

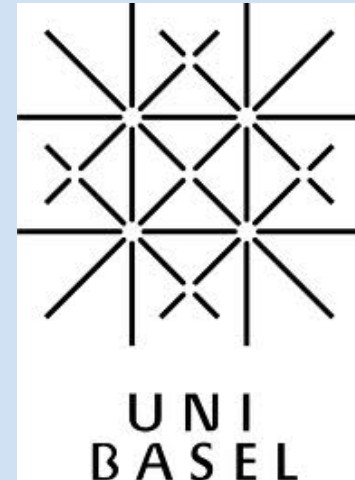
EAA Helsinki, August 2012, Session A4:
Living and Being in Wetlands and Lakes



Sampling and Recovery Techniques of Botanical Macroremains* from Waterlogged Archaeological Sediments

The logo for IPNA (Integrative Prehistory and Archaeological Science) is shown in a white box. It consists of the letters 'IPNA' in a red, serif font, with a red underline beneath the text.

Stefanie Jacomet, IPAS**, Basel
University



- * I consider also remains of small animals as well as to some degree microremains
- ** Integrative Prehistory and Archaeological Science, Dept. Environmental Sciences

I. Introduction



Reconstructions of Neolithic houses (Museum Unteruhldingen D and at Lac Chalain F), Fotos SJ

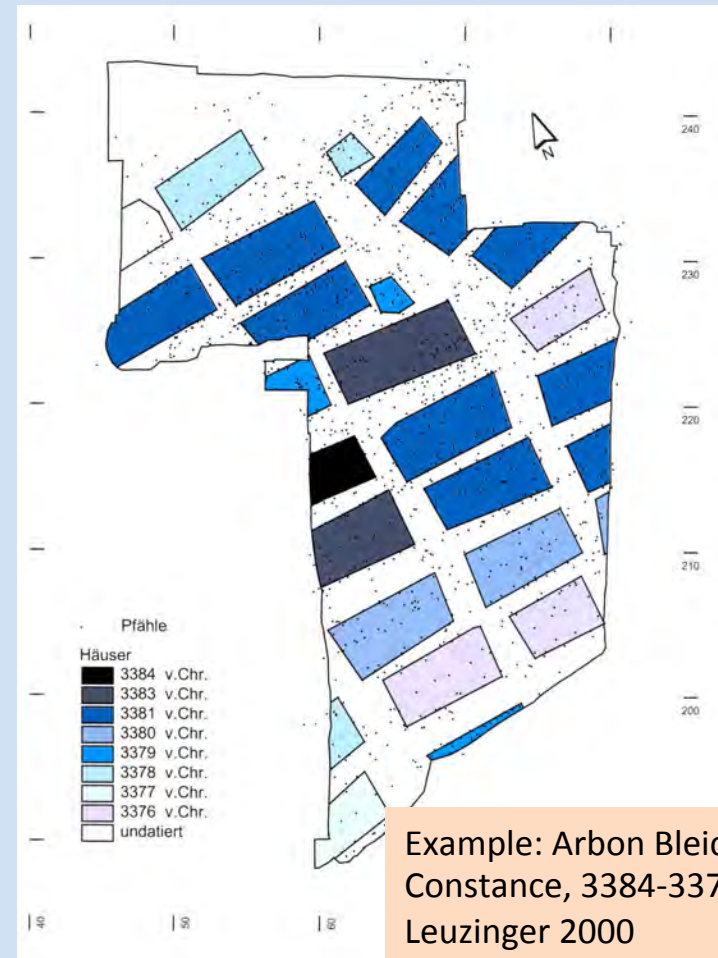
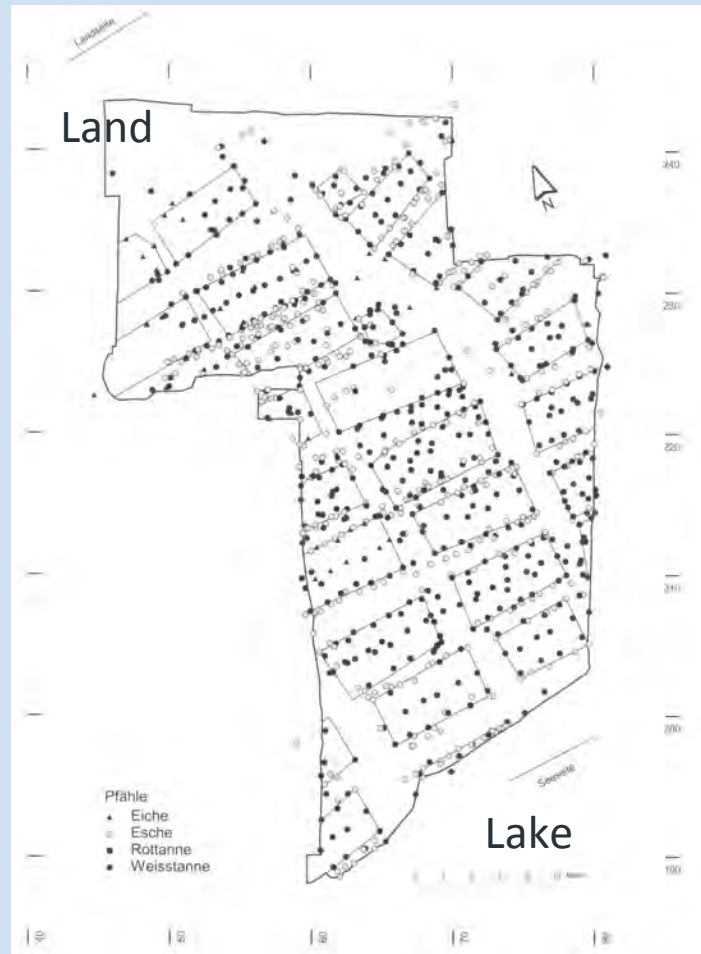
- I consider only lakeshore settlements
- Examples from the “pile dwelling” area in the surrounding of the Alps (ca. 4300 – 800 BC cal, Late Neolithic – Late Bronze Age) where plenty of work has been done since 40 years
- May be also applied for other types of waterlogged settlements we tried it for e.g. Iron Age site in Lithuania, Roman period layers ...
- I do not discuss preservation issues – preservation is usually excellent, density of plant remains is high (often >10'000 macroremains per litre of sediment)



For **AIMS** of the archaeobotanical work: see Antolin's input earlier in this session!!

A flax seed from Arbon Bleiche 3 TG CH, 3380 BC, Foto IPNA

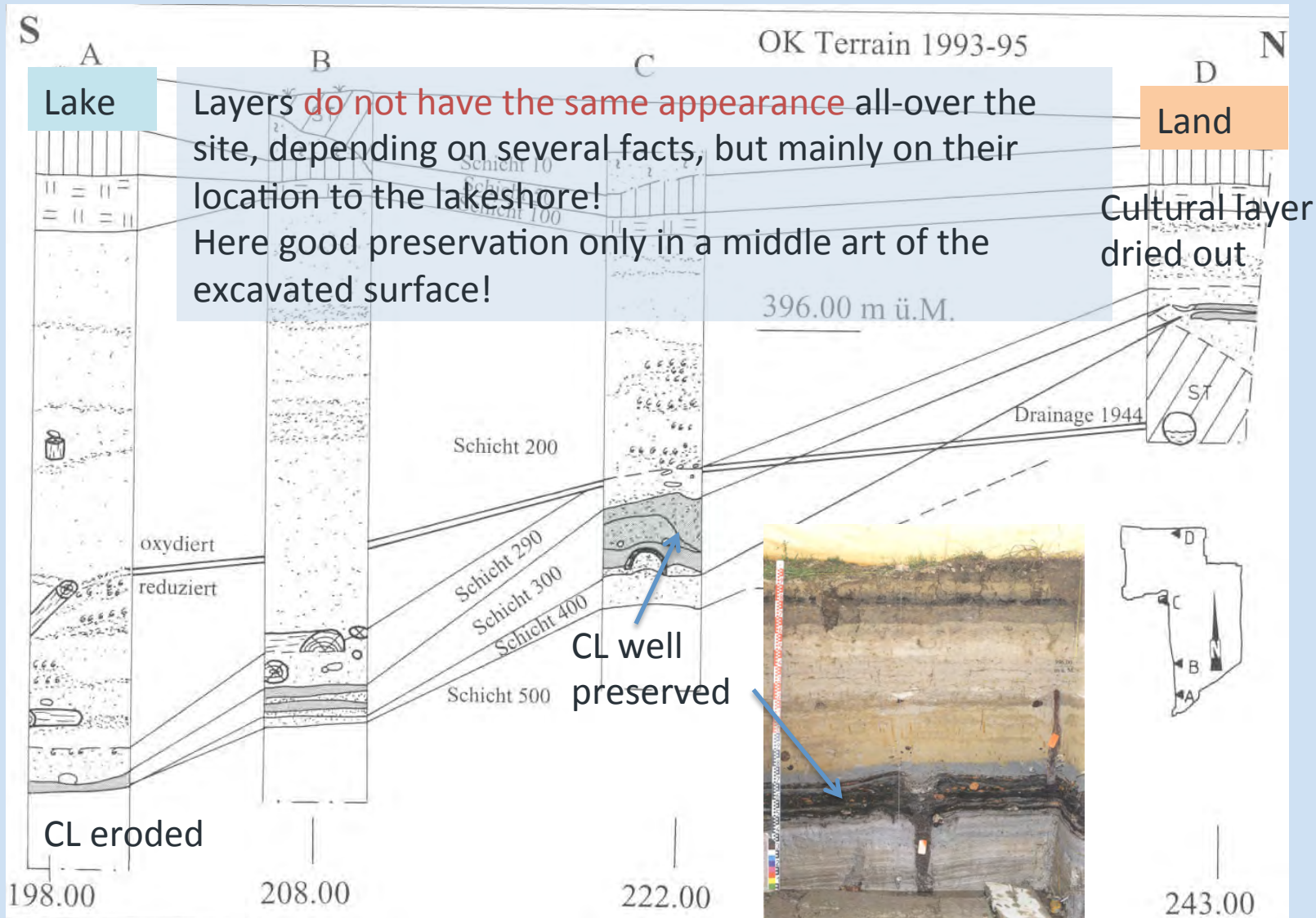
Archaeological facts



Example: Arbon Bleiche 3, Lake Constance, 3384-3370 BC, Leuzinger 2000

- Houseplans may be visible already during excavation, if 1-phased settlement (like Arbon Bleiche 3)
- Otherwise houseplan reconstruction and dating by dendrochronology, AFTER excav.
- max. duration of the settlement can be reconstructed as well as it's building history

Archaeological facts



Layers **do not have the same appearance** all-over the site, depending on several facts, but mainly on their location to the lakeshore!
Here good preservation only in a middle part of the excavated surface!

Cultural Layer dried out

CL well preserved

CL eroded

Example: Lake-Land Section, excavation Arbon Bleiche 3, Lake Constance, Leuzinger 2000

Archaeological facts

- Layers contain different features like rubbish heaps, stone heaps, fireplaces, clay“lenses” (housefloor?), etc.



Housefloor in situ, peat settlement Torwiesen II, Bad Buchau, D, short time settlement, 1 phase, 3283-3279 BC (max. 10 years)

Foto SJ

- ... but often not very much of such structures is visible



Archaeobotanical / geoarchaeological facts

- Cultural layers are a **mix** of building materials, stored material, cleaning residues, daily refuse, cooking refuse, dung (animal, human...), etc.
- **Very small-scale patterns** may be visible („mosaic“) – however, difficult to “disentangle”
- **in-situ** preservation possible (when well preserved)
- Signs of erosion, flooding, drying-out may be present
- Usually not deposited under water, **peat-like**



II. Sampling

.... is dependent on knowledge of the mentioned facts!
(which may be poorly known ...)



Pictures: excavation Zug-Riedmatt, Lakeshore settlement, Canton of Zug, around 3100 BC, ca. 4 settlement phases, photos SJ, 2008

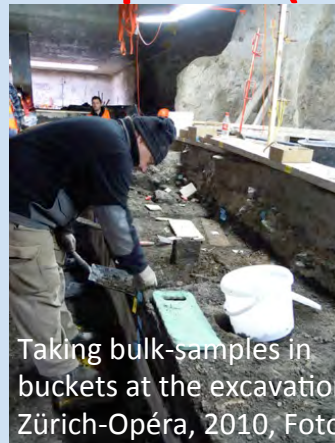
.... ideally, a mixed sampling strategy is necessary!!

- taking **profile columns (1)** →
- taking **judgment samples (2)**
- taking (large) **bulk-samples (3)**
("surface samples") →



Profile columns Horgen Scheller, ZH

Moss pad, Zug-Riedmatt (leaves were partly still green when excavated!) Foto SJ



Taking bulk-samples in buckets at the excavation Zürich-Opéra, 2010, Foto SJ

Profile Columns (1)

- are of crucial importance for a **reconstruction of the layer formation** (anthropogenic versus natural influences, sedimentation processes...) (and to some degree also for the detection of intra site patterns)
- Should be enough voluminous for a multi-disciplinary investigation (usually micromorphology, plant microremains (pollen), plant macroremains (see forthcoming))
- Only option, if stratigraphies complex (difficult to interpret...)
- **Advantages:** excellent image of the stratigraphy – fine differences become visible
- Single (even tiny!) strata are represented / distinguishable
- Macroremain samples large enough for a statistically proper representation of smaller items (<1-2 mm)
- **Contra:** samples too small for a proper representation of larger items, small vertebrates etc.
- Extremely small section of the layer represented – may be random



1a Taking columns out of sections, Horgen Scheller, Foto KA ZH



1b Taking profiles with tubes, Bad Buchau Torwiesen II (Foto SJ)

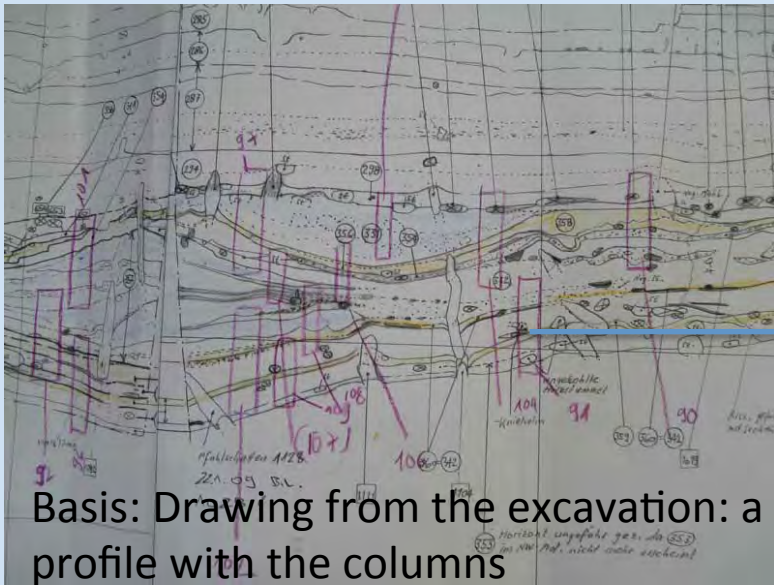
(Sub-)Sampling the Profile Columns

- Several disciplines should be involved (geoarchaeology: micromorphology; archaeobotany: micro- and macroremains)
- Crucial is the active involvement of an archaeologist (ideally: the excavator and evaluator)

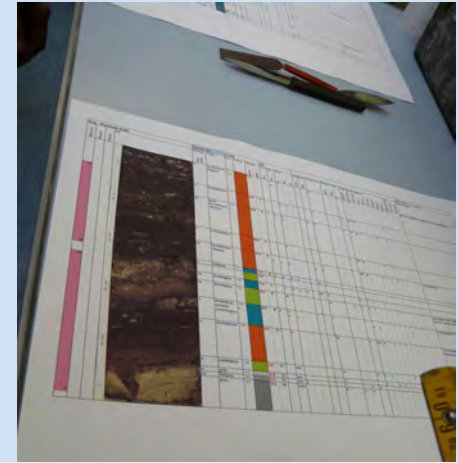
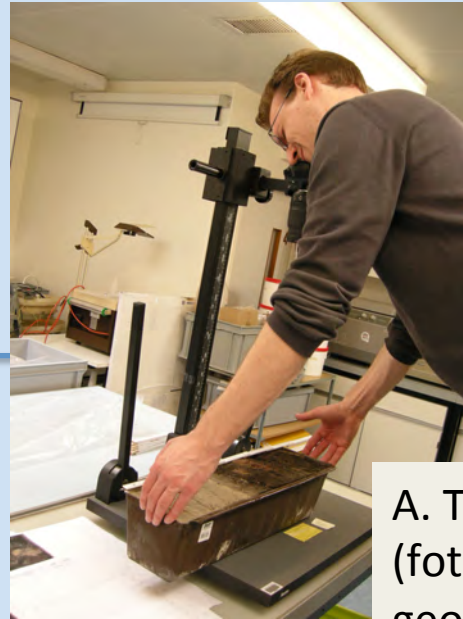
Understanding the stratigraphy and formation processes should form the **BEGINNING** of every investigation!!!

The Zug-Riedmatt-Team begins to discuss the stratigraphy, present in the many profile columns taken during the excavation of the site in 2008, before taking apart them (at IPNA)





Basis: Drawing from the excavation: a profile with the columns



A. Thorough documentation (foto, description) by the geoarchaeologists

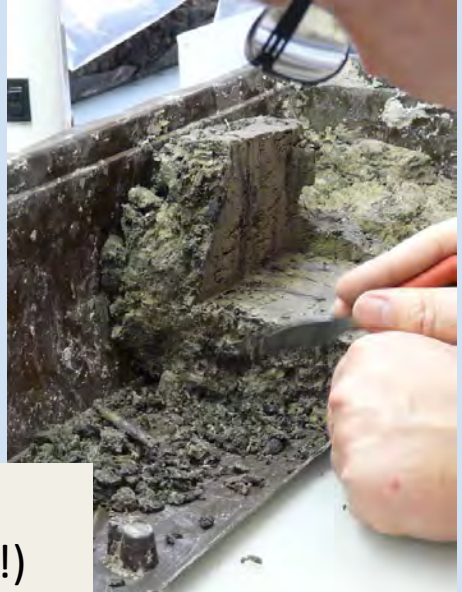


B. Sampling for pollen

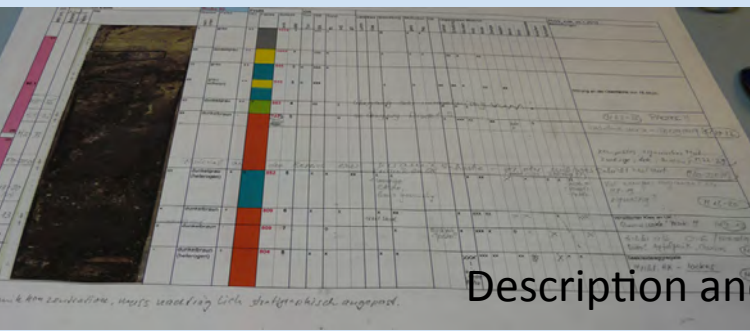


C. Taking samples for micromorphology

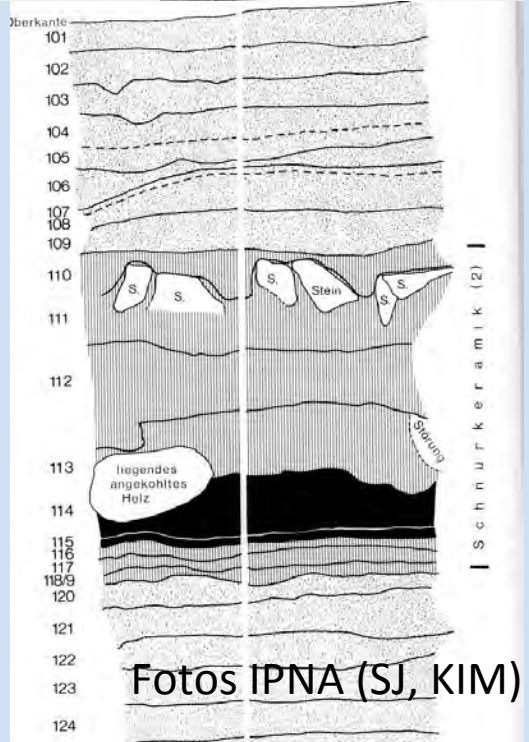
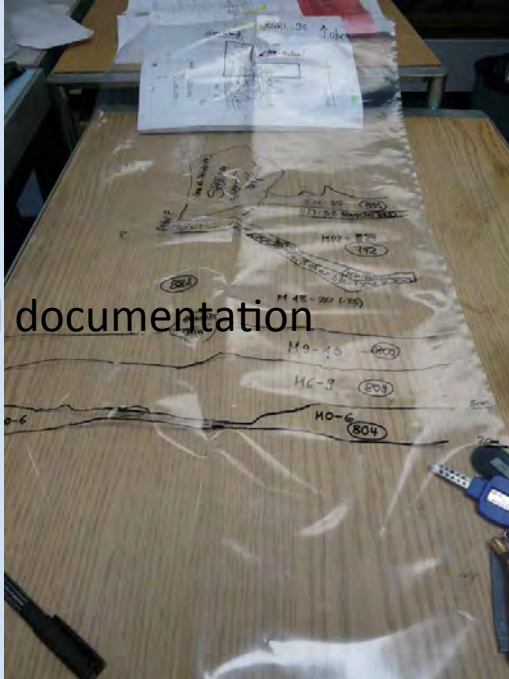
Sampling the profile columns (cont): D. final cutting for macroremain samples



Taking samples according to layers (may be only 2mm thick!)



Description and documentation



Fotos IPNA (SJ, KIM)



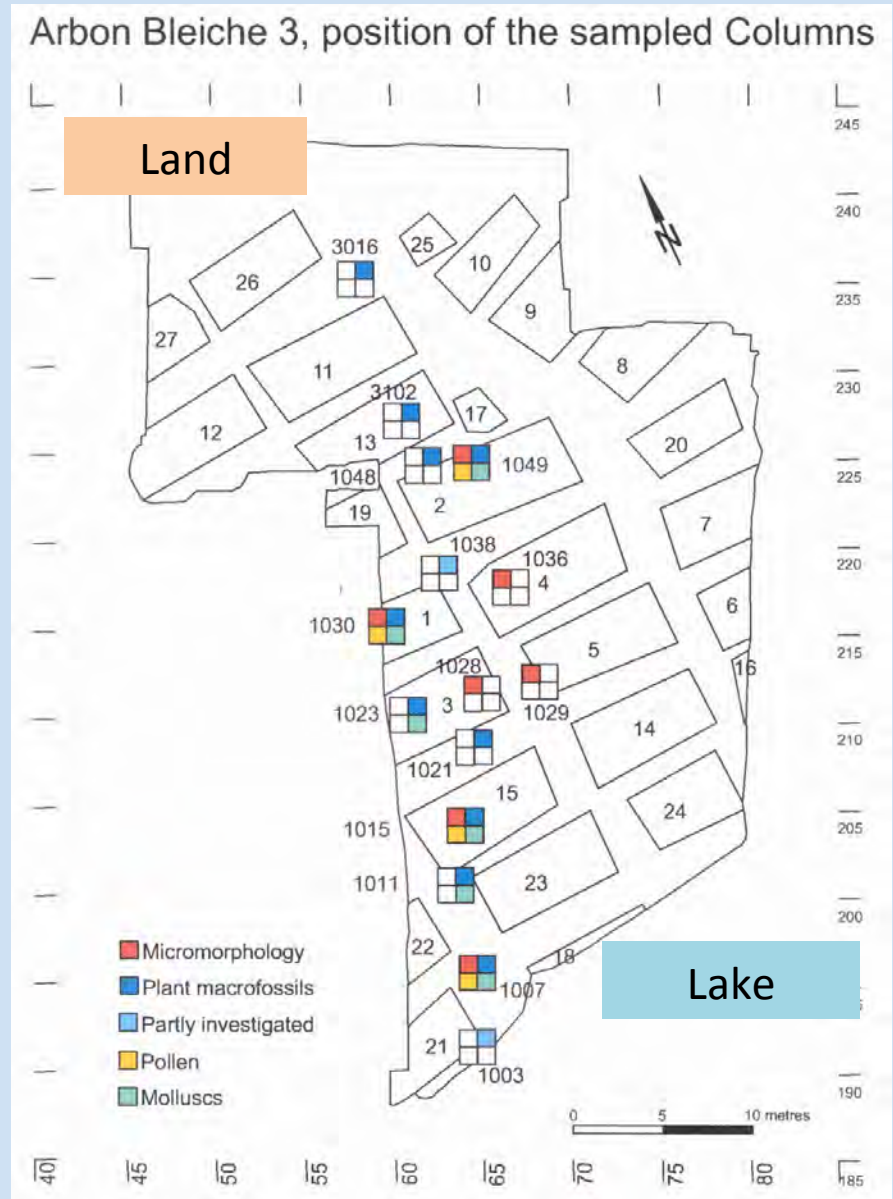
E. storing

Profile Columns (1a): sampling along a Transsect Lake-Land

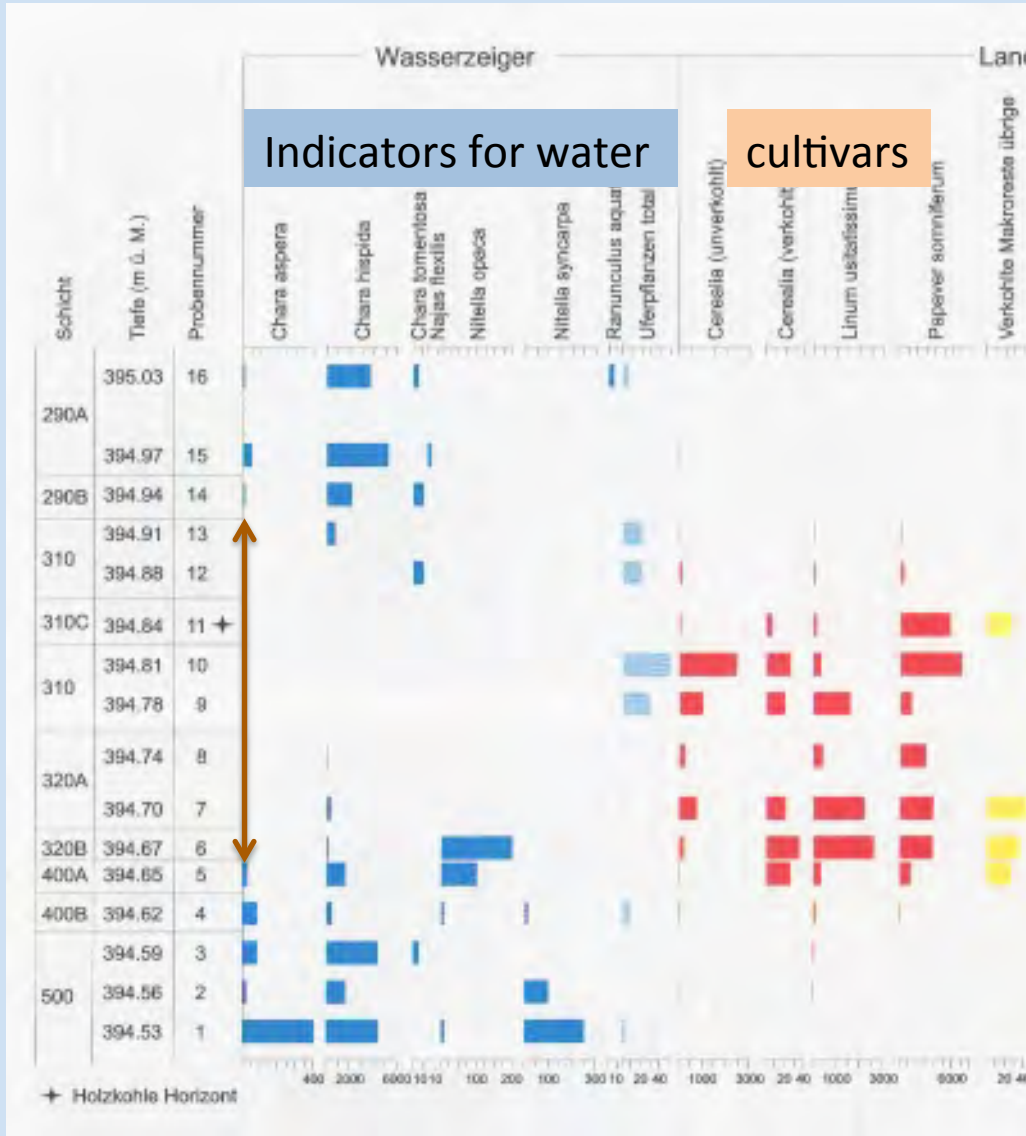
Aim: reconstruction of
the layer formation

Spectra of lake shore vegetation
may allow a reconstruction of the
litoral zone where the cultural layer
was deposited, give hints on eroded
and/or badly preserved parts
Etc.

Should always be done....!



Profile columns (1a): result: detecting layer formation



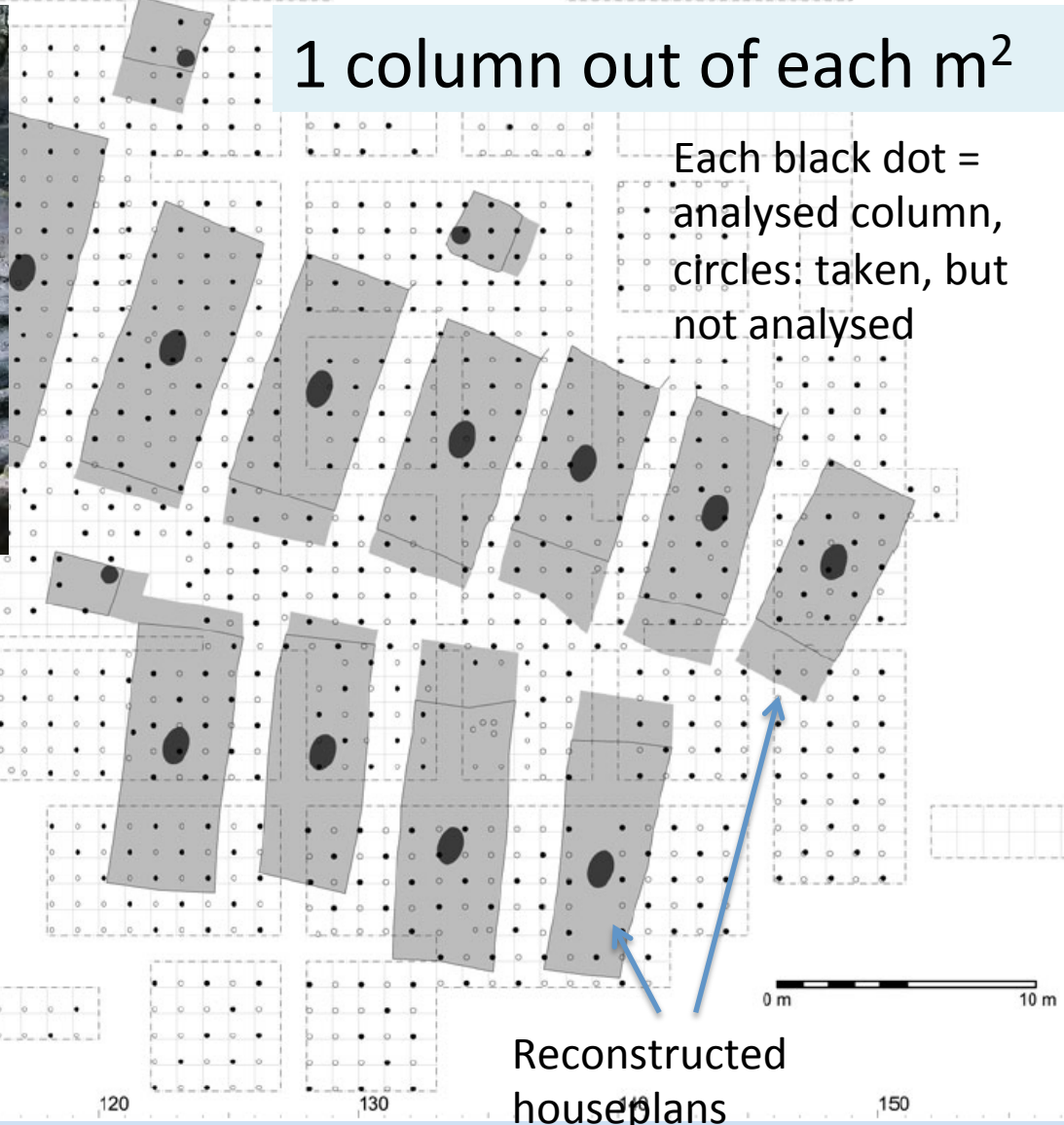
Lake marl above the cultural layer: water plants dominate: limnic environment

In the cultural layer hardly any water indicators, remains of human origin dominate: terrestrial environment

Mix-zone at the bottom of the cl

Lake marl below the cultural layer: water plants dominate: limnic environment

Profile Columns (1b): sampling for detecting of intra site patterns

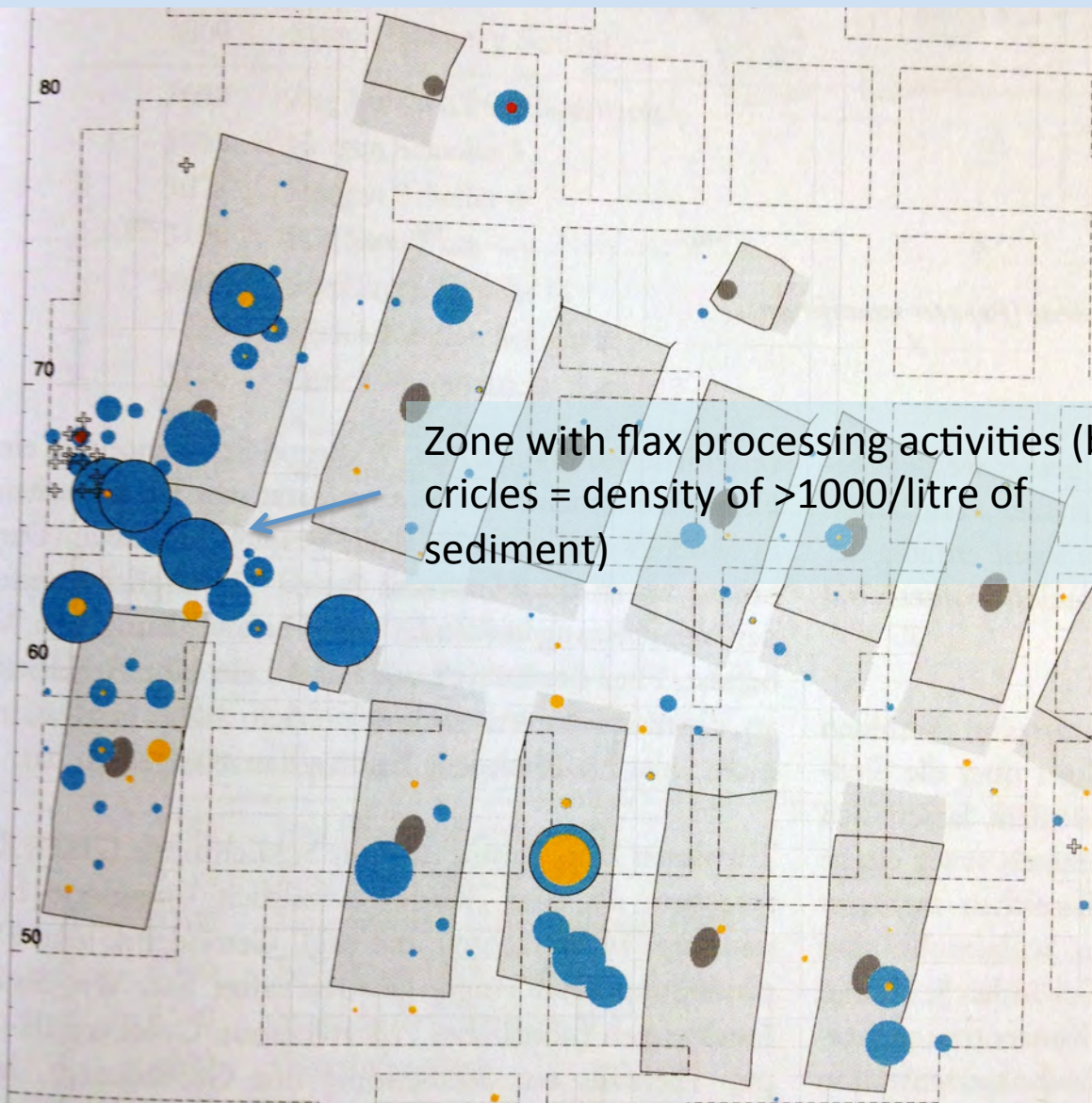


Profiles: plastic tubes, 10cm in diameter*

Example: site of Bad Buchau, Torwiesen II, short time settlement, 1 phase, 3283-3279 BC (max. 10 years)
12 larger houses, 3 smaller ones

*Too small for multi-purpose investigation

Profile columns (1b): Result: detecting intra site patterns



Density (items / Litre of sediment) of flax remains, site Bad Buchau Torwiesen II (Maier 2012)

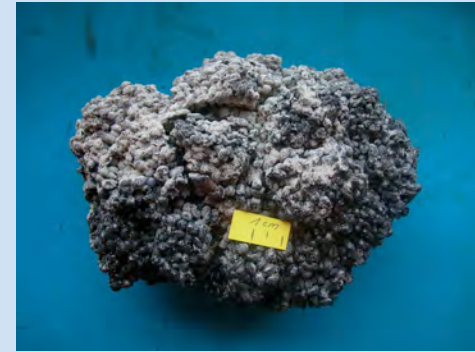
Only small (<2mm) remains ± properly represented!!!

With such a type of sampling also layer formation can be reconstructed!

Judgement samples (2)

- Examples: moss-pads, accumulations of seeds, dung, accumulations of any kind of material....
- **Advantages:** „closed“ assemblage, representing a short-term-event
- Give precise information on „events“, „situations“ (agricultural and cleaning activities, food / fodder composition...)
- **Contra:** a large part of the spectrum may be missing; does not represent the “average” situation over a longer period of time ...
- Excavators have not the knowledge to recognize all of the special accumulations of material; there is usually no time to sample all of the accumulations properly ... !!

Investigation of judgement samples always **in addition** to profiles and/or bulk samples!!!



Accumulation of cleaned cereal grains (naked wheat), charred (3400 BC, Oberrieden-Riet, ZH, Foto SJ)



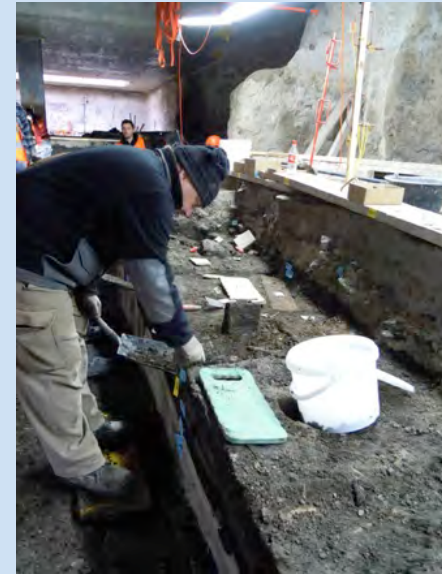
cattle dung, Arbon Bleiche 3, 3380 BC, Foto IPNA



Layer with sheep / goat dung (Federsee, 2900 - 2600 BC)

Bulk samples (3)

- taking bulk-samples (each of **min. 5 litres**) is often practised
- Makes only sense, when settlement-“phases” can be separated during excavation
- BS contain normally a **mixture of “events”**
- **Advantages:** Large items (seeds, wood, twigs, charcoal, remains of smaller vertebrates etc. = **multi-purpose samples!**) present in high enough numbers for a statistical evaluation
- Good representation of the “average” situation
- May contain **remains of short term events** which cannot be sampled individually during excavation!
- May contain special and rare items (see examples in Antolin’s lecture)
- **Contra:** represent usually a mixture of single events – may be difficult to interpret
- (sub-)layers may be mixed during excavation
- large amounts of samples (storage problem, see forthcoming)
- Laborious

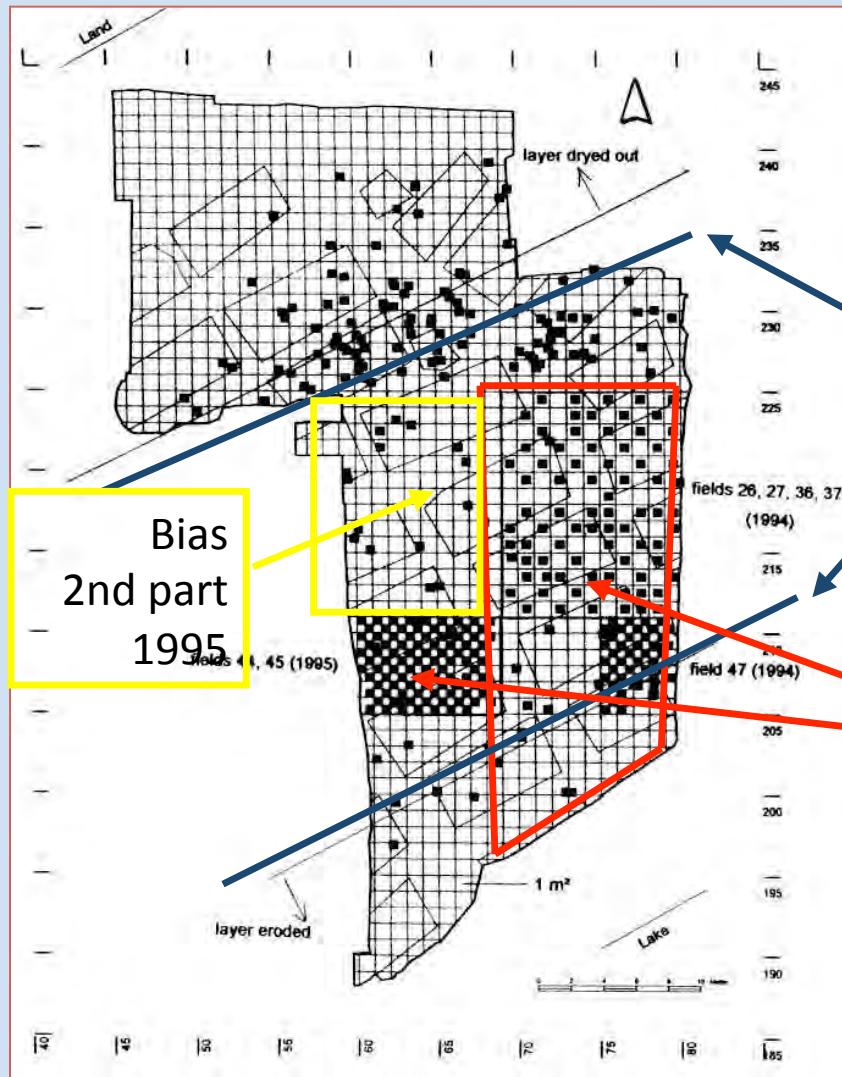


Taking bulk-samples at the excavation Zürich-Opéra, 2010 (above) and Zug-Riedmatt, 2009 (below), Fotos SJ



Taking bulk samples (3): surface sampling

Arbon Bleiche 3, TG, CH: Short term (1-phased) settlement (max. 15 years, 3384-3370 BC)



Surface sampling has to be systematic !!!

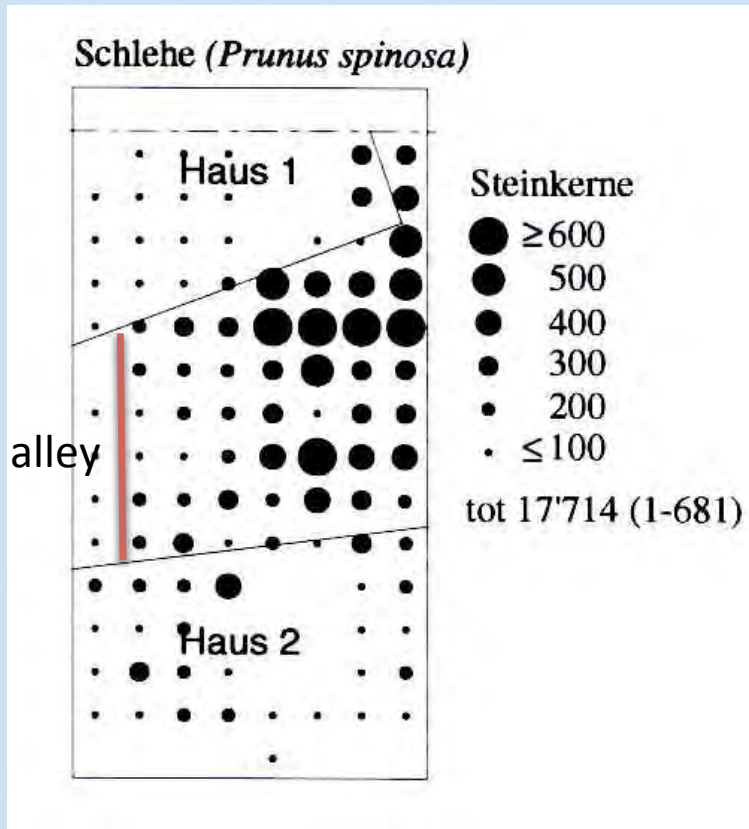
Zone of best preservation of the organic cultural layer

surface sampling was systematic (one sample of each $\frac{1}{4}$ of a m^2 or 1 sample out of each m^2) during campaign 1994 and the first part of 1995

● Samples (>5 litres each)

Sampling: e.g. Djindjan 1991; plan from Hosch & Jacomet 2001

Bulk samples (3): Result: finding intra-site patterns



- **Rubbish and excrements** are mainly found in zones **outside of the houses** (rarely also below) (e.g. Hornstaad, Horgen-Scheller, Zürich AKAD J)
- **Carbonised cereal remains** are concentrated near/in **hearths inside the houses**: these were used for cooking (Chalain3, Horgen-Scheller, Concise Ens. 2)
- much **lower concentrations** of plant remains in the **hearths**: they were relatively **clean** (Horgen Scheller, Concise Ens. 2)
- **Twigs and mosses** were used as **isolation / bedding layer** inside of houses (Horgen Scheller, Hornstaad)

Sloe stones thrown out of the houses after consumption; rubbish between the houses

III. **Storing** of waterlogged samples (and all waterlogged material classes issued out of them)

- **Cool** (<5°C) (or even deep-frozen!)
- +
- **Dark**
prevents development of fungi, algae...
- **NEVER** let dry the samples out!!!

Exceptions may be: bone material (if not used for aDNA!), charred material



Cooling chamber, IPNA, Basel. Foto SJ

IV. Recovery Techniques

Sieving methods have a **strong influence** on ubiquities and concentrations of plant remains in waterlogged layers..... **Wash-over technique is the only option** – also for large samples of >5l volume each (if you want to have botanical or fishscale remains properly represented!!!!)

strongly affected by „common wet sieving“ by unexperienced people:

- Uncarbonised cereal chaff
- Flax capsule parts
- Apple remains (seed, pericarp)
- etc.

Not very much affected:

- carbonised cereal (chaff and) grains
- poppy seeds
- hazelnut shells
-

Not discussed here is subsampling etc.



Foto SJ, somewhere

(may only be suited for the detection of hardshelled taxa like sloe, for finding archaeological artefacts etc.)

1. Soak sediment in water (ev.: pre-treatment by deep-freezing needed), measure volume



Wash-over technique (after Kenward & Hall 1980, Hosch & Zibulski 2003)



2. Take a small amount of material in a bowl



Sieving facility, with sieves (usually 2mm and 0,35mm → fractions)



4. Thoroughly decant

3. Bloat in water

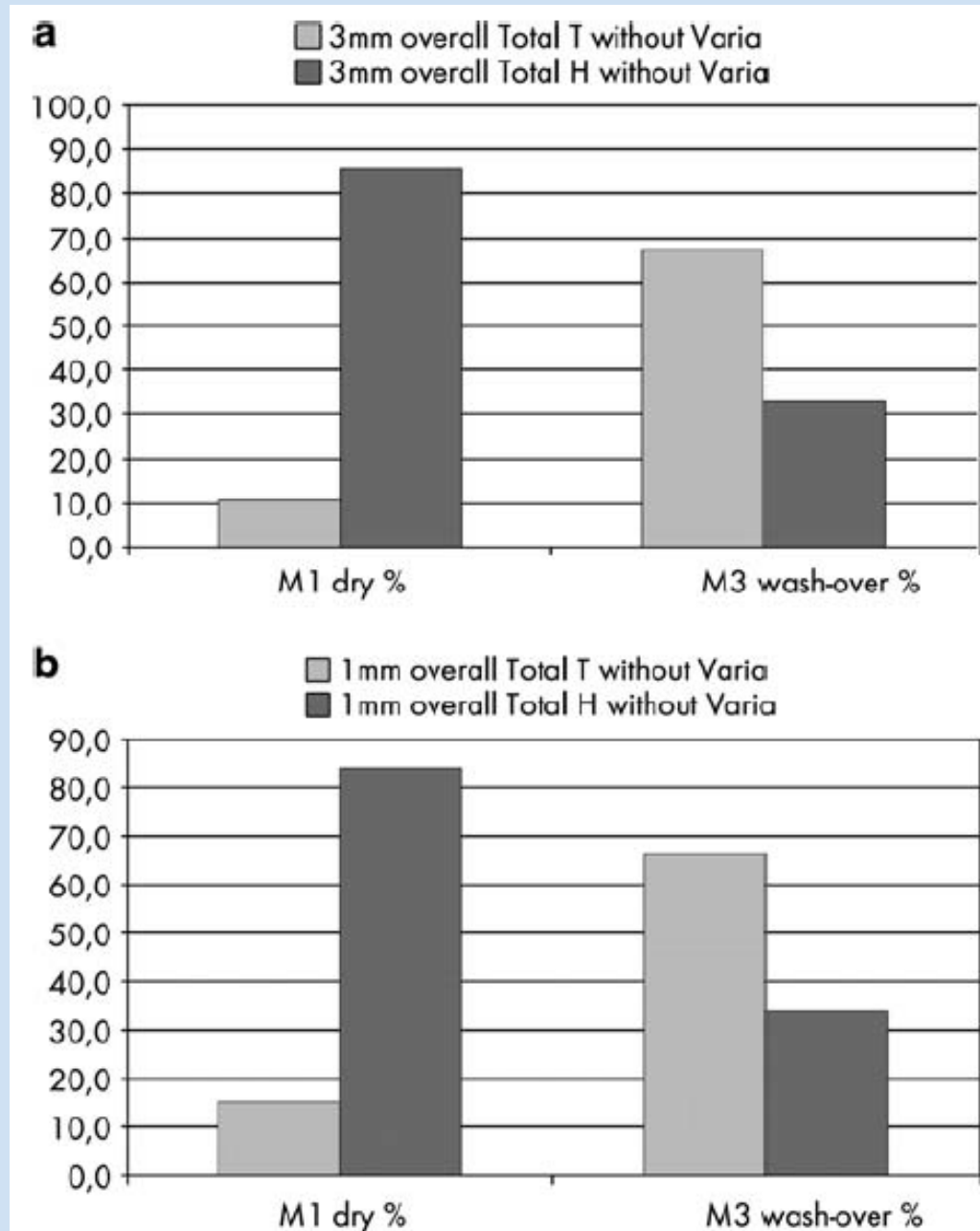
V. Treatment of the fractions

Hard-shelled (lignified, petrified) items may survive drying (dark columns) and are then overrepresented

Only a small proportion of thin-walled (subtle) items (light grey columns) survives drying!

**NEVER DRY
WATERLOGGED
MATERIAL!!!!!!**

Tolar et al 2010 in VHA, showing an example from a lake dwelling in Slovenia



VI. Investigation of the fractions: counting units

- Take subsamples
- Define counting units

Example: counting units for the 0,35mm-fraction of samples from neolithic lakeshore cultural layers

<i>Remain type</i>	<i>Morphological unit</i>	<i>TP</i>	<i>value</i>
Whole seeds		yes	1
Cereal bran	Fragments with hilum, >1mm	yes	1
Rachis internodes of cereals	One internode (if items with several internodes, each is counted as 1)	yes	1
Glume bases	One glume base (a spikelet fork is counted as 2)	yes	1
Flax seeds	Whole seeds, seed fragments with hilum	yes	1
Flax capsule segments	Whole items, Fragments with tip	yes	1
Opium poppy seeds	Whole items, two halves	yes	1
Strawberry, nutlets	Whole items	yes	1
Raspberry, blackberry stones	Whole items	yes	1

VI. Investigation of the fractions: target populations

- We usually use the numbers of van der Veen & Fjeller 1982)
- With those numbers it is possible to detect the proportions of the most important Taxa (=10%) with a defined probability
- Usually in waterlogged material we sort **ca. 400 items** per large and small fraction each (Hosch & Jacomet 2001)
- In fact it is not known how many items have to be counted for recording the maximum diversity – basic research has still to be done (e.g. sorting of subsamples until the maximum is reached)

d (%)	1- α (%)	P (%)	N						Target pop n
			100		500		1000		
			n	%	n	%	n	%	
5	95	50	80	80	218	44	278	28	384
		20	72	72	166	33	198	20	246
		10	59	59	109	22	122	12	138
2	95	50	97	97	415	83	707	71	2401
		20	94	94	378	76	607	61	1537
		10	90	90	318	64	465	47	864
5	98	50	85	85	261	52	352	35	541
		20	78	78	205	41	258	26	346
		10	67	67	141	28	164	16	195
2	98	50	98	98	436	87	772	77	3381
		20	96	96	407	81	684	69	2164
		10	93	93	355	71	550	55	1217

n, the required number of seeds in the subsample,
N, the total number of seeds in the target population,
P, the proportion of the particular species in the target population,
p, the observed proportion in the subsample,
d, the required accuracy or tolerance,
1- α , the chance of obtaining that required accuracy,
Z α , the two-sided α percentage point of the normal distribution (see Table 3).

Many thanks too many people...!!!!

THE END



Archaeobotanist at work (Circaea)

Check for a pdf of this lecture our website (from ca. 10th Sept. onwards):
<http://ipna.unibas.ch/archbot/index.htm>