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Radoslaw Grabowski. Identification and delineation of settlement space functions in south Scandinavian Iron Age: theoretical perspectives and practical approaches

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Mats Ravn, reviewer

Review of Radoslaw Grabowski

Identification and delineation of settlement space functions in south Scandinavian Iron Age: theoretical perspectives and practical approaches.

The paper confronts an important archaeological question: Can we from a multiproxy analysis perspective reach a better understanding of functionality of space, and what are the weaknesses and positive aspects of this approach in a theoretical and practical perspective. The question is answered satisfactorily by the author by confronting it with empirical evidence. The approach is innovative, illustrating the potential for adding such methods in often badly preserved house remnants preserved under the surface soil.

Regarding contents, the perspective is wide and comparative, making it operational at least throughout the south Scandinavian area, and thus making it innovative owing to its comparative transnational approach, that crosses different Scandinavian archaeological traditions. This approach is rare and needed. The language is almost perfect and the paper is well-written. The paper is relatively long, but this seems to be necessary, owing to all the empirical results and illustrations presented as documentation of the analyses. Some of the illustrations are not easily accessible, especially if they are not in color. (See details below).

The structure is good, starting with a geographical presentation aims and a theoretical perspective. This section is very useful for non-specialists. The second part confronting theory with empirical material is interesting and useful in a comparative perspective, opening up to various interpretations based on different observations. The conclusion is differentiated and interesting, paving a way forward for a question-oriented as well as interdisciplinary approach.

In sum, the paper is original and interesting and useful, not least for implementation in field archaeology.

Details
Fig 1. Copyright google - is that needed or is another map following? Otherwise good overview.
Table 4 is too small in the present version
Figure 6 is difficult to understand. Consider more explanation under the picture captions
Figure 7 what do the x axis and y-axis explain? Please add in the illustration
Page 28: under headline functional evidence: line 10 from below distribution not distributed ?

Anneli Ekblom, reviewer

Identification and delineation of settlement space functions in south Scandinavian Iron Age: theoretical perspectives and practical approaches

RADOSLAW GRABOWSKI

Summary

This paper aims to enhance the understanding of activities played out in house constructions and by extension functional analyses of house sections through the combination of multiple sources of evidences. It provides a comparison of the botanical, geochemical and geophysical data with approaches interpretations based on structural (architectural) and artefactual evidence recorded during excavations for analysis of internal house function showing how these different approaches may complement each other. The paper consists of two sections. It begins with reviewing the potential and problems of using macrofossils, phosphates, mineral magnetics and organic matter for functional analyses of house structures. In each case, the author gives a detailed account of methodologies and possible applications in functional analyses. The review elaborates the context and methodologies chosen in case study examples that are presented in the second part of the paper and here potential of different strategies for phosphate sampling are evaluated in the context of other multiple sources of evidence.

The paper presents a valuable review of house structure analyses of interest to a broader audience and suitable for publishing in JAAH. However, I think the text would benefit greatly from a re-structuring and from making the aims and content more clear to the reader from the onset. The aims as now expressed focus on sampling strategies and do not balance well with the actual content of the paper. The main aim of the paper (which is already there but needs to be emphasised more clearly) should be rephrased to reflect the present content of the paper.

The paper should start with the aims and the broader aim of the paper along the lines given in the summary above. The aims should be moved to the very beginning of the paper and restructured to make the potential of the paper more clear and relevant to the reader.

I also suggest that the subchapter "Functional interpretation based on house structure, internal features and distribution of artefacts" should be moved to beginning, after the geological setting and made into a heading level 2. "Living and dying houses in dynamic societies" should also be moved to here (at least the section before beginning of the section on "life history of houses"). The 13 parameters listed should be used to lay out the context of *how* the methodologies present here (and as shown in the case studies) can assist in answering or testing the assumptions based on house structure and finds alone. Only after this, the reader will have enough background to follow the very relevant discussion on methodology and important source criticism, the authors will also the more clearly be able to relate back to the archaeological questions.

Below I will give more detail comments on each section phrased directly in communication with the author.

Detailed comments

Aims and background

As I read the paper, the main objective should be "to enhance the understanding of activities played out in house constructions and by extension functional analyses of house sections through the combination of multiple sources of evidences". The aims listed as they now stand are *means* by which to address the main research question and you cannot assess the applicability of sampling methods or results without referring back to the overall archaeological objective.

The scope as presented in the background appears to narrow and does not well reflect the actual content of the paper (and the aim as I interpret it). I suggest introducing the paper based on what it presents rather than as now based on what was left out in another paper, which the reader is not likely to have read. Thus, begin with a summary, e.g., this paper will …. (See the above summary for a suggestion).

The present focus in the introduction on phosphate feature fill analysis of phosphates vs spatial distribution does not well capture the overall content of the paper and much of this discussion should instead be moved to the Phosphate analysis section. The two (relatively long) quotes should be also be deleted, it is better that you summarise this in your own words and draws out the relevance of the methodologies chosen in the case study examples.

Geographic and chronological setting of the study

This text is somewhat misdirected in relation to the content, the geographical setting of the review you start with is Scandinavia and the focus is broader than the Iron Age as you review functionality analyses of (long) houses in general, though the focus is on long houses. Thus, once you have begun with the broader introduction on geographical and chronological scope and introduce the geographical and chronological scope of your actual case study examples. In the case study examples, again as I read the paper the phosphate feature fill analysis of phosphates vs spatial distribution is only one of the many different methodologies discussed in the case studies thus you should rephrase this accordingly.

The chapter "Functional interpretation based on house structure, internal features and distribution of artefacts….." should be moved to beginning of after the geological setting as discussed above

Methods and underlying theory

I suggest you rephrase this to "Complimentary methods and interpretation" or something similar. Throughout this chapter, I am missing headings of level four, which would make the structure of the text come out better. For instance Heading three "Plant macrofossil analysis: formation and operational background" and heading four "Plant macrofossil analysis and identification of functional spaces". The same applies for the other methodologies presented. You should also point out in the introduction to this section that there are other useful methods that you will not discuss here e.g. lipid analyses and multi-elemental analyses (e.g. chemical elements *other* than phosphates).

This section begins with the statement of what you will not discuss in this paper. It is as a rule more pedagogic to tell the reader what the text will present. E.g., here methodologies complementary to conventional archaeological interpretations will be presented focusing of possibilities and problems of interpretation of longhouses in particular. Contrary to how it is now phrased I do think you give a very detailed review of "the technical specifics of each method, and aspects of how they can be combined" and you also give ample reference to the authors listed in the below discussion so I don't see that you have reserve yourself in the introduction or list the references as you now do. It is better to add them in your review of each method in parenthesis (e.g. for a full review of this problem/method see XXXX).

In the text you make a very loose parallel to *Chaîne Opératoire,* if this comparison is to make any sense to the reader you have to explain how this is relevant, what is the similarities. If you move the "Living and dying houses in dynamic societies" to before methods you reference to Shiffer and C- and N-transformations will more make sense to the reader, but you must relate it more clearly to what you are saying here more exactly.

"Human handling of botanical material often leaves patterns in botanical assemblages" this is somewhat of a tautology, in this case you are exploring context that are entirely humanly constructed. Delete this sentence and go straight to next one.

The wording "functional insights" gives the wrong association, rephrase to "By assessment of these variations it is possible to gain insights about the activities and possible function of the spaces from which they derived" E.g. in this sentence you were jumping one step, you trace the activities first and then from there the function.

"The properties listed above make archaeobotanical interpretation a complex task. They…" It is unclear what the properties refers to and accordingly even more unclear what "they" refer to. Rephrase to make clearer, explain what is it that is complex, the activities or the interpretation or both?

Plant macrofossil analysis and identification of functional spaces

This section begins with a very long sentence; try to break this up. In addition, as this section is so short it is better to combine it with the one following.
"Plant remains in unburnt houses will therefore tend to cluster around the former location of the heat source where they were carbonised." Rephrase this as suggested in the text and see the following sentence.
"represent shorter time spans; essentially reflecting what was in the house at the time of the fire" see suggested rephrasing in text as I am missing a verb here…houses don't do anything. I suggest to add "activities" same with the sentence above e.g. it is a snapshot of the use of plants in the household/or amongst the occupants/dwellers/users of the house and activities linked to the use of plants"

MS-analysis, possible archaeological scenarios

You write: "Samples showing *increased* MS550 levels (high MSQuotas); are interpreted as unburnt." Is it not better to write samples with values close to 1 here? At least according to what

you write above. There is also a small imbalance here. In all other sections when reviewing proxies you also review its use in house investigations but not here. Is this because it has not been done before or why? Point this out in that case or say that more concrete examples of applications will be given below or something similar.

Analysis of organic and inorganic phosphates by weak acid extraction

I do not see why the quote is needed, it is better to formulate this in your own words.

Phosphate analysis of south Scandinavian longhouses

"More specifically, the working hypothesis is that the two fractions should be primarily representative of bone and manure accumulations respectively, since these were presumably the main sources of phosphate-rich material circulating on prehistoric settlements (Engelmark and Linderholm 1996, Grabowski and Linderholm 2013)." However, the latter can also be enriched through decomposing vegetable matter, or?
"2) bones and manure were presumably transported along completely different pathways". This sentence is not very clear what do you mean exactly. In addition, I am wondering under what conditions would bone/waste from bone be accumulated inside a house. Presumably, people did not through their waste inside the house or leave decomposing animals inside the house when it was still in use? So, if the enrichment of phosphate took place due to decomposing animals would this not be more likely to be linked to activities taking place after/before the house was abandoned?

Functional interpretation based on house structure, internal features and distribution of artefacts and anthropogenically modified soil

I see this chapter as crucial in the choice of complementary methods and their application thus it should be moved to the beginning of the paper and be used to formulate specific questions which the complimentary methods presented here can answer/test

It is unclear from the introduction if these parameters are defined by Maria Pettersson or yourself, or if you have added to Pettersson's parameters and in that case how, rephrase accordingly.

Living and dying houses in dynamic societies and landscapes

"Regardless of which type of social unit inhabited a house, the structure of the unit would never have been static. People are born, grow up, grow old and eventually die. As an effect of these inevitable changes, the role of a household… " In the beginning of this sentence you use the phrase "social unit" and I guess this is because you (wisely) want to avoid the term "household", be consequent and rephrase to social unit and avoid the term household as you cannot assume that a house represents a household (see comments in text and below)

"could have archaeological implications" what is meant by this? Rephrase, for instance "could affect the archaeological record differentially?" or similar

"dividing the available evidence sources into three groups" Suggest to rephrase groups to categories (see comments directly in the texts)

Also in the first group/category there is a step missing and that is "clearing of the spot where the new house will constructed". This is in fact crucial also for archaeological interpretation and when attempting to following stages/categories in a houses life cycle, particularly when it comes to archaeobotanical sources and geochemistry. Many houses are built on top of old cultural layers or old houses that in best-case scenario (for our archaeological interpretation has been cleared out). Thus, "N and C transformation processes" also precede the building of a new house. This is relevant also for the interpretation of your case study examples and should be raised.

The byre booth section is important but distracts attention from the presentation of the groups/categories of evidence. I therefore suggest condensing this or putting as a footnote or move part of this to the discussion of the 13 parameters. What is relevant here is rather to discuss how/of the complimentary methodologies presented here can address this question.

Grid survey or analysis of feature fills? Functional analysis and comparison of sampling strategies at Gedved Vest

General comments
I suggest restructuring headings here e.g. start with JAAH Heading two "Case study examples" and then AAH Heading three "Gedved Vest"

This section is not merely a comparison of grid or feature fill sampling strategies for phosphate analyses (as the title suggest) but also an evaluation of the various complimentary methods that have been discussed here in the context of other archaeological data and analyses e.g. finds and house structure. All the case studies presented are good and the interpretations sound but the discussion should be reformulated according to the suggested rephrasing of the main aim of the paper as suggested above.

It should be made clear from the onset if all of the analyses and results of methodologies presented here are based on a review, or if the author has contributed with own analyses of data. To balance the text, the sampling strategies for macrofossil material also needs to be briefly summarised in one or two sentences, e.g. how many samples, focusing on what contexts?

The text as it is now structured does not separate data results from interpretation consequently, nor evidence from different sources, which means that it is difficult for the reader to follow the discussion and assess the "plausibility" of different interpretations. Many times the discussion in "the functionality analyses" is intermingled with interpretation and there is unnecessary repetition between the two sections. If the separation of these sections is to be meaningful there needs to be a restructuring here, or alternatively fuse the two and cut down the text.

"Due to the comparatively clean siting of these houses a grid sampling for…" You have to explain what clean siting refers to in this case.

Raä 593, Svarteborg sn, House II

"It may be possible that this hearth is not related to the house at all, but rather belongs to an unrelated phase of activities." Develop this discussion a little bit, e.g. since the postholes does not show elevated signature it is likely that these events took place *after* the posthole was closed (and thus also after the house was abandoned?)

"European archaeology's tendency of equalling one house with one household". This statement is I believe an incorrect summary of the sources referred to. A farmstead usually consist of more than one house and is unclear what is meant in this text by "household", any bigger farmstead/household in this period would be likely to have consisted of a number of individuals with different social roles in relation to each other and all did not necessarily share the same hearth. Hearth and even occasional cooking does not equal "kitchen" and long houses with several hearths are not uncommon in the archaeological record from this period; this section therefore needs to be rephrased.

Raä 106, Fyllinge, Snöstorp sn, Houses 1 and 3

Westernmost postholes in house three has high organic phosphate, which is taken to indicate stables but how do you explain the pattern furthermore continues outside the house in samples taken from the cultural layer" This is taken up further in the discussion and needs to be elaborated was there any signs of an entrance here, or is it due to runoff from the byre, or did they put manure outside the house or what?

"pottery in posthole S173, interpreted as a house offering." By whom and on the basis of what? Explain this, and explain the link between a supposed offering of "kitchen ware" to the functional interpretation that the area was a kitchen better.

"There are several clues pointing to the second alternative as the more convincing" Not clear what the second alternative refers to

"The kitchen space is identified to the middle of the house, between postholes S170 and S181, based on high CitP-inorganic levels, high SOM, of kitchen indicating finds and the occurrence of a kitchen resonating house offering" This sentence does not appear to be a full sentence and there is a sentence missing here.

Elestorp sn, House 1

Here the interpretation fluctuates between stating that there is no clear pattern but still the author continues to make conclusions on the basis of the same data which does suggest that you can indeed make conclusions on functionality that are convincing. So I suggest to rephrase this section in more positive terms, based on what can be said, simply be deleting a few sentences (see text)

For continuation of the text see comments made directly in the text.

RADOSLAW GRABOWSKI[1]

Identification and delineation of settlement space functions in south Scandinavian Iron Age: theoretical perspectives and practical approaches

This article presents an overview of methods used in south Scandinavian archaeology for identification and delineation of settlement space functions. The overview includes commonly utilised archaeological approaches, such as artefact distribution studies and inferences based on assessment of house and settlement morphologies, as well as archaeobotanical, geochemical and geophysical approaches to functional analysis. The theoretical potential and limitations of each presented functional parameter are outlined and thereafter applied and compared on material from five case study sites in east-central Jutland, Halland and Bohuslän. The presentation of the site of Gedved Vest in east-central Jutland also incorporates a comparison of two common approaches to geochemical sampling: 1) sampling and analysis of soil retrieved from feature fills, and 2) horizontal sampling of soil from the interface between the topsoil (A/Ap) and the subsoil (C) - horizons along a pre-determined grid.

Keywords: settlement archaeology, Iron Age, longhouses, functionality of space, multiproxy analysis, phosphate analysis, plant macrofossil analysis, magnetic susceptibility, soil organic matter, artefact distribution, house architecture, settlement structure.

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Background

The first prehistoric longhouses were excavated in Scandinavia more than a hundred years ago (Hvass 1988:53). The archaeological record assessed to date shows that the concept of building elongated dwellings with functions beyond mere habitation, existed for almost five thousand years; from the Neolithic until the end of the Viking Age (Ethelberg et al 2000, Ethelberg et al 2003, Welinder et al (eds.) 2004). Understanding of the functional aspects of these structures, the functions of surrounding spaces, and how these functions changed over time, is therefore important if one seeks to grasp the dynamics of prehistoric settlements.

Over the last two decades the Environmental Archaeology Laboratory in Umeå (MAL, *Miljöarkeologiska Laboratoriet*) has been participating in attempts to elucidate functional aspects of settlement spaces by use of archaeobotanical, geochemical and geophysical methods. Utilised separately at first, these strands of evidence have over time been integrated into a comprehensive multiproxy strategy where space functions are identified and delineated by comparison of the spatial distribution of plant macrofossils, distribution of inorganic and organic phosphates, variation in soil organic matter, and variation in magnetic susceptibility (Grabowski and Linderholm 2013).

Although this set of methods has been applied on numerous archaeological cases - for example during the E6 motorway and the West Coast Rail Link projects in Halland (see articles in Carlie et al (eds.) 2004) and the E4 motorway project at Pryssgården in Östergötland (Borna-Ahlqvist 2002) - its possibilities and limitations are still insufficiently presented in easily accessible publications; most work having been published in various reports or local archaeological monographs and anthologies. In a recent article (Grabowski and Linderholm 2013) the development history, underlying theory, and examples of application have been presented in an attempt to remedy this situation. This publication did however, mainly due to time and space constraints, limit itself to an assessment of the multiproxy method independently of other sources of archaeological functional evidence. Lacking in particular was a comparison of the botanical, geochemical and geophysical data to that originating from approaches commonly applied by "mainstream" archaeology, i.e. interpretation of structural and artefactual evidence recorded during excavations.

The geochemical and geophysical analyses presented in the abovementioned article were furthermore exclusively performed on soil retrieved from feature fills; the theoretical supposition being that the sediment within the features should have originated mainly from activities in the immediate surroundings of the features and thus botanical, geochemical and geophysical signatures would be informative of activities taking place near the features. As such the study represents one common way in which sampling for geochemical and geophysical settlement analyses has historically been

performed in Scandinavia; another common method being horizontal grid sampling of soil strata presumed to carry information relevant to prehistoric settlement activities.

Previous publications where feature-fill sampling for chemical and physical analyses has been considered have, however, on occasion voiced reservations about the reliability of feature sampling. Zimmermann (2001: 42), for example, writes the following about sampling for phosphate analysis:

> As a rule it is not worth taking samples from postholes. Generally they are full of randomly mixed soil. Such samples will therefore often have a random character. Since the fill material from the pits is mixed with soil from the old surface, their phosphate values will be higher than the values from the surrounding subsoil. When one is taking phosphate samples it is therefore advisable to steer clear of all structural traces.
>
> At Flögeln samples were only taken experimentally from the post-hole fill. The result showed that the highest values emerged from the byre section. Nevertheless the picture provided by the surface-covering mapping is much clearer. When Blidmo recommends that one should take samples from the post-holes, this is not meant to document the demarcation of the various functional areas, but to demonstrate different construction phases (Blidmo 1995).

The accumulating corpus of results from phosphate (and other geochemical) analyses does however seem to indicate that the above stated reservation may not be completely accurate. The soil eroding into feature fills can instead be seen as carrying relevant information relating to anthropogenic processes, and demarcation of functional spaces may be attempted based on this type of material. The "random" character referred to by Zimmermann can be argued to mirror the intricacies that prehistoric human action, taphonomy and archaeological extraction imposes on settlement soils, making its assessment highly relevant for archaeological research.

A similar argument is presented by Blidmo (1995: 19) in the publication cited by Zimmermann above:

> In complicated cases, with numerous postholes, this type of analysis [phosphate analysis of feature fills] may be used to control whether or not they belong to the same construction. One can also functionally identify different parts of houses, i.e. determine where living space and byre were located, and also determine how the latter was organised [author's translation].

Clearly, there is need to compare and evaluate the applicability of both sampling strategies under the specific conditions of south Scandinavian settlement archaeology.

Aims

Based on the research situation outlined above this article sets out to address three explicit aims:

1. To enhance the understanding of activities played out in house constructions and by extension functional analyses of house sections through the combination of multiple sources of evidences.
2. To compare the results of the mentioned multiproxy analysis to those obtained from other archaeological sources of functional evidence such as artefact distributions and settlement morphology.
3. By reviewing illustrative cases where a multiproxy analysis of botanical, geochemical and geophysical methods has been applied for the purpose of identifying and delineating settlement space functions.
4. And by extension to assess whether relevant geochemical information can be obtained by analysis of feature fills, and to compare this sampling strategy to horizontal grid sampling of settlement surfaces.
5.

Figure 1. Satellite image of southern Scandinavia showing the locations of case studies presented in the article.

Figure 2. Time-line displaying the local Danish and south Swedish chronological nomenclature.

Kommentar [a1]: Mmove this to the begnnning and rephrase

Kommentar [a2]: I This is a means to an aim not an aim itself

Geographic and chronological setting of the study

Two groups of material are utilised in order to address the aims of the article.

Material from two late pre-Roman/early Roman Iron Age longhouses from the Danish site of Gedved Vest is presented in order to compare the attainable results from geochemical feature sampling and horizontal grid surveys. The two houses and their surroundings have been subject to both a high resolution grid sampling, performed in accordance with the guidelines formulated by Zimmermann (2001), and sampling of all archaeological feature fills within the area covered by the grid. This material thus presents an ideal case for comparison of the respective sampling strategy.

The case studies used to illustrate various situations in which a multiproxy analysis of feature fills may or may not be useful have been selected from the corpus of analyses performed by MAL during the south-west Swedish road and railroad projects of the late 90s and early 2000s. The material from these projects is particularly well suited to a comparison of the botanical, geochemical and geophysical results to other types of archaeological data since the methodologically ambitious projects have been well documented, interpreted and extensively published in report, article and thesis formats over the last decades.

The time-frame for the case studies and discussion of this article has been set as the Iron Age, i.e. 500 BC – AD 1100.

The methods and their underlying theory

The multiproxy analysis presented in this study utilises four individual methods. The technical specifics of each method, and aspects of how they can be combined, have been previously presented in several articles (Engelmark 1985, Engelmark and Linderholm 1996, Engelmark and Linderholm 2008, Grabowski and Linderholm 2013, Linderholm 1998 and 2010, Viklund 1998a and b, Viklund et al 2013). The method statement of this text is therefore limited to aspects relevant for the herein presented Danish and south-west Swedish houses.

Plant macrofossil analysis: formation and operational background

Macrofossil analysis of carbonised plant remains is a method with a comparatively straightforward analytical procedure but complex interpretative aspects.

Preservation of plants by carbonisation effectively cancels their usefulness to humans and animals. In settlement contexts charring is therefore commonly either accidental or the result of use as fuel. In both cases the preserved material has presumably undergone a complex series of modifications stemming from human use prior to preservation (Grabowski and Linderholm 2013 and therein listed references, compare also to the concept of *Chaîne Opératoire*, Schlanger 2005). The pre-preservation use of plants may result in innumerable variations within the encountered carbonised plant assemblages. After preservation this material is furthermore susceptible to modification by C- and N-transforms unrelated to human handling of plant resources (Schiffer 2010).

Human handling of botanical material often leaves patterns in botanical assemblages. Preserved assemblages from different activities, or from different stages of a protracted process, will tend to differ in species composition and relative abundance of various plant parts. A newly harvested assemblage which for any reason becomes carbonised will, for example, contain a high portion of arable weeds as well as the chaff and straw portions of the harvested cereal, while a processed crop storage will in contrast contain almost exclusively contain clean grain. By assessment of these variations it is possible to gain insights about the activities and possible function of the spaces from which they derived (e.g. Andréasson 2008, Engelmark 1981 and 1985, Grabowski and Linderholm 2013, Grabowski in press. [see reference list for comment] Gustafsson 2000, Karg et al 2004, Maier and Harwath 2011, Moltsen 2011, Viklund 1998a and b, Viklund et al 2013).

The properties listed above make archaeobotanical interpretation a complex task. They are, however, also a necessary condition for their use in functional analyses of settlement spaces.

In this study all analysed plant remains are derived from feature fills; primarily postholes. Previous studies have suggested that postholes would, after the removal or disappearance of the post, quickly fill up with soil eroding from the surrounding floor and activity layers. If the soil contained carbonised plant remains these would also have been deposited in the features. If the feature was deep enough, the plants would thereafter have been comparatively protected from mechanical damage, bioturbation, and later human disturbance such as agriculture and plowing (Engelmark 1981 and 1985).

Figure 3. Schematic illustration showing the formation of a sampled posthole (d). Once the post (a) is removed surrounding floor/yard layers erode into the posthole, forming the secondary fill, also commonly termed as "the post trace" (b). If the posthole is sufficiently deep it may survive subsequent disturbances such as bioturbation and ploughing, and be identified and sampled by archaeologists.

Plant macrofossil analysis and identification of functional spaces

In functional analysis of south Scandinavian longhouses carbonised plant macrofossils have to date mainly been used for identification of kitchen/living spaces with hearths, through delineation of concentrations of food plants presumably carbonised during preparation; byres, through concentrations of fodder plants; cereal processing areas, through concentrations of weeds and/or chaff; and cereal storage spaces, through concentrations of cleaned grain (e.g. Andréasson 2008, Engelmark 1981, Grabowski & Linderholm 2013, Grabowski in press, Henriksen 2007, Moltsen 2011, Ramqvist 1983, Rowley-Conwy 2000 and therein listed early 20th century Danish examples, Robinson 2000, Viklund 1998a and b, Viklund et al 2013).

Plant macrofossils in burnt and unburnt houses

Carbonised plant remains can also occasionally provide information about the formation history of the archaeological context from which they were retrieved. Particularly relevant for this study is the fact that plant remains in a longhouse can provide a clue to whether the house has burnt.

In unburnt houses carbonisation of plants presumably took place primarily during everyday handling in proximity to heat sources such as hearths. Plant remains in unburnt houses will therefore tend to cluster around the hearths or a heat source . A concentration of carbonised plant remains associated to coking or similar may therefore on occasion also used as an indicator for the siting of former hearths, even if other traces are no longer recognisable in the archaeological record. It should however be noted that hearths would have been regularly cleaned, which could have created more complex patterns of deposition and redeposition inside a house. The timespans represented by plant material in unburnt houses are usually impossible to define, and one must assume that the material could reflect accumulation over

many months, years or even longer. The corpus of archaeobotanical analyses in Scandinavia has to date shown that the amount of carbonised plant remains in unburnt houses tends to be limited, commonly only a few remains per litre of sampled soil. In contrast, burnt houses have been shown to contain high concentrations of macrofossils, often hundreds or thousands of individual remains in single samples (cf. Grabowski & Linderholm 2013, Grabowski in press., Gustafsson 2000, Henriksen 2007, Viklund 1998a and b, Moltsen 2011). Plant remains in these cases also tend to be more widely distributed, since plant material in spaces which were presumably protected from fire during an active phase of the house also became carbonised. Material from burnt houses is commonly interpreted to represent shorter time spans and as reflecting activities? that took place in the house at the time of or just before the fire. Such cases can therefore be perceived as snapshots of the botanical composition of a house at a specific time in its history. An underlying signal from everyday carbonisation which took place prior to the fire is of course also embedded in the material, but due to the differences in sheer amounts of macrofossils the effects of preceding activities should have limited effect on the composition of the assemblage (Grabowski and Linderholm 2013, Moltsen 2011, Viklund 1998a and b). There are, however, no doubt examples in the archaeological record which deviate from the above generalisation.

Magnetic Susceptibility

Magnetic susceptibility (*MS*) is a soil-physical property largely linked to the content and composition of iron (Fe).

This property may change by human disturbance of soils, water logging, microbial activity, burning, or deposition of iron rich material in the soil. An important quality of MS in the context of this study is its strong tendency to increase due to high temperatures, thus acting as an indicator for fires. The effects of fires may be measurable by MS-analysis even if physical traces of fires are no longer detectable by other archaeological methods (Dearing 1994, Linderholm 2010, Thompson and Oldfield 1986, Walden et al 1999).

There are two characteristics of MS-analysis which are important for understanding the herein presented results: 1) MS from heating is not cumulative, it may only be raised or lowered within specific limits determined by the chemical composition of the soil, and 2) MS may be naturally high or low without necessarily indicating human action.

In order to discern between anthropogenic and natural elevated MS the soil is measured twice, with a laboratory controlled heating performed between the measurements. MS levels that do not increase in the second measurement may be interpreted as representing previous exposure to intensive heating. In this article all measurements of pre-heating susceptibility are designated as *MS* and post-heating measurements as *MS550*. Once both measurements have been performed a simple mathematical calculation can be applied on the two

values in order to obtain an *MSQuota*, i.e. an expression of the difference between pre and post-heating values (MS550/MS=MSQuota). A low MSQuota indicates a higher similarity between the two measurements, and therefore also a higher probability that the soil was exposed to heating prior to sampling; a quota of 1 indicates that the two measurements were identical, and that the pre-heating sample had already attained its maximum possible susceptibility.

In functional interpretation of houses MS-measurements are useful mainly for differentiating between burnt and unburnt structures. This in turn allows for more reliable assessment of the background history of carbonised plant macrofossils as well as other types of material culture with formation and/or preservation properties which may be affected by house fires (for example animal bones, daub from house walls and burnt clay).

In unburnt houses MS may occasionally also give indications of where the hearths were located (e.g. Engelmark and Olofsson 2000, Gustafsson 2001). Such indications are, however, not always present, even when the house under study should presumably have contained a hearth. It is possible that the nature of the hearth construction, for example whether it was raised, placed on the ground, or even dug into a pit along with post-use transforms such as bioturbation and ploughing, have a significant effect of the preservation of hearth related MS-signals.

MS-analysis, possible archaeological scenarios

In this study, two plausible scenarios of MS-signatures in longhouses have been defined for comparison to other types of archaeological data:

1. Samples showing increased MS550 levels (high MSQuotas); are interpreted as unburnt.
2. Samples showing similar or equal MS and MS550 levels (low MSQuotas) are interpreted as probably burnt. When signatures of this kind are limited to only parts of a house they may be seen as indications of previous hearth locations or of partial burning.

Analysis of organic and inorganic phosphates by weak acid extraction

> Many elements are left in the soil by humans; but few are as ubiquitous, as sensitive, and as persistent of an indicator of human activity as phosphorous. […] When people add P to the soil as organic products or inorganic compounds, the P quickly bonds with Fe, Al or Ca-ions to form relatively stable chemical compounds of inorganic phosphate minerals and organic phosphate esters (Holliday and Gartner 2007:301p).

As expressed by Holliday and Gartner, phosphates are compounds of elemental phosphorous (P) and some of the building material of living organisms; which throughout the P-cycle of circulation may be bound in either organic or

inorganic forms. Phosphates can be highly informative of human activities which often result in re-distribution and accumulation of naturally occurring phosphorous.

Most organic matter handled by humans contains phosphates, ranging in concentration from 0,01% in fruit to 20-35% in human and animal bone. The ratio between inorganic and organic phosphates also varies, from mostly inorganic in bones to predominantly organic in plants and thereof derived matter, such as manure (Hartmann 1992, Holliday and Gartner 2007, Zimmermann 2001).

A common method of analysing phosphates is through extraction with a weak acid, for example citric acid ($C_6H_8O_7$), which was used in this study (Arrhenius 1934; Linderholm 2010).

Extraction with citric acid allows primarily for analysis of the inorganically bound phosphates present in the sample, here termed as *CitP-inorganic*. Through exposure of a sample to controlled heating in a laboratory furnace, the organic material in soil can be decomposed and the organically bound elements released. A subsequent measurement also utilising citric acid will therefore result in measurement of both the original inorganic and the organic phosphates, now transformed into inorganic compounds, providing a measurement of all phosphate present in the sample accessible for measurement by the citric acid method, here termed *CitPOI* (CitP on ignition). The organic fraction can thereafter be calculated by subtraction (CitPOI – CitP-inorganic = *CitP-organic*). For interpretative work, the relation between inorganic and organic P can also be expressed as a quota (CitPOI/CitP-inorganic = CitP*Quota*). A low quota is indicative of a larger content of the inorganic fraction. A quota of 2 represents equal amount of each fraction (Holliday and Gartner 2007, Linderholm 2010).

It should be noted that the chemistry of phosphorous is very complex, and that acid extraction techniques and processing in furnaces provide estimates rather than exact measurements of the phosphate fractions present in the analysed sediments. According to current research, however, these estimates should be sufficient for addressing the questions posed to the material by archaeological research (Holliday and Gartner 2007, Linderholm 2010).

Phosphate analysis of south Scandinavian longhouses

The herein presented study is based on an assumption that valuable information may, when utilising a suitable methodological approach and theory, be extracted even from complex source materials by separation of the inorganic and organic fractions of CitPOI, i.e. total phosphate content extractable with citric acid. More specifically, the working hypothesis is that the two fractions should be primarily representative of bone and manure accumulations respectively, since these were presumably the main sources of

phosphate-rich material circulating on prehistoric settlements (Engelmark and Linderholm 1996, Grabowski and Linderholm 2013).

On the scale of houses, the phosphate analysis is herein hypothesised to provide evidence for identification of byres and/or manure storage (concentrations of organic phosphates, also expressed as high CitPQuota), and house sections containing kitchens or spaces where refuse was handled (concentrations of inorganic phosphates, also expressed as low CitPQuota). Ash from hearths, where the organic matter was combusted and the phosphates rearranged into inorganic forms, is also considered as a contributor to accumulation of CitP-inorganic in kitchen spaces.

A common statement in archaeological literature is that phosphate analysis may be applied to delineate byres through elevated phosphate levels in a specific part of a house (e.g. Aarsleff and Appel 2011:56, Ethelberg et al 2000:193pp, Karg et al 2004:143, Sundkvist 1998:172). Such studies almost always refer to estimates of total phosphate content, commonly attained by extraction with a strong acid, as a single parameter. This supposition may, however, be argued to be founded on a problematic generalization (cf. Zimmermann 2001: 23ff). As mentioned above, mammal bone contains approximately 20-35% phosphate, while the amount of phosphates in manure is in contrast only about 0,2-1,1% (Hartmann 1992, Holliday and Gartner 2007, Zimmermann 2001). Bones are therefore more likely to result in high "total" phosphate levels than manure. There are however factors which add layers of complexity to any archaeological interpretation of total levels in soil: 1) Manure is likely to have outweighed bone in sheer volume, although the scales are rarely known, 2) bones and manure were presumably transported along completely different pathways, and 3) the time span and frequency of accumulation of manure? is almost never known (Hartmann 1992, Linderholm 1998, Zimmermann 2001). These facts make any statements about the origins of phosphate based solely on P-total estimates highly speculative. High P-total in a house may indicate a byre or a manure storage, or it can indicate a kitchen or a waste handling space, or it may represent an unknown, and non-definable, combination of both.

Well-founded identifications and delineations of byres and kitchens by means of phosphate analysis could therefore be argued to be only attainable through either measurement of the organic and inorganic phosphate fractions respectively, or through comparison of the phosphate data to other archaeological functionally indicative evidence.

Measurement of soil organic matter by loss on ignition

Loss on ignition (*LOI*) is a rather straightforward way of measuring the amount of soil organic matter (*SOM*). By weighing a sample, heating it at 550°C, and weighing it again once the organic matter is oxidised it is possible to calculate the percentage of organic material.

Such measurement can provide information about the nature of a deposit, and also be utilised as a correlate to phosphate analysis of byre spaces and/or kitchens, since both intensive input of manure and deposition of kitchen waste may change the stable level of SOM in soils (Engelmark and Linderholm 1996).

Phosphate analysis and measurement of SOM, possible archaeological scenarios

In this study four possible scenarios of phosphate and SOM-accumulation in longhouses have been defined for comparison against other types of archaeological evidence:

1. Houses without byre; which should display relatively stable values of CitP-organic and CitPQuota throughout, and concentrations of CitP-inorganic in kitchen spaces or other areas where bones were deposited. The kitchen and refuse handling spaces may also display elevated SOM.
2. Houses with a byre which was either intensively used or used over an extended period of time, and where the manure was not rigorously cleaned away; which should display high or at least moderate CitPOI in the byre, with a clear CitP-organic signature (high CitPQuota), and high CitPOI in the kitchen and refuse handling spaces, with a signature of CitP-inorganic (low CitPQuota). Elevated SOM-levels should be expected in the kitchen/refuse handling spaces and in the byre if sufficient amounts of manure were retained.
3. Houses with a byre which was only used periodically, used over a short period of time, or was rigorously cleaned when the manure was taken out into the fields. These houses should display high CitPOI in the space where bone was deposited but not in the byre. The signature of CitP-organic and CitP-inorganic should however still be detectable in the respective areas as high CitPQuotas in the byre and low CitPQuotas in the kitchen/refuse handling spaces. Elevated SOM should be expected mainly in the kitchen/refuse spaces.
4. Houses with internal spaces used interchangeably for different activities, or houses severely affected by functionally unrelated N- and C-transforms; displaying "random" unintelligible patterns, i.e. houses where the resolution of the methods is not sufficient for identification of the sought-after activities.

Functional interpretation based on house structure, internal features and distribution of artefacts and anthropogenically modified soil

Functional analyses of longhouses have been attempted previously based on various types of archaeological data besides plant macrofossils, geochemistry and geophysics. Overviews of these approaches have been presented in numerous publications. Because a comprehensive review of the discussion concerning longhouse functionality would strain the space limits of this article the reader is directed to these sources for in-depth references and details (e.g. Borna-Ahlqvist 2002, Carlie 1999, Ethelberg et al 2000, Ethelberg et al 2003,

Hvass 1985, Karlenby 2007, Olausson 1999, Peterson 2006, Ramqvist 1983, Rasmussen 1999, Streiffert 2004, Webley 2008).

One of the more comprehensive presentations of evidence used for functional interpretation is a chapter of Maria Petersson's thesis (2006) which addressees whether or not animals were kept in late Bronze and early Iron Age longhouses in Östergötland. The presentation of functional data, other than that provided by the botanical, chemical, and physical multiproxy analysis, has in this article been strongly influenced by Peterson's list of evidence.

Kommentar [a3]: Nnew paragraph

In total 13 parameters have been assessed besides plant macrofossils, MS, phosphates and SOM:

1. House dimensions. Although not a functional evidence in its own right, the size of a house may give some indications of its function, particularly if compared to other buildings with a spatial and/or chronological association.
2. Post setting. The arrangements of posts, for purposes of creating more or less open spaces, or for creating support for various types of internal features, have often been used in functional interpretations of longhouses. Open spaces, particularly when found containing the remains of a hearth, have been proposed to indicate kitchen/living spaces, while tighter regular settings have occasionally been used to identify and delineate byres. There is, however, some variation in the interpretation of post settings. Unless supported by other data variations in internal post arrangements should perhaps best be seen as indications of possible differences in the functions of spaces, but not of the nature of the function (Ethelberg et al 2003, Olausson 1998, Pedersen and Widgren 2004, Petersson 2006, Tesch 1993).
3. Internal walls. Internal divisions of the interior of a longhouse should presumably indicate some form of functional delineation, although the walls themselves provide little evidence of the nature of the activities they are delineating. It should also be noted that many types of internal divisions, such as light wall constructions or simple railings, may be invisible in the archaeological record but could have been very influential in shaping everyday movements and actions inside a house (Carlie 1999 and 2004, Petersson 2006).
4. Entrances. Presumably the entrances of a house were placed with some functional rationale in mind. Houses with byres have, for example, been proposed to contain a separate entrance for the animals. Larger, or at least separate, entrances may also have been necessary to facilitate transport of manure out of the house (Carlie 1999, Petersson 2006).
5. Wall details. Many wall construction techniques have been inferred for prehistoric houses based on the traces left behind in the soil. The wall construction does not provide functional information about a house, but if the walls vary in different parts of the same house one could

assume some functional difference between the respective spaces (Ethelberg et al 2003:139pp, Ramqvist 1983).

6. Topography. If a house was not placed on a level surface the topographical alignment of the house could indicate functional aspects. A good example are houses which could have contained a byre and were built on sloping ground. The byre would presumably have been placed at the lower part of the slope in order to prevent the waste from the animals running toward the habitation space (Olausson 1998, Petersson 2006). The symbolism of placing humans "above" animals has also been suggested as a possible factor (Webley 2008:63).
7. Physical remains of hearths. Hearth are commonly argued to indicate the kitchen/living space of a house. Although there may have been hearths in other spaces as well, there are some areas where the presence of fires was presumably avoided, for example the fodder and cereal storage areas (Hvass 1985, Olausson 1998, Peterson 2006).
8. Other internal features. Similarly to hearths, other internal features may be tied to different types of activities. Features of this kind are ovens, cooking pits and storage pits (Webley 2008).
9. Distribution patterns of artefacts, soil modified by human action, and faunal remains. Artefacts such as pottery, material culture from constructions such as daub fragments, faunal remains in the form of bone, and various types of soil modified by human action often show variations in distribution which may be interpreted as patterns stemming from different types of activities (Olausson 1998, Peterson 2006, Webley 2006).
10. Byre booths. In some longhouses internal features in the form of elongated narrow troughs or smaller postholes forming short parallel lines perpendicular to the main axis of the house have been interpreted as traces of animal booths. If this interpretation is true the booth traces should provide convincing evidence of byres. These booths are commonly encountered in Bronze and Iron Age longhouses in Denmark (although far from all houses display these traces), while being very rare in the south Swedish material (Olausson 1998, Ethelberg et al 2000 and 2003, Hedeager and Kristiansen 1988, Petersson 2006)
11. Floor layers inside houses and "cultural" layers outside. Soils which form the floor space for activities over prolonged periods of time may become modified in ways which are identifiable in the archaeological record. Such activities may include animal trampling (possibly combined with input of animal waste), storage and handling of manure (in the form of input of organic matter and repeated removal and cleaning of this material), or waste management (in the form of repeated depositions of organic material and spent artefacts). If found inside or close to a longhouse a "cultural" layer may provide functional

information about the space. In this category may also be included physical traces after consciously constructed floors, for example in the form of paving or packed clay (cf discussion in Peterson 2006:69).

12. Replacement of posts. The wooden posts of a longhouse had a limited lifespan. Eventually they would rot and would have to be replaced. Replacement of posts is archaeologically identifiable as posthole traces partially overlapping, or closely adjacent, to the original ones. It has been argued that the humid conditions inside byres could necessitate post replacement at shorter intervals than in the rest of the house (Peterson 2006:66p and therein listed references).
13. Evidence of house fires. Evidence of house fires can be manifest in the archaeological material in the form of burnt clay, burnt daub, burnt animal bones, heat affected artefacts and stone, charcoal rich feature fills, and charred structural house details. Although not a functional evidence in its own right, the assessment of a house as burnt or not is important for interpretation of many other evidence sources, such as carbonised plants, burnt clay presence, and distribution of burnt faunal material (Grabowski and Linderolm 2013, Gustafsson 2000, Moltsen 2011, Ramqvist 1983).

Living and dying houses in dynamic societies and landscapes

All material measured by the herein presented multiproxy analysis is susceptible to processes which hinder functional interpretation of longhouses. Using Schiffer's (2010) terminology these can be termed as C and N-transforms, i.e. anthropogenic or "natural" processes which modify the original depositions and impose various degrees of complexity.

Anthropogenic modification of the original depositions which are used for functional interpretation include redeposition due to waste management, redeposition stemming from symbolically, ritually or ideologically influenced views of "how things should be done", which may be counterintuitive to an interpreting archaeologist, and mixing of material due to succeeding habitation and/or activity phases. The C-transforms also include more recent processes, such as the cultivation of a settlement space after its abandonment. N-transforms which presumably have a significant impact on the analysis results are soil erosion and bioturbation.

It should be noted that the abovementioned transforms also affect many other parameters commonly documented during excavations and used in functional studies; for example the distribution of bones and artefacts, the preservation chances of structural details, or even the chances of identifying lighter types of buildings on a settlement.

Functional analyses of houses must also consider their individual biographies, which are closely tied to the life histories of their inhabitants

(Brück 1999, Gerritsen 1999, Webley 2008:21, Ängeby 1999 as main references for discussion below).

Regardless of which type of social unit inhabited a house, the structure of the unit would never have been static. People are born, grow up, grow old and eventually die. As an effect of these inevitable changes the role of a social unit inhabiting a house in the context of the wider community of the settlement area or village would have changed over time. A house could, for example, have been a nexus of certain agricultural activities for some period of time, with this role shifting to another social unit due to changes in the demographic composition of the local community. Variations in the functionality of a social unit inhabiting/or using a house may also have occurred due to changes in the social or economic standing of the inabitants within the wider community irrespective of demographics. Such shifts in the role of a social unit could have had significant influence on the internal workings of its associated houses. They could have necessitated changes in construction details which were not anticipated when the house was first designed and, perhaps more likely, imposed variations in the utilisation of already available space. If the house was used over extended periods of time generation shifts may furthermore have resulted in a cyclicity in the functionality and therefore also the physical house. Each generation may however also have imposed idiosyncratic variations unique for its cycle.

Eventually a house would have been abandoned, and also the abandonment process could have archaeological implications. As mentioned earlier, the burning of a house would affect the degree of preservation of various types of material. House fires could also have been either planned or accidental, presumably resulting in different archaeological outcomes. A house destroyed by a planned fire could, for example, have either been cleaned prior to the event, or, if burned as part of a ceremony, been enhanced with special types of material culture. A house could, however, also have been modified by less dramatic abandonment. Old houses could have shifted in function, while slowly falling to pieces, from habitation spaces to byres or storage barns. They could also, over time, have been cleaned of most material culture, or been enriched with additional material depositions and soil modifications related to its end-life role.

Based on the discussion above a final theoretical supposition of this study is therefore that the results of the multiproxy analysis, as well as the other evaluated functional evidence may present hardly intelligible patterns due to a combination of non-human transforms, quotidian anthropogenic processes, and an unceasing dynamic of house use, or in other words; the definition and delineation of functional spaces may on occasion be constrained in outcome regardless of how stringently archaeological methods of functional evaluation are applied due to a daunting underlying complexity in the histories of the houses and activities played out there.

As a result of this reasoning all information presented in this article is assessed with the life-history concept of houses in mind. In practice this is done by dividing the available sources of evidence into three categories where each category represents a life-stage of a house which should be archaeologically identifiable for most houses (see table 1).

The first category refers to *construction* and contains the parameters: house dimensions, post setting, internal walls, entrances, wall details and house topography. Important to note is that all these parameters are primarily perceived not as evidence of the nature of activities performed in a house, but rather as indicators for which activities were planned by the designers of the house. One could therefore argue that parameters such as posthole settings or placement of internal walls do not ever, on their own, provide evidence of actions, but solely evidence of intent.

The second category refers to *use* and consists of evidence deriving from activities which were presumably performed within a house such as: presence of hearths, presence of internal features such as storage and cooking pits, distribution of artefacts, modified soil or faunal remains, presence of booths, presence of floor and "cultural" layers, and replacement of posts. To the "traditional" archaeological data can be added distribution of phosphates, indications of hearths through MS-analysis and distribution of soil organic matter. All of these sources provide direct evidence about the activities performed in a house, and could be argued to be more reliable for functional interpretation; although all of them are also more susceptible to N and C-transforms ,than the parameters in the *construction caegory* due to variations in deposition patterns throughout a houses life history, and also to interpretative difficulties stemming from irregularities in excavation and analytical technique.

A special note should also be made about byre booths. These could, just as posthole settings, be seen as questionable as direct evidence of or a direct reflection of the stalling of animals and number of animals in a house. Lennart Carlie (1999) has questioned the archaeological practice of equalling the number of byre booths with the animal stock of a household by showing that most booth-carrying houses could not house the fodder necessary to feed a full complement of animals over any extended period of time. A study from Nørre Tranders in Denmark (Nielsen 2002), where nineteen animals were found burnt to death inside a house, showed that the sheep inside the house had either been pregnant or had recently born their lambs. These examples put into question the nature of information about the actual animal stock which can be extracted from the number of stalls . It is possible that a byre designed for a specific number of animals at some times could have carried a much smaller compliment of animals, perhaps the vulnerable or particularly valuable ones, while the rest were stationed and foddered outside. At other times the byre could have been filled to the brim and beyond, such as during times of birth, when the animals were at risk, or during times when there was other danger in the form of predators, aggressive neighbours or invaders, or particularly harsh

climatic conditions. One must therefore conclude that, even if a byre is indicated by structurally clear structural traces, its presence and size does not provide actual evidence about its use. One must also consider the possibility of booth-carrying rooms being used for other purposes during times when animals were stationed elsewhere.

The third and final category of evaluated parameters is termed *abandonment*. In this study the evidence in this group limit themselves to those indicating whether a house was burnt or not, including presence/absence of heat affected artefacts, distribution of burn bone, burnt clay and daub, and observations made during the excavation such as the presence of charcoal rich feature fills. To this may be added analysis of magnetic susceptibility.

Table 1. List of parameters which may convey functional evidence on south Scandinavian settlement sites marking the likelihood of their usefulness for identifying and delineating various functional spaces. The parameters are grouped into three main categories: *construction*, *use*, and *abandonment*; representing different life stages of prehistoric houses. Parameters included in the botanical, geochemical and geophysical multiproxy analysis developed at MAL in Umeå are marked in bold italics.

Grid survey or analysis of feature fills? Functional analysis and comparison of sampling strategies at Gedved Vest

Archaeological background and sampling

The site of Gedved Vest, situated in east-central Jutland, approximately 33 km south-west of Århus and 8 km north of Horsens, was excavated between 2008 and 2010 by Horsens Museum in connection with an industrial development project (Hansen 2012).

Habitation traces found on the site extended chronologically from late Bronze Age (periods V and VI) to the Viking Age; with a strong predominance of settlement remains from early Roman Iron Age onward. The herein presented case derives from Locality 1 (sub-area) of Gedved Vest which has been dated, by house and artefact typology as well as ^{14}C-analysis, to late pre-Roman and early Roman Iron Age.

In the western section of Locality 1 two longhouses (A11298 and A11299) were detected, situated comparatively clear of other observed activity traces and displaying only one construction phase each. Replacement of some posts may, however, have taken place, embodied by the presence of double and elongated postholes (see figure 4 for plan).

The design of the two houses has parallels elsewhere in Denmark, indicating an early Iron Age date (e.g. Ethelberg et al 2003:194, Kaul 1986). This is confirmed by three ^{14}C-samples from each house which provided a cal. 2σ-span of 401 BC-AD 18 for A11298 and 191 BC-AD 70 for A11299. One of the dates from A11298 deviated strongly from the other two. This date was obtained from a charcoal fragment of probable beech (cf *Fagus*) while the other two were obtained from carbonised cereals. Since beech can reach an age of several hundred years it is probable that the cereals, being annual plants, in this case is more reliable. The span of the two cereal-based dates is 341 BC-AD 18. It is therefore possible that A11298 was a precursor of A11299, although the possibility that the houses were contemporaneous should not be excluded.

Figure 4. Plan of longhouses A11298 and A11299 with surroundings; showing the locations of samples taken along a horizontal grid (small crosses), samples taken from feature fills (turquoise triangles), and recorded artefact finds, in this case consisting solely of pottery (P).

Table 2. ^{14}C-data for House A11298 and A11299.

Due to the comparatively clean siting of these houses a grid sampling for geochemical and geophysical analysis was performed, covering both houses as well as the in-between lying space. The area between the two houses contained six pits with varying horizontal shape, and depths ranging from 21 to 105 cm. A seventh pit (112 cm in depth) also covered by the grid was situated just to the south-west of A11299. The last feature within the grid was a long, narrow, and curved trough, possibly a drainage ditch belonging to A11299, situated just south-east of the roof-supporting postholes of that construction.

Kommentar [a4]: Not sure what this means explain

The samples for the grid survey were taken in what was interpreted as the uppermost layers exposed by the machine stripping of topsoil and should represent the transition zone between the Ap and C-horizons. The samples were taken in accordance with the principles proposed by Zimmermann (2001), with feature fills consistently avoided. A total of 345 samples were analysed for phosphates and SOM.

In addition to the grid-survey, 91 samples from feature fills were also collected. These samples were extracted mainly for archaeobotanical analysis but prior to floatation sub-samples were retrieved from each bag of soil. In addition to house A11298, A11299 and the previously mentioned pits, this sampling also included nearby structures and features which were situated directly outside the areal grid. Just south of A11299 was a small rectangular structure (A11310) interpreted as an associated outhouse. Two smaller structures were also encountered and sampled in proximity to A11298. A11304 is believed to be a related outhouse and was situated directly north of the eastern half of the longhouse. A11303 was situated somewhat further to the north. This structure was larger than outhouses A11310 and A11304 and may represent a second and larger outhouse of A11298, but it may also belong to an unrelated activity phase or even represent poorly preserved remains of a separate longhouse. All presumed associations between the mentioned houses are based on their relative placement. There are no overlapping stratigraphies on which a relative chronology can be formed.

Between A11298 and A11303 and just west of A11304 a cluster of pits was also sampled by bulk collection of soil from feature fills. These pits differ morphologically from the ones situated between A11298 and A11299 by being significantly shallower and having more irregular cuts. The most dug down of these pits was 42 cm in depth, with the remainder ranging from 10-15 cm.

A final observation which may be of relevance to a functional interpretation of this space is the presence of a “cultural” layer just east of A11299. This layer contained large amounts broken pottery and burnt bones; and a portion of the latter was sent for osteological analysis. All bones belonged to mammals, and the ones which could be identified to genus or species level derived from dog, dear, cow, sheep, goat and horse (Gregersen 2011). The layer has been interpreted as a refuse layer formed by repeated deposition of household waste.

FUNCTIONAL EVIDENCE

There are almost no indications in the material recorded during the excavation of the possible functionality of A11298, A11299 or the surrounding features and structures. Double and elongated postholes which may indicate re-posting are present, but irregularly distributed without any pattern. The post-settings are generally regular and, with the exception of the enigmatic trough south-east of A11299, no other details of the houses have been preserved.

The only artefacts encountered in the investigated area were pottery fragments. These were ubiquitous in almost all recorded contexts. Unfortunately no metric analysis (for example weighing) or type classification has been performed on this material, making it difficult to ascertain whether there is any pattern in the distribution of pottery. In figure 4 the letter *P* represents each recorded find-coordinate for pottery. It should be noted that each point may contain from a single to any number of fragments. The only clear pattern apparent in the distribution of pottery is that there seems to be comparatively little of it in outhouse A11304, with only one documented find.

The magnetic susceptibility analysis of feature fills in the investigated houses showed no evidence of intensive heating, thus indicating that all houses were unburnt.

This indication is consistent with the sparse amounts of carbonised plant remains recovered from the constructions. The most probable interpretation is that the plant remains represent sporadic, accidental, carbonisation around heat sources over an unknown period of time. The small amounts of material precludes any high-resolution botanical interpretation of internal house functionality. The inter-house distribution may, however, be seen as providing some tenuous functional data. As seen in Table 3 almost all plant remains were recovered from A11298 and A11299, i.e. the two longhouses. It is therefore plausible that these houses contained hearths around which carbonisation could take place while the other structures did not.

Table 3. Summary of carbonised plant macrofossils recovered from the houses in the case study section of Locality 1 at Gedved Vest.

The phosphate analysis of CitP-inorganic shows similar results in both the feature fills and the grid survey (figure 5a). Both longhouses display comparatively low levels of CitP-inorganic with little internal variation. Elevated levels were, however, recorded in the space between A11298 and A11299; both inside the pits occupying that area (feature fills) and in the surrounding subsoil (analysed by grid sampling).

The analysis of CitP-organic showed, similarly to CitP-inorganic, a reasonably consistent pattern in both feature fill results and those from the grid survey (figure 5b). The area between the two longhouses still displays high

CitP-levels but a second space with elevated levels is now also identified to the north of A11298.

The visualisation of the CitPQuota (figure 5c), which also shows largely consistent results between the two data sets, allows for an interpretation of the possible sources of the mentioned phosphate concentrations. The concentration of phosphates between A11298 and A11299 displays a low CitPQuota, indicating that CitP-inorganic made up the largest portion of CitPOI in this area. To the north of A11298 the CitPQuota was comparatively high, especially in the posthole fills of A11304. This result indicates that the northern phosphate concentration contained a larger fraction of organically bound phosphates, probably representing accumulation of manure and other plant based matter. This result is furthermore strengthened by the results of the SOM-analysis (figure 5d), which shows high levels of organic matter north of A11298 only. The SOM-analysis results from feature fills and grid survey are, similarly to the phosphate data, largely consistent.

Figure 5. Plan of longhouses A11298 and A11299 with surroundings; displaying an overlaid interpolation of data from the horizontal sampling as well as the results of feature-fill analysis with categorized symbols; a) inorganic phosphates, b) organic phosphates, c) phosphate quota, and d) soil organic matter.

Functional interpretation

Based on the combined evidence presented above it is possible to formulate a functional interpretation of the analysed area.

The two longhouses may, on the basis of available data, be interpreted as used primarily for habitation. Both houses probably contained one or more hearths around which household activities were performed and around which plants were accidentally carbonised. There is no indication in either house of a byre or storage of manure. The low CitP-inorganic levels inside the houses also indicate that they were kept clean of phosphate rich matter. It is possible that the phosphate concentration between A11298 and A11299 (concentrated in one of the pits) reflects these cleaning activities. It is also possible that the waste management extended to include the "cultural" layer east of A11299 where animal bones and pottery were recovered.

While byres were not identified inside the longhouses there is a strong indication of manure, based on material rich in CitP-organic (expressed as a high CitPQuota) and SOM, north of A11298. The geochemical byre signature is concentrated inside house A11304, which is also the only building where little pottery was encountered during excavation. Figure 6, displaying CitPOI, CitPQuota and SOM-levels on a three parameter bubble-chart, shows clearly how the chemical signature of A11304 distinctly differs from all the other buildings which otherwise show similar signatures. Put together the evidence indicates that this house was the byre of the farmstead represented by longhouse A11298. The management of manure probably also affected some

parts of the northern yard space, and it is possible that the cluster of irregular shallow pits be a result of removal of soil during cleaning activities associated with the transport of manure to the fields.

The manure indicating space is enclosed by A11298 to the south, A11304 to the east and A11303 to the north, with the three houses arranged in a rectilinear formation. Although impossible to substantiate on basis of available data, it is tempting to interpret this neat cluster of houses as a coherent farmstead. Supporting analogies for such arrangement being conceivable for the area and period in question are found at the early Roman Iron Age sites of Priorsløkke, approximately 6,5 km from Gedved Vest, where the second phase of the settlement showed clear arrangements of long- and outhouses in rectilinear clusters, and even closer at HOM 1856 Skovvej, only two kilometres distant, where the individual houses were not only arranged in a way comparable to Locality 1 of Gedved Vest, but were also bounded by enclosures which clearly confirmed the associations between identified long- and outhouses (Borup 2004; Kaul 1986). Speculating that the three buildings belong to the same farmstead would mean that animals and manure generating activities were performed in the inner yard, while household/kitchen waste disposal took place behind the house.

Whether A11299 housed similar organisation of external activities is difficult to assess since the sampling grid did not cover a sufficiently large space south of the building, i.e. the space which would presumably have been the inner yard of the house. Furthermore the boundary of the Locality 1 excavation was situated mere three metres south of A11310, effectively precluding any further analysis and interpretation of that space.

Grid survey or analysis of feature fills?

Once visualised, the above presented data from the geochemical analyses of feature fills and of soil extracted from the subsoil along a grid pattern showed distinctly comparable patterns.

The most significant difference between the data sets is in the actual values and not in the resulting patterns. Figure 7 shows that phosphate levels and SOM are higher in samples retrieved from features than those from the grid survey. This is an expected result, which is consistent with the theoretical supposition that material which erodes into a posthole or a pit should remain comparatively sealed and protected from subsequent disturbances which may dilute the signal. This result is also seen as evidence that the chemical signature of soil which has eroded into dug features is not random, as proposed by Zimmermann (2001), but rather consistent with the chemical alterations imposed on the surrounding surface areas; i.e. the soil inside features is an encased portion of old yard surfaces and house floors.

Figure 6. Three parameter plot showing CitPOI (circle size), CitPQuota (Y-axis) and SOM (X-axis) in houses A11298, A11299, A11303, A11304 and A11310 at Gedved Vest, Locality 1.

Figure 7. Box-plots showing the measured phosphate and SOM-variation in samples from the horizontal grid-survey and sampling of feature fills respectively.

Figure 8. Reconstruction of a farmstead at Gedved Vest around the shift from late pre-Roman to Roman Iron Age, inspired by analysis of House A11298 and its surroundings. The longhouse is adjoined by outhouses, of which one acts as a byre. Manure is handled in the front yard, while waste disposal takes place behind the main longhouse. Illustration by Sofia Lindholm.

Functional interpretation of longhouses in Halland and Bohuslän based on analysis of posthole fills

Longhouses from four sites have been selected as illustrative examples of how the botanical, geochemical and geophysical multiproxy analysis of posthole fills may be integrated with other types of archaeological evidence on house functionality.

The locations of the four selected sites of Raä 593 in Svarteborg sn (*sn*: Swedish abbreviation for *parish*), Raä 106 (Fyllinge) in Snöstorp sn, Raä 59 in Elestorp sn and Raä 195 in Skrea sn are presented above in figure 1 .

Raä 593, Svarteborg sn, House II

Archaeological background and sampling

Raä 593 in Svarteborg sn was discovered in connection to the construction of the E6 motorway through Bohuslän County. The site turned out to be a settlement area containing several longhouses, small post-built structures, wells, hearths, an oven, and various kinds of pits (Flagmeier 2003).

Numerous archaeological features were sampled for macrofossil analysis during the investigation. When these samples were processed at MAL in Umeå they were sub-sampled for additional analysis with geochemical and geophysical methods (Viklund 2003a).

One of the detected longhouses, House II, was sampled for WHAT? along its entire length; allowing for comparison of results from different sections of the house. Ten samples were analysed FOR WHAT? in total.

Charcoal from two hearths found inside the house has been ^{14}C-dated, providing a combined cal. 2σ-span of 395 BC-AD 20, i.e. mid to late pre-Roman Iron Age (Flagmeier 2003).

Figure 9. Plan of House II at Raä 593, Svarteborg sn, overlaying the distribution of cereals, weeds-ruderals and oliferous plants (a). Beneath the plan are b) remaining plant categories, c) MSQuota, d) inorganic and organic phosphates, e) phosphate quota and, e) soil organic matter. The overlain lines in graphs c-f show the median for each population (middle dot) and 1 standard deviation (upper and lower dot).

Functional evidence

House II was a three-aisled construction, approximately 30 metres in length and 7 metres in width. These dimensions place the house among the largest dating to the beginning of the Iron Age so far excavated in Bohuslän (Flagmeier 2003). The wall construction was only preserved along a section of the south-eastern boundary, where it was made up of a narrow trench with adjacent traces of very small posts. A total of ten roof-supporting posthole pairs

were found inside the house. These were spaced rather irregularly, with a slight tendency to more open spaces in the south-western end of the house. Re-posting was not positively observed, although the third and fourth posthole pairs (counting from south-west) are placed so close to each other that they may in fact represent a post replacement event. House II was not sited completely isolated on the prehistoric settlement as it partially overlapped House III (see figure 9). Since the wall-trench of House II clearly cut similar trenches in House III the former is positively determined as the younger construction. Besides the wall-trenches no other features belonging to House II cut into those of House III. No samples were taken from house III.

Inside the house were three hearths. One, located at the centre of the house, was cut by the wall-trench of House II and cannot belong to this structure. It is however ideally placed to have belonged to house III. The remaining two hearths were both situated in the south-western half of the house, one at the very end and one closer to the centre next to the third posthole pair counting from south-west. No other internal features were observed inside the house.

Artefacts in the form of pottery, burnt clay and heat affected stones were recorded in the house, as were fragments of burnt bone. These finds were however sparse and did not allow for identification of depositional patterns (Flagmeier 2003).

House II was almost certainly unburnt since only occasional fragments of charcoal were encountered during the excavation of feature fills. This result corresponds well with the results of the archaeobotanical analysis (figure 9a and b), showing sparse amounts of macrofossils; only 49 in the entire house. The distribution of these plant remains is, however, interesting despite the low amount since they cluster in two areas; the majority in the north-easternmost end of the house and a smaller concentration by the fourth posthole pair, next to one of the hearths. The majority of the plants consisted of cereals and arable weeds, although smaller occurrences of oliferous plants (flax, *Linum usitatissimum*), hazelnut (*Corylus avellana*) and grassland taxa were also observed. The overall nature of the assemblage clearly indicates household activities in the form of food preparation.

The results of MS-analysis in house II (figure 9c) corresponds well to the pattern seen in the macrofossil record and the observations made during the excavation. In almost all samples the MSQuota is significantly higher than 1, indicating that the samples were not previously heated. There are however three exceptions to this result, showing MS-levels indicative of previous heating: 1) Sample S18765 was taken from a posthole directly adjacent to the more centrally located hearth of House II. This sample also contained the smaller concentration of plant remains mentioned above. In this case the hearth traces, plant remains and MS-levels are in agreement; all indicating the presence of a hearth. 2) Low MSQuota was also recorded in sample S18764, which is the next posthole pair toward north-east from the S18765. It did not

correspond to any identifiable hearth traces in House II but is adjacent to the hearth cut by the wall trench which most likely belongs to house III. This MSQuota value may thus be a disturbance resulting from the overlap of two habitation phases. 3) Low MSQuota was recorded in S18760, located in the north-eastern end of the house, together with the largest concentration of carbonised plant remains. Since both the plant material and the MS-levels point toward the presence of fires in this part of the house a possible interpretation could be that this part of the house also housed a hearth, but that physical traces of it were for unknown reasons not preserved in the archaeological record. A final note should be made on the south-westernmost hearth of House II, which does not appear to have left visible traces other than the physical modification of the sediment. It may be possible that this hearth is not related to the house at all, but rather belongs to an unrelated phase of activities. This would explain the lack of hearth-indicating signatures in the surrounding postholes since they would either not yet have been dug or already been sealed when the activities took place. An asynchrony between the two hearths would also explain the somewhat awkward location of the south-western hearth, places right next to one of the walls. Pointing against this hypothesis is the fact the two dates obtained for House II came from each of the hearths showing strikingly similar results; 372 BC-AD 20 (cal. 2σ) for the hearth in the centre and 395-54 BC for the south-western one. With ^{14}C-spans ranging over several centuries, however, the possibility that the south-western hearth was not a part of the house cannot be precluded.

Analysis of CitP-organic (figure 9d and e) in house II shows comparatively stable levels throughout the house. CitP-inorganic, on the other hand, fluctuates with two observed concentrations. Both of these correspond with hearth indications in the already mentioned evidence. The first concentration is situated by the fourth posthole pair, just beside the centrally placed hearth. This concentration stretches on to also include posthole S18764, which is situated close to the hearth believed to belong to House III. The second concentration was observed in posthole S18760, which is in the middle of the area with the largest accumulation of plant remains and the posthole with an MS-signature indicating a hearth. Low CitPQuotas corresponding to these concentrations of CitP-inorganic indicate that the majority of the phosphate derived from sources such as bone.

Lastly the measurement of SOM (figure 9f) show a correlation to the areas with hearth-signatures and P-concentrations. This may be seen as an indication that these parts of the house were “dirtier” than average, but since they do not appear along with high CitPQuotas the organic refuse presumably did not consist of manure.

Functional interpretation

House II can be interpreted as a case where numerous measured parameters show compatible indications of house functionality, but also enhance each other by confirming results which may have been less than convincing on their own; for example the sparse but clustered plant macrofossils.

It appears that House II had two kitchen areas containing a hearth each, one corresponding with the physical hearth remains next to the third and fourth posthole pair, and one somewhere in the north-eastern end of the house. In the latter kitchen area no physical traces of a hearth were recovered, but its existence is indicated by both plant macrofossil data and MS-analysis. Between these two kitchen (and living spaces?), is a smaller space which provided little in the way of functional evidence. The same is true for the south-westernmost end of the house, which although containing a hearth, provided little evidence about possible function. It is also possible, and tenuously supported by the analysis data, that this hearth may not have belonged to the house. No indication of a byre was obtained from any evidence category, and it is possible that the entire house was used for habitation and presumably a number of settlement activities which did not leave traces measurable by the here utilised methods.

The two postulated kitchen/living spaces of House II may at first be perceived as somewhat unexpected considering south Scandinavian and north European archaeology's tendency of equalling one house with one household (see for example discussions in Gerritsen 1999, Herschend 2009:156ff , Holst 2010). The results from House II are, however, not completely unique. In connection with the E22-motorway project at Bruatorp outside of Kalmar in Småland an unusually large (55 × 8 metres) three-aisled longhouse was encountered. The house was sampled and analysed in the same manner as House II at Svarteborg, showing two almost identical mirrored halfs, with areas of increased P, accumulations of carbonised plants and MS-signatures indicatiing hearths of which no physical traces remained (Engelmark and Olofsson 2000, Gustafsson 2001). The house at Bruatorp was dated to period II/III of the Bronze Age (1500-1100 BC), and is therefore clearly separated from the building tradition of Svarteborg by both space and time. These two cases may however be examples of a previously little known prehistoric phenomenon of large byreless longhouses housing two separate kitchen/living quarters, possibly indicating shared habitation by two households, or at least some form of delineated social units. Future analyses will hopefully shed more light on this intriguing possibility.

Raä 106, Fyllinge, Snöstorp sn, Houses 1 and 3

Archaeological background and sampling

Raä 106 in Snöstorp sn, more commonly known in literature as the *Fyllinge* site, was excavated in 2001 and 2002 in preparation for development of an industrial area outside of Halmstad. The site turned out to house a settlement with two identified longhouses and traces of smaller buildings, pits, hearths, ovens as well as features associated with iron production. Agricultural activities were also represented in the form of ard marks and a stone clearance cairn (Toreld and Wranning 2005).

House 1, turned out to be one of the largest ever excavated in Halland, with an estimated original size of 58 × 6 metres. The house also displayed a somewhat unusual (although not unknown) trait of being slightly bent, with the main axis of the house changing by 6° roughly halfway along its length (Toreld and Wranning 2003). Three ^{14}C-dates were obtained for the house, providing a cal. 2σ-span of 810 BC–AD 40. One of the three dates deviated from the other two and has been interpreted as the result of contamination (Toreld and Wranning 2003). The typology of the house construction, as well as the pottery recovered inside the house points to a probable late pre-Roman Iron Age date. This is supported by the two remaining 14C-samples, which have a calibrated 2σ-span of 378 BC-AD 40.

House 3, was substantially smaller, with an estimated size of 18 × 5 metres. The chronologically indicative material remains from House 3 point to an early Roman Iron Age date. This is supported by a single ^{14}C-date which provided a cal. 2σ-span of AD 23-222. The overall chronological information from the two longhouses seem to indicate that House 3 was the successor to House 1 (Toreld and Wranning 2003).

Both houses were sampled for archaeobotanical analysis during the excavation, and subsequently sub-sampled at MAL for geochemical and geophysical studies. Seven samples were collected from House 1, covering almost its entire length except for the south-westernmost end. Five samples were collected from House 3, representing each of the identified posthole pairs (Viklund 2003b).

Figure 10. Plan of Raä 106, Snöstorp sn, Fyllinge.

Functional evidence

The unusually long House 1 contained a total of 26 roof-supporting posthole pairs (figure 11a). The large amount of pairs could be interpreted as evidence of extensive re-posting, or even of independent but similar construction phases. Toreld and Wranning (2003) do however argue that the postholes are sufficiently homogeneous in design and fill material to assume their contemporaneity.

There were no internal features detected inside the house which could indicate functional areas, neither was a hearth recovered. There was also no distinctly open area which could indicate an intentionally larger kitchen/living

space with a hearth. Slightly more open posthole placement was, however, observed between 22 and 29 metres counting from the west. This area corresponds to the space around and between samples S181 and S183 on the plan in figure 11a.

House 1 has been interpreted as at least partially burned, based on occurrences of burnt daub and burnt clay throughout its length (Toreld and Wranning 2003). This result is supported by the results of the botanical and physical analyses. All MSQuota levels (figure 11c) are quite close to 1, signifying that the soil had probably been heated before. The botanical material (figure 11a and b) was not overwhelmingly numerous, totalling 300 identified remains besides charcoal, but showed a distributed along the entire length of the house; something which should not have been the case if carbonisation only occurred around the hearths of the house in connection with everyday activities. It is, however, possible that the fire was not very intensive or long-lived since sample S173 stands out distinctly from the rest with almost identical MS and MS550-levels. This could of course be the result of more intensive heat during the house fire in that particular section, but may also be interpreted as the previous location of a hearth. There are several clues pointing to the second alternative as the more convincing. The first of these is the distribution of artefacts in House 1; consisting of pottery (mostly of kitchen character), glass and flint; which all cluster distinctly in the area represented by samples S170-S181. The second evidence is the occurrence of burnt faunal material, which shows a cluster comparable to the artefacts between postholes S170 and S181. A third evidence is the presence of a comparatively intact piece of pottery in posthole S173, interpreted as a house offering. The pot is of distinct food-preparation character (Toreld 2005), indicating an offering with clear kitchen connotations. Furthermore, the space between postholes S181-S183, as mentioned previously, displayed a somewhat less constricted arrangement of roof-supporting posts, possibly indicating an intention to create a slightly more open space. Lastly, the phosphate analysis (figure 11d and e) shows distinctly higher levels of CitP-inorganic, coupled with the lowest CitPQuotas in postholes S173-S183, values which are consistent with a phosphate signal from the accumulation from bones. Elevated SOM-levels (figure 11f) were also measured in postholes S181 and S183, indicating a generally more “dirty” space.

Other than indicating a possible kitchen space the phosphate analysis also suggests phosphate accumulation from manure by high CitP-organic levels in posthole S170. The high CitP-organic levels are coupled with the highest SOM-levels in house 1.

Turning back to the results of the botanical analysis (figure 11a) two additional areas stand out with higher than average concentrations of plant remains. Posthole S177 contained an assemblage consisting almost exclusively of weed-ruderal taxa, with a smaller admixture of cereals. In posthole S175 the

relations were reversed, with a majority of the material being composed of cereals, with smaller inclusions of oliferous plants and weeds-ruderals.

House 3 contained five identified roof-supporting posthole pairs (figure 12a). They were regularly arranged with the exception of significant open space between the second and third pair counting from the west. Toreld and Wranning (2003) speculate whether this area could have housed a sixth pair, which for some reason did not survive in the archaeological record. This hypothesis would result in a construction with roof-supporting posthole pairs at almost even intervals throughout the structure. Supporting their argument is the fact that the northern post of the third pair was also missing, thus opening up for the possibility that more could have vanished due to the same but unknown reasons. Not able to conclude this issue the excavators of House 3 present both an alternatives as possible. Besides the roof-supporting postholes no wall traces or internal features were encountered in House 3, neither was a hearth belonging to this house identified during the excavation.

Mere two metres west of House 3 a "cultural" layer, 546 m^2 in size, was encountered, consisting of several strata which were covering or embedding numerous pits, postholes and hearths (see figure 10). The layer was rich in artefacts, including pottery, oven wall fragments, slag, pieces of iron, glass, etc. It is quite likely that the layer represents a prolonged period of activities in a yard-space, with a resulting accumulation of material debris and organic matter. The layer has not been ^{14}C-dated but the recovered pottery spans types from late Bronze Age into Roman Iron Age (Toreld and Wranning 2003). Since it is clear that the activity area represented by this layer existed prior to the establishment of House 3 it is possible that considerations were made during the construction of the house as to its alignment toward this yard space.

Toreld and Wranning (2003) interpret House 3 as burnt on the basis of finds of burnt daub throughout the house, but also note that these fragments seem less heat-affected than those in House 1, possibly indicating a less intensive fire. Neither the botanical material (figure 12a and b) nor the MS-measurments (figure 12c) immediately support a hypothesis of a house fire. The botanical remains are sparse, totalling a mere 40 individual specimens in the entire house. The MSQuota in most postholes is significantly above 1, indicating a likelihood that the soil was not heated prior to sampling. One sample does however deviate from this result; S161 where the MS-analysis indicates previous heating of the soil. Such result could be the result of a partial or uneven house fire, or it could represent the siting of a hearth. There are several clues pointing to the second alternative as more convincing. The botanical material is clearly clustered in S161 and in S145. The macrofossils are also predominantly made up of cereals with a small admixture of weeds-ruderals. Such assemblages could have been created during food preparation and as the last remaining weeds in the grain meant for consumption were hand-sorted out of the material and thrown into the fire. A second clue pointing toward this area housing a hearth, and thus functioning as a kitchen,

is the distribution of burnt bone fragments (figure 12a). Although sparse, these were clearly clustered in the three easternmost posthole pairs (Toreld and Wranning 2003). The phosphate analysis (figure 12d and e) is also consistent with this evidence, showing high CitP-inorganic levels with low P-quotas. S144 and S145 also display somewhat elevated SOM (figure 12f), indicating a slightly "dirty" part of the house.

The sparse carbonised macrofossil material in House 3 precludes further functional interpretation based on botanical evidence. The phosphate analysis, coupled with measurement of SOM, however, gives one more indication about function as the two westernmost posthole pairs show increasing CitP-organic levels from east to west, coupled with increasing CitPQuota, i.e. a signature consistent with signal from accumulation of manure. This pattern furthermore continues outside the house in samples taken from the "cultural" layer.

Figure 11. Plan of House 1 at Raä 106, Snöstorp sn, Fyllinge, overlaying the distribution of cereals, weeds-ruderals and oliferous plants (a). Beneath the plan are b) remaining plant categories, c) MSQuota, d) inorganic and organic phosphates, e) phosphate quota and, e) soil organic matter. The overlain lines in graphs c-f show the median for each population (middle dot) and 1 standard deviation (upper and lower dot).

Figure 12. Plan of House 3 at Raä 106, Snöstorp sn, Fyllinge, overlaying the distribution of cereals, weeds-ruderals and oliferous plants (a). Beneath the plan are b) remaining plant categories, c) MSQuota, d) inorganic and organic phosphates, e) phosphate quota, and e) soil organic matter. The overlain lines in graphs c-f show the median for each population (middle dot) and 1 standard deviation (upper and lower dot).

FUNCTIONAL INTERPRETATION

House 1 at Fyllinge is one of the best previously published examples of a functional interpretation based on integrated structural, artefactual, botanical and geochemical/geophysical evidence. Based on a thorough review of the material Toreld, Wranning (2003, 2005) and Viklund (2003b) have presented a detailed functional interpretation of this structure. The herein presented description of results is therefore mainly a repetition of a previously formulated functional evaluation.

Integrating available strands of evidence the three researchers suggested that: 1) The easternmost end of the house was a threshing and cereal storage space. This is a plausible interpretation since the most readily available explanation for the therein encountered assemblages; one dominated by weeds-ruderals, the other by cereals; is that the former represents a cereal cleaning area, where weeds were deposited during cleaning of grain meant for consumption, while the latter was clean grain stored until needed in the kitchen (cf. Grabowski & Linderholm 2013, Grabowski in press., Moltsen 2011, Viklund 1998). It should be pointed out, however, that neither of these plant assemblages would probably have been preserved unless the house was exposed to fire. 2) The westernmost part of the house has been proposed as the byre. This interpretation is based on the geochemical evidence pointing to accumulation of material with a high content of organically bound phosphates and organic matter. 3) The kitchen space is identified to the middle of the house, between postholes S170 and S181, based on high CitP-inorganic levels, high SOM, concentration of kitchen indicating finds and the occurrence of a kitchen resonating house offering. One deviation between the herein presented overview of House 1 and the one presented by Toreld, Wranning (2003, 2005) and Viklund (2003b) is that the latter assumed the most probable location of the hearth at posthole S181 which showed the highest recorded MS and MS550-levels. In this overview focus has been shifted from raw MS-levels to the relationship between pre-heating and post-heating values expressed as MSQuota. Based on the review of the MSQuota in House 1 it seems that the location of the hearth should be shifted further to the east, with a more probable siting around posthole S173.

House 3, although being investigated with the same methodology as House 1, resulted in a more cautious interpretation by Toreld and Wranning (2003), who consider the lack of fodder indicating plants in House 3 as an indication that animals were not housed there despite the high levels of organic phospates in the western half of the house. This signature was instead explained as possible contamination from the "cultural" layer. The two archaeologists also use the lack of high MS-levels to argue against the presence of a hearth. A contrasting interpretation may however be formulated based on the review above.

As discussed in the methodological section of this article, MS-values have a pre-determined highest level which is bound to the chemical composition of the soil. It is therefore more relevant to assess MS-results by calculation of the MSQuota, which could be seen as expressing the likelihood of whether soil was previously heated. The MSQuota in house 3 shows clearly that a hearth could have been located in the eastern section of the house, but not in the western. This result is also supported by the presence of the only carbonised plant material in the house. This sparse botanical material, along with the MSQuota result for all areas outside the eastern half also puts into question whether the house had burnt. If the house was not submitted to fire the lack of seeds from fodder plants, or indeed any other seeds, is not surprising since fodderplants presumably would not be exposed to fire or heat sources. The similarities with high organic phosphate results in the western end of the house and the "cultural" layer, should not automatically be dismissed as contamination. An alternative explanation is that the activities which resulted in the formation of the "cultural" layer and those going on in the western half of the house were interconnected, perhaps as animals and manure were moving between the byre and the yard space. This alternative would mean that the contamination was in fact a reasonable end-effect of the use of the two spaces.

Raä 59, Elestorp sn, House 1

Archaeological background and sampling

House 1 at Raä 59, Elestorp sn, was encountered on a site excavated in connection to railroad reconstructions in the area. The site contained remains dating from the Neolithic to the Roman Iron Age, with a predominance of remains from the Bronze and Iron Ages (Fors 1998).

House 1 represents the latest phase of the Elestorp site and has been ^{14}C-dated to AD 174-400 (cal. 2σ).

Samples for archaeobotanical analysis were taken from seven postholes, representing all sections of its length. All samples were sub-sampled at MAL for further analysis by geochemical and geophysical methods (Viklund 1997).

Figure 13. Plan of House 1 at Raä 59, Elestorp sn, Fyllinge, overlaying the distribution of cereals, weeds-ruderals and oliferous plants (a). Beneath the plan are b) remaining plant categories, c) MSQuota, d) inorganic and organic phosphates, e) phosphate quota, and e) soil organic matter. The overlain lines in graphs c-f show the median for each population (middle dot) and 1 standard deviation (upper and lower dot).

Functional evidence

House 1 was 26 metres long and 6 metres wide. Although few remains of the wall construction were preserved at least two entrances are still recognisable,

situated almost opposite to each other between posthole pairs S123 and S125/126 (figure 13a). The internal structure contained six roof-supporting posthole pairs. There was a clear difference in spacing between the north-western and south-eastern ends, the posts being placed in a tighter arrangement in the latter space. Furthermore, an open space had also been created at the centre of the house between posthole pairs S125/126 and S127. The remains of a hearth were encountered inside the house, surrounded by the twin postholes of pair S127, which were placed more widely apart than the remainder, indicating conscious design to fit the hearth. No internal wall divisions were detected in House 1 (Fors 1998).

The presence of a hearth, coupled with the diverging post arrangement in that part of the house indicates the kitchen/living space of this house. This indication is consistent with the results of the MS-analysis (figure 13c) , which although indicating destruction by fire of the entire building through MSQuota levels close to 1, show increased exposure to heat in posthole pair S127. This indication is further supported by comparatively high CitP-inorganic and low CitPQuotas levels spanning posthole pairs S125/126 to S129 (figure 13d and e); results consistent with an area where inorganic matter, such as bones was handled. Additional evidence of a kitchen area in the south-eastern half appear also in the form of pottery finds, which are constricted to the south-easternmost posthole pair, and by the highest concentrations of burnt clay (figure 13a).

The plant remains in House 1 (figure 13 a and b) numbered 156 individual remains excluding charcoal. This is a comparatively sparse amount compared to other burnt houses in south Scandinavia (cf. Grabowski 2013, Grabowski in press, Henriksen 2007, Moltsen 2011, Viklund 1998), which may perhaps indicate that the fire which presumably affected House 1 was limited in intensity, explaining why the MS-signature around the hearth is still identifiable.

The plant remains in House 1 were quite diverse, consisting of cereals, weeds-ruderals, oliferous plants, wetland and grassland species which probably interpreted as fodder collection, and stalk fragments of heather (*Calluna vulgaris*). The distribution of edible plants, as well as the weeds which were presumably brought along with these from the fields, are clearly delineated to the south-eastern half of the house, supporting the hypothesis that this part of the house was the kitchen. Plant taxa interpreted as fodder includingheather, do not show any clear spatial patterns, being spread out across the length of the building (figure 13b). It should however be noted that plant remains in none of these groups are numerous enough to provide truly convincing patterns.

The phosphate analysis does, besides indicating a possible kitchen, also show two samples with signatures suggesting deposition of manure. The first is centred on postholes S123 and S125/126, which show a high proportion of CitP-organic (high CitPQuota) and comparatively high levels of SOM (figure 13f). This result may indicate the presence of a byre in this part of the house.

Such placement would also be consistent with the topographic siting of House 1 which was placed on a slope with a total difference of 1,2 metres from end to end. The possible byre section is located in the lower part of this slope, which would have facilitated movement of animal waste out of the house. The second indication of elevated organic phosphates and possible, a byre was obtained in posthole S133, located at south-east of the kitchen, in the south-easternmost end of the house. Although one cannot exclude the possibility of a secondary smaller byre in this part of the house, its placement would have positioned it right above the space containing the kitchen and where people presumably slept. An alternative, and perhaps more plausible, explanation could be that the data from posthole S133 partially derives from some unrelated event which is distorting the interpretation of results in this part of the house.

Kommentar [a5]: Not sure what is meant with above here as I read the description there is some distance between the "kitchen" and the possible byre

Functional interpretation

The functional evidence from House 1 at Elestorp, with the notable exception of sample S133, all seem to provide a largely coherent picture of its internal organisation. The clear differences in posthole arrangements, the underlying topography, the location of the hearth and the distribution of finds are all in agreement with the results of the multiproxy analysis; showing jointly that the house contained at least two rooms. A kitchen and living space was probably housed in the south-east, while a byre occupied the north-western half. An interesting result is that posthole pair S125/S126 showed a signature consistent with both kitchen activities (plant remains, low CitPQuota) and manuring (high CitP-organic and SOM). It is perhaps possible that whichever type of boundary, if any, separated the two functional areas was located in its immediate proximity. Such internal division of space would place the hearth of House 1 more or less at the centre of the proposed kitchen/living space.

Raä 195, Skrea sn, Houses 5/6 and 1; an illustrative case of the limitations of functional analysis

Archaeological background and sampling

Similarly to all other case localities presented in this paper the settlement site of Raä 195 in Skrea sn was excavated in connection to a modern development project, in this case the modernisation of the west-coast railroad outside of Halmstad. The site consisted of thirteen identified buildings of different sizes and shapes as well as numerous ancillary features such as pits, hearths and cooking-related features. The ^{14}C-data along with house and artefact typologies indicate a main, continuous, activity phase from pre-Roman Iron Age to the Vendel Period; with traces of Mesolithic and Neolithic stone artefacts as well as

a single building argued to belong in the early medieval period possibly indicating additional settlement phases (Wranning 2004).

The presentation of material from Skrea 195 in this paper limits itself to a segment of the sites history represented by longhouses 5/6 and 1 and four adjacent and chronologically interconnected outhouses; houses 7, 8, 9 and 10 (see figure 14). This time segment has been interpreted as containing three construction/reconstruction phases (Wranning 2004). The earliest is represented by House 5 and outhouses 7, 8 and 9. Houses 7 and 8 have both been ^{14}C-dated, providing very similar dates with a joint cal. 2σ-span of AD 231-542. House 5 has, on typological and artefactual grounds, been dated to the same period. That the outhouses and the longhouse are part of a single farmstead is argued on grounds of the comparable alignment of their main axes. The second construction phase is represented by House 6. This structure was initially discussed as a separate building, but the lack of entrances as well as its constructional correspondence with house 5 have resulted in a final interpretation as an extension of House 5. Wranning (2004) also argues for the possibility that this extension was a replacement and enlargement of the roofed-over space represented by outhouses 7, 8 and 9. The third phase of construction is represented by House 1 and outhouse 10. A hearth cut by House 1 has been ^{14}C-dated to AD 424-606 (cal. 2σ), providing a *terminus ante quem* which fits well with the typological dating of Houses 5/6 and 1 as well as the ^{14}C-data from outhouses 7 and 8. Several features belonging to House 1 clearly cut those of House 5/6, confirming the interpretation of the relative chronology of this place. Outhouse 10 is argued to belong to House 1 on grounds of its axial alignment to the larger building, which is also inconsistent with the other three outhouses.

Samples were taken along the entire length of the longhouses, but more sporadically from the outhouses. All samples were sub-sampled for geochemical and geophysical analysis (Linderholm, 2001, Viklund 2001).

Figure 14. Plan of Raä 195, Skrea sn; showing the construction phases represented by House 5/6 and outhouses 7, 8 and 9 (thin red lines) and House 1 and outhouse 10 (thicker black lines).

Functional evidence

The constructional details of Houses 5 and 6 give little indication of their functionality. Artefacts were present but in such small quantities that few functional patterns could be obtained from their distribution (Wranning 2004). House 1 also displayed unclear artefact patterns. For all three phases one must furthermore question the reliability of artefact distributions due the significant overlap between these buildings. In contrast to House 5/6 the plan of House 1 displays distinct variation in posthole placement, indicating open spaces at the centre and more constricted ones at each end. The easternmost end is proposed by Wranning (2004) as having possibly housed a byre.

Wranning (2004) argues that the second phase of construction, represented by House 5/6 and their adjoining outhouses, possibly concluded with a fire destroying the entire farmstead. This interpretation is made on grounds of charcoal rich fills in features belonging to this phase. The MS-levels (not shown in this paper, but see Linderholm 2001 and Viklund 2001) show neither convincingly low nor high MSQuota thus it cannot be concluded weather there has been a farmstead fire or not. Recovered plant macrofossils were sparse in the longhouses, especially considering their size, with only 22 remains in House 5, 13 in House 6 and 64 in House 1. Similarly to plant macrofossils and artefacts the phosphate and SOM-measurements did not show any clear pattern within the houses (Linderholm 2001, Viklund 2001).

Although no clear pattern was observed within the individual houses, some functional evidence may be elucidated from an inter-house comparison. With the exception of outhouse 9 from which little material was retrieved, all houses contained a mixed material of cereals, weeds-ruderals and possible fodder plants from both wetland and dryland biotopes (fig 15a). All houses, except 9 and 10 also contained heather, which could have been used as fodder, fuel or perhaps floor covering material. In the analysis of house functionality at Skrea 195 Wranning (2001, 2004) goes into great detail describing the variation in the recovered botanical material in order to find functionally indicative tendencies. By comparison to previously investigated comparable houses displaying clearer patterns (Grabowski and Linderholm 2013, Grabowski in press, Karg et al 2004, Moltsen 2011, Ramqvist 1983, Viklund 1998a and b), one may however argue that the material at Skrea 195 is too small and the variation too insubstantial to be used for in-depth functional interpretation, particularly when the unknown formation history and overall archaeological complexity is taken into consideration. The plant macrofossil analysis also shows that the majority of the fodder plants was recovered from outhouses 7 and 8 and not from the longhouses. This could possibly strengthen the interpretation of a farmyard-enveloping fire, since this material is otherwise unlikely to have been carbonised (unless these small structures also contained hearths, of which there are no evidence). Another possibility is that the plant remains represents waste management pathways on the site. Scrapings from the hearths inside the longhouses could possibly have been temporarily deposited by the outhouses before being taken out to the fields along with manure or to some other final disposal space. 3) The plant macrofossil analysis furthermore revealed organic material in the form of coprolites from goats in outhouses 7 and 8 and from cows in outhouse 8. These coprolites could indicate the presence of animals in these structures, or be the result of movement of material on the site.

Comparing the phosphate and SOM results between the houses provides little additional information to the one presented above (figure 15b). The signatures in most investigated buildings are similar and overlapping, with only two exceptions. House 9 shows higher CitPOI and CitPQuota than any other

Kommentar [a6]: I suggest to move this paragraph to the below section and rephrase as suggested below

Kommentar [a7]: TThis word is not very clear presumably then the waste would have been burnt? Or

Kommentar [a8]: HHow, eg through secondary processes? Or what?

building, a result consistent with manure deposition. There is however no other evidence in the form of plants, coprolites, or structural details which could indicate a byre. House 7, which did contain coprolites and shows SOM-levels somewhat deviating from the rest of the buildings on the other hand displays phosphate levels and CitPQuotas mostly in line with all other samples.

FUNCTIONAL INTERPRETATION

Based on the data presented above one can argue for the likelihood of several activities taking place at Skrea 195. Cereal storage and processing is represented in the botanical material by carbonised grains and weeds. Preparation of processed cereal products is also likely to have taken place inside the longhouses. Animal husbandry of at least cows and goats is indisputably indicated by preserved faeces. Finds of fodder plants from both wetland and dryland meadows also indicate that these animals were, at least to some extent, foddered in proximity to the houses.

Skrea 195 is however also a site where the indicated activities are difficult or impossible to delineate in space. Each of the presented houses shows a mixture of activities with few intelligible patterns visible in the material. This is no doubt a partial result of the prolonged and overlapping settlement history of the analysed space in comparison to previously investigated and comparable houses/farmsteads displaying clearer patterns (Grabowski and Linderholm 2013, Grabowski in press, Karg et al 2004, Moltsen 2011, Ramqvist 1983, Viklund 1998a and b), thus previous analysis of house functionality at Skrea 195 Wranning (2001, 2004) needs to be reviewed with some criticism as it can be argued that the variation too insubstantial to be used for in-depth spatial interpretation. Roofed-over spaces probably changed function over time, as indicated by the addition of House 6 to House 5, while construction and reconstruction events, coupled with everyday activities may have facilitated a non-reconstructable mixing of soil and the therein embedded material culture.

Kommentar [a9]: The problem here is rather the spatial interpretation as the presence of animals is, as pointed out above indespuatble…

Although the results of the Skrea 195 investigation could be interpreted as disappointing, one may also argue that the site not only demonstrates the limitations of functional analysis, but also allows for an evaluation of the probable factors behind these limitations. In this sense a lot can be learnt from this case study; insights which can be carried into future research on house and site functionality.

Figure 15. Archaeobotanical and geochemical results from Raä 195, Skrea sn; a) composition of carbonised botanical assemblages, and b) three parameter plot showing CitPOI (circle size), CitPQuota (Y-axis) and SOM (X-axis) in houses 5/6 and 1 as well as outhouses 7, 8, 9 and 10.

Discussion and conclusions

Grid survey or analysis of feature fills?

The results of phosphate and SOM-analysis of Locality 1 of Gedved Vest, performed on both soil from a horizontal grid survey and on material extracted from feature fills, show largely comparable patters in both data sets. One may therefore conclude that both approaches are valid in attempts to identify and delineate functional spaces. The choice of strategy should perhaps best be governed by the questions posed to the material and the desired resolution of geochemical results.

Grid sampling may, if the sample points are laid out tightly, provide a higher resolution than analysis of feature fills since the latter is restricted in resolution by the distribution of the features. A high-resolution grid sampling is, however highly time consuming as hundreds of samples need to be collected and analysed to cover even relatively small spaces.

Feature sampling is less time consuming, especially since the geochemical samples can be extracted from bulk soil collected for archaeobotanical analysis and has the advantage of directly targeting archaeological features, which tend to be at the centre of all other archaeological analysis of a site. This approach is also preferable if the questions under study necessitate an assessment of the internal stratigraphy of an individual feature.

When used in combination the two approaches have the capacity to provide highly resolved information with much potential for functional interpretation of houses, features and surrounding spaces, in the way illustrated for Locality 1 at Gedved Vest.

Functional interpretation of houses based on analysis of feature fills

Six longhouses from south-western Sweden as well as the two abovementioned longhouses from Jutland were analysed with an archaeobotanical, geophysical and geochemical multiproxy method, as well as assessed on grounds of house design, site morphology, and distribution patterns of various types of material culture.

In all cases interpretations could be formulated taking into account functional indications from both of the main evidence categories. It should, however, be noted that no single strand of evidence presented in this article, regardless of whether it belongs to the multiproxy approach or to a more commonly known archaeological technique, would on its own have provided a sufficiently convincing functional model. The compatibility between the various evidence parameters is therefore not only interpreted as mutual confirmation of their applicability in research on settlement functionality, but

also as motivation for deeper integration of functional parameters in future research.

At Raä 195 in Skrea sn the botanical, geochemical and geophysical multiproxy analysis was shown to be severely constricted due to a spatial intersection of at least three habitation/activity phases as well as an observed multifunctionality of investigated spaces within each chronological phase; the complex life and death histories of houses. It is, however, important to highlight that the limitations of the multiproxy approach on this site also affected all other evidence parameters except analysis of building structures as expressed by posthole placements. Although this is an expected result, it should nonetheless be emphasised because it demonstrates how the archaeological record ultimately is one coherent entity. When specific archaeological situations constrict the usefulness of a method, this should perhaps not immediately be perceived as a methodological failure, but rather as a reality of the archaeological profession stemming from the nature of our source material, and a source of motivation for further methodological development, preferably by integration of singular approaches into broader, integrated, strategies which in time may allow for extraction of valuable information even in more complex archaeological cases.

PHOSPHATE ANALYSIS OF BYRES AND KITCHENS

In the theory section of this article an argument was put forward that identification and separation of functional spaces may be difficult by assessment of only estimates of P-total levels in soil. A particular scepticism was proposed about a commonly occurring equalling of high P-total levels with the location of byres. This supposition is largely confirmed by the examples in this paper. Except for A11304 at Gedved Vest, none of the here proposed byres showed the highest CitPOI values (total phosphates extractable by citric acid). Identification of byres was only possible by separation of the here measured CitPOI into its organic and inorganic fractions, or through comparison to other byre indicating evidence. The indication of this result is that some previously published interpretations of byres based on P-total-estimates alone may have to be re-evaluated.

Kommentar [a10]: How, how would you interpret elevated values of inorganic phosphates in a housestructure, as secondary activities after house abandonement, presumably the bones needs to decompose for phosphates to be enriched? OR this relates to my question in the methodology section

PLANT MACROFOSSILS IN UNBURNT HOUSES

Based on previous presentations of plant macrofossils from houses analysed in ways similar to those in this paper (Grabowski and Linderholm 2013, Grabowski in press, Karg et al 2004, Moltsen 2011, Robinson 2000, Viklund 1998a and b) one could argue that archaeobotanical analysis should primarily be performed on houses defined as burned, since these tend to present more numerous and less fragmented assemblages on which interpretations are more easily formulated. This has on occasion also been expressed explicitly (Henriksen 2007, Karg et al 2004).

This study, presenting numerous unburnt cases, shows however that even small botanical assemblages from unburnt houses/farmsteads may provide valuable insights about their internal organisation. At Locality 1 of Gedved Vest, for example, the material was very sparse, but nonetheless clustered distinctly in areas indicated by other evidence as the living/kitchen quarters where hearths should have been present. At Raä 593 in Svarteborg sn there was a good correspondence between the physical remains of a hearth and a comparatively small concentration of plant remains, while a second concentration clustered neatly with kitchen indicating geochemical evidence. Similar correspondence was observed at Raä 59 in Elestorp sn, where the recovered plant remains corresponded spatially with geochemistry, house topography, physical traces of a hearth and artefact distribution.

Based on the herein presented cases one could therefore argue that houses for functional macrofossil analysis should not be selected on grounds of being burnt or unburnt, but rather on the overall questions defined for the material and the complexity of the site in question; making it a task for archaeologists and archaeobotanists to evaluate suitable objects for study.

Stepping out of the house …

The analysis of Locality 1 at Gedved Vest and of Raä 195 in Skrea sn shows that everyday activities on both sites in no sense were constricted to the longhouses. At Gedved Vest there is a strong indication that the byre of the farmstead was situated in outhouse A11304 and not in the adjacent longhouse. Results from the outhouses at Skrea 195 showed that settlement functions were as extensively performed there as in the longhouses. Another example of how activities are observed leading out from the longhouses into surrounding spaces is House 3 at Fyllinge, which indicated a functional connection between the house and an adjoining "cultural" layer.

All of these indications lead up to a conclusion that understanding of a settlements functionality must be sought as much outside the longhouses as inside them. In practice this necessitates future sampling of not only postholes in the primary buildings, but also of smaller and less secure constructions, of postholes belonging to enclosures, and of course also the myriad of other feature types dotting prehistoric settlement sites; such as pits, wells and various types of anthropogenic deposits commonly known as *cultural layers*. The strategies for this analytical work will have to be carefully developed, and an in-depth integration and cooperation between different archaeological specialisms will no doubt be required.

Kommentar [a11]: AAgrred and I think partly you make this error when discussing the cases above so you there you should put out in the introduction that in some of the cases you will zoom in on one house or isolated buildings

Final remarks

Table 4 summarizes which functional parameters outlined in the methodological section of this paper ended up contributing to the final interpretation of the analysed case study examples. An obvious apparent

observation is that none of the investigated sites displayed the full spectrum of function-indicating parameters. In fact, some parameters, such as byre booths, were not encountered in any of the presented cases.

It may therefore be prudent to emphasise one final conclusion of this study, namely that functional analysis of settlement spaces is difficult. There is not, at this time, a universal method or approach to functional evaluation of settlements. If south Scandinavian archaeology is to take functional analysis seriously it needs to consider a future filled with complex, expensive and tedious (?) work, requiring long-term cooperation of numerous specialist and institutions. Integrating strands of evidence into coherent functional analyses requires clearly question-oriented approaches. Methods must be applied strategically within a theoretical framework, with a degree of planning and inter-specialism communication, and with ongoing evaluation of both successful and dead-end cases (which may be more numerous than desired) if we are to proceed beyond the insights available to us today.

Although this last statement may at first appear as somewhat dismaying, those of us enjoying the challenge of archaeological practice should also, in this future, expect a great deal of fun.

Table 4. An overview of which function-indicating parameters were used on each of the herein presented cases in order to attain an interpretation about past use of spaces. The asterisk denotes parameters which were observed, but which did not contribute toward the final interpretation. To the far right is also an overview of indications of whether the house was burnt or not.

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Radoslaw Grabowski, Author's comments

Dear editorial board and reviewers,

I would like to start out by thanking the editors and reviewers of my paper for the quick and thorough review process, and also for their overall positive opinion about the relevance of my paper as well as for constructive comments and critique.

The reviewer comments from Mads Ravn and Annelie Ekblom are quite different. The main difference as I perceive it is that Ravn considers the structure of the text to be good while Ekblom calls for some significant restructuring. Ravn's comments are also mostly general, with few concrete calls for changes, while Ekblom's are far-reaching and as thorough as I have ever seen in a review. Because of this, I will address the comments from the reviewer's in turn. I shall start out with Ravn's comments, because these have less dramatic effects on the text and continue with Ekblom's. Concerning the structure of the article, I shall attempt to strike a balance between the second reviewer's comments and my own desire to keep certain things in their current place. When not re-structuring the text I shall endeavour to rephrase parts of it in accordance with the issues outlined by Ekblom.

The editorial board should note that since both reviewers' comments were overall positive and their comments more of editorial rather than questioning character this reply is written more as a list of implemented changes rather than a debate and rebuttal.

Sincerely,

/Radoslaw Grabowski

Ravn's comments

I was happy to see this name in the reviewer list since a portion of the material as well as many of the topics addressed in the submitted article were presented and discussed during a Dialpast PhD-course on agrarian transformations in Scandinavia also hosting Ravn as as one of the teachers, and the moderator for the session of which my presentation was part. In fact, some of the questions discussed in the paper were initially triggered by the many interesting conversations during the week-long course. Ravn's own list of publications furthermore clearly shows that he has a relevant research background for the period and geographic area discussed in the paper, making his positive comments supportive for my confidence about the validity of the text.

I want to thank to thank Ravn for the review and express my gratitude especially for the last sentence of the comments:

In sum the paper is all added together original and interesting and useful, not the least ready for implementing in field archaeology.

This sentence coincides well with my own thoughts about functional analyses of prehistoric houses. It seems that the archaeological discipline as a whole at current already possesses numerous means of functional analysis of houses and settlement spaces, but also that these methods are used in relative isolation, resulting in research where "parallel" prehistories are being created for comparable archaeological phenomena. This article is an attempt to alleviate this, but not only on a theoretical level, but also by proposing pragmatic techniques that can be used in the field. It was thus a joy to read the last sentence of the review as it shows that I achieved one of the main objectives of the paper.

Fig 1. Copyright google - is that needed or is another map following? Otherwise good overview

RG: According to google support one is allowed to use Google earth maps for non-profit publications as long as: **1)** credit is given to google, **2)** the google logo is still part of the image, **3)** information about original source of the satellite image is still in the image. (https://support.google.com/earth/answer/21422?hl=en).

All of these things apply to figure 1.

Table 4 is too small in the present version

RG: As most colleagues probably would agree to, complex tables are notoriously difficult to fit into the dominating A4 paper format. This article has, however, already been printed as a submitted in-prep version in my compilation PhD-thesis (defended in May 2014). In that manuscript version, I chose to place the table on its own page at a 45° angle. This made it perfectly readable. Maybe something similar can be done in the published version of the article? If not I shall attempt to re-work the table.

Figure 6 is difficult to understand consider more explanation under the picture captions

RG: Figure text for figure 6 has been revised for better clarity. The same has been done for figure 15, which is the same type of three-parameter plot.

Figure 7 what are the x axis and y-axis explaining? please add in the illustration

RG: Figure 7 has been modified.

Page 28: under headline functional evidence: line 10 from below distribution not distributed?

RG: Corrected.

Ekblom's comments

Ekblom's comments are exceptionally detailed. More so than I would expect during a review process. This is input of which I am very appreciative, since it gives the text a significant amount of "polish", All comments are also valuable when coming from an external researcher not directly involved with the area/periods addressed in the article who can see the text with fresh eyes and evaluate its general clarity.

I will not comment upon all of the extensive suggestions for editing provided by Ekblom, but rather only on the major ones or those where I in some way deviate from her suggestions, i.e. if no comment is given the change has been implemented as suggested.

***

The aims should be moved to the very beginning of the paper and restructured to make the potential of the paper more clear and relevant to the reader.

RG: I disagree. The aims of the article are based on the current state of research and discussions among excavators. For this to make sense I argue that the aims part should be kept after the background.

***

The aims listed as they now stand are means by which to address the main research question and you cannot assess the applicability of sampling methods or results without referring back to the overall archaeological objective.

RG: The aims list has been rewritten to better correspond to the comments of the reviewer.

***

The scope as presented in the background appears to narrow and does not well reflect the actual content of the paper (and the aim as I interpret it). I suggest to introduce the paper on the basis of what it presents rather than as now on the basis of what was left out in another paper which the reader is not likely to have read. Thus begin with a summery, e.g this paper will ….(see the above summary for a suggestion).

The present focus in the introduction on phosphate feature fill analysis of phosphates vs spatial distribution does not well capture the overall content of the paper and much of this discussion should instead be moved to the

Phosphate analysis section. The two (relatively long) quotes should be also be deleted, it is better that you summarise this in your own words and draws out the relevance of the methodologies chosen in the case study examples.

RG: I disagree with Ekblom on these points.

1) The reference to an earlier article is deliberate and planned, and I intend to keep it in the text. The point is to show the progression of the research presented in the text. I understand that the reviewer is concerned with making this article as easy to read as possible as an independent text. Independent, however, it has never been. The article is part of a process and thought has been given to that the text should reflect this fact.
   This is a point I want to insist upon. Not only because of my choice to structure this part of the article in the current form, but also because I myself often lack clear references to previous and foundational texts in articles.
2) I want to argue for the quotes to stay. If read carefully it becomes apparent that the statements in the two quotes are contradictory. This is highly important since the first quote refers to the second for support of its argument. My point here is that Zimmermann, presumably inadvertently, misunderstood and misquoted Blidmo. He did so in an important and widely circulated paper which to this day influences how excavators perceive phosphate sampling. Yes, the scope of the article goes beyond questions of feature fills contra areal surveys, but nonetheless this part of the article is of utmost importance since it governs strategies for collection of the primary empirical material, and since I am directly questioning the statements made by another researcher I find that a direct quote in the text is more than justified.

On basis of the above arguments I argue to keep the background more or less unchanged. It states what this article was written for: 1) to present a combination of methods which has been applied in the field, but not sufficiently published, and 2) to evaluate whether the main strategy of sampling for this method combination is a valid one under the conditions of south Scandinavian research.

I have however rewritten this section somewhat to put emphasis on why I think that it is important for this background to be written in the way it is.

***

Geographic and chronological setting of the study

This text is somewhat misdirected in relation to the content, the geographical setting of the review you start with is Scandinavia and the focus is broader than the Iron Age as you review functionality analyses of (long) houses in general, though the focus is on long houses. Thus once you have begun with the broader introduction on geographical and chronological scope and introduce the geographical and chronological scope of your actual case study examples. In the case study examples, again as I read the paper the phosphate feature fill analysis of phosphates vs spatial distribution is only one of the many different methodologies discussed in the case studies thus you should rephrase this accordingly.

RG: This part of the article has been rephrased to address the comments made by the reviewer. The heading has also been changed to “Chronology and geographic context of analysed case studies”.

***

Functional interpretation based on house structure, internal features and distribution of artefacts" should be moved to beginning, after the geological setting and made into a heading level 2. "Living and dying houses in dynamic societies" should also be moved to here (at least the section before beginning of the section on "life history of houses"). The 13 parameters listed should be used to lay out the context of how the methodologies present here (and as shown in the case studies) can assist in answering or testing the assumptions based on house structure and finds alone. Only after this the reader will have enough background to follow the very relevant discussion on methodology and important source criticism, the authors will also the more clearly be able to relate back to the archaeological questions.

RG: The segments have been reshuffled as suggested by the reviewer. Some sub-headings in this section of the article have been adjusted to accommodate this restructuring.

***

Methods and underlying theory

I suggest you rephrase this to "Complimentary methods and interpretation" or something similar.

RG: The entire chapter has now been rephrased to "Methods of functional analysis and their underlying theory".
I want to note here however that the multiproxy method, which is such an important component of this article does not consist of "complimentary". They can all very well be used independently and should be considered equal to more common means of functional interpretation. There are no "archaeological" and complimentary methods. All methods in archaeology are "archaeological".

***

This section begins with the statement of what you will not discuss in this paper. It is as a rule more pedagogic to tell the reader what the text will present. Eg. Here methodologies complementary to conventional archaeological interpretations will be presented focusing of possibilities and problems of interpretation of longhouses in particular. Contrary to how it is now phrased I do think you give a very detailed review of "the technical specifics of each method, and aspects of how they can be combined" and you also give ample reference to the authors listed in the below discussion so I don't see that you have reserve yourself in the introduction or list the references as you now do. It is better to add them in your review of each method in parenthesis (eg for a full review of this problem/method see XXXX).

RG: This section has now been removed and references moved to the respective method sections below.

***

In the text you make a very loose parallel to Chaîne Opératoire, if this comparison is to make any sense to the reader you have to explain how this is relevant, what is the similarities. If you move the "Living and dying houses in dynamic societies" to before methods you reference to Shiffer and C- and N-transformations will more make sense to the reader, but you must relate it more clearly to what you are saying here more exactly.

RG: As mentioned above the segments of this chapter have now been reshuffled. This means that an outline of Schiffer's N- and C-transform concepts is now at the beginning of the chapter as the reviewer here suggests.

I have chosen to remove the reference to Chaine Operatoire completely as it is not necessary and an elaboration upon this would add more text to an already long article.

***

The properties listed above make archaeobotanical interpretation a complex task. They…" It is unclear what the properties refers to and accordingly even more unclear what "they" refer to. Rephrase to make more clear, explain what is it that is complex, the activities or the interpretation or both?

RG: This paragraph has been rephrased as suggested.

***

Plant macrofossil analysis and identification of functional spaces

This section begins with a very long sentence, try and break this up. Also as this section is so short it is better to combine it with the one following.
"Plant remains in unburnt houses will therefore tend to cluster around the former location of the heat source where they were carbonised." Rephrase this as suggested in the text and see also the following sentence.
"represent shorter time spans; essentially reflecting what was in the house at the time of the fire" see suggested rephrasing in text as I am missing a verb here…houses don't do anything. I suggest to add "activities" same with the sentence above eg it is a snapshot of the use of plants in the household/or amongst the occoupants/dwellers/users of the house and activities linked to the use of plants"

RG: The section has been rephrased and restructured as suggested by the reviewer.

***

I am wondering under what conditions would bone/waste from bone be accumulated inside a house? presumably people did not through their waste inside the house or leave decomposing animals inside the house when it was still in use? So, if the enrichment of phosphate took place due to decomposing animals would this not be more likely to be linked to activities taking place after/before the house was abandoned? Or?

RG: I envisage the accumulation of inorganic phosphate to derive from food preparation and eating. One can almost assume a constant drop-off of small bone (and meat) fragments from animal products inside the house. Most of it was probably removed during cleaning, but any smaller fragments would have had a high probability of penetrating into the floor. After a generation or two of cooking I assume that the trampled earth or clay floors of prehistoric longhouses would have been significantly enriched with animal derived phosphate.
As seen in the case studies presented further down in the article the kitchens almost always display heightened CitP-inorganic levels. This highly recurring pattern, seen all over Scandinavia, seems to support the above stated assumption.

***

I suggest to restructure headings here eg start with JAAH Heading two "Case study examples" and then AAH Heading three "Gedved Vest"
This section is not merely a comparison of grid or feature fill sampling strategies for phosphate analyses (as the title suggest) but also an evaluation of the various complimentary methods that have been discussed here in the context of other archaeological data and analyses eg finds and house structure.

RG: I agree, and hence the chapter's title involves both the comparison and "functional analysis".

I furthermore do not wish to restructure the headings in this section and subsume them in a unit together with all the other functional analyses. The reason for this is the fact that the sampling method comparison presented in the "Locality 1, Gedved Vest section" is a pre-requisite for all other presented cases being convincing, since this section demonstrates that feature fill sampling, under the right conditions, may be just as effective as area covering grid surveys.

***

It should be made clear from the onset if all of the analyses and results of methodologies presented here are based on a review, or if the author has contributed with own analyses of data.

RG: All presented analyses have been performed either by myself or by students practicing in the Environmental Archaeology Lab in Umeå on parts of the material (see acknowledgements). Locality 1 was not included in the main publication on the archaeobotany of Gedved Vest (Grabowski 2014), due to the sparse finds at Locality 1, and is therefore previously unpublished.
The text has been adjusted to make this explicit.

***

To balance the text the sampling strategies for macrofossil material also needs to be briefly summarised in one or two sentences, eg how many samples, focusing on what contexts?

RG: This is already in the text, see: "[…] 91 samples from feature fills were also collected. These samples were extracted mainly for archaeobotanical analysis but prior to floatation sub-samples were retrieved from each bag of soil."

***

"Due to the comparatively clean siting of these houses a grid sampling for…" You have to explain what clean siting refers to in this case.

RG: adjusted the wording of this sentence to be more clear; that the houses were selected for phosphate survey because they were situated clean from other habitation traces and with only one identified phase of activities.

***

"It may be possible that this hearth is not related to the house at all, but rather belongs to an unrelated phase of activities." Develop this discussion a little bit, eg since the postholes does not show elevated signature it is likely that these events took place after the posthole was closed (and thus also after the house was abandoned?)

RG: I am perplexed at this suggestion. In the reviewed manuscript this sentence is followed by:
"This would explain the lack of hearth-indicating signatures in the surrounding postholes since they would either not yet have been dug or already been sealed when the activities took place. An asynchrony between the two hearths would also explain the somewhat awkward location of the south-western hearth, places right next to one of the walls."
Is this not what the reviewer calls for?

***

"pottery in posthole S173, interpreted as a house offering." By whom and on the basis of what? Explain, also explain the link between a supposed offering of "kitchen ware" to the functional interpretation that the area was a kitchen better.

RG: This part has been rephrased and expanded.

***

"There are several clues pointing to the second alternative as the more convincing" Not clear what the second alternative refers to.

RG: This and the preceding sentence have been rephrased to clarify the statement.

***

"The kitchen space is identified to the middle of the house, between postholes S170 and S181, based on high CitP-inorganic levels, high SOM, of kitchen indicating finds and the occurrence of a kitchen resonating house offering" This sentence does not appear to be a full sentence and there is a sentence missing here.

RG: I suspect that the reviewer accidentally deleted a part of this sentence during the review of the article-doc-file. In the submitted document this is a complete sentence with the missing "*concentration of* kitchen indicating finds.." in place.

***

Westernmost postholes in house three has high organic phosphate, which is taken to indicate stables but how do you explain the pattern furthermore continues outside the house in samples taken from the cultural layer" This is taken up further in the discussion and needs to be elaborated was there any signs of an entrance here, or is it due to runoff from the byre, or did they put manure outside the house or what?

RG: this has now been elaborated. See last paragraph of the "Fyllinge" section of the article.

***

"All of these indications lead up to a conclusion that understanding of a settlements functionality must be sought as much outside the longhouses as inside them."

Agreed and I think partly you make this error when discussing the cases above so you there you should put out in the introduction that in some of the cases you will zoom in on one house or isolated buildings.

RG: I agree with the review. But rather than putting in a reservation at the beginning of the article I chose to discuss this in the section where the reviewer posted her comment. I elaborate and expand this section to account for the reviewers comment.