCHAEOBOTANICAL RESEARCH

- collection (sampling) and preparation of archaeobotanical samples from archaeological sediments
- classification of plant macro-remains
- botanical identification
- counting and statistical processing
- interpretation

# SPECIALISED RESEARCH IN ARCHAEOBOTANY

- dendrochronology
- morphological analyses
- genetic analyses
- other: coprolites, textile remains, food remains in vessels, daub remains and other clay-organic remains, etc.

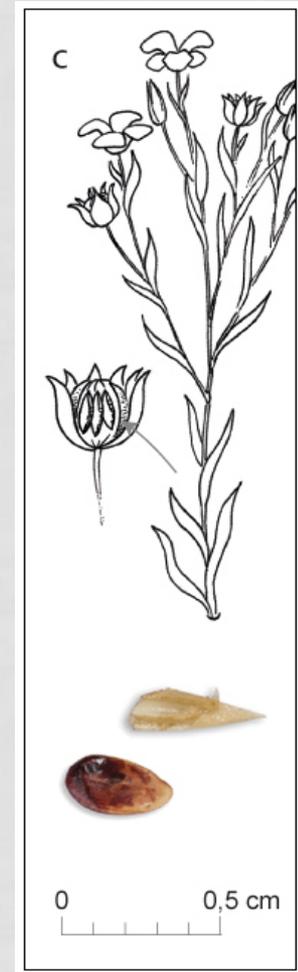
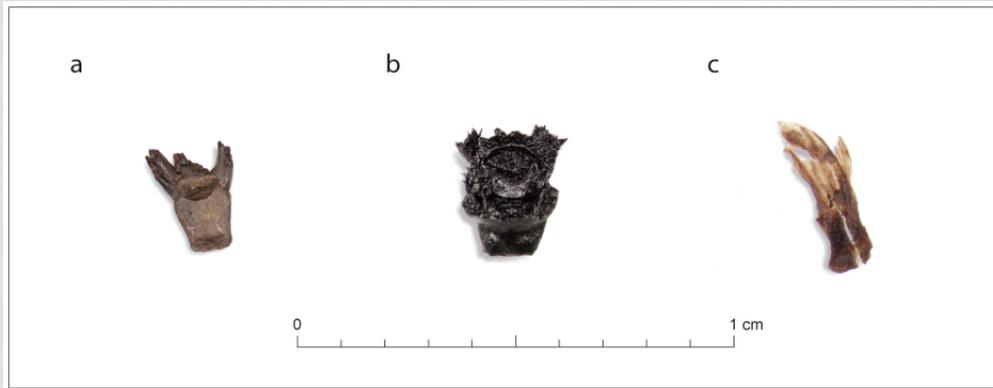
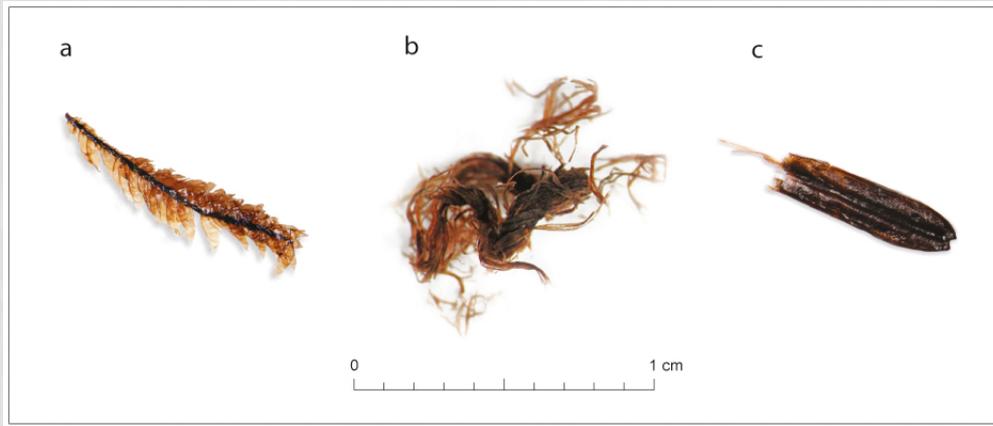
# RESEARCH OUTCOMES

- human diet in the past
- economy: farming vs. gathering
- beginnings of domestication (cultivation)
- native status of plant species
- past environment, climate and vegetation
- human impact on the environment
- absolute dating of the archaeological site
- level of societal development (knowledge, skills, techniques)
- kinship relationships, evolution

# TAPHONOMY

Studies the processes of preservation (often fossilisation) of biological remains, e.g., charring, mineralisation, waterlogging, desiccation, freezing, etc.







Ice Man Ötzi (3320–  
3050 cal BC)  
contemporary with the  
pile-dwelling site  
Stare gmajne  
(3350 – 3110 cal BC)

(after Dickson et al. 2005)

# METHODS

# METHODS IN ARCHAEOBOTANY

- SAMPLING, FIELD COLLECTION
- SAMPLE PREPARATION IN THE LABORATORY
- SUBSAMPLING
- SORTING, COUNTING / CLASSIFICATION,  
QUANTIFICATION OF PLANT MACRO-REMAINS
- STATISTICAL ANALYSIS AND INTERPRETATION OF  
RESULTS

# FIELD SAMPLING

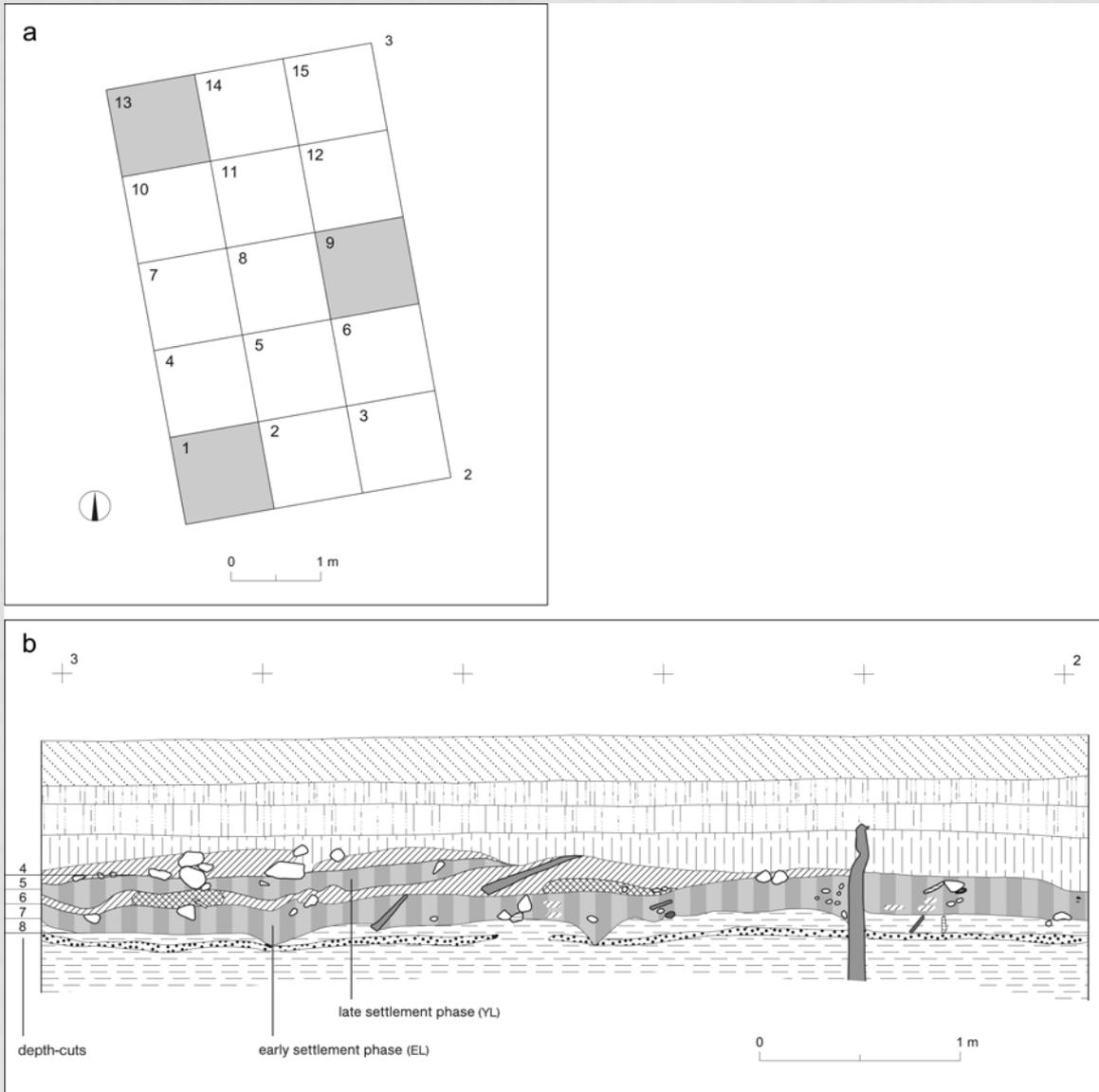
1. Surface sampling
2. Profile sampling: taking stratigraphic sediment columns
3. Judgement sampling

# 1. SURFACE SAMPLING

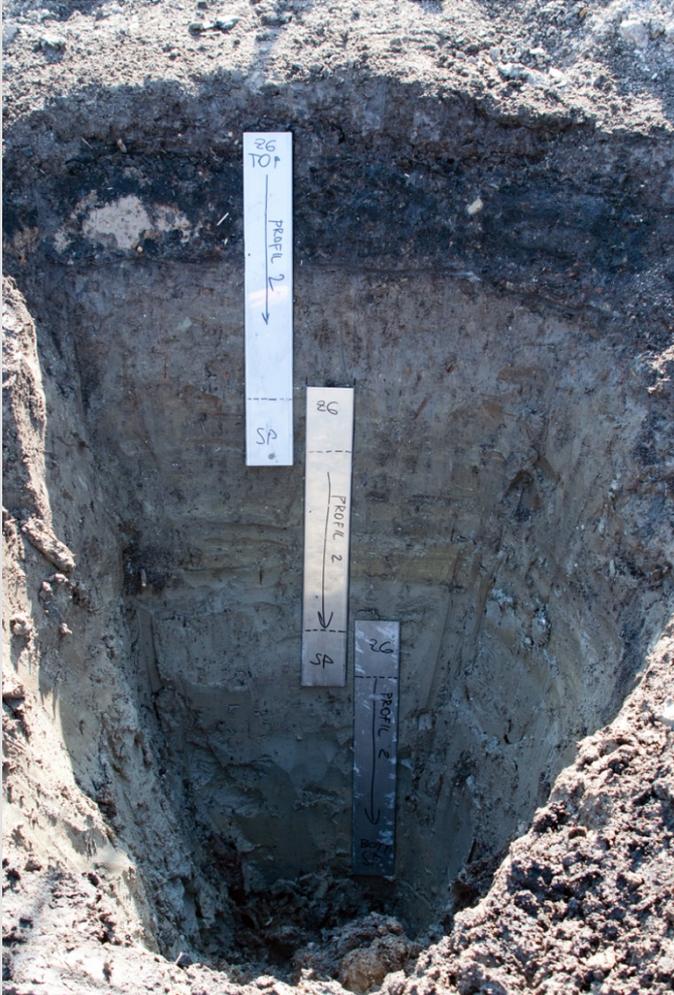
we take samples systematically, layer by layer, and from randomly selected locations, which we **determine** before excavation begins



# Surface sampling (from the 4th–8th excavation level – i.e. depth-cut)



## 2. PROFILE (COLUMN) SAMPLING



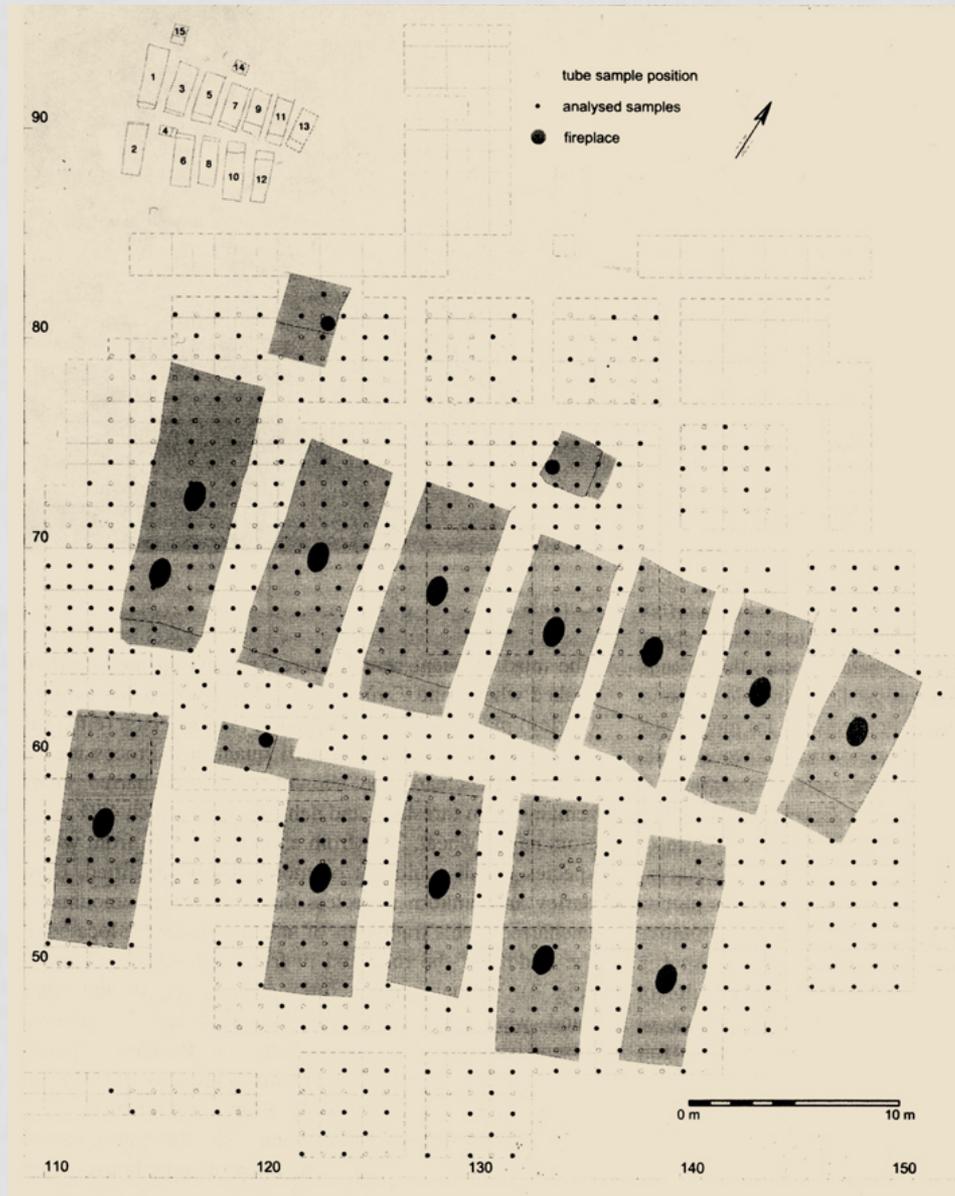
**STRATIGRAPHIC COLUMN:**  
It is important to take as long as possible column of sediment sample (i.e. from the upper, youngest — to the lower, oldest sediments)!

Example of systematic column sampling in the excavation area:



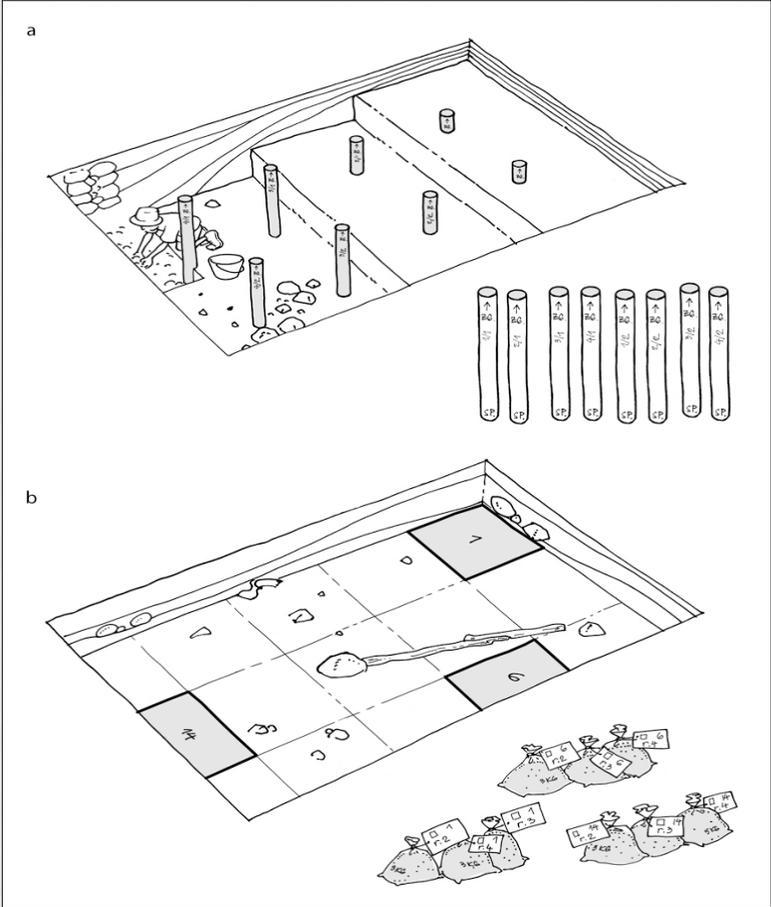
(after: Schlichtherle et al. (eds.) 2011)

# Stratigraphic column sampling



(after: Schlichtherle et al. (eds.) 2011)

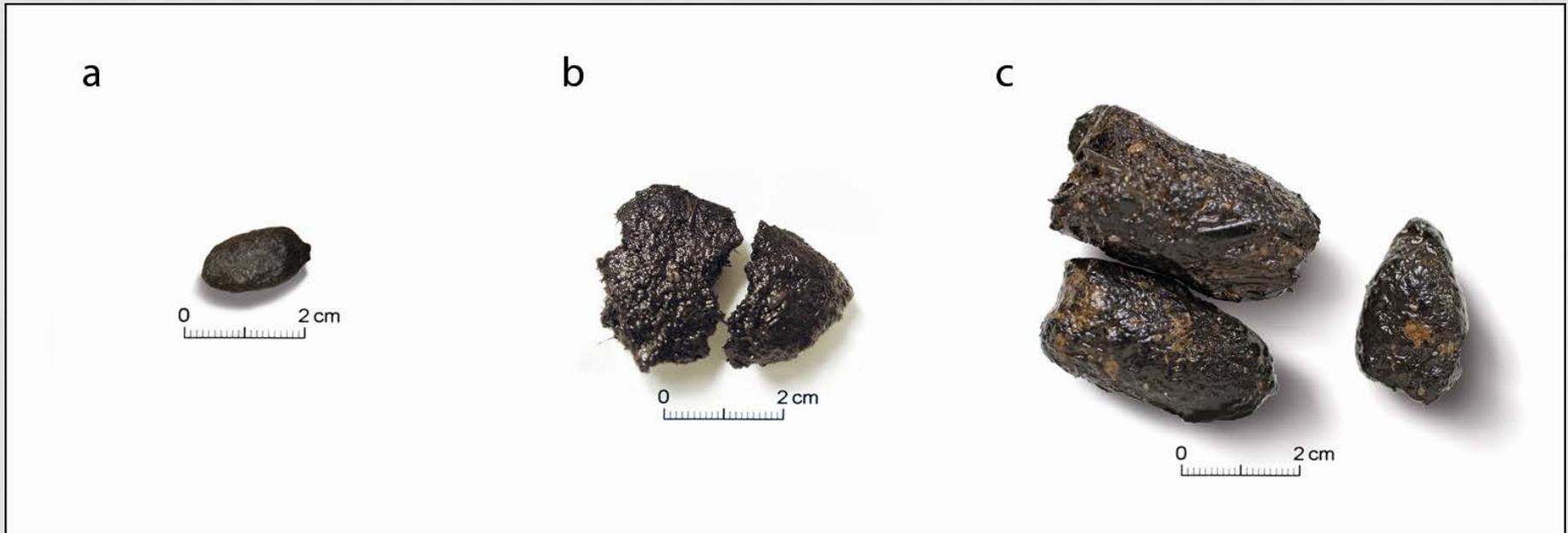
In the case of Stare gmajne site:



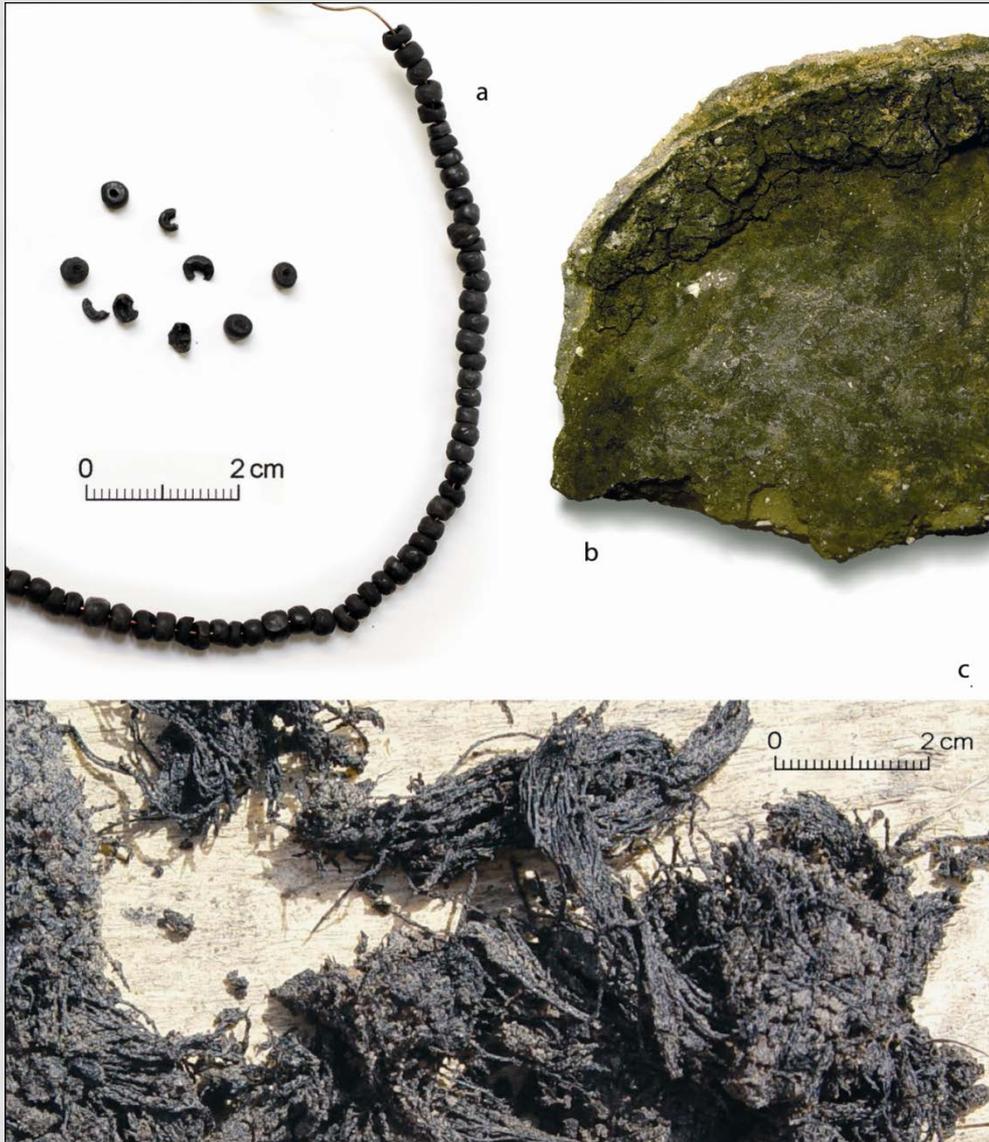
### 3. JUDGEMENT SAMPLING

- animal or human fossilised excrements (coprolites)
- textile remains
- remains of fodder, bedding
- food remains in a vessel
- grain storage
- daub remains, complemented with other materials (wood, clay, cereal-processing residues)
- Fireplaces, etc.

Coprolites: a) goat/sheep, b) cattle, c) dog/human



Products: a) necklace rings, b) food remains, c) textile fibres



Wooden objects: a) structural timber (wooden pile), b and č) handles, c) charcoal from the fireplace, d) wooden rings



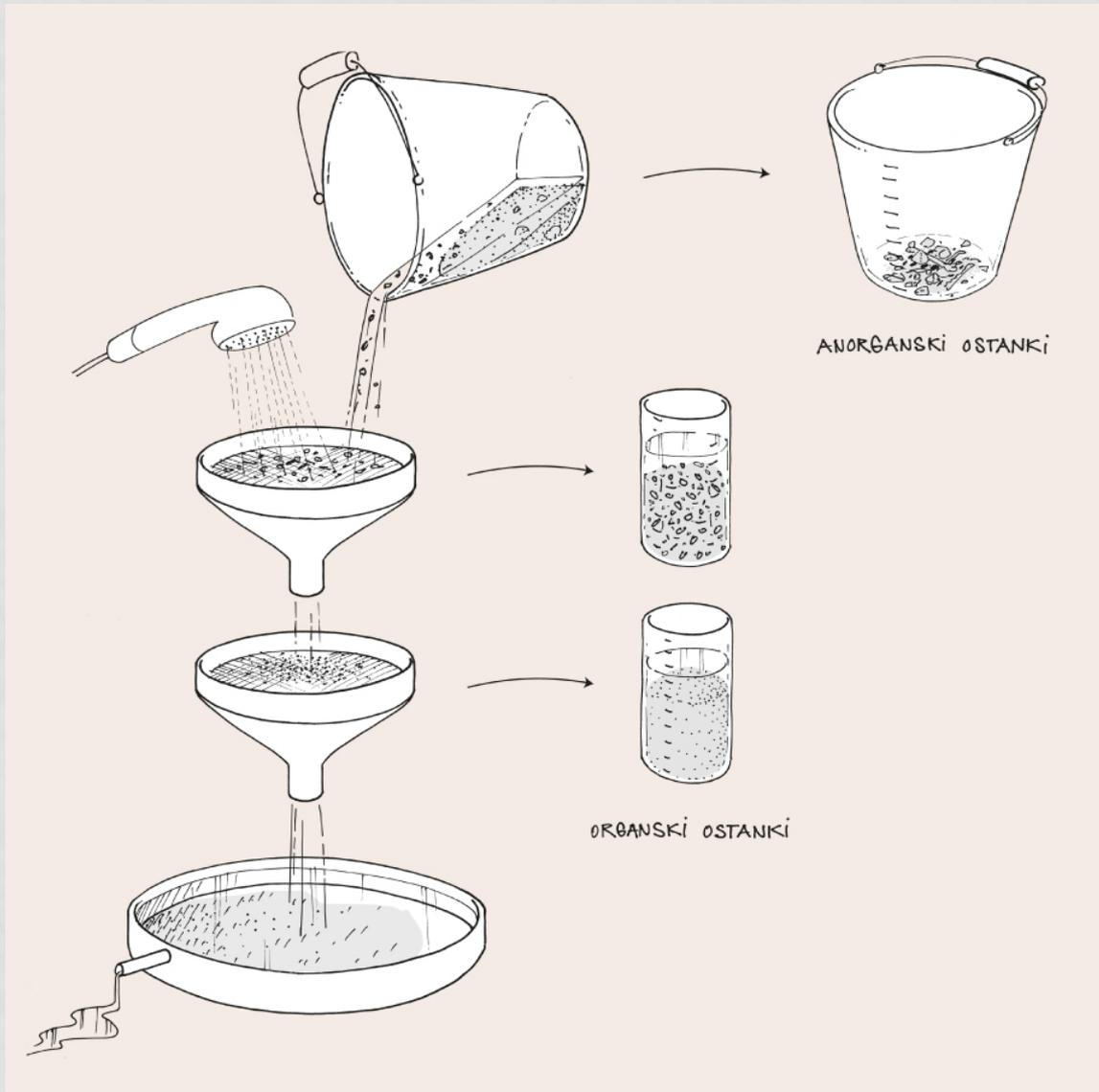
# SAMPLE PREPARATION IN THE LABORATORY



# WET SIEVING



# Half-flotation, separation of inorganic remains and larger bones



Volume before, after  
sieving

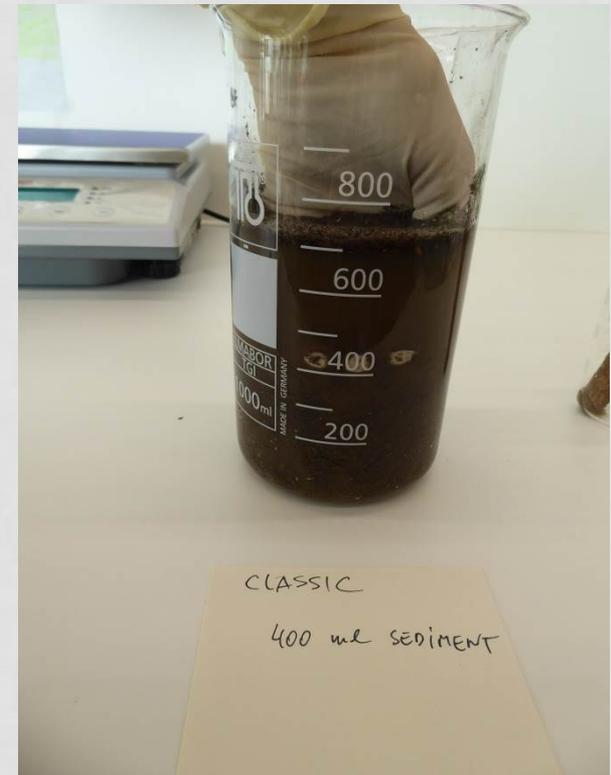
and

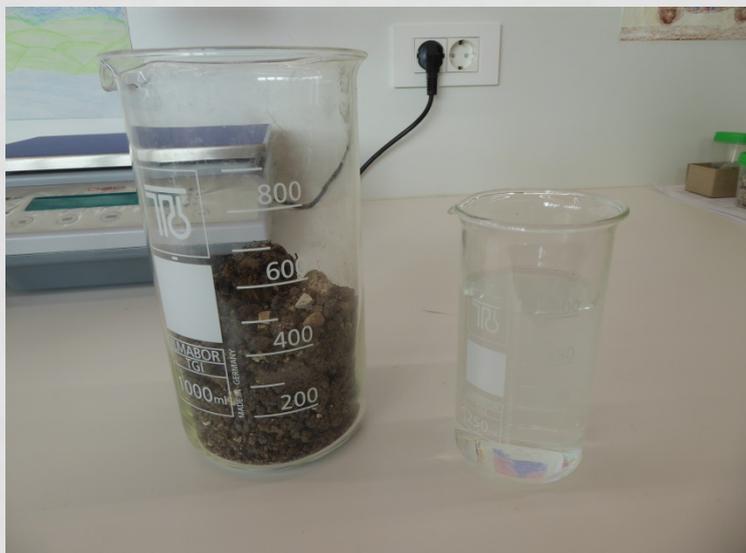
Volume of the examined  
sample / subsample

# VOLUME MEASUREMENT



CLASSIC METHOD





METHOD WITH  
ADDITION OF A  
KNOWN WATER  
VOLUME



400 ml water added  
→ 625 ml TOTAL  
⇓  
225 ml SEDIMENT

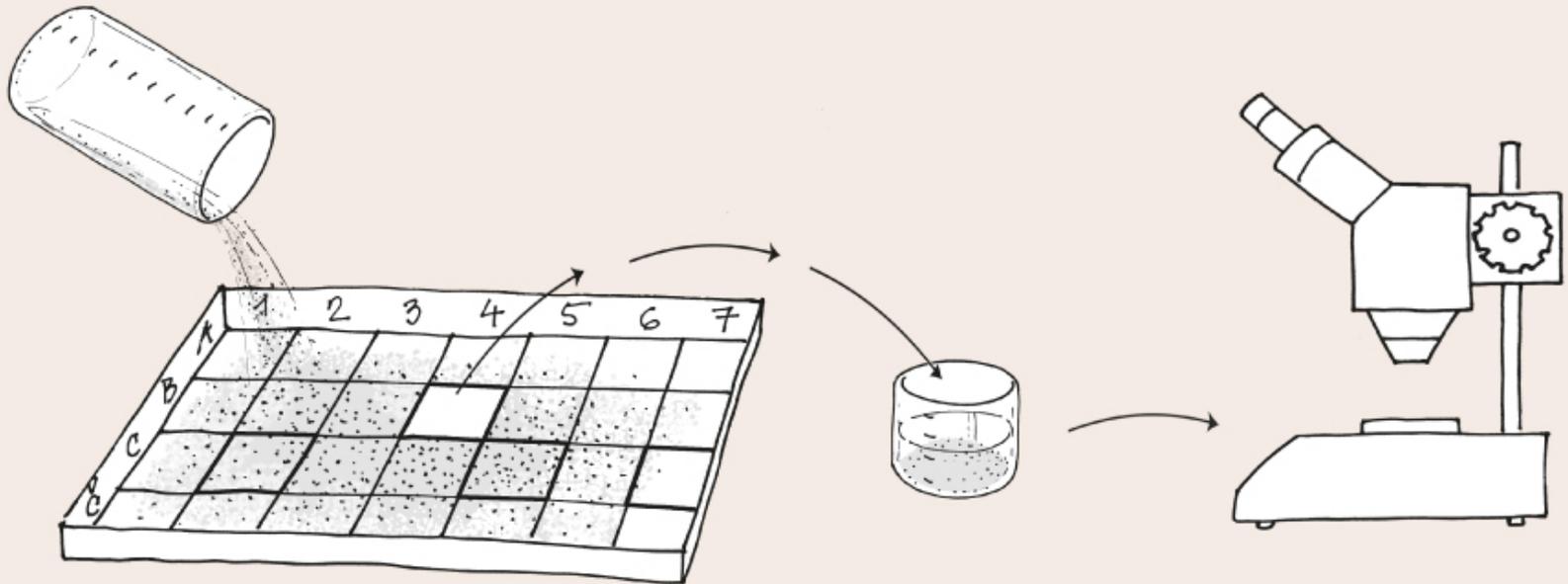
		<b>Volume dry</b>	<b>Volume WV</b>	<b>Volume C</b>	<b>differences</b>
	3. SP.SLOV. UFREDIT V 793	752.41 g	550 ml	600 ml	50 ml
	5. SP.SLOV.LSS_2019_205_366	614 g	450 ml	600 ml	150 ml
	4. SP.SLOV.LSS_2019_205_363	607 g	420 ml	650 ml	230 ml
	1.SP.SLOV. ZGRI 927	401.29 g	400 ml	500 ml	100 ml
	2. SP.SLOV. ????	388.93 g	360 ml	600 ml	240 ml



subsampling,  
examination,  
classification,  
identification



# SUBSAMPLING



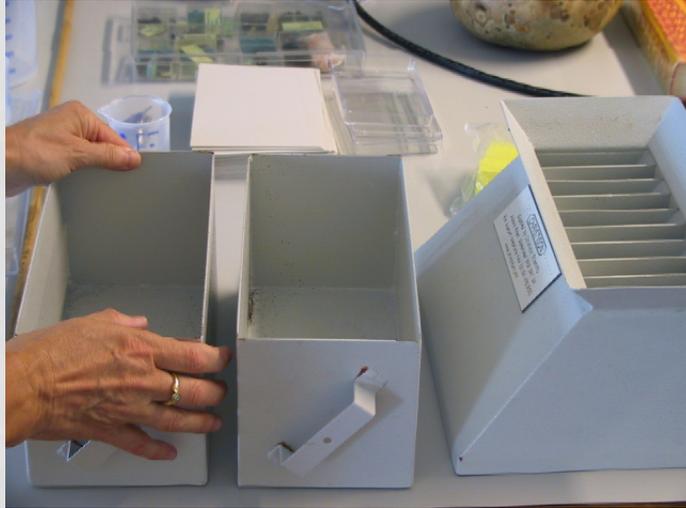
# SUBSAMPLING METHODS

**1. with a spoon** (a rough and quick method. The least reliable. If the material is heterogeneous, small seeds remain at the bottom; larger pieces slip off the spoon)

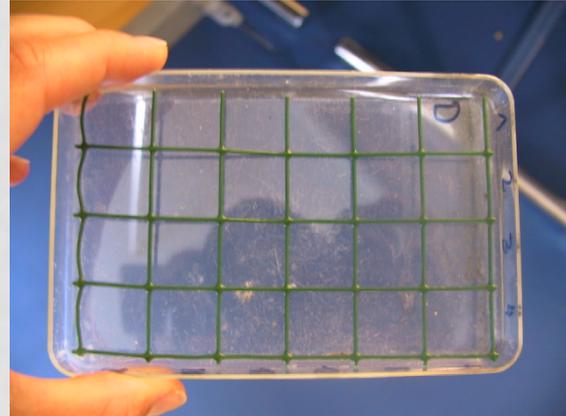
**2. with a splitter devicer** (requires a mechanical devicer that objectively splits the material into two equal parts)

**3. with a grid** (we spread the sample in a tray and draw random subsamples using numbered positions)

## Subsampling with a splitter device



## Subsampling with a grid





Subsamples for large (2 mm) and small (0.355 mm) fractions



# ARCHAEOBOTANICAL FINDS

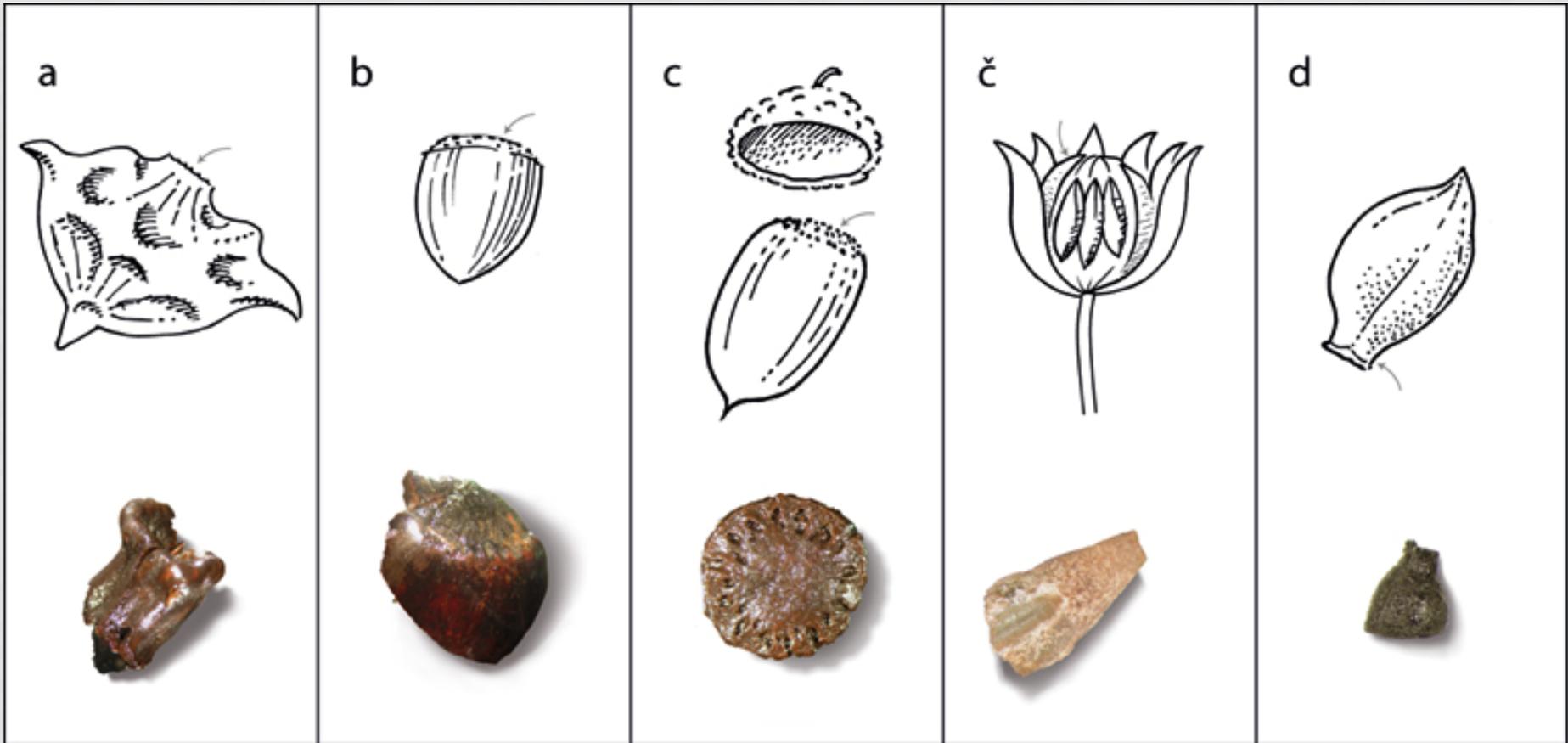


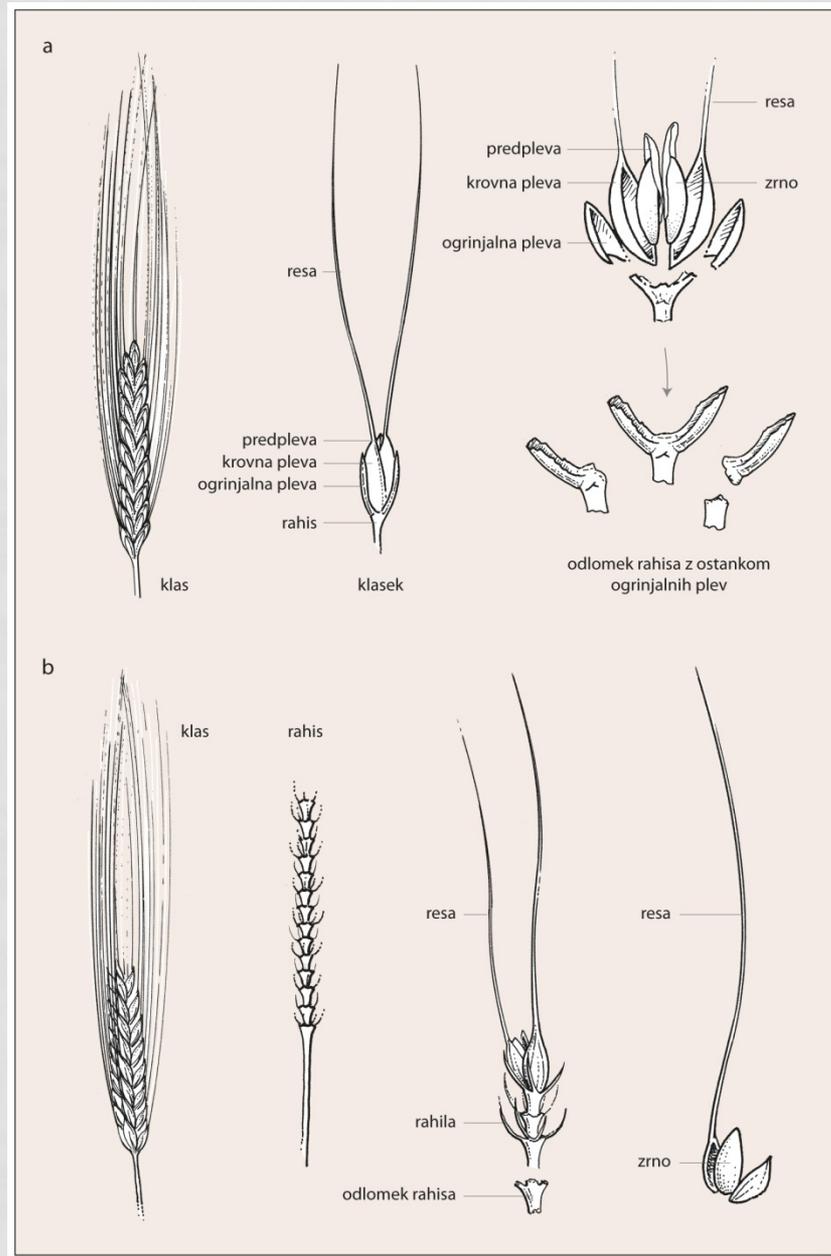
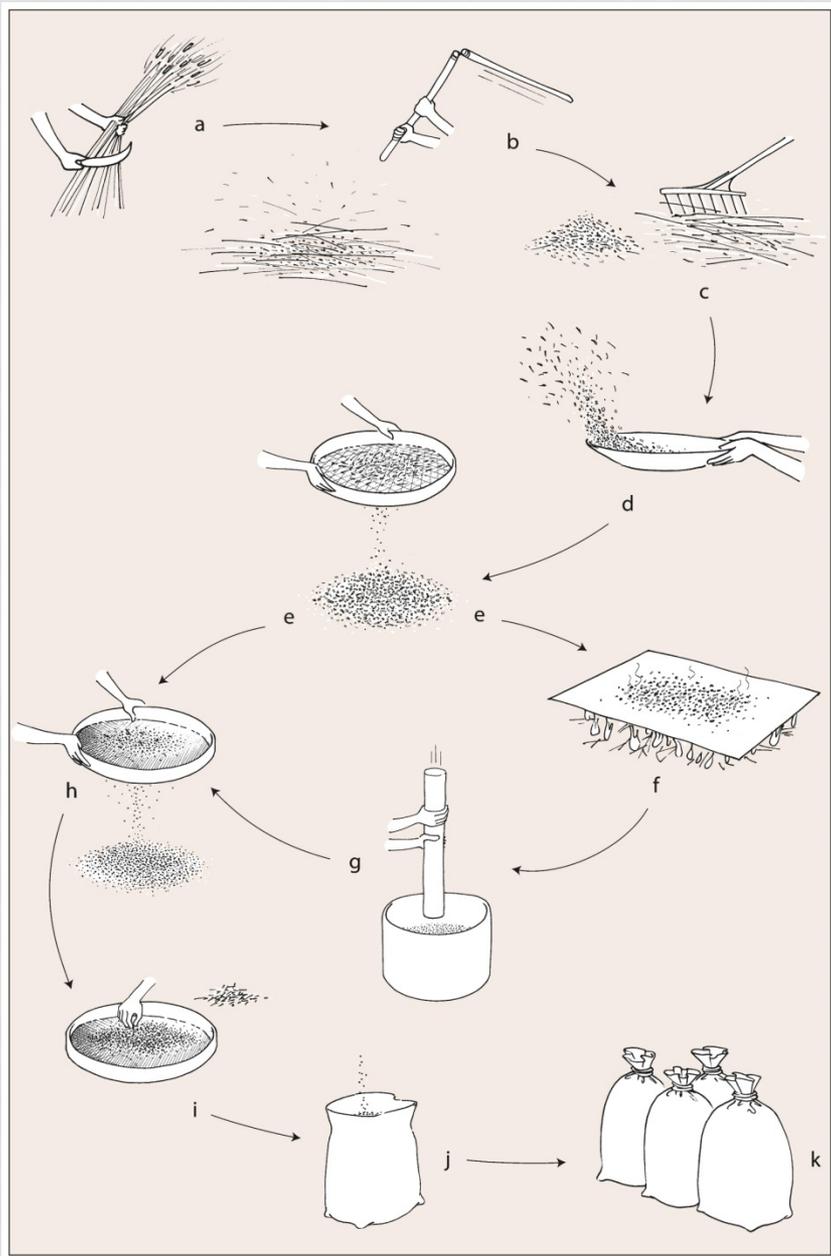
# CLASSIFICATION AND QUANTIFICATION OF PLANT MACROREMIANS



# Counting archaeobotanical remains: what is the unit?

whole seeds/fruits, bases, apical parts of fruits, cereal chaff,...





# MINIMUM NUMBER OF INDIVIDUALS (MNI)

- If we have numerous fragments, e.g., hazelnut shell fragments, we weigh them and extrapolate the number of units using the weight of one complete archaeological hazelnut shell.
- Because variability among hazelnuts is high, it is advisable to weigh several whole hazelnuts from the same site and use the average value.



# CHOOSING THE VOLUME OF THE EXAMINED SUBSAMPLE

384 COUNTED units  
(95% confidence level)

*Journal of Archaeological Science* 1982, 9, 287-296

## Sampling Seeds

Marijke van der Veen\* and Nick Fieller\*

Problems of sampling carbonized plant material are discussed. Firstly, the problem of actually selecting a sample in the laboratory is considered, and some experiments which investigate various procedures are described. Secondly, the statistical aspects of determining optimal sample sizes are considered. Formulae are given for calculating optimal sample sizes and confidence intervals. Upper bounds, which are independent of the total population size, are provided for the sample size required to achieve any desired accuracy.

**Keywords:** RANDOM SAMPLING, SEEDS, CARBONIZED PLANT REMAINS, SAMPLE SIZE DETERMINATION, SAMPLE SELECTION, CONFIDENCE INTERVALS, PALAEOBOTANY, ARCHAEOBOTANY.

### Introduction

Although archaeologists have realized that their conclusions about past human life were based upon small and sometimes inadequate samples, it was not until the late 1960s that sampling became an issue of major concern. It has become increasingly necessary to work out a detailed and adequate sampling strategy, since the total survey of a region, the total excavation of a site and the total analysis of an assemblage have become virtually impossible (Mueller, 1975).

Palaeobotanists have not, until now, taken much part in the general discussion on sampling strategies. Until recently, palaeobotany was mainly concerned with qualitative statements about the kinds of plants that were exploited and with their phylogenetic history. Slowly, however, the emphasis is changing towards a more economic approach, in which the need for quantitative evidence is felt more strongly.

A major development in the history of palaeobotany was certainly the improvement of the retrieval methods of plant remains from archaeological sites. Various "seed-machines" have been developed and although they differ in cost, efficiency and processing times (Cherry, 1978; Keeley, 1978) they all have in common an enormous increase in the amount of soil being processed for plant remains, and consequently an enormous increase in the amount of material to be analysed. This is already beginning to cause problems in laboratories, as it becomes impossible, both in terms of time and money, to analyse all the samples.

\*Department of Prehistory and Archaeology, University of Sheffield, Sheffield, S10 2TN, England.

\*Department of Probability and Statistics, University of Sheffield, Sheffield, S3 7RH, England.

# STATISTICAL ANALYSIS AND INTERPRETATION

- Comparable units between samples, between sites, periods and between countries!

CONCENTRATION OF SEEDS/FRUITS PER LITRE OF SEDIMENT !!!  
and NOT absolute numbers of counted seeds/fruits!!!



4 barley grains in a 20 ml subsample

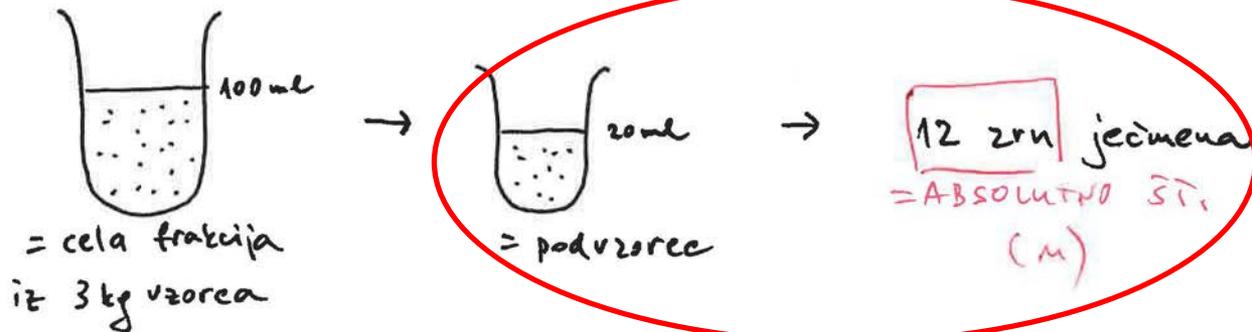
+



4 barley rachis fragments

= **12**  
**GRAINS**  
in a 20 ml  
subsample

EXTRAPOLATION TO THE WHOLE SAMPLE (100 ml)  
+ CONVERSION TO CONCENTRATION per 1 litre of  
sediment !!!



↓

v 100 ml  
=  $12 \times 5 = \underline{60 \text{ zrn}}$  ~ ~ 3 kg vzorca sedimenta  
(= 3000 ml)

$\frac{60}{3} = \underline{20 \text{ zrn}}$  ~ ~ 1000 ml sedimenta  
= KONCENTRACIJA v 1 l SEDIM.  
(c)

# FIBS

Methods for reconstructing past farming practices using weed communities and their modern ecology.

Approach: functional ecology of weed species (**F**unctional **I**nterpretation of **B**otanical **S**urvey)

Uses functional attributes that measure the ecological characteristics of weed species, e.g., growth/flowering period, tolerance to drought/manuring, regeneration ability, etc.

These attributes enable the transfer of modern ecological data into archaeobotany and thus help to disentangle the impacts and modalities of past farming practices: manuring, irrigation, timing of sowing/harvesting, weeding, crop rotation, etc.

Acta Palaeobot. 42(2): 185-193, 2002

## Weed ecology as a method for the archaeobotanical recognition of crop husbandry practices

GLYNIS JONES

Department of Archaeology and Prehistory, University of Sheffield, Northgate House, West Street Sheffield S1 4ET UK; e-mail: g.jones@sheffield.ac.uk

Received 8 April 2002; accepted for publication 29 October 2002

**ABSTRACT.** This paper reviews the methods used to reconstruct past crop husbandry practices from the ecology of the weed species associated with archaeobotanical crop remains. The contributions of phytosociology and Ellenberg numbers, in particular, are reviewed and critiqued, and an alternative approach using the functional ecology of weed species is proposed. This approach uses functional attributes, which measure the ecological characteristics of weed species, and is not dependent on the co-occurrence of particular species or the reliability of field observations to indicate species preferences. Functional attributes permit the 'translation' of present-day ecological data to archaeobotanically attested species and, through an understanding of ecological processes, provide the means to disentangle the separate effects of different husbandry practices, so allowing the identification of novel combinations of practices in the past. An understanding of the, often complex, functional relationships between husbandry practices and weed floras also enables a more sophisticated approach to the interpretation of archaeological weeds through a consideration of attribute suites, or species functional types, as a reflection of the combined effects of different ecological factors.

**KEY WORDS:** archaeobotany, crop husbandry, weed ecology, phytosociology, functional ecology

### INTRODUCTION

It has long been recognised that the crop weeds in archaeobotanical samples provide a potentially useful source of evidence for past agricultural activities. Their quantities in relation to crop remains (grain and chaff), for example, have been used as a means of distinguishing crop processing products and by-products (Hillman 1981, Dennell 1974, G. Jones 1988). More specifically, the types of weed seeds associated with crop remains have proved useful for identifying particular stages in the crop processing sequence (Hillman 1984, G. Jones 1984, 1987). Through a consideration of their ecology, weeds also have potential for the identification of husbandry practices applied to growing crops before they are harvested. This paper reviews the different approaches that have been applied to archaeobotanical data in attempt to use weed ecology in the identification of husbandry

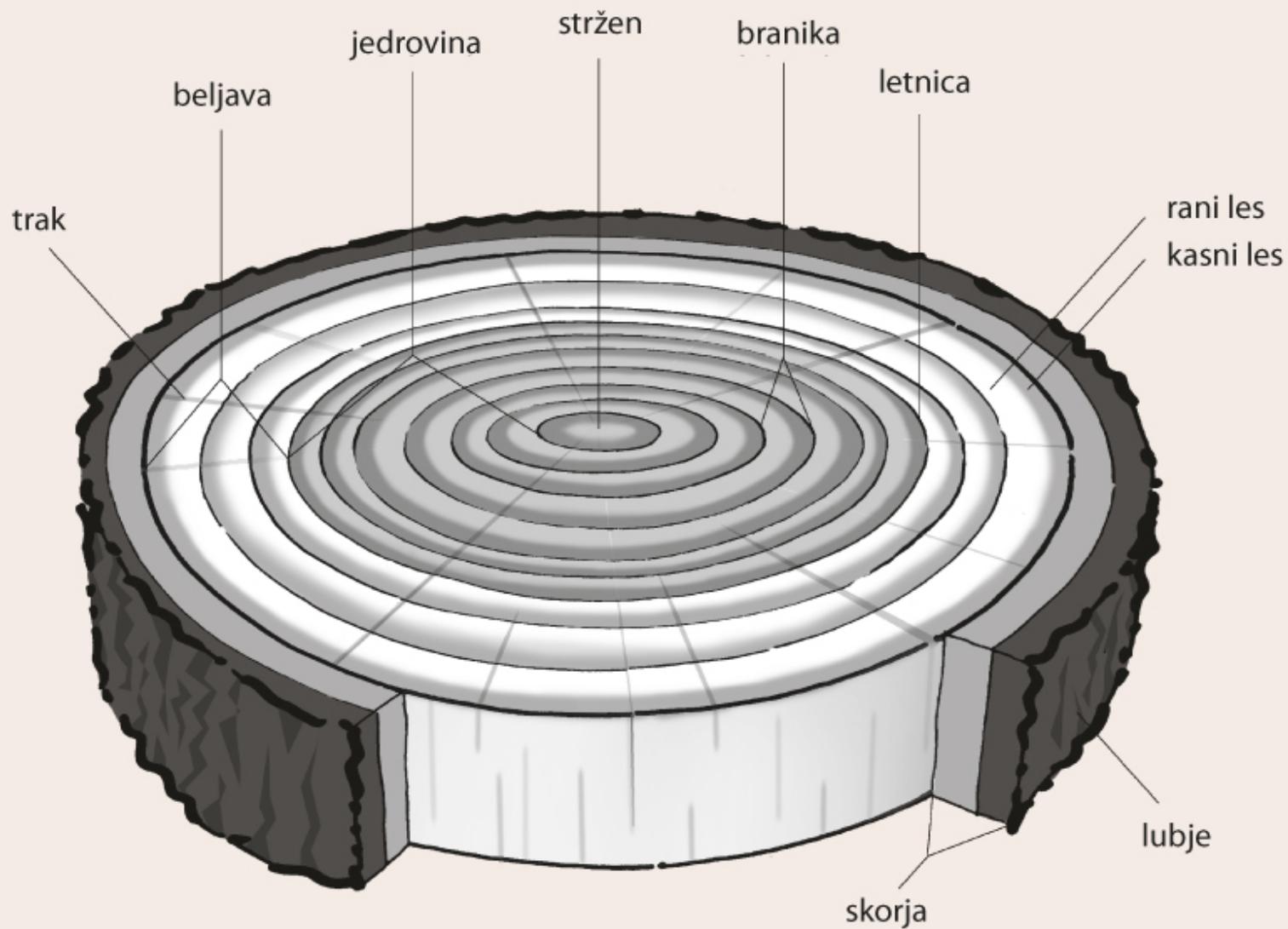
practices such as tillage method, time of sowing, irrigation/drainage, following/rotation, manuring and weeding. In all three of the areas considered below, the pioneering work of Krystyna Wasylikowa can be identified.

### PHYTOSOCIOLOGY

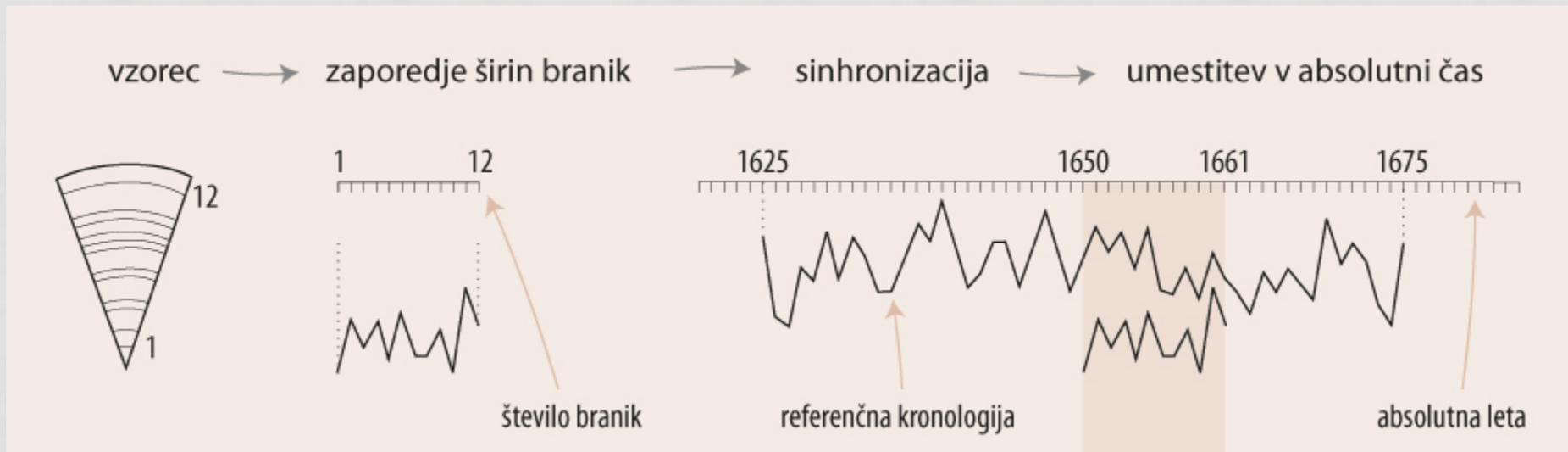
One of the most frequently used ecological approaches is that of phytosociology. This hierarchical method of classifying plant communities relies on the co-occurrence of species in the field and on the presence of diagnostic species (character species) which are relatively restricted to one community (association) or group of communities in the hierarchy (Westhoff & van der Maarel 1973). This approach has the great advantage that phytosociological data have been accumulated for a large num-

# DENDROCHRONOLOGY

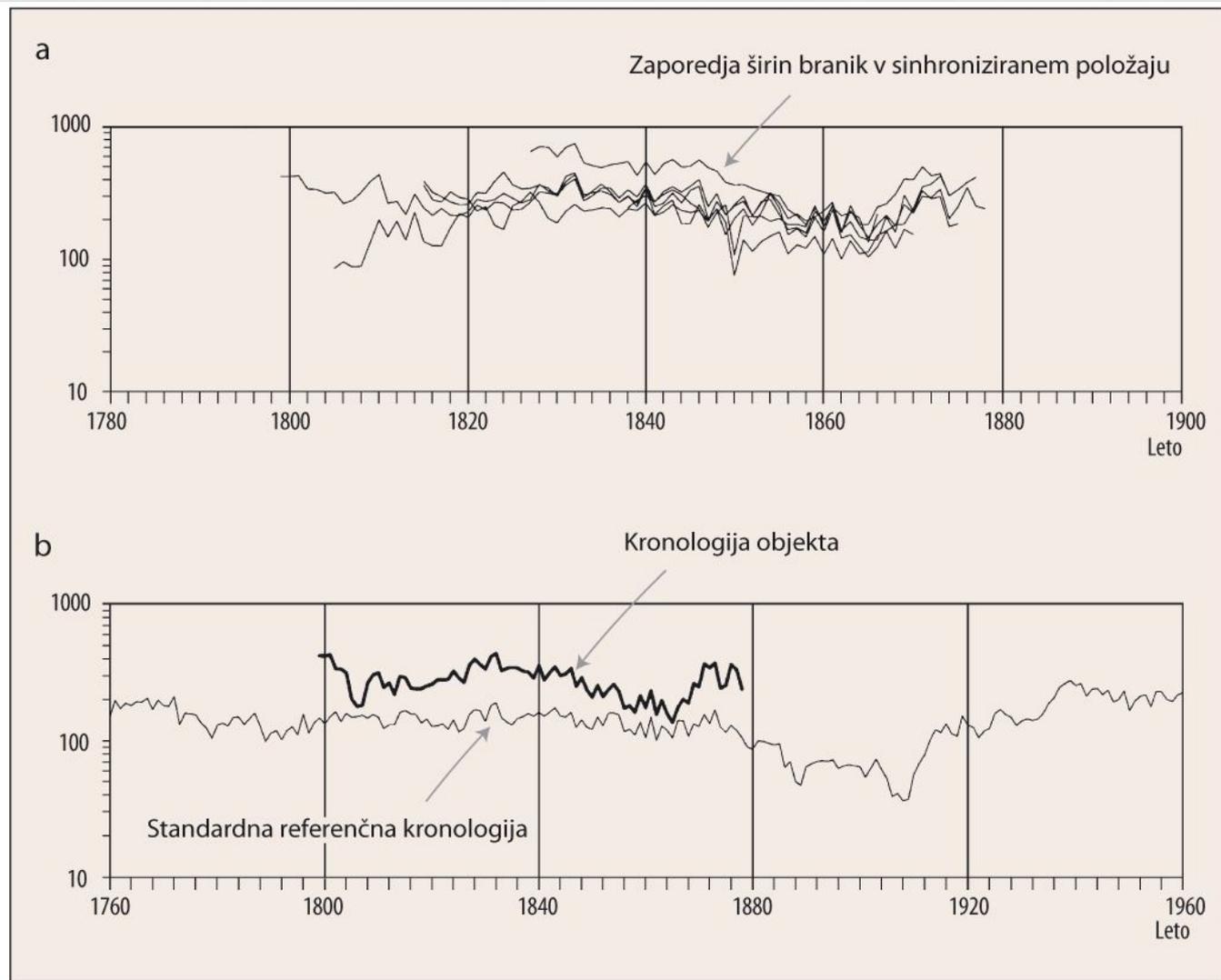
- Is a discipline based on the analysis of tree rings in wood.
- It is a method for determining the age of wood, which is why it has become well established in archaeology.
- It relies on the fact that tree rings—annual rings formed in the tree trunk during yearly growth—are not always equally wide.



- In the tree trunk, different widths of annual rings are formed in different years
- They can be measured and graphically presented to show their year-by-year sequence of ring widths – i.e. growth



# Sequences of tree-ring widths and the Chronology of the object



# DENDROCHRONOLOGY LABORATORY



# Okoljska arheologija in paleoekologija

ARHEOBOTANIKA

Tjaša Tolar



PALINOLOGIJA

Maja Andrič



ARHEOZOOLOGIJA

Borut Toškan



**Maja Andrič**, palinologinja

[maja.andric@zrc-sazu.si](mailto:maja.andric@zrc-sazu.si)

<http://iza2.zrc-sazu.si/sl/sodelavci/maja-andric-sl#v>

<http://iza2.zrc-sazu.si/sl/oddelek/9279#v>

**Tjaša Tolar**, arheobotaničarka

[tjasa.tolar@zrc-sazu.si](mailto:tjasa.tolar@zrc-sazu.si)

<http://iza2.zrc-sazu.si/sl/sodelavci/tjasa-tolar-sl#v>

<http://iza2.zrc-sazu.si/sl/oddelek/9278#v>

**Borut Toškan**, arheozoolog

[borut.toskan@zrc-sazu.si](mailto:borut.toskan@zrc-sazu.si)

<http://iza2.zrc-sazu.si/sl/sodelavci/borut-toskan-sl#v>

<http://iza2.zrc-sazu.si/sl/oddelek/4495#v>

Avtorji smo zaposleni na ZRC SAZU, Inštitut za arheologijo  
p. p. 306, 1001 Ljubljana

<http://iza2.zrc-sazu.si/#v>

ISBN 978-961-254-872-8



Založba ZRC  
<http://zalozba.zrc-sazu.si>  
ZRC Publishing

37 €

# EXAMPLES OF RESEARCH AND THE METHODS USED

# PILE-DWELLING SITE STARE GMAJNE NEW METHODS IMPLIED

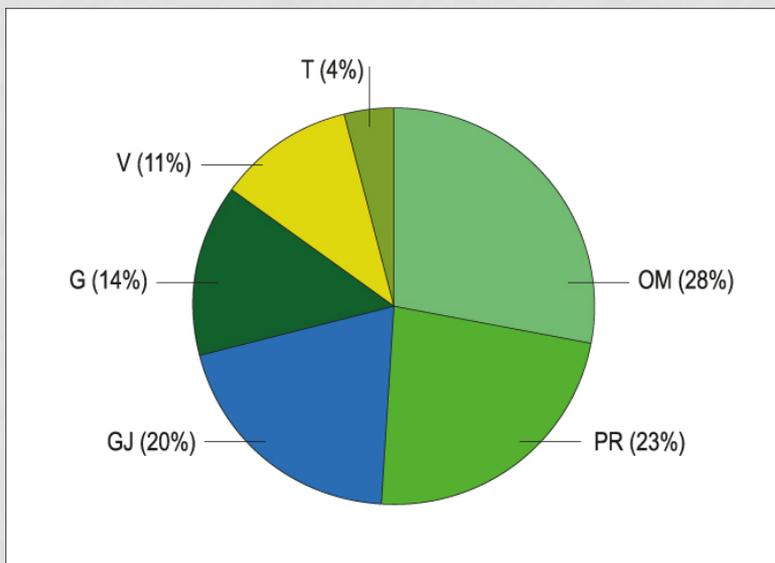


gobo, suho

flotacija, mokro

TOLAR, Tjaša, JACOMET, Stefanie, VELUŠČEK, Anton, ČUFAR, Katarina. Recovery techniques for waterlogged archaeological sediments: a comparison of different treatment methods for samples from Neolithic lake shore settlements. *Veg. hist. archaeobot.*, 2010, 19: 53–67.

TOLAR, Tjaša, JACOMET, Stefanie, VELUŠČEK, Anton, ČUFAR, Katarina (2011) Plant economy at a late Neolithic lake dwelling site in Slovenia at the time of the Alpine Iceman. *Veg. hist. archaeobot.* 20: 207-222.

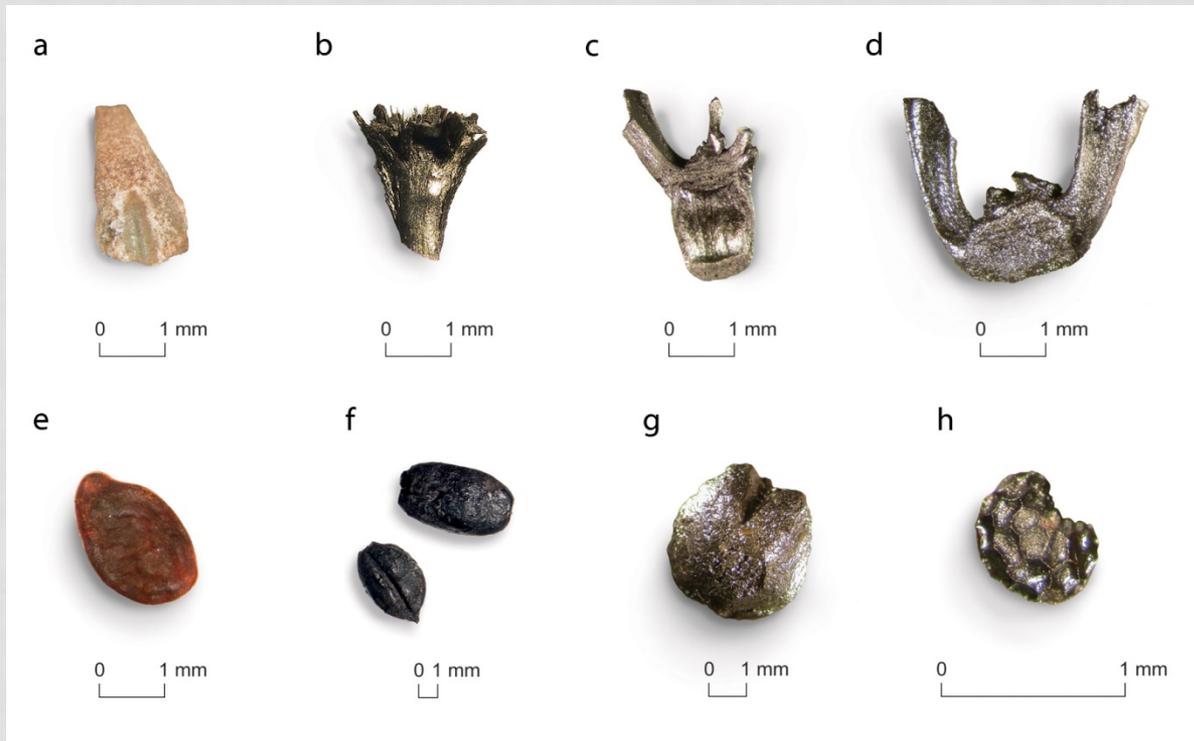


Proportions of 71 identified wild plant taxa according to ecological groups.

Aquatic plants (V), riparian and marsh plants (OM), forest plants (G), plants from forest edges and clearings (GJ), weedy and ruderal plants (PR) and plants from grasslands (T).

Rastlinska skupina	Rastlinski takson	Koncentracije na liter			
		ZF	VF	PF	
Gojene rastline	<i>Triticum dicoccum</i> (dvozna pšenica)	330	106	14	
	<i>Triticum mono/dicoccum</i> (eno / dvozna pšenica)	136	56	19	
	<i>Triticum monococcum</i> (enozna pšenica)	55	3	14	
	<i>Hordeum vulgare</i> (navadni ječmen)	131	92	82	
	<i>Papaver somniferum</i> (vrtni mak)	1304	596	5	
	<i>Linum usitatissimum</i> (navadni lan)	155	62	7	
	<i>Pisum sativum</i> (navadni grah)	0.84	0	0	
Nabirane rastline	Oreški in taksoni z olji bogatimi semeni / plodovi	<i>Chenopodium album</i> (bela metlika)	1869	835	213
		<i>Brassica rapa</i> (oljna repica / repa)	392	68	17
		<i>Quercus</i> sp. (hrast: perikarp želoda)	189	61	7
		<i>Quercus</i> sp. (hrast: baza želoda)	13	6	1
		<i>Corylus avellana</i> (leska: baza lešnika)	11	8	0
		<i>Trapa natans</i> (vodni orešek: baza oreška)	7	3	0
	Divji sadeži	Maloideae (lesnika / drobnica: perikarp v sadežu)	187	129	4
		Maloideae (lesnika / drobnica: pečka)	33	16	0
		<i>Fragaria vesca</i> (nav. jagodnjak: seme)	158	109	8
		<i>Rubus fruticosus</i> agg. (robida: seme)	141	35	5
		<i>Physalis alkekengi</i> (volčje jabolko: seme)	22	19	2
		<i>Cornus mas</i> (rumeni dren: koščica)	3	0	0
		<i>Crataegus monogyna</i> (enovrati glog: koščica)	2	4	0
		<i>Prunus spinosa</i> (črni trn: koščica)	2	1	0
<i>Vitis vinifera sylvestris</i> (divja vinska trta: pečka)	2	0	0		
<i>Rosa</i> sp. (šipek: seme)	1	0	0		

# CULTIVATED PLANTS 4000 BC



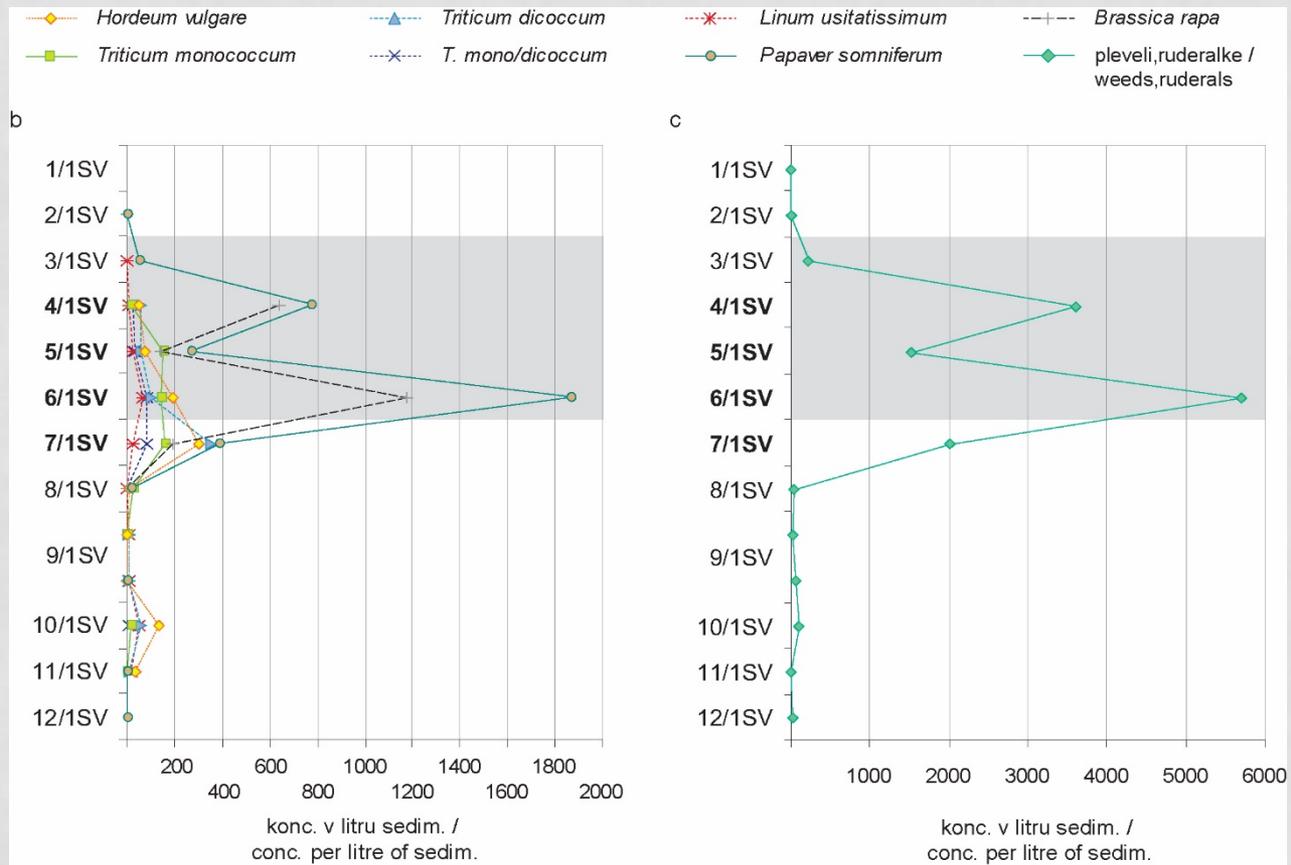
# GATHERED PLANTS 4000 BC



# PILE-DWELLING SITE STROJANOVA VODA PROFILE COLUMN



TOLAR, Tjaša (2018) Comparison of different sampling and preparation methods for archaeobotanical samples from the Eneolithic pile-dwelling sites Strojanova voda and Maharski prekop in the Ljubljana Marshes. *Arheološki vestnik* 69: 461-498.



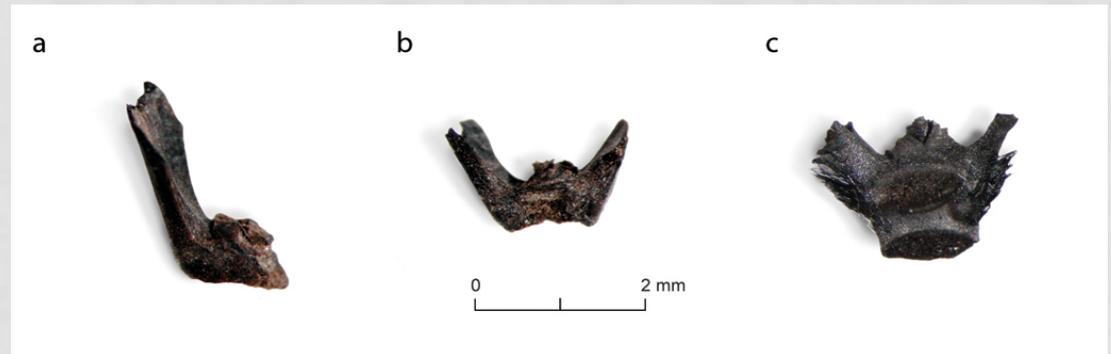
- remains of cultivated plants in 94 cm (11-3/1SV)
- archaeobotanical the richest sequence (7-4/1SV): 31 cm

# JUDGEMENT SAMPLING



TOLAR, Tjaša, JACOMET, Stefanie, VELUŠČEK, Anton (2016) Cereal chaff used as temper in loom-weights : new evidence from a Slovenian Eneolithic pile-dwelling site (ca. 3100 cal BC). *Vegetation history and archaeobotany* 25/3: 291-301.



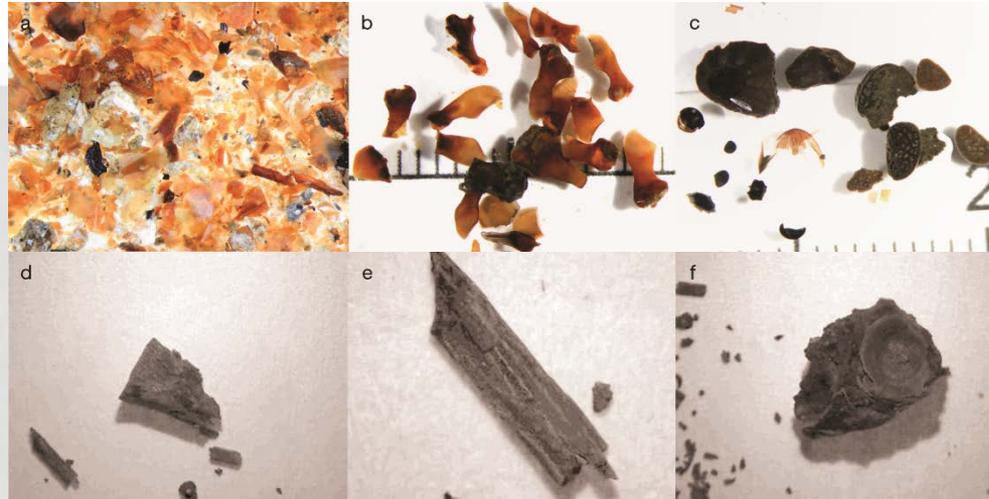


Cereal macro-remains dominate (n=1841) (glume chaff with and without rachis fragments: einkorn and emmer wheat and barley).  
The ratio of the added chaff to clay is 7 : 93

# COPROLITES



Pile-dwelling site Črnelnik



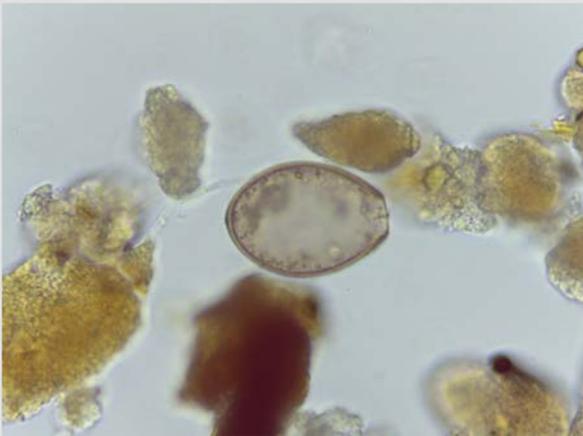
Pile-dwelling site Stare gmajne

TOLAR, T., et al. (2021). Multi-proxy analysis of waterlogged preserved Late Neolithic canine excrements. *Vegetation History and Archaeobotany* 30: 107-118.

	1 (7th d.)	2 (8th d.)	4 (7th d.)	5 (7th d.)
sample				
volume	10 ml	20 ml	5 ml	3 ml
Cerealia	x	x		
Linum usitatissimum	x		x	
Chenopodium album	x	x		
Schoenoplectus, Cyperaceae	x	x		
charcoal	x	x	x	x
Fish (Cyprinidae, small sized)	x	x	x	x
Bird (Passeriformes)	x		x	
Mammal (small)	x	x	x	

# ADDITIONAL ANALYSES

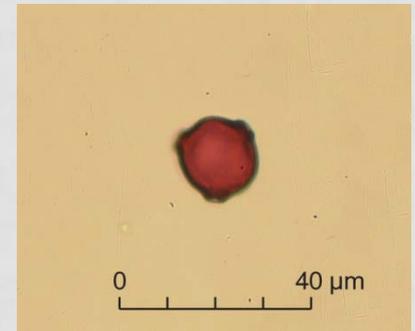
- pollen: hazel, birch, alder—indicating the spring season
- parasites: eggs of tapeworms and roundworms—confirming a canine host



tapeworm egg



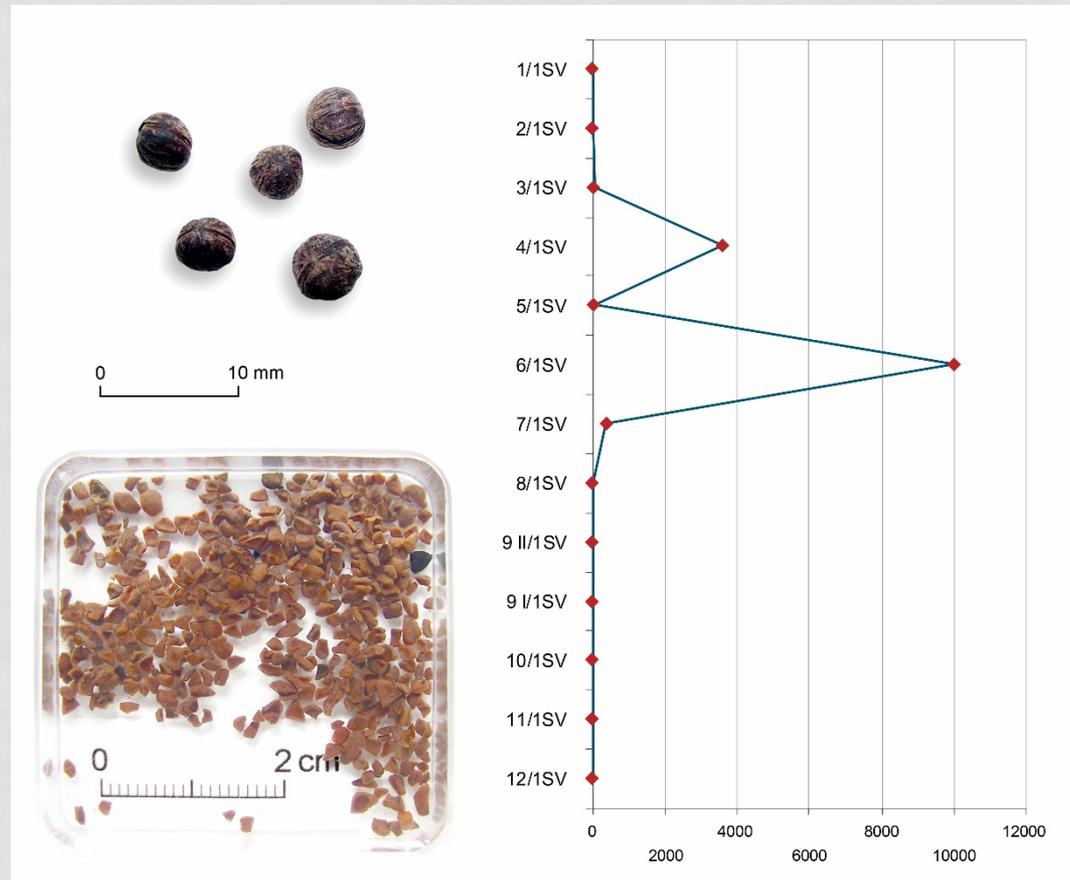
hazel pollen



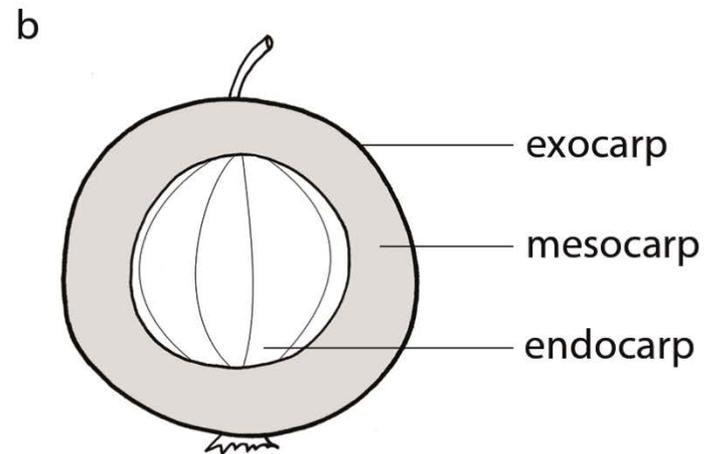
birch pollen

# USE OF RED DOGWOOD FRUITS?

TOLAR, Tjaša, VOVK, Irena, JUG, Urška (2021) Selective use of *Cornus sanguinea* L. (dogwood) fruits or fruitstones in the Late Neolithic. *Vegetation History and archaeobotany* 30/3, 347-361.



# EXPERIMENTAL ARCHAEO- /ETHNOBOTANY





- pounding in a mortar is difficult
- mortar cleaner than before the experiment



?? detergent, soap



- grinding on a quern stone is easy
- spreadable and kneadable substance obtained, pleasant to the touch

? cream, ointment

During cooking, we obtain a greenish colour and dense foaming.



During cooking of crushed fruits, oil droplets have released.





- Dyeing:
- wool
  - flax
  - hemp
  - cotton

Un-/successful?!

# CHEMICAL ANALYSES CONFIRM

## LIPIDS

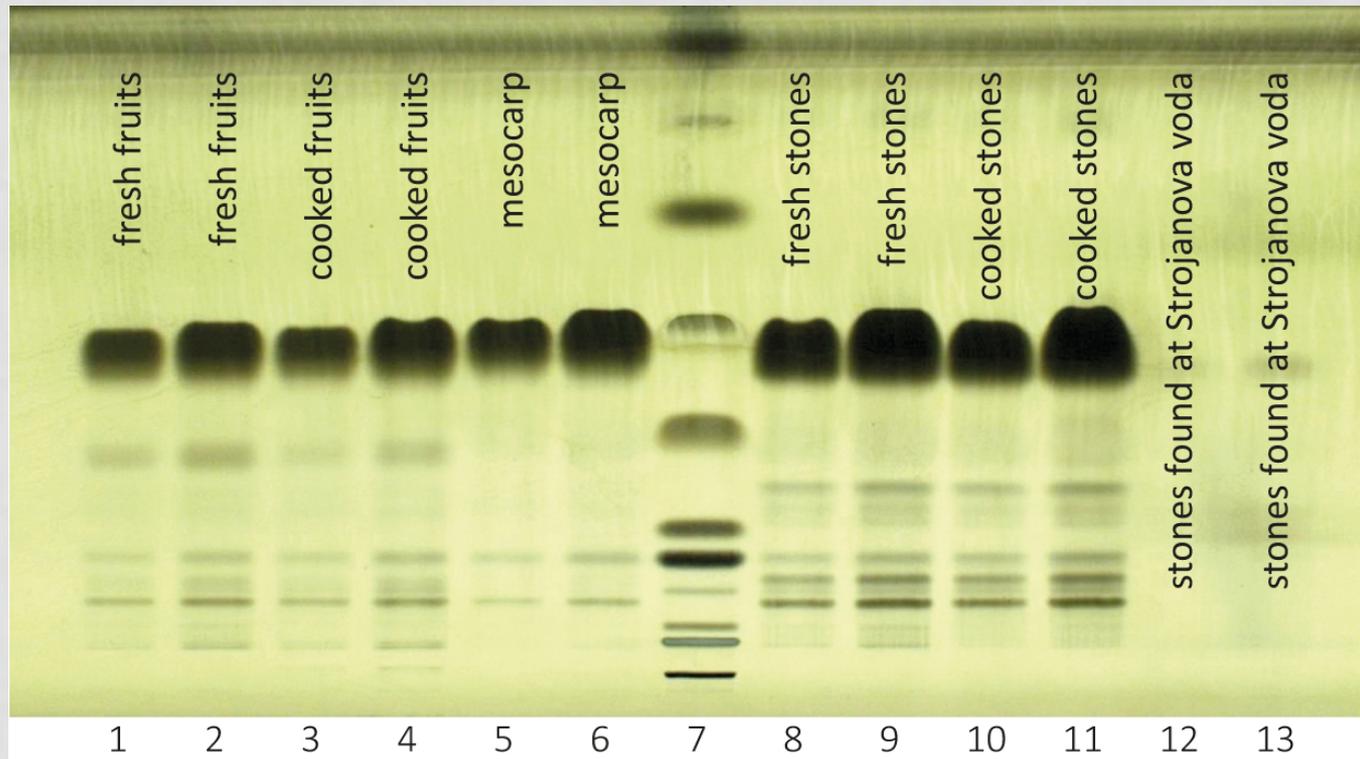


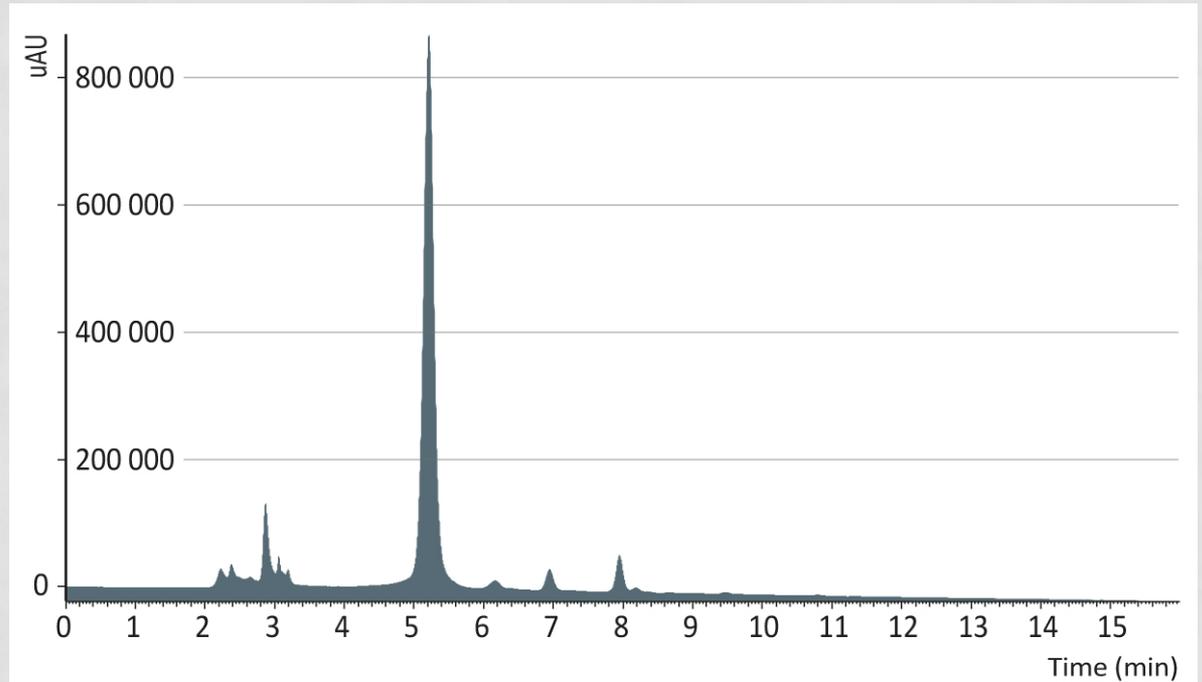
Foto: I. Vovk, V. Glavnik

# SAPONINS



in the mesocarp of fresh fruits

# ANTHOCYANINS (red and blue pigment)



in the exocarp of fresh fruits

# PROANTHOCYANIDINS

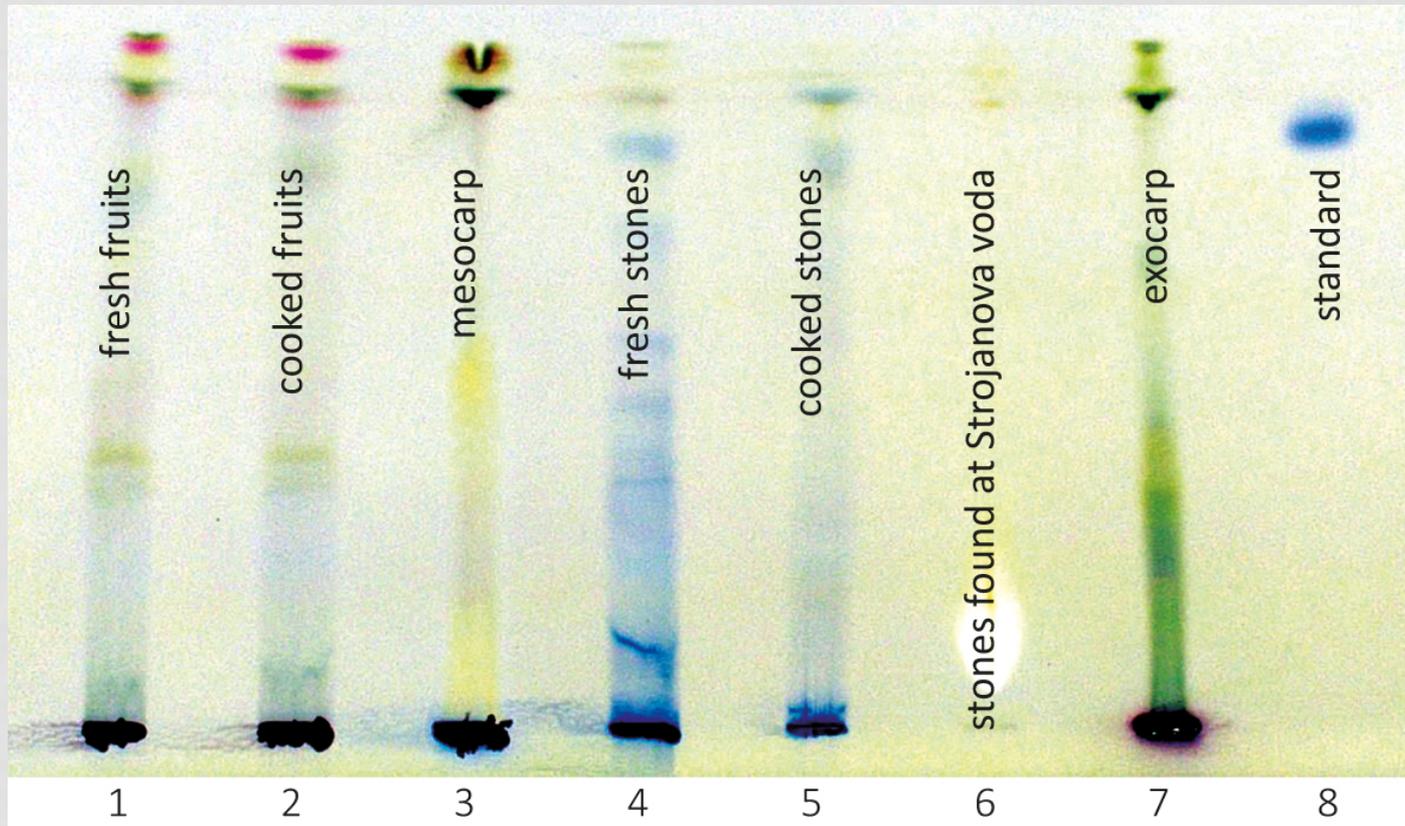


Foto: I. Vovk, V. Glavnik

antioxidants (also tannins) are more abundant in fresh, unboiled fruit stones (endocarps)

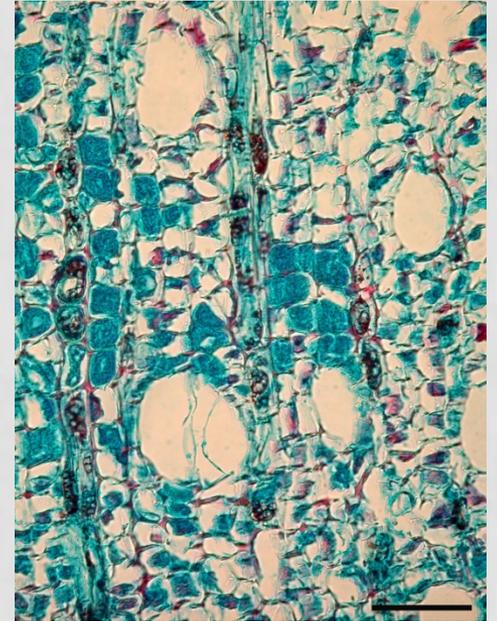
# OIL PRESSING AND SOAP MAKING



# WOODEN FINDS

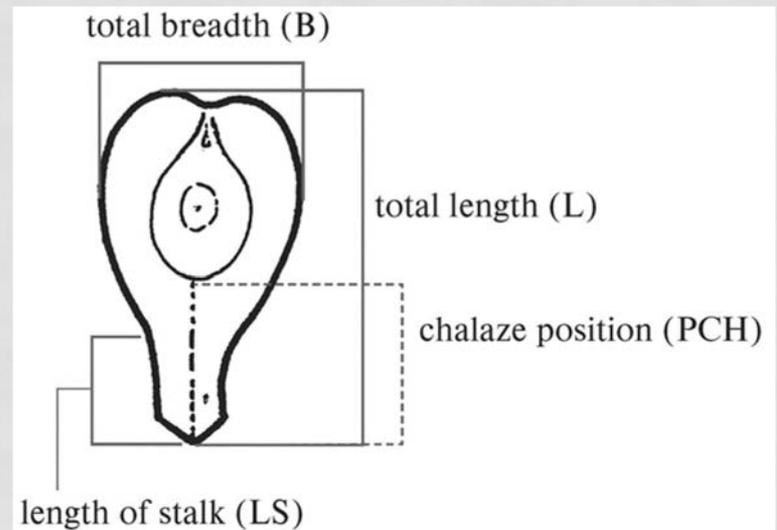


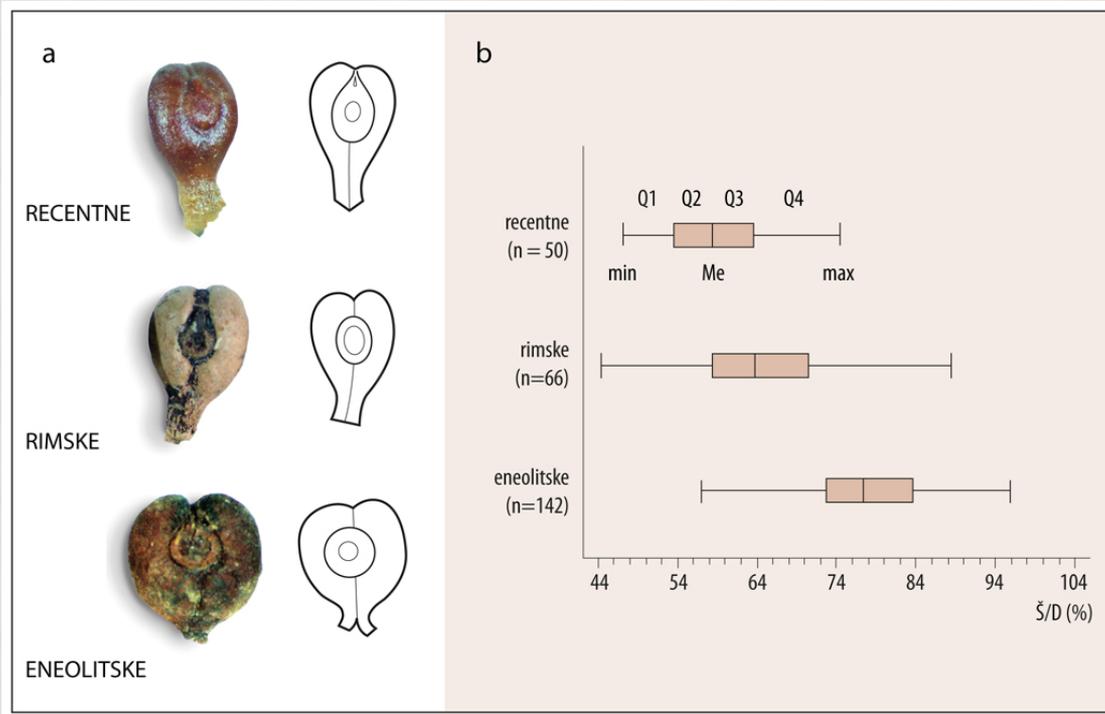
TOLAR, Tjaša, ČUFAR, Katarina, VELUŠČEK, Anton (2008) Wooden handle of a hammer-axe from the pile-dwelling site Stare gmajne in the Ljubljana Marshes. *Arheol. vestn.* 59: 49-56.



dogwood handle

# MORPHOMETRIC ANALYSES

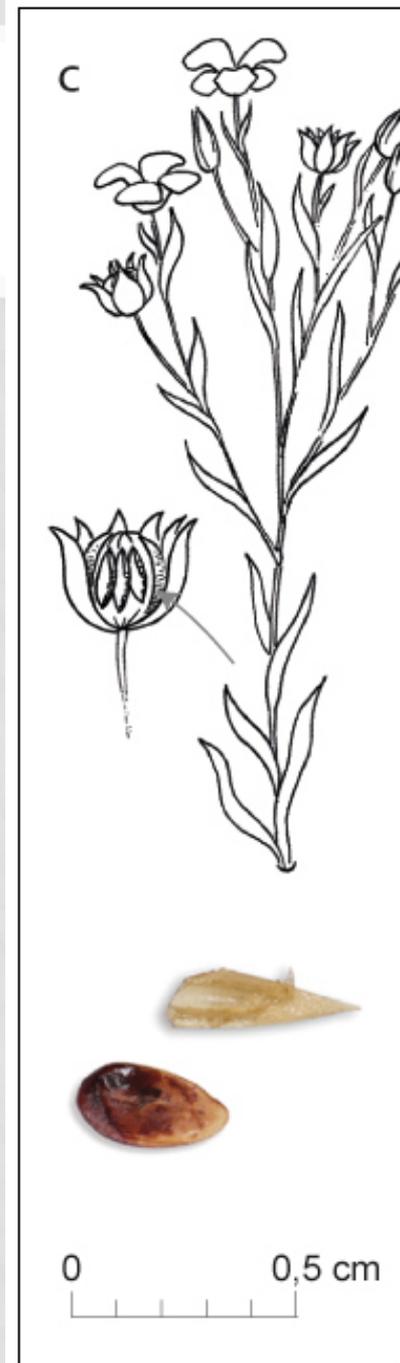




TOLAR, Tjaša, JAKŠE, Jernej, KOROŠEC-KORUZA, Zora (2008) The oldest macroremains of *Vitis* from Slovenia. *Veg. hist. archaeobot.* 17/1: 93-102.

# FLAX: OIL OR FIBRE CROP?

- Transition from the 4th to the 3rd millennium BC: the secondary products revolution (such as wool and dairy products).
- Part of this process is also the introduction of a new fibre-flax variety and, with it, intensification of flax cultivation.
- Morphometric analyses (size of flax seeds).



Period	Plant length	Stem	Seeds	No. of capsulas
4000-3400 cal BC	Less 70 cm	branched	bigger	100
3400-2400 cal BC	More 70 cm	straight	smaller	30

Recent flax plant	Length (mm)	Width (mm)
Seeds of oil flax	4.8 – 6.4	2.5 – 3.4
Seeds of fibre flax	3.0 – 4.9	1.8 – 2.6

Sabine Karg, Free University of Berlin, Department of History and Cultural Studies –  
*morphology of flax seeds and determination of subspecies for food/textile raw material*



## Abhandlung

Sabine Karg\*

# Flax seeds from Neolithic and Bronze Age pile-dwelling sites in Europe

<https://doi.org/10.1515/pz-2022-2036>

**Zusammenfassung:** Pflanzenfunde aus neolithischen und bronzzeitlichen Feuchtbodensiedlungen im Alpenraum weisen in der Regel außerordentlich gute Erhaltungsbedingungen auf und stellen daher eine unerschöpfliche Quelle für die Erforschung der Pflanzenkenntnis und -nutzung des prähistorischen Menschen dar. Im Verlauf des 43. bis 20. Jahrhunderts v. Chr. zeichnen sich im botanischen Fundgut Änderungen im Anbau von Lein/Flachs (*Linum usitatissimum* L.) ab. Die Zunahme von Faserlein könnte mit gleichzeitigen Neuerungen in der Herstellung von Textilien stehen. Die Studie ist daher für beide Disziplinen relevant, sowohl für die Archäobotanik wie auch für die Archäologie.

Leinsamen aus 33 neolithischen und bronzzeitlichen

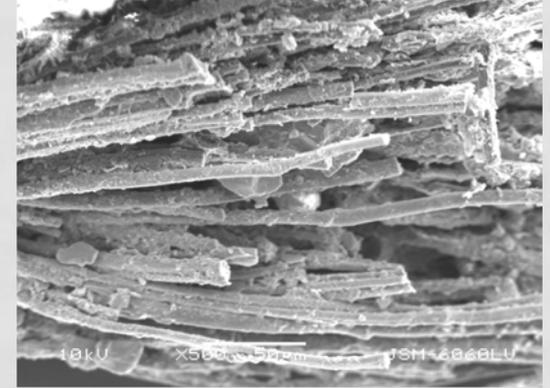
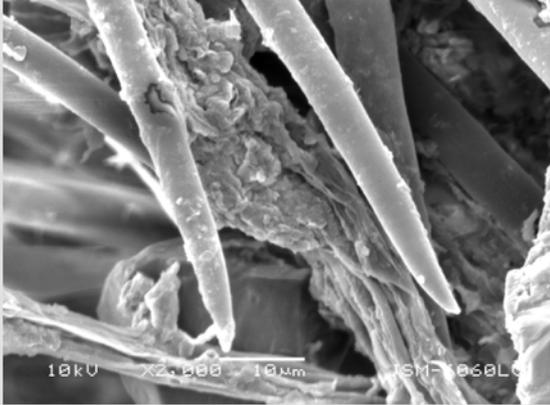
sibilities to study the relationship between plants and humans in the past. Changes in the importance of cultivating oil- and/or fibre flax (*Linum usitatissimum* L.) in the period between the 43<sup>rd</sup> and the 20<sup>th</sup> century BC are discussed. These changes might be explained by innovations in textile production at the same time. Thus, the study is considered to be relevant for both archaeologists and archaeobotanists.

Flax seeds from 33 Neolithic and Bronze Age wetland sites were measured. The results show that two transitions in seed size occurred in the entire Alpine region. From the 38<sup>th</sup> century BC onwards a new variety of flax with smaller seeds was cultivated, and at the same time textile tools such as loom weights and spindle whorls, as well as textiles made of flax increased. In all sites that have been

- Comparison of flax seeds from 33 waterlogged sites across Europe
- Two samples also from the pile-dwelling site Strojanova voda (ca. 4000 cal BC) in Stare gmajne (ca. 3100 cal BC)

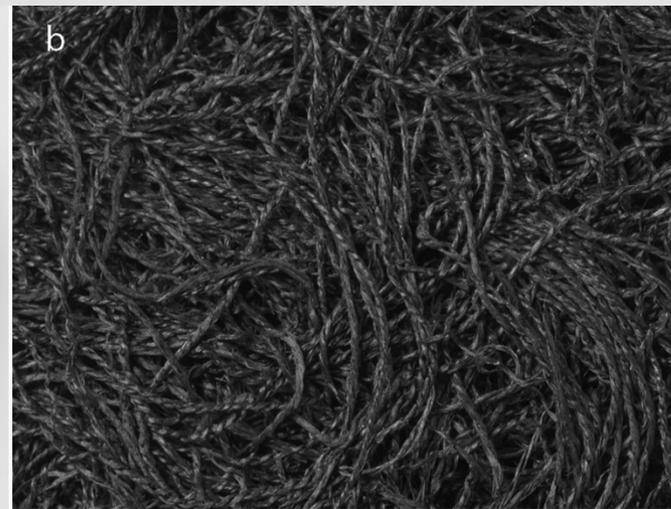
	width	length
Strojanova voda	2,21 – 1,63 mm	3,90 – 3,17 mm
Stare gmajne	2,29 – 1,45 mm	3,62 – 2,78 mm

# YARN MADE OF PLANT FIBRES

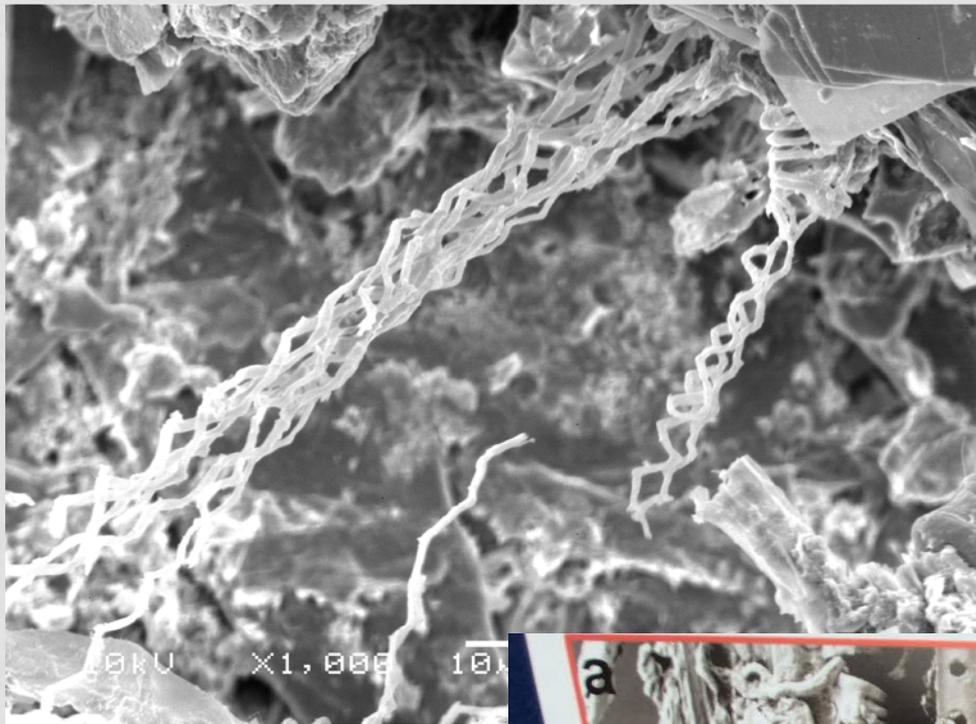


Stare gmajne site

? grass



# Yarn from Stare gmajne site



IWGP 2025, Groningen  
University of Valencia,  
Spain

? flax



Fig. 3. Microscopic Comparison of Flax Fibres: a) Modern flax; b) Valencia; c) S'Urachi.

Fig. 4. F

# THE IDOL FROM IG PILE DWELLING SITE (3. rd MILL. BC)



THANK YOU

