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Sexual inequalities in the early Neolithic? Exploring relationships between sexes/genders at the cemetery of Vedrovice using use-wear analysis, diet and mobility.

--Manuscript Draft--

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Abstract:	This paper aims to address relations between sexes at the start of farming in Europe, particularly through studying the funerary practices of one of the most important North Carpathian Basin Neolithic cemeteries: the site of Vedrovice (Moravia, Czech Republic), considered to be the first Linearbandkeramik (LBK) cemetery documented to date. In order to approach the relationships between women, children and men at the dawn of agriculture, use-wear studies have been undertaken on both ground and flaked stone instruments deposited as grave goods, thus generating new data about the activities performed using these tools. Furthermore, the relationship between sex, age, health condition and spatial distribution has also been addressed together with the isotopic information related to diet and mobility. The results suggest that sexes were valued differently in death. Unequal farming and/or hunting product distribution between the sexes and between women of different origin has been observed as well as higher tool and ornaments accumulation in male burials and a marked sexual differentiation of the male and female spheres of production represented through the stone funerary tools. A discussion is made around the possible interpretation of this results in terms of presence/absence of sexual inequalities.

COMMENTS FOR THE AUTHOR:

First, we would like to express our gratitude to all the reviewers that have dedicated time and effort to improve the quality of this paper. In the following lines we will answer every one of the reviewers' comments.

The changes have been written in blue colour to make it easier to be identified through the text.

Reviewer #1:
1. Content clarification
*** Terminology connected to sex and gender.**

Reading the abstract, I already fell over the use of 'sex' versus 'gender' here, and various times throughout the text (e.g. page 5, bottom half; p35, line 26) I wondered at what point sex actually turned into gender in this analysis. It does not seem quite consistently used to me, so perhaps it deserves clarifying.

That is very true. We changed the first part of the introduction to try to clarify this problem:

"On the basis of Beauvoirian ontology embodied in the well-known phrase "*On ne naît pas femme, on le devient*" (Beauvoir 1949), gender was long ago acknowledged to be a cultural construct that changes throughout time (Butler 1993, Irigaray 1985). More recently, the same has been applied to the concept of "sex" (Butler 2009, Preciado 2002), which has been assumed to represent a socially constructed identity established based on biological and social criteria. This last proposal, however, creates certain analytical problems in Archaeology. We need a language to discuss the categories created by skeletal, and increasingly aDNA, analysis. Therefore, "gender" will be used hereinafter to refer to the cultural attributes and "sex" to the predominant biological differences, as a starting point from which to determine how strongly the latter is expressed in the former.

Then there are other terms, such as 'sexist practices' on p4, line 2. How does this, with all its modern connotations, actually improve on the more neutral 'gender inequalities' used in the same sentence? In particular since the distinction is not picked up again at any point in the discussion or conclusion. It is therefore a little confusing.
We agree, it is confusing and unnecessary. We deleted "sexist practices".

The same goes for 'equity' (p4, line 40), which has very specific modern-day meanings. But in your case, in prehistory, what does it mean? Equal access to the same sorts of activities - or equal social standing, even if based on (complementary, but similarly valued) gendered activities? Making this point clearer will also help better draw out the social significance of the observed axes of difference in your discussion, where the relationship between 'difference' and 'social differentiation' could do with a clearer, summarising statement.

We agree that there is a slight shortening of the text here and have added this text:

"Accordingly, if one can determine the prehistoric uses of the tools, there is a chance to reveal which activities were recurrently associated with social groups for reasons of sex, age, or other hierarchies. This is a significant step in determining the extent of the division of labour based on an individual's sex/age or, rather, the community's understanding of that individual's sex/age at

death. From the strength of the division of labour, more qualitative interpretations about the values placed on those tasks, and how they were incorporated into modes of social differentiation, such as an unequal hierarchy between the sexes/genders, can be developed.

For example, on p40 you state that "While we must also be careful not to allow our own value judgements about the comparative significance of activities to lead interpretation, we conclude here that as the activities represented by grave goods are narrower range than represented in the LBK in total, and correlate with the sex of the individual buried, the genders were valued differently in death".

But what is 'valued differently in death', actually. Are you claiming a different (hierarchical) social value for these activities, in line with your 'sexism' question? How have you assigned 'social value' to activities? Why 'valued' rather than 'represented'?

What we want to say is that there is a selection of the activities and artefacts represented in the grave goods and that this could (though not necessarily) imply different (hierarchical or not) social value for these activities. However, we decided to delete this sentence: "*While we must also be careful not to allow our own value judgements about the comparative significance of activities to lead interpretation, we conclude here that as the activities represented by grave goods are narrower range than represented in the LBK in total and correlate with the sex of the individual buried, the genders were valued differently in death."* Speak about "social value" here, without introducing the topic before is not pertinent we think.

*** Clarifying male roles. On p3, line 39/40, you provocatively point towards limited possibilities of gendered expression for me. This is worthy of note, given the usual male focus. But I wonder whether it goes a little too far. Yes, you have a group of males that is very stereotypical, much more than any female grouping. Highly interesting.**
But you also have males that fall outside that, and have a much wider range of variation in treatment. This is the case all across the LBK, where the distinction really is 'axe men' versus 'everyone else'. So you could even be more provocative and argue for a binary gender grouping in this way - men with axes, and then women, children and men without axes, which has its own further subdivisions. Even if you do not (and I wouldn't blame you), you are I think too quick to equate all men with the 'men with axes'. Looking for example at the study by Bentley et al. that is quoted, the pattern applies best to some sites (he calls them SNAKES), but is less clear in others. In addition, he claims that axes are almost exclusively used for local males. This is NOT the same as 'local males basically always have axes' (which you suggest on p3). The distinction is important, as the level of axe provision is in general rather varied between funerary sites, certainly outside of SNAKES.

We thank the reviewer for this observation but think it may be better clarified in section *8.1. Male-sexed skeletons*. We think further detail can be added by considering whether males are local or non-local. Of the 21 males in the cemetery 9 don't have axes, and 8 don't present PBAs, Spondylus ornaments or flaked tools among their grave goods.

We added a paragraph at the text to clarify this and deleted some sentences that may lead to ambiguities.

Of the 21 males in the cemetery, 8 don't present PBAs, *Spondylus* or flaked tools among their grave goods. Of those, two burials (50/77 and 25/75) were rather disturbed, one (99/81) belong to a non-local individual and two more (108/84 and 82/79) to the only senile individuals in the cemetery. Once those somewhat unusual burials are removed, there are only 3 male graves left without grave goods: burial 63/78 (adult mature, NCL3), burial 73/79 (young adult, NCL4) and

burial 23/75 (juvenile, NCL4), whose ages, origin and nitrogen rates do not allow to find any kind of pattern that distinguishes them from the remaining furnished male burials.

We do not agree that with that data it is possible to argue for a "**binary gender grouping in this way - men with axes, and then women, children and men without axes, which has its own further subdivisions**". At least not at Vedrovice considering the available data, though it is true that only the 28% of the population is "male", which (as we say in the text) could mean that "our observations of the male inhabitants cannot be applied to all the men present in the area". And, in any case, the fact that some men do not have PBA does nor mean that they belong to the same "gender" as the rest of women, it could also be the consequence of other social constructs.

* **Questions concerning ritual. Cemetery burial is highly selective in the LBK (so not even all the sites in the region would give you the full picture). But this means we are not sure what social roles it played and therefore, how quickly it changed. On p 35, you seem to argue for a snapshot view - but really, your maximum figure is seven generations, and yes, there could be change over that time, or even over 3 or 4 generations. This is no disaster, but an all-or-nothing claim like that will simply open you up to easy criticism. Phrasing this more neutrally ('unusually tight control' etc) or briefly considering a possibility for change over time in a couple of sentences will in no way detract from the main conclusions of your study.**

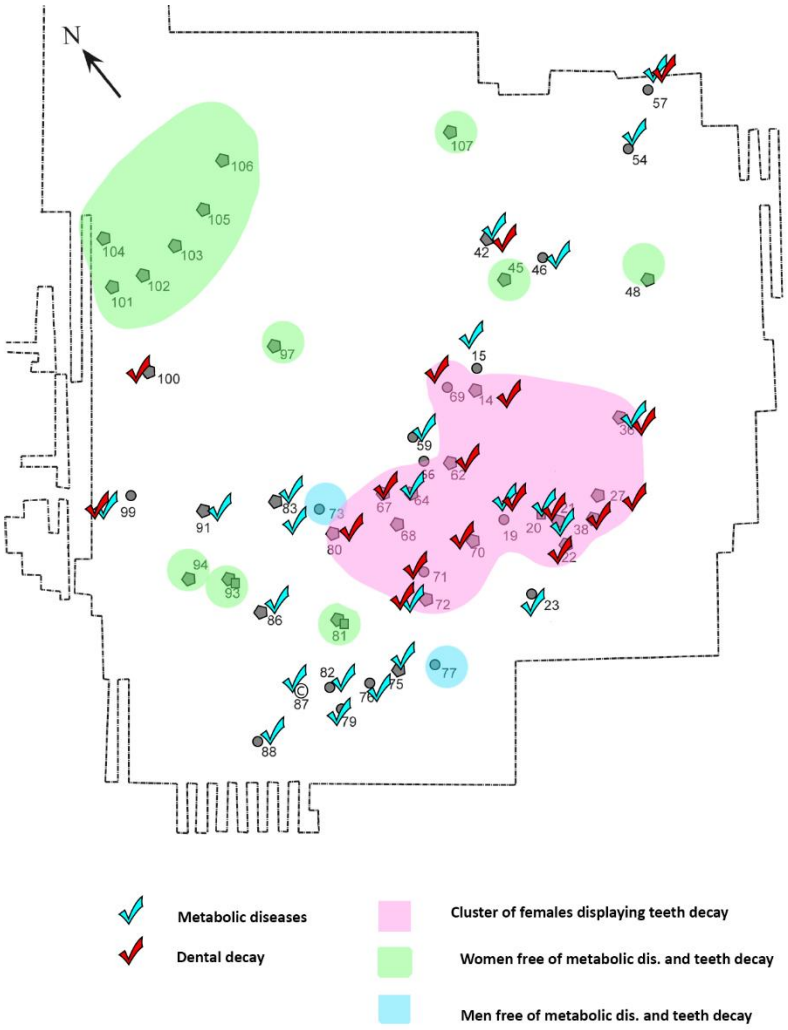
We corrected this: "The Vedrovice record offers a unique opportunity to approach a very short and specific period within the sequence of LBK funerary patterns changes. This unusually tight control over the variable of time has allowed us to focus our attention in other elements that could explain the data variability. Four main factors have been identified (…)".

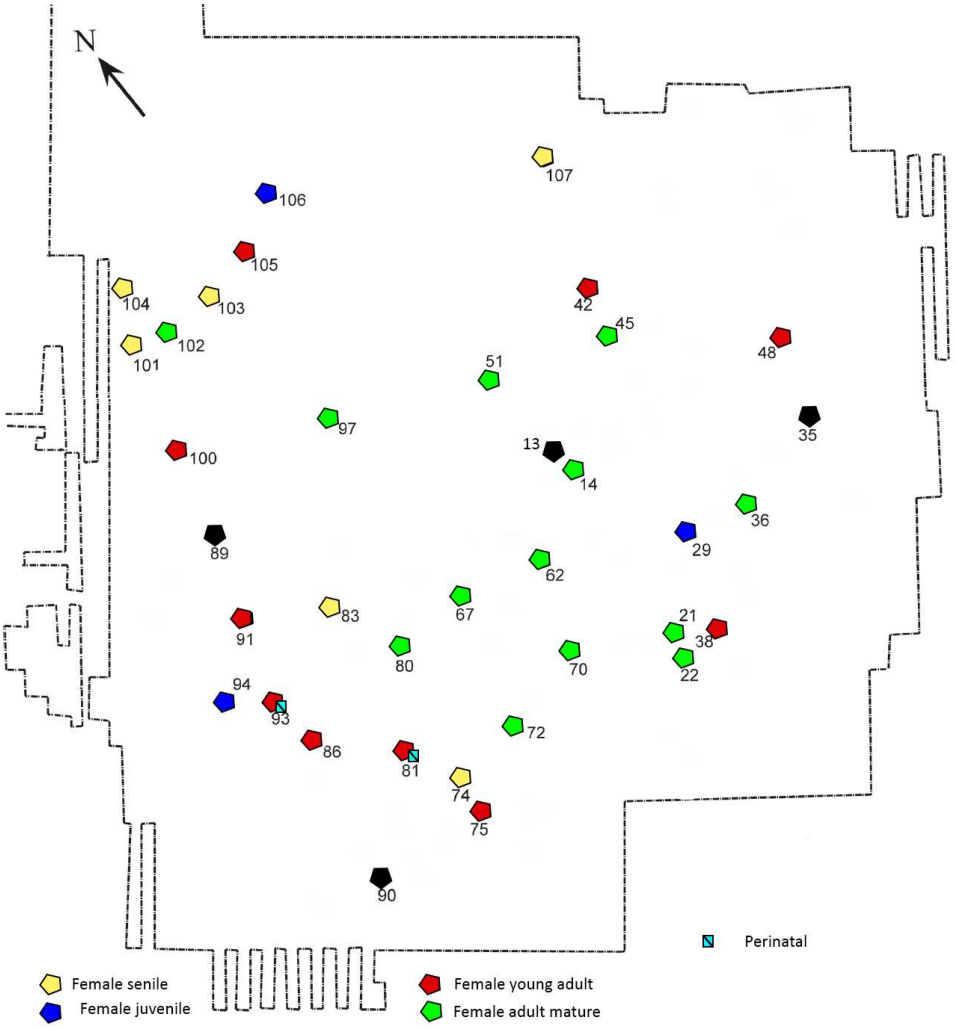
* **Small points. On p38, line 10-12 you remain very veiled concerning your alternative to patrilocality. I agree with you, but as an unsupported statement it remains rather weak. Any chance of a hint at what you are thinking about here?**

We tried to make it better here: "Female-sexed skeletons present quantitatively more variability than men as well as more internal strontium variation, possibly reflecting the fact that they had moved to a different location than their birthplace by the time they reached adulthood. This pattern has often been explained as a resulting of exogamy practices in a patrilocal system (Bentley 2007; Bentley et al 2012). Although this is a plausible hypothesis, more data is needed in order to dismiss other explanatory possibilities for women moving away as a result of ~~them~~ being married out of their immediate community. Patrilocality itself is not an absolute self-explanatory category concerning women's living conditions, as a huge range of scenarios might arise around this kind of residence pattern (Bickle 2019). In any case, until baseline models predicting superficial geological variations have been fully developed, it is not possible to advance this discussion, as the degree of mobility cannot be ascertained. Wider research reconstructing' kindship through DNA analysis on an inner-community scale of interaction may also shed some light on this matter."

Also, I was wondering whether on p39, you controlled for age in assessing caries frequency. Higher ages are after all more likely to develop it (and of course there are hereditary factors in the propensity to caries).

When we did the test I removed the senile female individuals and included the rest. As you can see in the pictures, the tooth decay is concentrated at the south of the cemetery. It is true that there are many mature adults there, but they are also in other areas of the cemetery and there they don't present caries.





2. Non-English literature and other additional references

*** This is a multi-linguistic team. It is therefore a little strange to see the research history section on gender in the LBK essentially being limited to Robb and Harris and to Bickle's (very good) summaries. I do not think this is fair to the efforts of earlier scholars. Although of course there is no room for an in-depth discussion of all relevant work, a few references will ensure that readers realise there is longer history of investigation here.**

=I totally agree with the reviewer. More references are needed.

For example, Eisenhauer (and others) have written on patri- versus matrilocality from an archaeological point of view, based on pottery decoration. This is something that could be cited when this paper criticises the recent interpretative focus on patrilocality.

I added this reference. “Consequently, it has been suggested that ground stone axes and adzes played a prominent role as symbolic items of status in what has been considered a patrilocal system (Eisenhauer 2003, Bentley 2007).”

Röder, in her article 'Jungsteinzeit - Frauenzeit' made use of a combination of osteological and archaeological indicators, so she pioneered the multi-proxy study of gender in the LBK (before isotopes, admittedly). Nordholz's recently published thesis, although problematic in its details, has also attempted to correlate osteological indicators and grave good assemblages. This would be good to quote (if nothing else) because it summarises interpretations of the occurrence of axes and adzes in female graves, but in contrast to the present article does not take the use of these tools into account and thus perpetuates long-trodden erroneous

conclusions on 'females taking on male roles'. = I added these authors and some others to the discussion in chapter 1.

"In this paper attention is focused on *Linearbandkeramik* (LBK) contexts, especially funerary contexts, which show more distinct binary gender patterning than elsewhere in the European Neolithic. Sexual relationships have been addressed in this area during the last four decades, ensuring the possibility to open a deep and meaningful discussion on the subject.

Skeletal and isotopic analyses have shown that men and women were carrying out different habitual activities, had different diets and mobility patterns (Röder 1998, Bentley et al 2012, Bickle et al 2013). The grave goods assemblages signalled that gender differences were recognised in the material cultures of these communities, reaching a consensus by which biologically female-sexed skeletons could receive a wider and less sex-determined range of grave goods than their male-sexed counterparts, who were more frequently buried with identity markers, such as polished and bevelled artefacts (hereinafter: "PBAs"), arrows, bone/antler items and fire lighting sets (Van de Velde 1979, Jeunesse 1997, Hedges et al 2013, Nordholz 2015, Augereau 2018, Ib 2019, Müller-Scheeßel 2019). A recent study has concluded that there was diversity and fluidity in female identities, while male identities had more limited possibilities and were subject to more social constraints (Bickle 2019)."

Similarly, in the discussion on childhood in the LBK, it is crucial to mention Siemoneit's study - of course this is before isotopic information, but it is still the pioneering effort in the field, and the age classes she outlines are not actually that different from those in Bickle and Fibiger, so a good convergence there.

We corrected this mistake in two different places:

5.4. The polished and bevelled artefacts: "The PBAs from burials 30/76 and 32/76 (non-adult individuals) did not present evidence of use on their active surfaces, though one of them displayed clear traces of hafting. Furthermore, the technological and morphological characteristics of the PBAs indicated that they were very similar to the tools found in the male graves, but of much smaller dimensions. The absence of use-wear suggests that, like projectiles, unused PBAs had been specifically produced for deposition as grave goods for 12-14-year-olds. An alternative and more plausible hypothesis, given the presence of hafting traces on the medial area of tool 13048, would be that they were toys that were re-polished before their final deposition in the grave. This last hypothesis arguing for a close relationship between play and learning in the LBK context has already been addressed by Siemoneit (1997: 78) not only involving polished adzes, but other items such as small vessels or figurines."

Discussion: "However, among non-adults there is a spike in grave goods between c. 8-14 years old (non-adults II) and then a decrease until early adulthood, a pattern that had already been attested across the LBK by Siemoneit (1997) and Bickle and Fibiger (2014).

* **On p 40, it is a shame that the discussion on Spondylus is not taken further, as this is the only other indicator of 'status' widely discussed in the LBK, alongside polished tools - and in fact the only one open to women. So it actually seems crucial to the aims of this paper in discussing kinds of diversity and the relation of that to status (see point 1). The minimum that could be done here is to point the reader to Arne Windler's recent thesis on Spondylus, so at**

least they are guided to a summary of the evidence (presented in a drastically different theoretical framework, of course).

We did not know Arne Windler's work. It is very interesting. We added the reference:

"Exclusively mature adult females were buried together with stone tools, and only *Spondylus* ornaments were present in female graves regardless of the buried individual origin and protein ingestion rates. Although Spondylus management is not the specific object of this paper, those results are quite revealing and should be addressed and interpreted in the future in relation to the documented mechanisms of long-distance exchange suggested by Windler (2018)."

* **Where weaning and weaning practices are discussed, it could be a good idea (though not essential) to mention S. Stefanović's running ERC project on the matter, and particularly her recent PLOS One paper on tooth marks on bone spoons. Although this sounds exotic at first, it makes much more general points about the importance of weaning foods in the Neolithic demographic transition that may be useful for your argument.**

We did not know Sofija Stefanović work and thank the reviewer for pointing us to it. We have added the reference in the text. "The shortness of weaning periods (between 2 to 3 years) may be indicative of frequent pregnancies with consequential effects on juvenile and young women health, productive and symbolic attributions. In this sense the possible motherhood symbolic and economic changes derived from the Neolithic colonisation process should be addressed in depth in the area, as it is currently being done in other regions such as the Balkans (Stefanović 2019, Stefanović's BIRTH ERC-Funded project)."

* **Not being an expert on use wear, in the first paragraph on p25 I wondered how many times an arrowhead needs to be used to develop a use wear trace - is once enough? (Referring here to the sometimes voiced idea that arrowheads are not grave goods, but the murder weapons). A general nod with reference would satisfy the non-expert I think.**

The text is changed to:

"Gibaja and Palomo (2004: 91) identified four different traces that could be considered as evidence of use in the case of trapezes used as projectiles: fractures derived from impact, striation derived from impact, micro-chipping derived from impact and micro-polishes derived from contact with hard materials, possibly bone of the aimed target, not to mention the evidence for hafting. Being aware of the concerns about distinguishing production and use wear features (Rots and Plisson 2014), the microscopic observation of Vedrovice projectiles did not offer any evidence of use. On this basis, we consider that either those tools may have been made specifically with the intention of being deposited as grave goods or there was a specific selection of daily items in a very good state of preservation."

* **P6, line 14 - can you give a web address of where the Lifeways Open Access database can be downloaded? I couldn't find it**.= corrected.

"The isotopic raw data have mainly been collected from "Lifeways project" Open Access database (available on request from Dr. Penny Bickle: penny.bickle@york.ac.uk) as well as from several (…).

3. Proof-reading and editing details

*** In the bibliography (although not always in the text), a large number of authors are mis-spelled. Even just a very superficial glance has revealed the following:**

'Sanjuan' (should be 'García Sanjuán') = corrected
'Hoffmann' (should be 'Hofmann') = corrected
'Mazciniak' (should be 'Marciniak') = corrected
Mateiciucova (should be Mateiciucová) = corrected
Particularly badly affected was the entry for Meyer et al, which lists 'Lohrb' (should be 'Lohr') and a 'Detlef, G.', who is actually 'Gronenborn, D.' = corrected
as well as mis-spelling the site (missing hyphen). = corrected

References are an important part of a research article. In addition, scholars increasingly rely on citation indices to get jobs and promotions, and mis-spelling their names results in loss of citations for them, as automated search tools do not attribute the work correctly. It is therefore a matter of collegiality to get this right, and the bibliography should be carefully checked.
The bibliography has been thoroughly proofread.

* **From p28 onwards, isotope designations (such as Cδ13) sometimes use the Greek letter delta, and sometimes this symbol: ɣ, which appears to be an 'insular G' - I had to look it up, I admit. Sometimes, there is also just a small Latin d. So please double-check all that.**
The "insular G" has been removed and replaced with the delta symbol.

* **Page 12, line 52 - would be good to add to the text whether the projectile in a non-male grave is in a female or child grave.**
"In 7 cases, the trapezes accompanied a male individual, while in one case, a 5-year-old (39/76) received this item"

* **Figures: figure 3 has 'infantil' in the key - use English term** = corrected
figure 2 - I would advise using simple colours, as this prints better = corrected
figure 11 has a lot of detail to take in - could some of the grave good information be simplified, or the figure split in some way? = corrected

Reviewer #2:

From a methodological point of view, the authors must be aware that sex determination of the individuals is not optimum since partly based on pelvic and skull bones morphology (Dočkalová 2008). This method is less reliable than measurements of pelvic bones. Maybe, it is a point to take into account when evocating the male deficit in the necropolis.
In the paper we have considered the sex determination of Siroka u Lesa the buried individuals was performed by Lille 2008, who, I think, gave priority to pelvis measurements.

Concluding to the non-used arrowheads made for the grave and linked to funerary ritual not to everyday life, is not quite pertinent. Indeed, if those arrows were placed into a quiver (what we do not know due to the lack of contexts description), there is no reason that they were used. The archer, dead or alive, go to the real or symbolic war and hunting with non-used arrows. It is a possibility to keep in mind.
I changed the text to:

"Projectile use-wear analysis has been a well-known field of study since the early eighties (Moss and Newcomer 1982, Fischer et al. 1984). In the particular case of geometrics, Gibaja and Palomo (2004: 91) identified four different traces that could be considered as evidence of use: fractures derived from impact, striation derived from impact, micro-chipping derived from impact and micro-polishes derived from contact with hard materials, possibly the skeleton of the aimed target, not to mention the evidences of hafting. Being aware of the concerns about distinguishing production and use wear features (Rots and Plisson 2014), the microscopic observation of Vedrovice projectiles did not offer any evidence of use. On this basis, we consider that either those tools may have been made specifically with the intention of being deposited as grave goods or there was a specific selection of daily items in a very good state of preservation."

Some formal defects remain and must be corrected:

* **First, due to their complex typology including section, weight, width, thickness/width, etc., it necessary to illustrate the PBA typological variability with drawing or photo. I think that such illustrations should help to follow the argument. =** corrected. See "Figure 9. Polished and bevelled artefact types and sections examples. Types 1-4 corresponding to Ramminger's PBA classification (2007, 2009)."

* **Numerous abbreviations (PBA, HBI, T, FC… sections…, tool numbers…) make sometimes reading difficult. It would be necessary to delate part of them, especially in text or some tables (table 3: sections, HBI…) =** corrected in all the tables.
* **Abbreviations in tittles (Ex: "5.4 PBAs") must be avoided. =** corrected
* **Numbers in the beginning of sentences must be written in letters =** corrected

* **Many mistakes or lacks on figures, tables and captions:**

missing legends on figure 10 (A and B) = corrected; **non-homogenous abbreviations (table 5: Harris lines = HL or H? Cribra orbitalia = CB or CO? What is CB?).** corrected.
NCL4, NCL2, or SrCL1, 3… evocated in text must clearly be mentioned on figures and captions (figure 10, for example). = corrected
figure 8: where are double dots for female?= corrected
Figure 10. A) XY Biplot including $^{87}Sr/^{86}Sr$ values, $^{87}Sr/^{86}Sr$ concentration and Strontium clusters 1-4. Black dots correspond to females, grey dots to non-adults and white dots to males. B) XY Biplot including including Nδ15, Oδ13 isotope values and Nitrogen clusters 1-4. Black dots correspond to males, white dots to female individuals.

* **Two figures are very complicated to read, due to the numerous data they try to show:**
  - **Fig. 8: The definition of HBI and type numbers of polished tools must be mentioned =** corrected **. Colored figurative could be used for sex or activities =** corrected

Figure 8: Bivariate plot comparing Vedrovice adzes HBI and total width typology according to Ramminger (2007, 2009) classification. Squares corresponds to "U" -shaped sections, crossed dots to triangular and flat-cylindrical sections and ovoids to flat-convex and oval. Colour green corresponds to woodworking, white to indeterminate use, grey to hide work and red to butchering or meat-related activities. Types 1-4 corresponding to Ramminger's PBA classification (2007, 2009).

  - **Fig. 11: too many information make the figure not pertinent. As a first possibility, the graves numbers could be removed. =** corrected Regarding the rest, several figures will be maybe necessary. **Another missing legend: A, B and C groups not defined in caption =** corrected

Reviewer #3: Paper is good as is but the last sentence of the last paragraph of chapter one is problematic.

As a previous paper is critized and, as a result, the contents of the present research are highlighted and branded as hitherto unmatched. This is true for the lithic analysis of stone tools in burials, but not for the more general approach. Apart from the fact that the previous original publication is not correctly cited, and referring to the critique, the conclusions of the authors may be critizised with the same arguments: Burial goods are taken as face value and then deductions made from them on social sturcure: "Male-sexed individuals' funerary symbolism was related to interpersonal violence, animal resource acquisition and/or carcasses processing, as well as to a strong technological standardisation of their tools, which varied according to the individuals age." Not only does this support previous conclusions on male roles in LBK societies, it also bears the often critized problem that burial goods may have gone through many societal filters and thus cannot necessarily be taken as immediate indicators of actions of the buried persons. Therefore, if the authors claim to be so much more methodologically and theoretically sophisticated, why then fall back to traditional methods that were just before criitizised?

Maybe is better phrased in this way:

"Vedrovice's site was published by Podborský's (2002) in an extensive and detailed monography which is the basis on which all further studies have been built on the site. Due to its historical significance and thanks to the cemetery good level of documentation and preservation, this site has been included in several prominent international projects (*Vedrovice* Project, *Lifeways* Project) and leading scientific publications on the field of bioarchaeology (Bramanti 2008, Lillie 2008, Richards et al 2008, Smrčka et al 2005, 2008; Whittle et al 2013, Jorasová and Tvrdy 2017, Frayer 2004, Dočkalova 2008), making it one of the best studied sites of the European Early Neolithic.

Studies of the PBAs materials have been conducted by Salaš (2002) which performed an in-depth analysis of the artefacts morpho-metrical and weigh characteristics as well as pointed out the presence of used and unused PBAs and their possible hafting systems. Furthermore, Mateiciucová's (2008) study of the chipped tools suggested that imported flaked lithic raw materials, mainly corresponding to arrowheads, were found in male burials, while flaked items recorded in female burials were always made of local raw material, signalling that men were involved in contact with distant regions."

The same is for **"Therefore, if the authors claim to be so much more methodologically and theoretically sophisticated, why then fall back to traditional methods that were just before criitizised?".** We point out that use-wear analyses are almost absent in LBK contexts and that performing them could bring very interesting inputs to the discussion of gender construction within Neolithic communities. That does not underestimate any other technique or approach, it complements them.

We have added the following sentence to the end of the first section to strength this point:

This is especially the case when considering the identity of the deceased with whom they are buried, with the application of binary genders strongly debated and critiqued (e.g. the Schwanfeld "hunter"; cf. Gronenborn 2003 and Bickle and Fibiger 2014, 211). We hope to shed further light on these debates, by presenting the first complete micro-wear analysis of an LBK cemetery.

Apart from this general comment, I would strongly recommend making techincal drawings of the microliths and to mark the use-wear traces.

The technical drawings of the arrowheads can be consulted at Mateiciucova, I. 2008. Talking stones: the chipped stone industry in Lower Austria and Moravia and the beginnings of the Neolithic in Central Europe (LBK), 5700-4900 BC. 1. vyd. Brno: Masarykova univerzita. Dis. Archaeologicae Brunenses/Pragensesque 4 (pages 321-326).
We added this information to the text at Figure 5: "The technical drawings of the arrowheads can be consulted at Mateiciucova 2008: 321-326.".
The use-wear traces on projectiles can't be marked because they are absent from the objects.

Reviewer #4: My suggestions for improvement would relate mainly to the formal level:

5. Use-wear and technological analysis results
5.1 Sampling
Can you specify what is the taphonomic state and surface condition of the items.

I added the following paragraph: "As a result of the schistose nature of the PBA raw materials, the preservation of the active surface was generally good enough to make an approximation of what materials the tools were used on, though identifying specific activities and particularities of the worked materials presented a greater challenge. The flaked artefacts' surfaces preservation was very good, without significant post-depositional alterations that could prevent our analysis."

5.2 The flaked non-projectiles. There's a lack of figure calls. For example page 10, line 58 : male burials 43/77 (object 13077) and 79/79 (object 13180) = (fig.4, A et H) = I added the figure calls.

Figure 4 : the use-wear symbols are missing (location of wear, kinematics, etc.) and the details in the legend. = I did not add the use-wear images in the Figure 4, that is why there are no use-wear symbols nor details in the legend.

5.3 The projectiles
Page 12, line 12 - 14 : In my opinion, the fact that the projectiles do not show traces of use does not necessarily imply that they were specially manufactured for grave. This argument alone doesn't seem to me to be enough.
I changed the text to:

"Projectile use-wear analysis has been a well-known field of study since the early eighties (Moss and Newcomer 1982, Fischer et al. 1984). In the particular case of geometrics, Gibaja and Palomo (2004: 91) identified four different traces that could be considered as evidence of use: fractures derived from impact, striation derived from impact, micro-chipping derived from impact and micro-polishes derived from contact with hard materials, possibly the skeleton of the aimed target, not to mention the evidences of hafting. Being aware of the concerns about distinguishing production and use wear features (Rots and Plisson 2014), the microscopic observation of Vedrovice projectiles did not offer any evidence of use. On this basis, we consider that either those tools may have been made specifically with the intention of being deposited as grave goods or there was a specific selection of daily items in a very good state of preservation."

5.4 PBAs

The macroscopic observation of the hafted surfaces….= it's unfortunate that these traces aren't documented here = I completely agree but the fact is that the binocular available on the field did not have a camera so all I have are the macro photos. I added this "see Online resource 3 figures for more detail" so the reader can consult those macroscopic photos.

Figure 6: the scales on the photographs are missing and the caption is not very explanatory. For figure 7 it's the same, for example :F) 100x, G) 100x, H) 200x (idem figure 9).

The scales are missing in the image, but present in the caption. I added this text to make the figures more explanatory:

Figure 6: 1. Bone/meat use-wear evidence. A) Shiny compact directional micro-polish, Tool 13025 (grave 19/75), B) Fresh surface, Tool 13085 (grave 46/77), C) Shiny compact micro-polish and fresh chip, 13025, 200x D) Semi-open micro-polishes of irregular microtopography, 13085, 200x, E) Slight rounding and open/semi-open micro-polishes of irregular microtopography, 13025, 200x, F) Idem preceding illustration, 13025, 200x, 2. Evidence of woodworking G-H) Micro-polish of undulating micro-topography, Grave 15/75 (400x).

Figure 7: Hide-working evidence. A) Tool 13057, B) Tool 13021, C) Fresh pecking 100x, D) Smooth surface with ochre residues, 200x, E) Smooth surface with a semi-closed micro-polish of irregular micro-topography 200x, F) U-shaped in cross section deep striations perpendicular to the edge on a very rounded edge with directional semi-open/semi-closed micro-polish of irregular micro-topography, 100x, G) Idem preceding illustration, 100x, H) Detail of the micro-polish of irregular micro-topography, 200x.

Figure 9: A. Tool 13216. A) Ochre residues 100x, B) Indeterminate superficial micro-polish 100x, C) Fresh pecking, 100x, D) Fresh pecking, 100x. B. Tool 13216. A) directional micro-polish of semi-closed network and irregular microtopography, 200x, B) Idem preceding illustration, 200x, C) Idem preceding illustration, 100x, D) Fresh pecking, 100x.

Page 19, line 2 : tool 13021 (a child's grave) = add call to figure (Fig. 7, B)= I don't understand the comment.

Page 20, line 25: Table XX = missing the table number= corrected

6.1 Strontium isotope as mobility indicators

Page 24, line 26 : Bentley 2002 = for Bentley et al. 2002= corrected

6.2 Diet indicators

Page 30, line 1 : missing the table number= corrected

8.1 Male-sexed skeletons

Page 35, line 16 : "indicating that that dissemblance could be the result of a more abundant food…"

Bibliography : globally, there are problems of homogeneity in the presentation of references, line breaks, etc (see below for some indications).

Page 2, line 1 : Cruz = not in bibliography and line 28 (changed to "Berrocal") **Robb and Harris 2017 in the text = 2018 en bib** (corrected)

Page 3, line 53 : Richard = for Richards and line 54 : Smrka = for Smrčka = corrected

Page 5, line 16 : Smrka = for Smrčka= corrected

Page 7, line 58 : Rinne 2001 = not in bibliography= corrected

Page 10, line 24 : Mateiciucova 2009 = 2008 in bibliography= corrected

Page 24, line 45 : Bataille et al 2017 = 2018 in bibliography= corrected

Page 25, line 60 : Smrka et al 2005, 2008 = for Smrčka and Richard et al 2008 = for Richards= corrected

Page 28, line 4 : Nehlich et al 2010 = 2009 in bibliography = corrected.

line 56: Katzenberg 1999 = not in bibliography, only 2008 = corrected.

and Kinaston et al 2008 = 2009 in bibliography = corrected.

Page 35, line 49: Vencl 1999 = not in bibliography. Revised and in bibliography

Page 40, line 8: Cintas Peña 2018 = not in bibliography = corrected. line 39-: **Mittnik 2019 not in bibliography=** corrected.

Čižmář 1998 and Čižmář 2002 in bib but not mentioned in the text. They are mentioned at Online resource 1. Chronology

Hoffman 2009 in bibliography = for Hofmann.

Corrected

Douglas Price, Peter Schröter, Frank Söllner, Clark M. Johnson and Brian L.Beard. Applied Geochemistry 14, 263-269. = in bib but not mentioned in the text and the date is missing.

Deleted

Lee, S., &Bronk Ramsey, C. (2012). Development and Application of the Trapezoidal Model for Archaeological Chronologies. Radiocarbon, 54(1), 107-122. = to be deleted as mentioned twice (line 18 and 25).

It is mentioned in the text (page 6)

Reimer et al. 2013 = in bib but not mentioned in the text.

It is mentioned at Online resource 1. Chronology.

Sexual inequalities in the early Neolithic? Exploring relationships between sexes/genders at the cemetery of Vedrovice using use-wear analysis, diet and mobility.

Alba Masclans (corresponding author)

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Caroline Hamon

Abstract

This paper aims to address relations between sexes at the start of farming in Europe, particularly through studying the funerary practices of one of the most important North Carpathian Basin Neolithic cemeteries: the site of Vedrovice (Moravia, Czech Republic), considered to be the first *Linearbandkeramik* (LBK) cemetery documented to date. In order to approach the relationships between women, children and men at the dawn of agriculture, use-wear studies have been undertaken on both ground and flaked stone instruments deposited as grave goods, thus generating new data about the activities performed using these tools. Furthermore, the relationship between sex, age, health condition and spatial distribution has also been addressed together with the isotopic information related to diet and mobility. The results suggest that sexes were valued differently in death. Unequal farming and/or hunting product distribution between the sexes and between women of different origin has been observed as well as higher tool and ornaments accumulation in male burials and a marked sexual differentiation of the male and female spheres of production represented through the stone funerary tools. A discussion is made around the possible interpretation of this results in terms of presence/absence of sexual inequalities.

Key words: *Linearbandkeramik*, Early Neolithic, use-wear analysis, gender, sex, Funerary Archaeology, Vedrovice.

1. Introduction

On the basis of Beauvoirian ontology embodied in the well-known phrase "*On ne naît pas femme, on le devient*" (Beauvoir 1949), gender was long ago acknowledged to be a cultural construct that changes throughout time (Butler 1993, Irigaray 1985). More recently, the same has been applied to the concept of "sex" (Butler 2009, Preciado 2002), which has been assumed to represent a socially constructed identity established based on biological and social criteria. This last proposal, however, creates certain analytical problems in Archaeology. We need a language to discuss the categories created by skeletal, and increasingly aDNA, analysis. Therefore, "gender" will be used hereinafter to refer to the cultural attributes and "sex" to the predominant biological differences, as a starting point from which to determine how strongly the latter is expressed in the former.

Over the last decades, Gender Archaeology, Marxist Archaeology and Queer Archaeology have been addressing relationships and historical changes between sexes/genders (Arnold 2006, Berrocal 2009, Bolger 2013, Conkey and Spector 1984, Berrocal 2009, Ehrenberg 1989, Gero and Conkey 1991, Montón-Subías and Meyer 2014, Sanahuja 2002, Turek 2017, Voss 2000, Wylie 2007).

However, it has been recently argued that gender during the European Neolithic has not received the necessary attention required to gain a proper understanding of its cultural contents (Robb and Harris 2018). Unlike the mainly binary (male/female) gender structure developed in Europe from the Bronze Age onwards, evidence from the Neolithic does not reveal homogeneous patterns of differentiation suggesting strictly binary gender identities, even if gender was generally acknowledged (*Ibidem).*

This makes sense in the context of Neolithisation, which brought about significant changes and social consequences for thousands of communities in a relatively short period of time. A fragmented patchwork of heterogeneous gender identities could be the result of such a collective process of multiple social changes across Europe - changes which were not the result of a planned centralised political operation. What would be thus required to characterise gender during the Neolithic is, in the first place, the use of categories adjusted to particular contextual characteristics of every society (Barquer et al 2012). The lack of this type of historicised and local evidence strengthens the need to find alternative ways of recording the creation and manifestation of sexual identity (Bickle 2019).

In this paper attention is focused on *Linearbandkeramik* (LBK) contexts, especially funerary contexts, which show more distinct binary gender patterning than elsewhere in the European Neolithic. Sexual relationships have been addressed in this area during the last four decades, ensuring the possibility to open a deep and meaningful discussion on the subject.

Skeletal and isotopic analyses have shown that men and women were carrying out different habitual activities, had different diets and mobility patterns (Röder 1998, Bentley et al 2012, Bickle et al 2013). The grave goods assemblages signalled that differences were recognised in the material cultures of these communities between sexes, reaching a consensus by which biologically female-sexed skeletons could receive a wider and less sex-determined range of grave goods than their male-sexed counterparts, who were more frequently buried with identity markers, such as polished and bevelled artefacts (hereinafter: “PBAs”), arrows, bone/antler items and fire lighting sets (Van de Velde 1979, Jeunesse 1997, Hedges et al 2013, Nordholz 2015, Augereau 2018, Ib 2019, Müller-Scheeßel 2019). A recent study has concluded that there was diversity and fluidity in female identities, while male identities had more limited possibilities and were subject to more social constraints (Bickle 2019).

According to strontium analyses, polished and bevelled artefacts (hereinafter referred to as “PBAs) appeared almost systematically among grave goods assemblages of locally born males (Bickle and Whittle 2013, Bentley et al. 2012). Consequently, it has been suggested that ground stone axes and adzes played a prominent role as symbolic items of status in what has been considered a patrilocal system (Eisenhauer 2003, Bentley 2007). This, in turn, has led to the hypothesis that the funerary sphere was more concerned with emphasising male lineages rather than with how and whether gender (male, female) was constructed/evidenced (Hedges et al. 2013).

In the light of the foregoing, the symbolic representation of a female-male binarism appears plausible in LBK funerary contexts, even if a more rich and variable range of gender possibilities may have

coexisted to a lesser extent. However, the sexual roles and their variability is still far from having been characterised. Furthermore, it is undeniable that only individuals belonging to the female sex have the capacity to bear children and that this capacity must have acted as a strong cultural marker that must be explored. What is more, the objective conditions that may have led to sexual differentiation and, if present, to sexual inequalities have not yet been analysed using a broad and systematic approach.

One of the ways to gain more insight into sexual roles and inequalities can be built around two groups of empirical indicators: demography and living conditions on the one hand, and funerary practices on the other (Cintas-Peña and Sanjuán 2019). The first of these two groups of indicators involve in-depth knowledge of the buried individuals' biology and biography based on bioarchaeological or anthropological data. Funerary practices include variables such as the architectural features of the burials, their spatial organisation, the position and orientation of the body and the characteristics of the grave goods.

In this paper, special attention is given to exploring the presence of sexually differentiated work organisation through the study of those grave goods that can provide information about the activities potentially performed by the buried individuals. Associations between sex and productive activities have been successfully established in other Neolithic archaeological contexts (Masclans et al 2019, Duboscq 2017), whereby grave goods were considered to be representative of the buried individuals' former belongings, gifts from mourners, or a symbolic representation of the activities related to the identity of the deceased (Arnold 2006, Hamlin 2001). *Binfordian* isomorphism between social organisation and mortuary ceremonialism (Binford 1972) is adopted with caution when considering the social management of death, bearing in mind the possible bias resulting from post-depositional factors, as well as from potential ceremonial concealments of status, gender or other social hierarchies.

If a positive statistical relationship between a sexual group and the instruments deposited with them is established, the possibility that such a relationship can be interpreted as evidence of the activities performed by, or associated with, the different sexes during their lives will be considered, as the community will undoubtedly have considered them to be related to the identity of the deceased individual and therefore, partly, to the tasks undertaken by the dead whilst alive.

Accordingly, if one can determine the prehistoric uses of the tools, there is a chance to reveal which activities were recurrently associated with social groups for reasons of sex, age, or other hierarchies. This is a significant step in determining the extent of the division of labour based on an individual's sex/age or, rather, the community's understanding of that individual's sex/age at death. From the strength of the division of labour, more qualitative interpretations about the values placed on those tasks, and how they were incorporated into modes of social differentiation, such as an unequal hierarchy between the sexes/genders, can be developed.

A first step aimed at resolving the above questions was to perform a full use-wear analysis of the flaked and polished and bevelled tools recovered from the Vedrovice cemetery (Moravia, Czech Republic). Vedrovice is one of the most significant sites of the LBK horizon as radiocarbon dating has suggested it is one of the first cemeteries in the North Carpathian Basin. Studying its contexts can provide a better insight into the first funerary practices of the early farming communities.

Vedrovice's site was published by Podborský's (2002) in an extensive and detailed monography which is the basis on which all further studies have been built on the site. Due to its historical significance and thanks to the cemetery good level of documentation and preservation, this site has been included in several prominent international projects (*Vedrovice* Project, *Lifeways* Project) and leading scientific publications on the field of bioarchaeology (Bramanti 2008, Lillie 2008, Richards et al 2008, Smrčka et al 2005, 2008; Whittle et al 2013, Jorasová and Tvrdy 2017, Frayer 2004, Dočkalova 2008), making it one of the best studied sites of the European Early Neolithic.

Studies of the PBAs materials have been conducted by Salaš (2002) which performed an in-depth analysis of the artefacts morpho-metrical and weigh characteristics as well as pointed out the presence of used and unused PBAs and their possible hafting systems. Furthermore, Mateiciucová's (2008) study of the chipped tools suggested that imported flaked lithic raw materials, mainly corresponding to arrowheads, were found in male burials, while flaked items recorded in female burials were always made of local raw material, signalling that men were involved in contact with distant regions.

Other analyses are still to be applied on lithic materials. For instance, determining the past uses of the lithic tools found in grave goods assemblages can shed a light on multiple possibilities still to be found regarding the sex and age differentiations in those early farming communities. Use-wear analysis of stone tools has been proven to be a reliable methodology that provides evidence of people's past activities as well as of their cultural performances (Odell and Odell-Vereecken 1980, Vaughan 1985, González Urquijo and Ibáñez 1994, Adams et al. 2009, Lewis et al. 2011). Thanks to these studies, significant contributions have been made to better understand Early Neolithic lifeways by determining the spatial distribution of activities, both within and between settlements (Hamon 2008, Van Gjin & Mazzucco 2013, Mazzucco et al. 2018).

Important as this technique is to archaeology, it has been little used in *Linearbandkeramik* contexts, resulting in a scarcity of functional characterisations of stone artefacts. Particularly overlooked are grave goods assemblages. As a result, assumptions about what activities stone tools represent when used as grave goods persist. This is especially the case when considering the identity of the deceased with whom they are buried, with the application of binary genders strongly debated and critiqued (e.g. the Schwanfeld "hunter"; cf. Gronenborn 2003 and Bickle and Fibiger 2014, 211). We hope to shed further light on these debates, by presenting the first complete micro-wear analysis of an LBK cemetery.

2. Objectives

The first objective of this paper is to explore the way in which *differences between sexes were evidenced in Vedrovice* through an analysis of the grave goods and their spatial distribution. The following are explored: the presence of relationships between sexed human remains (i.e. male/female) and the grave goods distribution (including bone and stone tools, pottery vessels and ornaments) as well as the range of activities represented by the stone tools found in the graves. This information is obtained through the quantification and spatial localisation of the grave goods along with the use-wear analysis and technological characterisation of the tools.

The second objective of this paper is *to explore the presence of possible sexual differences in daily life practices (health, mobility and diet)* in order to further understand how identities in life may - or may

not - have been represented in death. Firstly, the presence of groups of sexed remains (male/female) or groups of age are examined in the isotope data, with a focus on isotopes relating to protein consumption and mobility. This information is to be obtained by analysing the available nitrogen and strontium data through the aid of statistical analyses. Secondly, in order to explore whether sexually distinctive patterns were directly related to the type of diet, care and infant nutrition, statistical analyses of male and female metabolic diseases and dental decay are also performed.

The third objective is to open a discussion around *whether sex was an explanatory factor of health, mobility, diet, spatial organisation of the burials and the variability of the functional characteristics of the grave goods*. An attempt will thus be made at finding patterns between sexed remains and the presence of groups that combine regular distributions of the mentioned variables, in order to distinguish gender from other explanatory factors of the material record, such as age, social hierarchies not related to sex or cultural identities.

3. Materials and methods

A multi-proxy approach is taken in this paper, based on two groups of empirical indicators: those revealing the living conditions of the studied community (demography, sex ratios, diet, mobility, pathologies and stress makers) and the funerary practices (grave goods and spatial organisation of the burials).

The isotopic raw data have mainly been collected from "Lifeways project" Open Access database (available on request from Dr. Penny Bickle: penny.bickle@york.ac.uk) as well as from several publications on the matter (Richards et al 2008, Zvelebil and Pettitt 2008, Smrčka et al 2008, Whittle et al 2013). A database containing all the values of the skeletons sampled by other research teams has been created (Online Resource 2. Database, Table 3) and subjected to further analysis.

The main methodological technique used during the artefactual analysis was use-wear analysis conducted by surface microscopic techniques. The examination was performed at 10-200x magnifications under a metallographic microscope and a stereomicroscope. Images were procured using a Canon EOS1100D camera and multifocal assemblage using Helicon Focus software. The cleaning procedures included washing the artefacts with soap and water. When an object had a concretion of calcareous nature adhered to it, the artefact was left submerged in a 10% aqueous NaCl solution in an ultrasonic machine for at least 5 mins. This procedure was repeated until the residue was completely removed.

Polished bevelled artefacts were analysed in accordance with the methods and techniques suggested in Masclans et al (2017a) and Masclans et al (2017b), using the macro-lithic tool experimental reference collection developed by Masclans (2020). The flaked tools were studied following the standards proposed by Clemente (1997), González and Ibáñez (1994), Keeley (1980) and Vaughan (1985). To support our functional interpretations, the experimental reference collection of flint, quartz and quartzite deposited at the ADS Laboratory of Microscopy (Spanish National Research Council - Mila i Fontanals Institute) was used.

4. Vedrovice: contextual data, demography and funerary pattern

Vedrovice is located in Southern Moravia (Czech Republic) at the base of the Bohemian Massif, between the rivers Dyje (south) and Jihlava (north) (Figure 1). The site comprises a settlement and a cemetery, including three different burial areas: the settlement ("*Sidliště*"), a grave cluster known as "*Za dvorem*" in the south of the cemetery and the cemetery named "*Široká u Lesa*". According to the grave descriptions in Podborský's (2002) and Dočkalova's (2008), 84 preserved burials have been identified at "*Široká u Lesa*", 10 burials at "*Sidliště*", and 8 at "*Za dvorem*", making a total of 102 burials (Online Resource 2. Database, Table 3, Table 1).

The graves are those characteristics of LBK burial practices: generally oval, dug directly in the ground, where the bodies were inhumed individually, generally crouched on the left side (70% of the cases) (Podborský 2002). The grave goods at Vedrovice generally consist of ornaments (*Spondylus* beads, pendants and medallions, snails, as well as marble beads and animal teeth), PBAs, flint blades and fragments, pottery vessels, pebbles possibly used as utensils, bone tools, antler items, ochre blocks, ochre powder, as well as a group of objects generally referred to as "grinding tools", whose precise usage is yet to be determined.

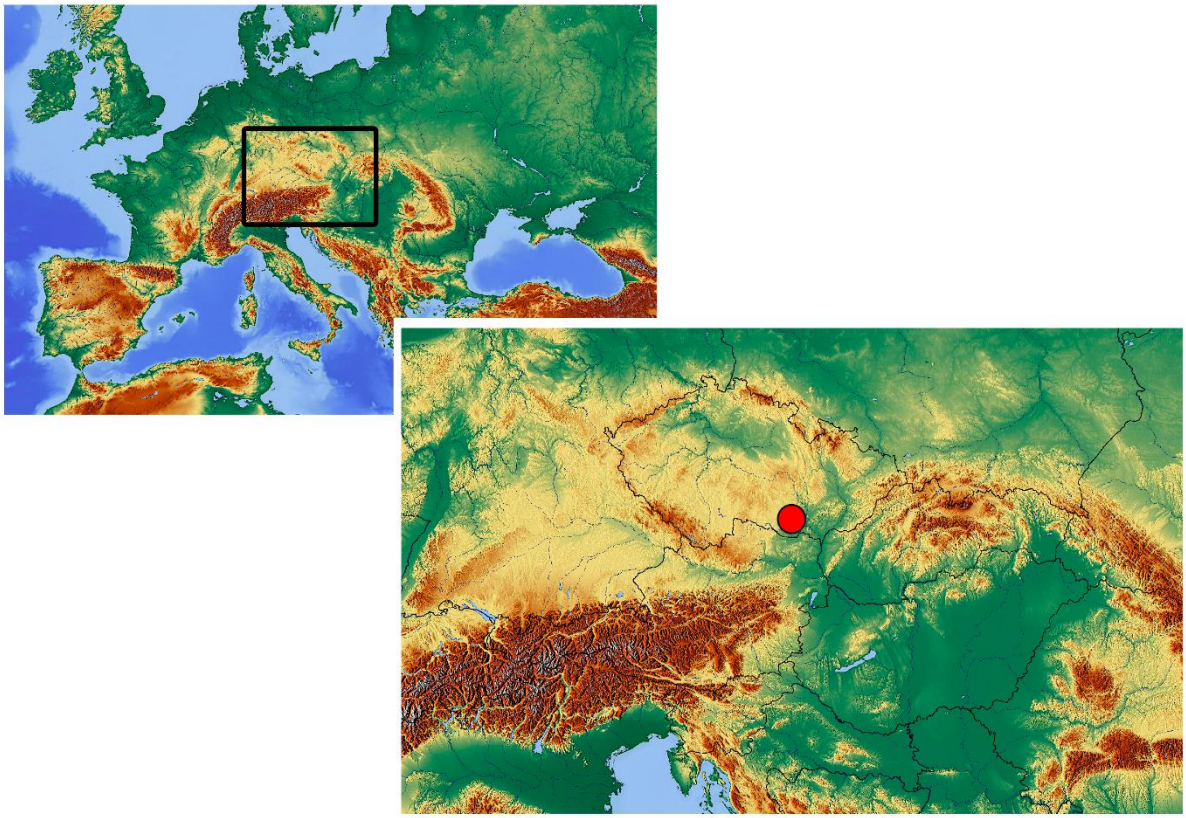

Figure 1. Location of the Vedrovice site in its regional and European context.

A set of 42 radiocarbon dates from 35 burials have recently been published and discussed (Griffiths 2013, Pettitt and Hedges 2008). Thus, 34.3% of the total of Vedrovice burials have now been dated, all of which are located in the "*Široká u Lesa*" sector (41.6% of which is dated). It is therefore currently not possible to ascertain the precise chronological relationship between the three major sectors of the site on the basis of C14 dates, nor the internal chronology of all the sectors. Therefore, this paper

will relate exclusively to the archaeological record of the only chronologically reliable sector: "*Široká u Lesa*".

In order to determine any chronological discontinuities within the "*Široká u Lesa*" occupation as well as an accurate duration of burial, a "Contiguous Phases" Bayesian Model was used (Bronk Ramsey 2009; Lee and Bronk Ramsey 2012). The results suggest that there were no temporal discontinuities within the site (Amodel index: 129.1) and that the occupation span was about 13-188 years (95.4% probable), beginning between 5315-5224 cal BC and ending between 5215-5110 cal BC (2 σ) (see raw C14 data and statistical modelling details in "Online Resource 1. Chronology"). What makes these results remarkable is the fact that the site offers an opportunity to explore the funerary practices of a very short and specific period, spanning across 1 to 7 generations at most.

In order to obtain an accurate overview of the age and sex ranges of the individuals buried at *"Široká u Lesa"*, anthropological data retrieved from Lillie's (2008) study was rearranged according to the age classification criteria proposed by White et al (2011) and Schaefer et al (2009) (Table 1, Figure 2). On the basis of the contextual information found in Podborský (2002), we decided to remove 12 burials from the database (Online Resource 2. Database, Table 3) due to preservation problems, keeping a total 86 individuals distributed in 84 graves to be studied. Only in two cases could a double burial be identified, corresponding in both cases to a young female skeleton buried with a perinatal baby (burials 81/79 and 93/80).

SEX/AGE	Female	Non-adult /unsexed	Male	Total
Perinatal	0	2	0	2
Non-adult 1	0	3	0	3
Non-adult 2	0	12	0	12
Juvenile	3	4	1	8
Young adult	12	1	11	24
Adult	5	2	2	9
Mature adult	14	0	5	19
Senile	7	0	2	9
Total	41	24	21	86

Table 1: Age and sex ranges of the individuals buried at "*Široká u Lesa*": Perinatal (birth - 3 months), Non-adult 1 (up to 3 years), Non-adult 2 (3-12 years), Juvenile (12-20 years), Young adult (20-35 years), Mature adult (35-50 years), Senile (50+ years).

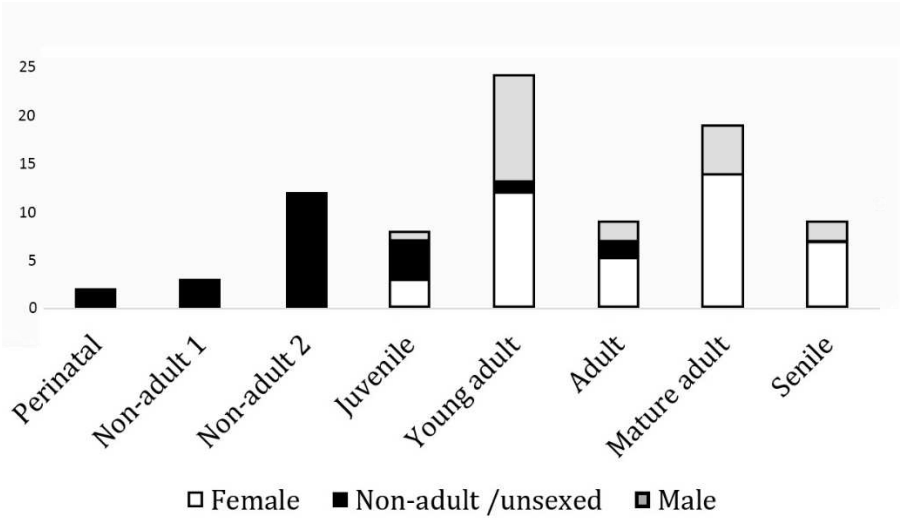

Figure 2. Graph displaying the age and sex ranges of the individuals buried at "Široká u Lesa".

Two significant topics arise from the observation of the age and sex patterns (see Table 1). In the first place, considering that the infant mortality rate in Prehistory is about 40-50% (Rinne 2001) the low percentage of non-adults at Vedrovice (around 24%) indicates a clear under-representation of this age group (Lillie 2008).The second and most striking feature of the demography is the lower number of mature adults and senile male individuals in comparison to females of the same age (Table 1). These exceptional numbers could be explained either by the fact that only a small proportion of the community's males lived a settled life or by the presence of differential access to certain funerary practices defined by sex. Female migration has also been considered as a factor explaining the higher proportion of females to males (Chamberlain 2006). Mobility is indeed a key topic to understand the LBK lifeways and is further discussed later in this paper through the analysis of strontium isotope data (*vide infra*). However, resolving the question as to who was moving and why, should include a thorough review of the sex rates among all the contemporaneous sites in the region.

As the plan (Figure 3) illustrates, age and sex appear to influence where in the cemetery an individual was buried. While female burials are distributed across the whole area of the cemetery, the male appeared to fall within a more restricted pattern. The male skeletons distribution is quite compact, along a continuous straight axis from the south-west to the east of the cemetery. They are found isolated, in clusters (between 2-3 graves) and, more rarely, close to females. Non-adult individuals are mainly situated to the right of the male axis, close to one another and/or to female burials (Figure 3). Female skeletons are found both isolated and in clusters, occasionally close to men and non-adult individuals. Furthermore, mature adult females tend to be distributed at the centre/ south of the cemetery, while senile, young adult and juvenile females were buried along the borders, suggesting that not only sex, but also age, were influencing choices relating to female burial.

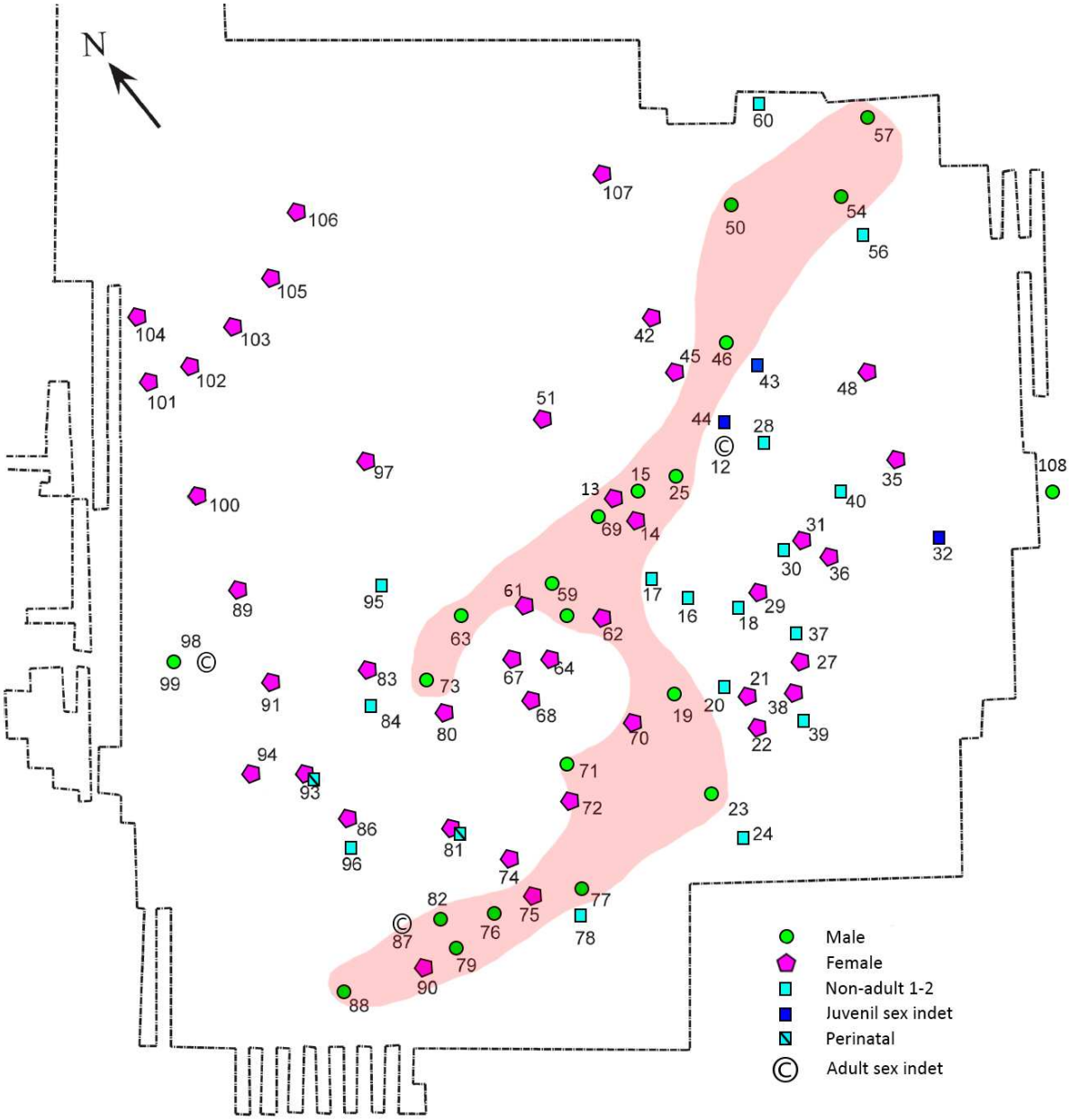

Figure 3. Vedrovice cemetery plan illustrating the spatial organisation of male, female and non-adult burials. The plan is a revised version based on Podborský (2002: 16) and Lillie's (2008) sexual determination. Graves not reliably attributed to the LBK horizon have been disregarded.

5. Use-wear and technological analysis results

5.1. Sampling

Eighty-seven lithic tools were selected for use-wear analysis, which included all the stone tools documented as grave goods at the site. Of that assemblage, 7 tools were absent from the museum at the time the study was performed: 69/78 (13152), 46/77 (13099), 19/75 (13026, 13027 and 13028), 10/89 (13319), 79/79 (13188) and 8/88 (13279). Ten stone tools were excluded from the sample because it was impossible to ascertain their association with the buried individual: burials 80/79

(13191), 91/80 (13224, 13225 and 13226), 73/79 (13169), 86/80 (13213), 65/78 (13138), burial 108/84 (13247), and burial 12/74 (13003).

This reduced the sample size to 68 stone artefacts, all from the "*Široká u Lesa*" cemetery. The results and contextual details can be found in Online Resource 2. Database, Table 1. Of the total 68 analysed tools, 47 were flaked artefacts, 39 of which were interpreted as projectiles, 18 items were PBAs and 2 were pebbles.

As a result of the schistose nature of the PBA raw materials, the preservation of the active surface was generally good enough to make an approximation of what materials the tools were used on, though identifying specific activities and particularities of the worked materials presented a greater challenge. The flaked artefacts' surfaces preservation was very good, without significant postdepositional alterations that could prevent our analysis.

5.2. The flaked non-projectiles

The non-projectile flaked items are found in 7 burials containing 1 (14/75, 15/75, 43/77, 62/78, 66/78, 76/79) and 2 (79/79) items (Figure 4). The prevalence of this tool type is therefore rather low, present in 6.8% of the total of the Vedrovice graves, and 8.3% of the "*Široká u Lesa*" sector. They can be found in burials belonging to 5 men between 14 and 40 years old and 2 women between 30 and 45 years old. In the two female burials, the flaked item was placed in the upper-right area of the grave, whereas no such patterning could be determined for the male graves. A similar difference could also be seen in the raw materials. While local Krumlovský Les II (KL II) chert was found in both male and female graves, imported Krakow Jurassic silicate was only associated with male burials (according to Mateiciucová's 2008 determination).

The main types of flaked flint artefacts are blades (6 items) (Figure 4, Table 2), which are predominantly associated to male individuals. Some differences have been found between male and female tools measurements although the sample is too small to suggest any generalisable pattern. Still, the observed differences between the male and female measures are thought-provoking and it would thus be interesting to contrast these with the results of a larger scale study.

Burial	Code	Sex	Age	Description	Specific raw materials	Length	Width	Category
14/75	13007	F	35-45	Fragment	KL II chert	33	13	Indeterminable
15/75	13016	M	35-40	Blade fg	Krakow Jurassic silicate	33	1	Not used
43/77	13077	M	14	Blade fg	KL I chert	52	17	Used tool
62/78	13135	F	30-40	Blade fg	KL II chert	24	12	Used tool
66/78	13142	M	30-35	Blade	Krakow Jurassic silicate	59	13	Not used
76/79	13173	M	30-35	Blade	KL I chert	46	17	Used tool
79/79	13180	M	25-35	Blade fg	Indeterminable	36	15	Used tool
79/79	13034	M	25-35	Fragment	Indeterminable	30	16	Not used

Table 2: The non-projectile flaked tools and their contextual, technological, metric and functional characteristics. Abbreviations: FG= fragment.

The use-wear analysis determined that in 3 cases, the item was not used, while in 4 (3 males, 1 female), use could be confirmed, though only in two cases could the specific activity be ascertained: male burials 43/77 (object 13077) (Figure 4.A) and 79/79 (object 13180) (Figure 4.G). These items demonstrated evidence of transversal movement against hard animal matter. Both tools have a length greater than 35 mm. Again, it is not possible to define patterns based on the available sample.

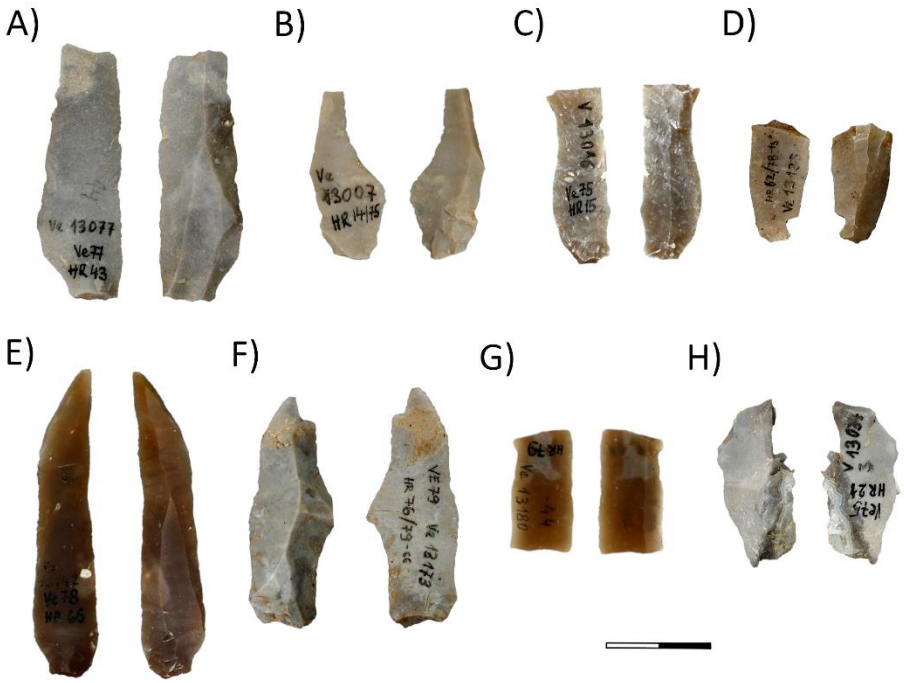

Figure 4: Flaked flint tools from Vedrovice. A) Burial 43/77 (tool 13077), B) Burial 14/75 (tool 13007), C) 15/75 (tool 13016), D) Burial 62/78 (tool 13135), E) Burial 66/78 (tool 13142), F) Burial 76/79 (tool 13173), G) Burial 79/97 (tool 13180), H) Burial 79/97 (tool 13034).

5.3. The projectiles

The remainder of the flaked flint tools correspond to the so-called trapezes or projectile points. A total of 35 projectiles and 4 items likely to have been projectiles were found in 8 burials: 1 item in burials 37/76, 54/78 and 66/78, 2 items in 59/78, 5 items in 79/79, 7 items in 57/78, 8 items in 39/76 and 14 items in 46/77 (Figure 5). All the projectiles are concentrated in the "*Široká u Lesa"* sector, in 7.8 % of the total Vedrovice graves, and 8.3 % of the "*Široká u Lesa*" sector. Mateiciucová (2008) determined that the majority of these projectiles were made of exogenous raw materials, mostly Krakow Jurassic silicate.

In 7 cases, the trapezes accompanied a male individual, while in one case, a 5-year-old (39/76) received this item. When multiple trapezes were found in one grave, they were placed closely together in all cases but one: burial (46/77), where there are two assemblages of 7 and 8 items (Figure 5.C and D). In some cases, the assemblages present similar colour and texture characteristics (Figure 5.C, D and E), suggesting that the same or very similar source cores were used. In 4 cases, the tools were

placed in the left and right medial zone of the grave, while in one case, these were located in the upper left part, and in 3 cases - in the lower left, demonstrating a general preference for the left side of the grave.

There is a clear preference for fragments of blades, either retouched (15 items) or not (11 items), while flake fragments (10 items) and indeterminate fragments (3 items) are less abundant. The sample is quite homogeneous in size, both in terms of the whole projectile assemblage and each burial. Lengths vary from 8 to 20 mm, though there is a concentration between 12 and 13 mm. The width varies from 9 to 23 mm, with the majority of tools falling between 13 and 15 mm. Again, the raw material from which the projectiles were made was identified by Mateiciucová (2008) as either Krakow Jurassic silicate or KL II chert.

Gibaja and Palomo (2004: 91) identified four different traces that could be considered as evidence of use in the case of trapezes used as projectiles: fractures derived from impact, striation derived from impact, micro-chipping derived from impact and micro-polishes derived from contact with hard materials, possibly bone of the aimed target, not to mention the evidence for hafting. Being aware of the concerns about distinguishing production and use wear features (Rots and Plisson 2014), the microscopic observation of Vedrovice projectiles did not offer any evidence of use. On this basis, we consider that either those tools may have been made specifically with the intention of being deposited as grave goods or there was a specific selection of daily items in a very good state of preservation.

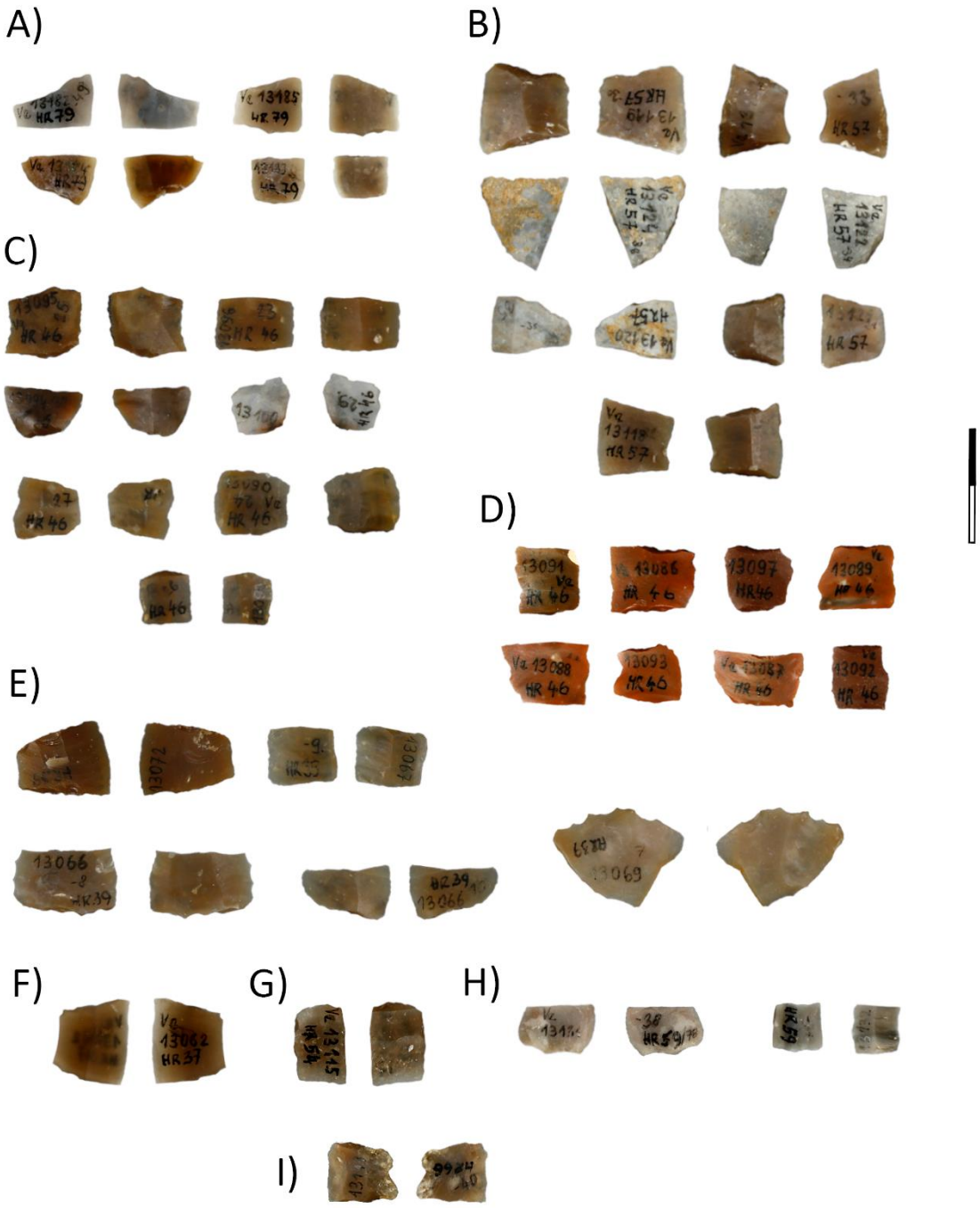

Figure 5: Projectiles from Vedrovice. A) Burial 79 (tools 13182-185); B) Burial 57 (tools 13118-124), C) Burial 46/77 (tools 13094-98 and 13100); D) Burial 46/77 (tools 13086-93); E) Burial 39/76 (tools 13065-68 and 13072); F) Burial 37/76 (tool 13062); G) Burial 54/78 (tool 13115), H) Burial 59/78 (tools 13131-32), I) Burial 66/78 (tool 813143). The technical drawings of the arrowheads can be consulted at Mateiciucova 2008: 321-326.

In summary, a certain degree of morphometrical and technical standardisation has been identified among the projectiles. Those tools were made specifically for the purpose of being deposited as grave

goods, and, given their shared raw material characteristics, it is very plausible that they had been made soon before being buried.

5.4. The polished and bevelled artefacts

Eighteen PBAs were distributed among 17 graves (Table 3) and are present in 20.9% of the burials in "*Široká u Lesa*". Therteen PBAs were associated with male adult individuals between 20 and 50 years old, 1 with an unsexed adult and 1 with a woman (grave 31/76). Three children were buried with a PBA: two individuals between 12-14 years old and one 6-year-old. Significantly, the PBAs found in the three non-adult and female graves are distinctly different from those buried with male adults, in terms of dimensions, shape and uses (*vide infra*). Tool 13057 (burial 36/76) (Table 3), a proximal and medial part of a PBA which was re-used as a hide scraper, has been treated separately from the rest, as it cannot be considered a PBA but rather a repurposed tool.

Burial	Code	Sex	Age	Section	HBI	Width	Thickness	Weight	Weight CL
12/74	13002	IND	adult	Triangular	65.57	36.6	24	172	3
15/75	13015	M	35-40	"u" section	88.07	35.2	31	554	1
18/75	13021	INF	6-7	Flat-convex	32.50	40	13	70	4
19/75	13025	M	25-35	Flat-cylindrical	80.54	37	29.8	313	2
30/76	13044	INF	10-12	Flat-cylindrical	62.50	17.6	11	34	4
31/76	13047	F	adult	Flat-convex	24.78	46	11.4	70	4
32/76	13048	INF	12-14	Triangular	126.67	15	19	63	4
36/76	13057	F	45-50	Oval	36.73	49	18	104	x
46/77	13085	M	20-35	Triangular	73.89	40.6	30	321	2
54/78	13114	M	20-25	"u" section	82.22	36	29.6	393	2
57/78	13125	M	40-50	"u" section	137.20	25	34.3	293	2
57/78	13126	M	40-50	"u" section	125.10	24.3	30.4	191	3
59/78	13130	M	25-35	Flat-cylindrical	75.97	38.7	29.4	341	2
69/78	13146	M	20-30	Flat-cylindrical	53.58	40.5	21.7	278	2
71/79	13163	M	35-45	Triangular	70.33	36.4	25.6	183	3
76/79	13171	M	30-35	Triangular	88.67	30	26.6	224	3
77/79	13175	M	40-50	Triangular	80.56	36	29	318	2
79/79	13190	M	25-35	Flat-cylindrical	61.35	37	22.7	300	2
88/80	13214	M	20-30	"u" section	122.95	24.4	30	242	3

Table 3: PBAs and tool 13057 (burial 36/76) contextual, technological, metric and morphological characteristics. Abbreviations: CL= cluster, HBI= height-breadth-index. *Vide* Online Resource 3 for PBA macroscopic images.

The raw material characteristics are quite homogeneous. All the artefacts are made of metamorphic rocks, particularly amphibolite, displaying a planar structure, generally oriented parallel to the vertical axis of the artefacts. This similarity of raw material qualities indicates intentionality and uniformity in the selection and conformation of the blanks in relation to the expected mechanical and aesthetic attributes of the tools. Furthermore, PBAs have very homogeneous technological features, all being whole, completely polished artefacts with a general absence of fresh pecking and proximal area extractions, as well as displaying generally very finely polished finishes. All the amphibolite adzes exhibited evidence of the negatives of roughout flaking. Subsequently, it can thus be assumed that flaking was performed to shape the raw material into blanks, prior to the final polishing of the surface.

The macroscopic observation of the hafted surfaces found 8 artefacts with evidence of transversal striation (multiple or isolated) perpendicular to the vertical axis of the tools as well as random striation along the medial and proximal parts. In some cases, a dark shiny band of 10 mm in width had developed along the medial area, in addition to intense rounding, dark colouring and/or smooth polishing of the heel (see Online resource 3 figures for more detail). Isolated fresh pecking in the medial area was also identified. These data suggest that the hafting techniques were also homogenous.

In 13 cases, the PBAs demonstrated clear use-wear traces. In 2 cases, it was difficult to determine whether the tools were used or not, and in further 2 cases, there was no evidence of use (Table 4). In 2 cases, (tools 13125-6 from burial 57/78), the PBAs had intentionally been broken in two halves after use.

Burial	Sex	Age	Category	General WM	WM gen charact.	Specific activity	Kinematics
12/74	IND	adult	Repaired	ind	hard		direct percussion
15/75	M	35-40	Used tool	wood	medium hard	wood	direct percussion
18/75	INF	6-7	Used tool	animal	abrasive elastic	hide	scrape
19/75	M	25-35	Used tool	animal	hard, soft	meat + bone	Direct percussion
30/76	INF	10-12	Not used	x	x	toy?	x
31/76	F	adult	Used/ not used	animal?	soft?	?	ind
32/76	INF	12-14	Not used	x	x	toy?	x
36/76	F	45-50	Reutilised	animal	soft, flexible	hide	scrape
46/77	M	20-35	Used tool	animal	hard, soft	meat + bone	direct percussion
54/78	M	20-25	Used tool	animal	hard, soft	meat + bone	direct percussion
57/78	M	40-50	Used tool	ind	hard	x	percussion

57/78	M	40-50	Used tool	animal	hard	bone	percussion
59/78	M	25-35	Used tool	animal	hard, soft	meat + bone	direct percussion
69/78	M	20-30	Used tool	animal	hard, soft	meat + bone	direct percussion
71/79	M	35-45	Used tool	animal	soft	meat?	direct percussion
76/79	M	30-35	Used tool	wood?	Hard, flexible	x	direct percussion
77/79	M	40-50	Used tool	animal	hard, soft	meat + bone	direct percussion
79/79	M	25-35	Used/not used	x	soft	x	x
88/80	M	20-30	Used tool	wood?	medium hard	x	direct percussion

Table 4: PBAs and tool 13057 (burial 36/76) use-wear results. Abbreviations: WM= worked material.

In 11 cases, the use-wear traces indicated activities related to the processing of different materials of animal origin. The most abundant was evidence of contact with a combination of hard worked material and a soft and fatty one (8 cases, Figure 6.1). As a result, a slight rounding had developed along most of the tool's edge, with open/semi-open micro-polishes of irregular microtopography on the matrix (Figure 6.D-F), possibly related to contact with fresh meat. Sporadically, there were fresh surfaces (Figure 6.B) and small spots of a shiny compact directional micro-polish (Figure 6.A and C), possibly indicating contact with a hard and moist material such as bone. We interpret these use-wear traces as the result of carrying out direct percussion on fresh meat/bone. More experimentation is needed in order to determine the exact butchery activity observed.

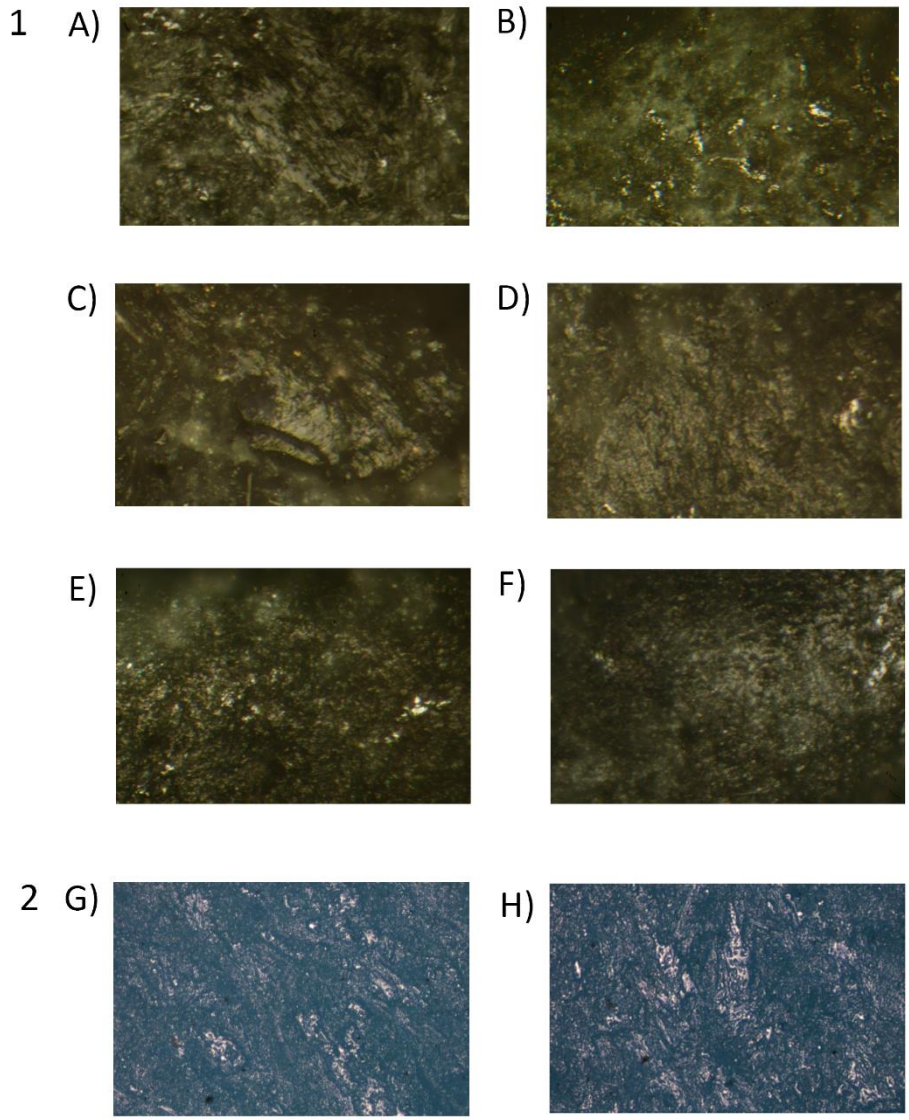

Figure 6: 1. Bone/meat use-wear evidence. A) Shiny compact directional micro-polish, Tool 13025 (grave 19/75), B) Fresh surface, Tool 13085 (grave 46/77), C) Shiny compact micro-polish and fresh chip, 13025, 200x D) Semi-open micro-polishes of irregular microtopography, 13085, 200x, E) Slight rounding and open/semi-open micro-polishes of irregular microtopography, 13025, 200x, F) *Idem* preceding illustration, 13025, 200x, 2. Evidence of woodworking G-H) Micro-polish of undulating micro-topography, Grave 15/75 (400x).

Two hide-working tools were also identified. Tool 13057 from Burial 36/76 is a flat proximal fragment of a PBA displaying significant evidence of having been scraped against a flexible, soft and not very abrasive animal material (Figure 7.A). On face A, ochre residues were concentrated over a smooth active surface, where a greasy semi-closed micro-polish with an irregular micro-topography had developed (Figure 7.D-E). On face B, the same deep striation crossing transversally is found on the vertical axis of the tool, with lateral fresh pecking also identified (Figure 7.C). Tool 13021 (grave 18/75) (Figure 7.B) is a flat and very asymmetrical adze which featured a contact face (face A) covered by deep striations that were perpendicular to the edge, u-shaped in cross section (Figure 7.F-G) and located on a very rounded edge, where a directional semi-open/semi-closed micro-polish of irregular

micro-topography had developed (Figure 7B.F-H). This suggests that the tool was used for scraping abrasive, elastic animal matter.

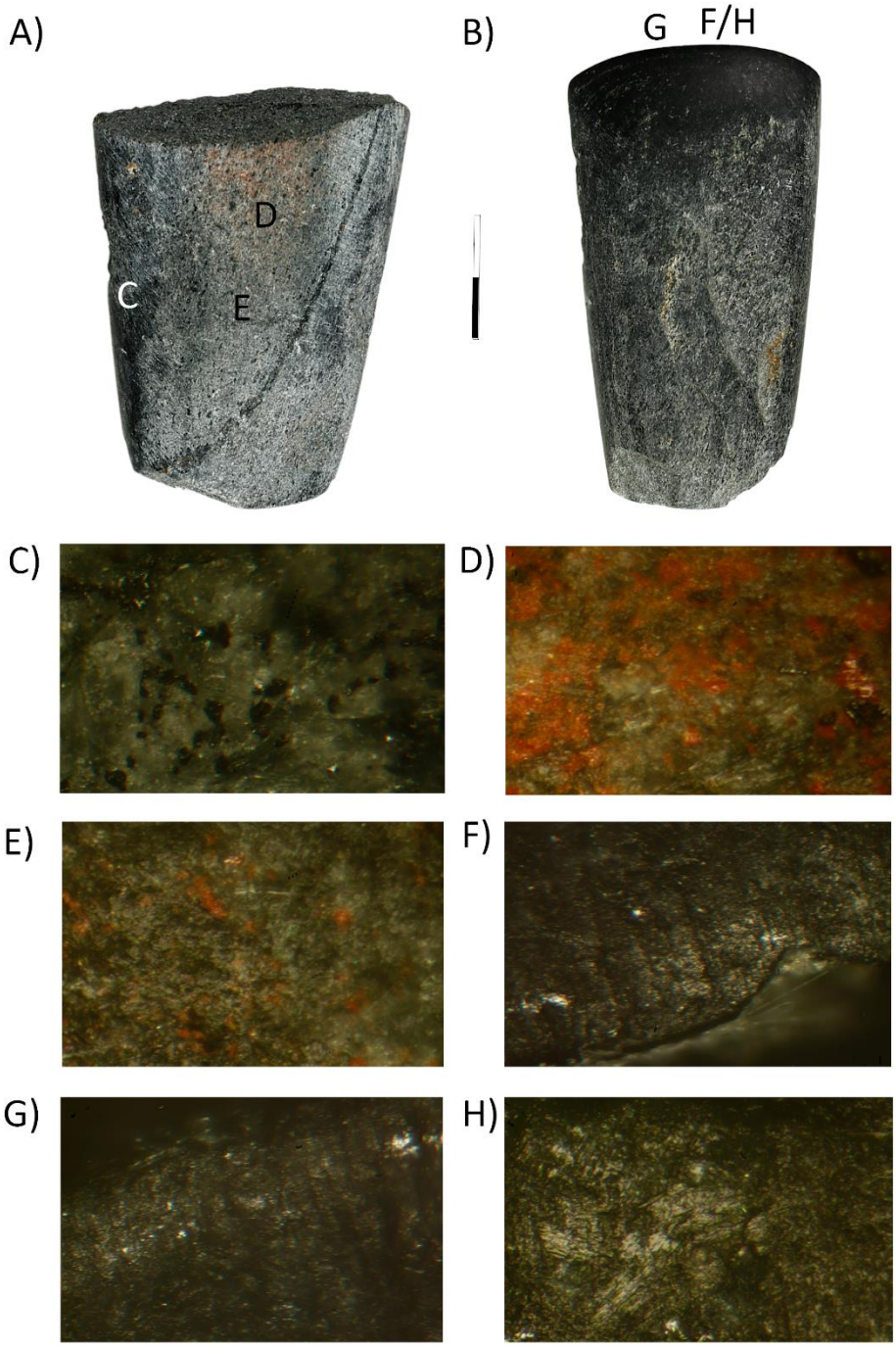

Figure 7: Hide-working evidence. A) Tool 13057, B) Tool 13021, C) Fresh pecking 100x, D) Smooth surface with ochre residues, 200x, E) Smooth surface with a semi-closed micro-polish of irregular micro-topography 200x, F) U-shaped in cross section deep striations perpendicular to the edge on a very rounded edge with directional semi-open/semi-closed micro-polish of irregular micro-topography, 100x, G) *Idem* preceding illustration, 100x, H) Detail of the micro-polish of irregular micro-topography, 200x.

Tool 13047 (grave 31/76), associated with a female-sexed skeleton, displayed shape and technological characteristics that were very similar to those of tool 13021 (a child's grave). Its active area demonstrated slight punctual rounding of the most prominent features of the topography, which could indicate its use on soft matter, though the absence of use has also been considered as an alternative hypothesis.

In three cases, the worked material was found to be wood, although this could only be fully confirmed for tool 13015 (Grave 15/75) (Figure 6.G-H). This last case corresponded to the largest artefact in the assemblage. It displayed evidence of being first used for woodworking, following which the tool was incompletely re-polished. The surfaces on the very edge of the active areas presented shiny open micro-polishes, with a non-diagnostic micro-topography. On face B, at 1 cm from the edge, the traces of the previous use were fully preserved, with isolated, compact and very shiny micro polishes of undulating micro-topography. In this area, the presence of unpolished deep striations is easily observable, together with isolated scratches. Those striations are also visible (though less abundant) on face A. In Tool 13214 (Grave 88/80), the active area displayed deep striations perpendicular to the edge and u-shaped in cross section, though these striations were more extensively developed on face B, where the micro-polish, too, was more closed and shinier, presenting an undulating tendency. In tool 13171 (grave 76/79), the same micro-polish pattern was observed, even though no striations were documented.

The PBAs from burials 30/76 and 32/76 (non-adult individuals) did not present evidence of use on their active surfaces, though one of them displayed clear traces of hafting. Furthermore, the technological and morphological characteristics of the PBAs indicated that they were very similar to the tools found in the male graves, but of much smaller dimensions. The absence of use-wear suggests that, like projectiles, unused PBAs had been specifically produced for deposition as grave goods for 12-14-year-olds. An alternative and more plausible hypothesis, given the presence of hafting traces on the medial area of tool 13048, would be that they were toys that were re-polished before their final deposition in the grave. This last hypothesis arguing for a close relationship between play and learning in the LBK context has already been addressed by Siemoneit (1997: 78) not only involving polished adzes, but other items such as small vessels or figurines.

These use-wear results correspond to the last use of the PBAs prior to being deposited as grave goods, which does not necessarily reflect the daily uses of those tools. Bearing this in mind, we note the great uniformity of uses found in men's graves, contrary to the more varied characteristics of PBAs found in the burials of children (not used, used to process hide) and females (re-used as hide-processing tools).

The shapes and measurements of the PBAs were assessed for correlation between use and the age and sex of the individuals with whom they were buried. Following the stone adze typologies proposed by Ramminger (2007, 2009), (Figure 8), the Vedrovice PBAs were classified into 4 types, by combining the total width values with the height-breadth-index (HBI), which is calculated as (thickness/width) *100.

It is noteworthy that the only PBAs belonging to Ramminger's *(Ibid*) Type 1 are those found with the two 12-14-year olds (30/76 and 32/76). The functional analysis of these artefacts suggested they were the only ones that had clearly not been used. Type 1 blades are characterised by a width of less than 20 mm and an HBI greater than 50. Their sections (triangular and flat-cylindrical) resemble those of

Types 3 and 4, found exclusively in association with male individuals. Type 1 also has the smallest weight of the sample (between 34 and 63g). The tools from burials 36/76, 31/76 (adult females), and 18/75, a 6-year-old of undetermined sex, belong to Type 2. This type consists of flat blades with a width of more than two times the height, with widths between 40 and 50 mm, lengths between 66 and 74 mm, weighing between 70 and 104 g. Not only were these tools morphologically and metrically homogeneous, they were also the only ones in the assemblage whose use-wear traces indicate that they are likely to have been used for scraping hide (*vide supra*) or to work very greasy, soft animal materials.

The majority of the artefacts were classified as Type 3, medium-high blades with an HBI between 50 and 100 and absolute widths between 35 and 50 mm (76/79, 15/75, 54/78, 77/79, 19/75, 59/78, 46/77, 71/79, 12/74, 79/79, 69/78). Found with adult men and one adult of undetermined sex, they present triangular, flat-cylindrical and "U"-shaped sections, weigh between 172-554 g, and are between 92-156 mm long. Finally, Type 4 brings together exclusively those PBAs with "U"-shaped sections and medium-large weights (191-293 g) and lengths (134-187 mm): the two intentionally broken PBAs from burial 57/78 (one of undetermined use and the other related to meat/bone) and a woodworking tool from burial 88/80.

PBAs used to chop meat/bone by direct percussion, presented HBI values between 53 and 125 and absolute widths between 25 and 40 mm. Woodworking tools were very similar, with HBI values between 88 and 125. These data agree with the Hierarchical Cluster analysis (Paired group Algorithm, distance 200) based on the weight values of the PBAs (Table 3), which distinguishes 4 weight clusters. Weight clusters 1-3 correspond to the heavier tools (554-172 g), recovered from male graves, while weight cluster 4 represents the lighter tools (10-34 g), found only with female individuals and infants.

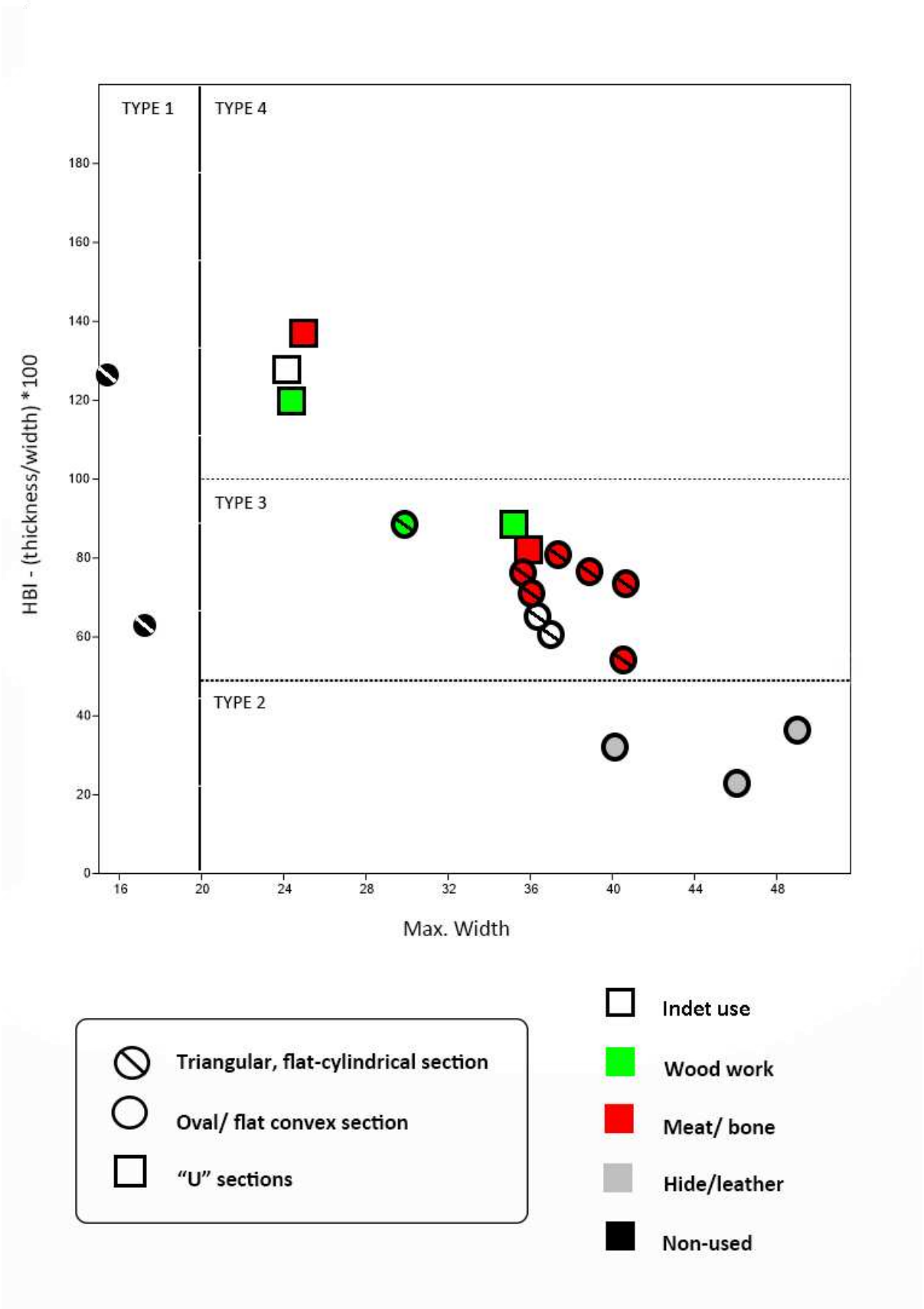

Figure 8: Bivariate plot comparing Vedrovice adzes HBI and total width typology according to Ramminger (2007, 2009) classification. Squares corresponds to "U" -shaped sections, crossed dots to

triangular and flat-cylindrical sections and ovoids to flat-convex and oval. Colour green corresponds to woodworking, white to indeterminate use, grey to hide work and red to butchering or meat-related activities. Types 1-4 corresponding to Ramminger's PBA classification (2007, 2009).

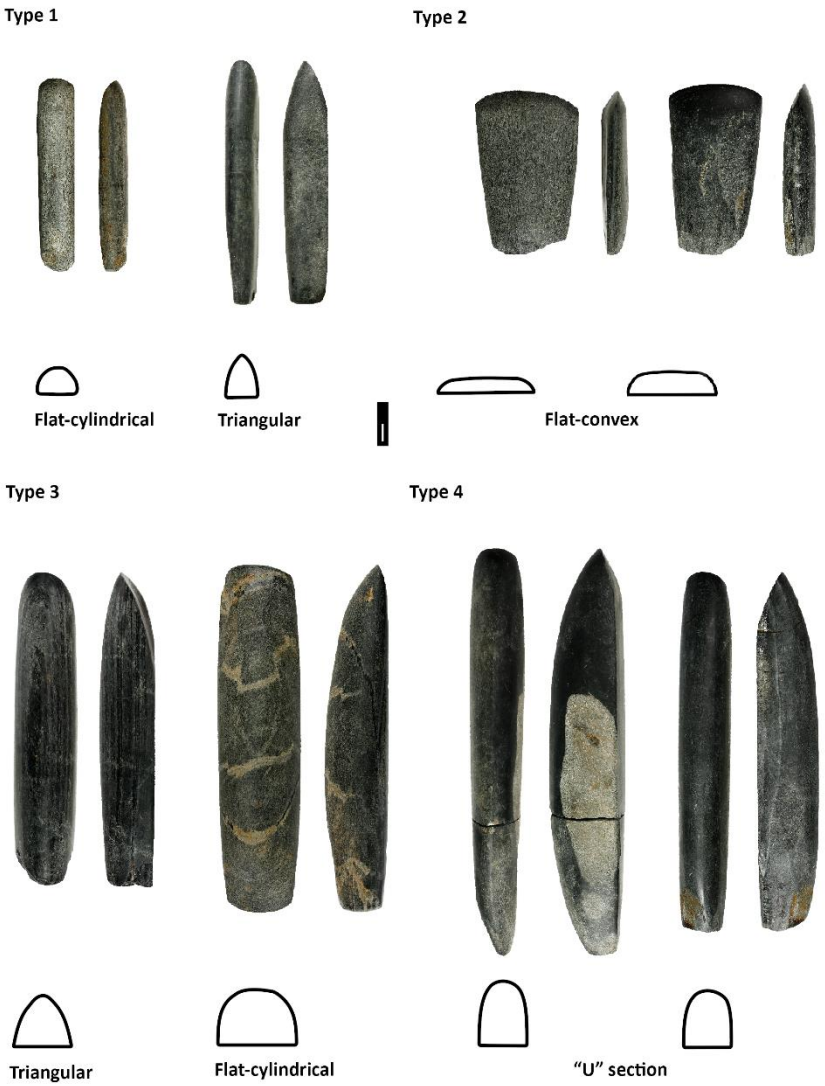

Figure 9. Polished and bevelled artefact types and sections examples. Types 1-4 corresponding to Ramminger's PBA classification (2007, 2009).

5.5. Pebbles

At Vedrovice, two pebbles were identified in female burials: tools 13243 (a senile female from grave 104/81) and 13216 (an adult female from grave 90/80). The first one, a quartzite pebble of 204 g and 81x28.9x52.8 mm, presents evidence of having been used for pecking a semi-hard non-fatty material (Figure 10.A.A-D). In the other case, which was a quartz pebble of 185g, 61x32x62 mm, two different use zones were identified. On the inner zone, a directional micro-polish of semi-closed network and irregular microtopography had developed, demonstrating that the tool was used to soften leather/hide using mineral particles as an abrasive (probably ochre) (Figure 10.B.A-C). On the lateral

sides, fresh pecking resulting from direct percussion against mineral matter can be observed along with a significant number of ochre residues filling the micro-holes (Figure 10.D).

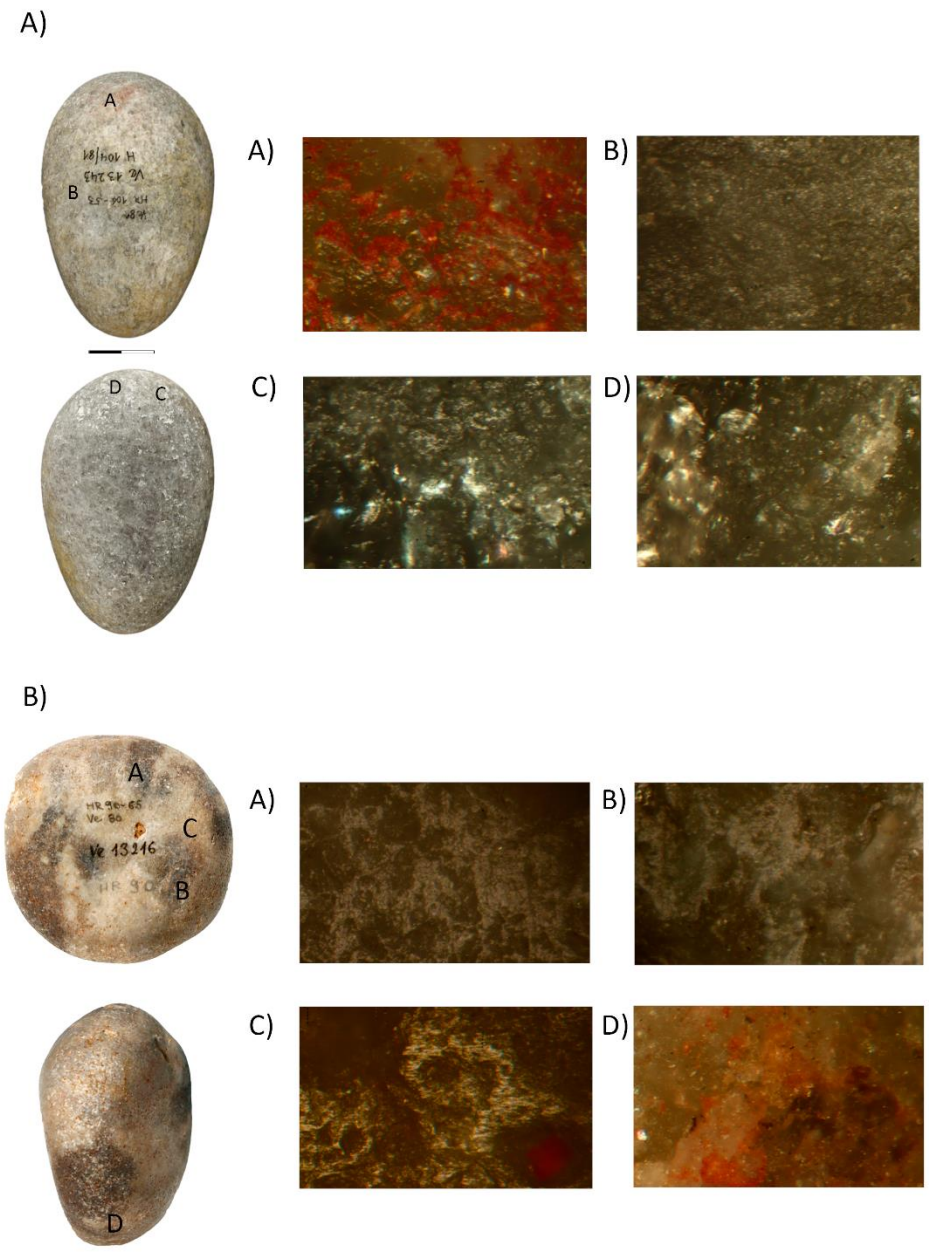

Figure 10: A. Tool 13216. A) Ochre residues 100x, B) Indeterminate superficial micro-polish 100x, C) Fresh pecking, 100x, D) Fresh pecking, 100x. B. Tool 13216. A) directional micro-polish of semi-closed network and irregular microtopography, 200x, B) *Idem* preceding illustration, 200x, C) *Idem* preceding illustration, 100x, D) Fresh pecking, 100x.

5.6. Use-wear summary

To sum up we conclude that there is a distinction on the basis of sex not only within tool types found in graves and how they are placed there, but also regarding to their uses. For the first time we have

been able to suggest that grave goods were not only tools from someone's life, but some of them were made specifically for the grave (in the case of projectiles), perhaps giving an indication more of funerary ritual than of everyday life.

Tools such as PBA, often considered as votive, have been demonstrated to be fully functional and quite used. Furthermore, the uses of those artefacts have proven to be the result of very similar, almost patterned, activity processes, indicating a strong relationship between the male burials and the processing of wood and possible butchering. Finally, those tools associated with women have proven to be used in activities absent among the male record, contributing to reach a new dimension concerning the division of tasks among sexes.

6. Bioarchaeological data analysis and interpretation

6.1. Strontium isotope as mobility indicators

Strontium isotopes ($^{87}Sr/^{86}Sr$) from human and animal teeth and bones are a widespread method used to determine geographic origin and mobility patterns (Montgomery et al 2000, Bentley et al. 2002, ibid 2004). Sr isotopic signatures make their way from local geological materials into the mineral composition of the human skeleton through the diet and local water sources. Typically, values obtained from the teeth of each individual are compared with a 'local' range, defined as within two standard deviations from the average $^{87}Sr/^{86}Sr$ in human bones recorded on the site (Price et al 2002). Following this definition, 'locals' may include people who moved between similar geochemical provinces, whereas 'non-locals' may include those individuals whose diet catchment extended beyond the local area (Bentley et al 2003).

Given that possible post-burial contamination may narrow the local range in a misleading way by reducing the variation in the archaeological human bone $^{87}Sr/^{86}Sr$ values (Horn and Müller-Sohnius 1999), local ranges are often further characterised (Beard and Johnson 2000, Price et al 2002). Geological maps have been used to develop baseline models predicting superficial strontium variations ("isoscapes"), as strontium ratios vary predictably between different geological provinces, based on their age and composition (Bataille et al 2018). Good results have also been achieved by using small mammals or domestic animals to contrast a probable local strontium signature with the values of potentially mobile humans (Gustin et al 2018), provided that the animals lived locally, which was not always the case (see Knipper 2011). The absence of "isoscape" models and of animal sampling from Vedrovice and its surroundings is currently making it impossible to use this approach, and the Sr data results have thus been taken with caution.

The Sr data obtained from Vedrovice has been revised and subjected to new statistical analyses in order to distinguish possible correlations between different origins and the different characteristics of the burials, such as sex, age, spatial distribution and grave goods. 29 females, 17 males, 4 juveniles of undetermined sex and 9 infants from "*Široká u lesa*" have been analysed as part of other projects (Whittle et al 2013, Richards et al 2008; Table 1). The sample size is thus large enough for analysis.

The $^{87}Sr/^{86}Sr$ mean ratio for all burials is 0.7109407, while the SD is ± 0.00010575, with a range from 0.70835 to 0.712627. Even if there is no statistical relevant difference between the sex groups present in the sample (=0.25427, Kolmogorov-Smirnov test), the females' (F) isotopic mean value was indeed

lower than the males' (M) (F=0.7108096, M=0.7109477), as well as presenting larger variance (F=9.99972E-07, M=6.083345E-07). On this basis, both Richards et al (2008) and Whittle et al (2013) proposed that there was greater female than male mobility among the individuals buried at *"Široká u Lesa"*.

Here, we define 4 clusters of $^{87}Sr/^{86}Sr$ ratios by means of a Hierarchical Cluster Analysis (Paired group Algorithm, distance 0.001): SrCL1, consisting of a male (99/81) and a female (29/76) (isotopic values 0.70849-0.70835); SrCL2, formed of 10 females and 1 male (79/79) (isotopic values 0.70944-0.710407), including female 51/77 and male 79/79, both presenting evidence of having spent the last 10-20 years of their lives in coastal regions (on the basis on their sulphur isotope ratios; Zvelebil and Pettitt 2008); SrCL3, formed of 3 mature adult women (isotopic values 0.70126-0.70122) and SrCL4, including 15 males, 15 females and 13 infants/juveniles of indeterminate sex (isotopic values 0.71067-0.711529) (see further details in Online Resource 2. Database, Table 1). We are aware of the low numbers in these clusters. However, the significant differences between their medians (=1.12E-07, Kruskal-Wallis Test) (Figure 11.A) together with the relevance of the strontium differentiation within the female sample, convinced us of the appropriateness of including the mentioned clusters in further analysis.The cluster that provides isotopic values which are the closest to the site mean is "SrCL4", which, given the lack of more accurate systems of reducing post-burial contamination errors (*vide supra*), is probably the "local" group. This group also included all the non-adult individuals, whose profile was more likely to represent a non-mobile mode of life, even if this cannot be considered as a general rule in LBK contexts (see Nehlich et al 2009). The individuals belonging to the "local" SrCL4 cluster are distributed across the whole cemetery (see Online Resource 2. Database, Figure 1). The remaining Sr clusters, consisting mainly of women, are situated principally in the south-east, although not exclusively.

It has also been suggested that a relationship between sex and strontium ratio variance depending on age was noticeable (Whittle et al 2013). A statistically significant difference is observed between females' M1/2 and M3 isotopic data (=0.018, T Test), while no such difference was identified among men, whose isotopic ratios remain stable across all age groups. Females had greater variability in their second molar (M2, mineralised between 12-13) Sr ratios than males, but this was not the case with the third molar (M3, mineralised between 17-21 years). This could mean that while men found at "*Široká u Lesa"* remained within the same area all their lives, women's mobility varied depending on their age, which suggests that they did not settle at their final place of residence until between 14-16 years of age.

To summarise, women presented an increased lifetime mobility, especially when their first and second molars were being formed. Men, with only two exceptions, presented an isotopic signature coherent with a lifetime residential sedentism.

6.2. Diet indicators: nitrogen, carbon and sulphur isotopes

Multiple rib and long bone samples have been studied for dietary isotopes (Nδ15, Cδ13 and Sδ34) confirming an essentially terrestrial diet based on cereals (Smrčka et al 2005, 2008, Richards et al 2008, Whittle et al 2013). These raw data are explored in this section with a view to determining diet patterns of the "*Široká u Lesa*" adult male and female individuals, with a total of 82 sampled individuals - a representative percentage of the buried population.

Carbon (δ13C) isotopic values, considered as reliable indicator of marine foods in European Neolithic diet, suggested the absence of marine and lacustrine resources as well as of the absence significant differences between the sexes. Contrarily, Nδ15 isotopic variance was statistically different between the male and female individuals (=2.0169E-05, T Student Test), which could be an indicator of different rates of protein consumption, with males eating more protein than females as suggested originally by Richards et al (2008). These differential values are supported by the dental microwear analysis. Although Jorasová and Tvrdy (2017) did not find a statistically significant difference between the dental microwear of the two sexes, given that there were twice as many women as men, the absolute percentages clearly indicate that females mainly consumed a mixed and vegetarian diet, while males had a higher rate of meat consumption.

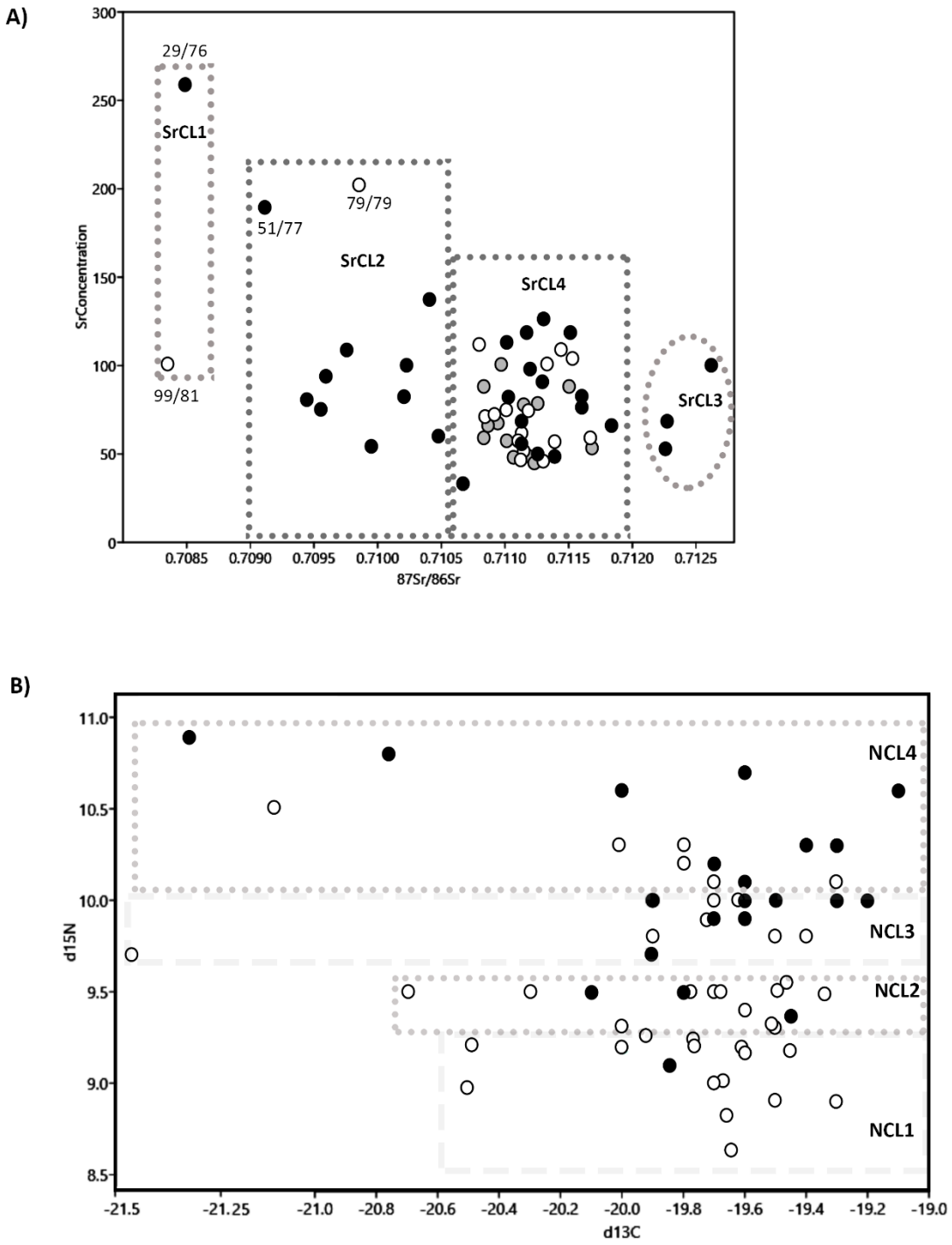

Figure 11. A) XY Biplot including $^{87}Sr/^{86}Sr$ values, $^{87}Sr/^{86}Sr$ concentration and Strontium clusters 1-4. Black dots correspond to females, grey dots to non-adults and white dots to males. B) XY Biplot including including Nδ15, Oδ13 isotope values and Nitrogen clusters 1-4. Black dots correspond to males, white dots to female individuals.

Sulphur isotope data resulting from the analysis carried out by Richards et al (2008) have been used here in combination with Cδ13 values to estimate if some of the higher nitrogen values could be related to freshwater fish consumption, which is an attested cause for the nitrogen values enrichment

(Nehlich et al 2009). At Vedrovice Sδ34 isotopic values range between -3.4 and 4.3 ‰ while Cδ13 values ranged between -20.3 and -18.7 ‰. In both cases the data confirm that the main dietary resource at the site consisted of adult terrestrial domesticated animals and that the amount of freshwater fish in the diet is negligible.

Four groups have been defined based on Nδ15 values by means of a Hierarchical Cluster Analysis (Ward's Method Algorithm, distance 1.5) including only the adult population (Figure 11.B) These nitrogen clusters (NCL) vary depending on the proportion and type of consumed protein. For instance, the ingestion of freshwater fish would also produce a trophic level effect, which results in higher d15N and slightly increased d13C isotropic values (Katzenberg 2008).

NCL1, composed of 15 females and 1 male, displayed the lowest protein values in the assemblage (between 8.6-9.1 ‰). NCL2, formed of 12 females and 3 males (values between 9.3-9.5 ‰), and NCL3, formed of 7 females and 8 males (values between 9.7-10 ‰), show intermediate protein ingestion. Finally, NCL4, composed of 6 females and 9 males (10.1-10.9 ‰) (Figure 11.B) (see further details in Online Resource.2 Database, Table 1) are the group of individuals who displayed the highest Nδ15 levels. A Kruskal-Wallis test was performed to test the statistical significance of these groups, and it confirmed a meaningful difference between the medians of the sampled groups (=8.109E-13).

Female skeletons present evidence of lower protein ingestion than males, most likely to reflect different dietary practices. Significant differences between men and women Nδ15 values were documented in the eastern LBK sites whereas none was found in the west (Hedges et al 2013, Bickle and Whittle 2013) which lends more credibility to the fact that it is a dietary difference, rather than due to biological processes.

This difference is especially significant in NCL1, which is a group of individuals displaying lower protein consumption and that is composed mainly of women distributed randomly across the cemetery. However, what is also noticeable is that the small number of females included in the group of skeletons with high protein rates (NCL4) are distributed inside or very close to the axis running from the south-west to the east of the cemetery, along which local males were buried (see Online Resource 2. Database, Table 1). This reinforces the idea that different dietary groups in life received different treatment after death.

Infant feeding practices are one of the main factors that influence the size and demographic structure of a population, with longer weaning periods generally resulting in larger inter-birth intervals and fewer children born, as well as possibly affecting both infant and mother morbidity and mortality rates (Waters-Rist et al 2011). In the case of Vedrovice, isotope analysis was performed on 14 children between 0 and 10-12 years of age. Of those, only one infant (17/75) of around 1-year-old presented nitrogen values suggestive of breastfeeding at death, reaching the expected ≈2–3% trophic level increase (Kinaston et al 2009). This was the only child under 3 years old present at "*Široká u Lesa*", except for two perinatals (81b/79 and 93b/80) interred with adult women. The isotope values of the only sampled perinatal, individual 81b/79, indicate that it had not yet been breastfed at the time of death, thus indicating death before or soon after birth (Katzenberg 2008). All the individuals older than 3 years of age present similar isotope values, suggesting that weaning was performed between 2 and 3 years of age, and that it was not "normative" to bury non-weaned babies in the cemetery.

6.3. Health condition

In order to explore the presence of food deficiency and/or nutritional stress among the Vedrovice population, metabolic diseases related to nutritional stress were examined through a bibliographic review of the presence of Harris lines, *Cribra Orbitalia* and Enamel Hypoplasia in male and female bones (Whittle et al 2013, Lillie 2008). These pathologies mainly form during infancy and may also arise from differential access to dietary proteins versus carbohydrates. Parallelly, data concerning the prevalence of dental health was also collected during the bibliographic research.

A total of 28 affected individuals from the site were identified (Online Resource 2. Database, Table 3). After removing burials with incomplete or absent skeletal remains due to preservation problems (skull and postcranial parts) that could reduce the reliability of the results (Table 5), no statistical relationship between the sex and the presence of metabolic diseases could be established.

However, the women were significatively more affected by pathologies associated with tooth decay than the men (Lillie 2008, Frayer 2004), which could suggest the presence of sex-based differences in the preparation and consumption of food.

	Presence	**Absence**		**Presence**	**Absence**
Caries Female	9	23	Female dental grooves	5	27
Caries Male	3	13	Male dental grooves	2	14
Female MA tooth loss	10	22	Female Harris Lines	3	31
Male MA tooth loss	1	15	Male Harris Lines	11	5
Male *Cribra Orbitalia* + H	1	16	Female *Cribra Orbitalia* + H	4	24

Table 5. Contingency table displaying the presence of metabolic diseases and dental decay according to the age and sex of the individuals. MA= Mature adult.

Tooth activity markers were also retrieved from the bibliography (Lillie 2008, Frayer 2004 and Jorasová and Tvrdy 2017), suggesting that the individuals used their teeth to chew fibrous materials (Frayer 2004). Such markers were found in 5 females (29/76, 68/78, 75/79, 94/80 and 97/80) and 2 males (46/77 and 82/79), from juvenile to senile ages (Table 5). When considering only those individuals with preserved skulls (32 females, 16 males), no statistical relationship was found between the sex and the presence of dental grooves. No further palaeopathological data is currently published preventing us from developing more hypotheses regarding the sexual division of labour and differential quality of life depending on gender.

As a final remark, the spatial distribution of the burials of adult individuals displaying metabolic diseases and dental decay indicates two significant trends. First, the absence of tooth decay and

metabolic diseases in the cluster of female burials located in the north of the cemetery is noteworthy, especially given the fact that their grave good presence is significantly low, as are their protein ingestion levels according to the Nδ15 isotopic values (Figure 11, Online Resource 2. Database, Table 1). The other trend is that women with teeth decay are mainly concentrated in the south of the cemetery, where the female burials tend to present more variety of grave goods (*vide infra*).

In summary, a certain degree of uniformity concerning the presence of metabolic diseases, as well as a general absence of tooth decay can be found in men. In contrast, the female skeletons present a greater degree of variation, as those found in the north of the cemetery display a noteworthy absence of tooth decay, while those in the south were significantly affected by it.

7. Grave goods distribution

In this section, statistical analyses performed on the basis of the new results of the use-wear analysis, as well as a bibliographic review of the rest of the grave goods, which were mainly bone tools, ornaments, pottery vessels and grinding tools, attending to their count and typological characteristics were considered. New results have been acquired, adding significant new trends and nuances to the grave goods distribution in relation to the individual's sex, age and the spatial distribution of the graves.

Seventeen of the 69 adult graves present in "*Široká u Lesa*" were unfurnished (i.e. no grave goods recorded, though, of course, there is the possibility of non-preserved goods made of organic materials), of which 12 were female, 4 male and 1 an adult of undetermined sex (Online Resource 2. Database, Table 1). Consequently, it appears as though no statistically relevant relationship between the sex of the individual and the presence/absence of grave goods in their burial can be established.

A χ^2 Test was performed to measure the intensity of the relationship between grave goods and the sex of the buried individuals (Table 6). To perform these tests the disturbed burials (eroded, disintegrated or partially cut) have been removed from the sample, contemplating exclusively what whole grave good assemblages. The results indicate that the only statistically significant relationship between the grave goods and the sex of the buried individuals existed for PBAs, flint tools and bone artefacts, all of which were associated with male-sexed skeletons. Consequently, it is possible to affirm that there, indeed, appears to have been an intentional grave goods differentiation depending on the sex of the buried individuals in Vedrovice.

Grave goods	**P**	**A**	**χ^2**	**Grave goods**	**P**	**A**	**χ^2**
PBA F	1	21	7.6976E-07	Bone/Antler F	0	22	0.0025222
PBA M	12	2		Bone/Antler M	5	9	
Pottery F	11	11	0.2036	Pebbles F	4	18	0.35048
Pottery M	10	4		Pebbles M	1	13	
Spondylus F	12	10	0.49412	Animal teeth F	0	22	0.068121
Spondylus M	6	8		Animal teeth M	2	12	
Flint F	7	15	0.006237	Stone Beads F	3	19	0.14898

Flint M	11	3		Stone Beads M	0	14	
Grinding Stone F	2	20	0.62875	Snails F	1	21	0.41849
Grinding Stone M	2	12		Snails M	0	14	

Table 6: Grave goods quantification according to sex. χ^2 Test results. Abbreviations: P= presence, A= absence, M= male, F= female.

The graves of perinatal and non-adult 1 individuals tend to be unfurnished. Non-adult 2 individuals are only accompanied by PBAs in three cases: a 6-year-old with a flat-convex PBA used to scrape hide (which is significant because no such object has been recorded in an adult male grave) and 2 unused small-sized replicas of the PBAs found in adult male burials. In four cases, non-adult 2 burials were found to contain *Spondylus* beads. As for juveniles, 1 flaked local blade and 8 projectiles were documented in two different tombs.

Both young and mature adult females were found to have been buried with *Spondylus* ornaments. However, other grave goods were only documented in the graves of mature adult females. Likewise, the only assemblage of *Spondylu*s beads formed of more than 3 items was recorded in the grave of an adult female. In total, mature adult female graves were found to contain 1 grinding stone, 2 local blades of undetermined use, 1 flat-convex PBA re-used to scrape hide and 1 macro-lithic instrument used for ochre pecking and for softening hides. What is noteworthy is the complete absence of projectiles as well as of PBAs displaying the same characteristics as those found in male graves.

Eight of 11 young male adults were found accompanied by PBAs, 3 - by flaked tools, and 6 - by projectiles. All 5 mature adult males were accompanied by a PBA, while a total of 1 flaked tool, 1 projectile, 2 unused exogenous blades and 2 local blades were found in all the mature adult graves. Furthermore, the assemblages of male individuals also contain bone tools and animal teeth.

Therefore, overall we observe that the frequency of each type of objects varies depending on the age/sex (Table 7). Analysing the total number of artefacts of each type and their distribution per grave reveals that male burials contain more tools than those of females and children, with the sole exception of the grinding tools. Furthermore, mature adults present a major density of objects which act as identity markers: *Spondylus* beads for females, and PBAs for males. Senile individuals are not found with PBAs or flint tools, and only one senile female was found to have been buried with a *Spondylus* bead.

	MALE (17 individuals)	**REP**	**FEMALE (29 individuals)**	**REP**	**INF 2 (12 individuals)**	**REP**
Spondylus	67 items (in 6 graves)	8.7	43 items (in 14 graves)	20.2	4 items (15 beads)	5.7
PBAs	13 (in 12 graves)	18.8	1	1.5	2 toys (ML), 1 hide scraper (F)	4.3

Projectiles	31 items (7 graves)	10	0	x	2 graves (9 items)	2.9
Grinding	1	1.5	1	1.5	1	1.5
Blades	4 (4 graves)	5.8	2 local (2 graves)	2.9	1 local	1.5
Bone tools	5 (5 graves)	7.2	0	x	0	x

Table 7. Grave goods quantity and distribution according to age/sex. Abbreviations: REP: Item representativity (across 69 burials).

The tools found together with females and children are characterised by more morpho-functional variability than those found with males, even if males present more variability of artefact types. Instruments 36/76 (broken and reused PBAs used to scrape hide), 90/80 (a pebble used for ochre pecking and hide-working) and 31/76 (flat-convex PBA used to work a soft material), though related to skin/leather/hide work, they are morphologically not specialised. The tools found with male individuals, both projectiles and PBAs, display greater use-wear regularity (i.e. the activity is more similar between them than between the activities performed using the tools found in female burials), while the technical and morphological characteristics of the tools are generally fully uniform, which is particularly the case with the tools accompanying adult males.

With reference to the spatial distribution of the grave goods, there are three especially significant clusters within Vedrovice: A, B and C (Figure 12). Cluster A is located at the centre of the male distribution and displays a significant concentration of projectiles, *Spondylus* items, flint blades and PBAs. The isotopic analysis indicates that cluster A coincides exclusively with NCL4 and NCL3 (those presenting higher nitrogen values) individuals of both sexes and of SrCL4 (local). Cluster B is composed exclusively of female and non-adult individuals of local origin, documented with Type 1 and 2 PBAs (not found in male graves) which were either used for hide-working and ochre pecking or showed no traces of use. All these individuals but one belong to NCL1 (low protein ingestion). Finally, Cluster C (south-west of the cemetery) is composed of SrCL4 males and females and the only male belonging to SrCL2. These groups display heterogeneous nitrogen values, grave good variability similar to that of Cluster A and a significant concentration of male individuals with evidence of metabolic diseases.

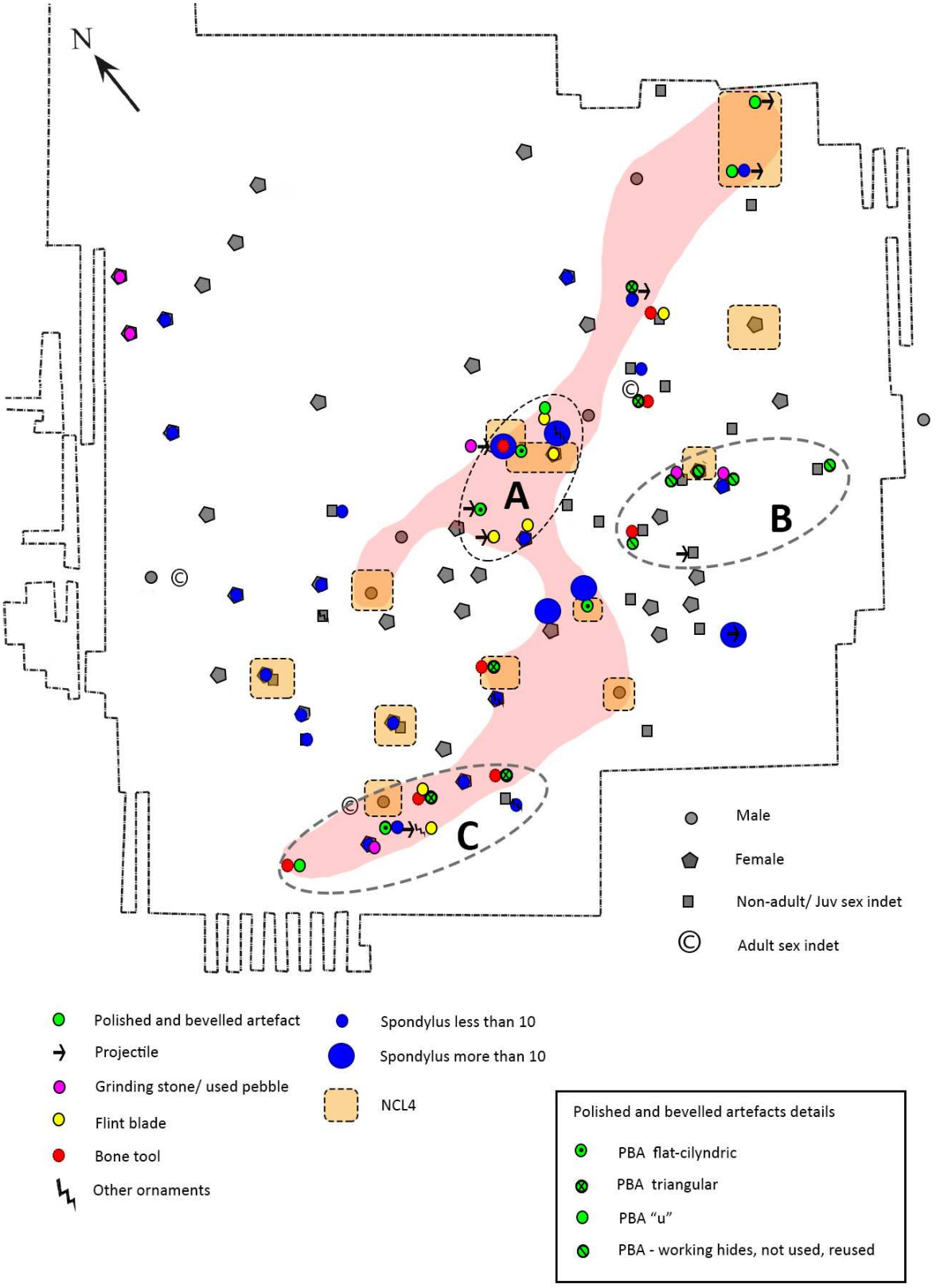

Figure 12. Plan of the Vedrovice site illustrating the grave goods localisation and functional and morpho-metrical data, the individual's sex and age and the graves belonging to the NCL4 cluster. Clusters A, B and C described in the text are represented by the corresponding letters A, B and C.

In summary, sex appears to be the decisive factor influencing the grave goods frequency. Men are buried with more artefacts than women, while their stone tools display more regularity both in terms of the uses and morphometrical and technological characteristics. Age is the second factor that determines the grave goods variability, as the non-adult and young individuals present less abundance of items than the adults. In parallel, mature adults are buried with more objects than young adults, especially displaying a major density of those objects that act as sex identity markers.

8. Discussion

The Vedrovice record offers a unique opportunity to approach a very short and specific period within the sequence of LBK funerary patterns changes. This unusually tight control over the variable of time has allowed us to focus our attention in other elements that could explain the data variability. Four main factors have been identified, in decreasing degree of importance: sex, age, geographic origin and diet. Sex is the main variable that explains the grave good variability as well as the isotopic, health and spatial organisation. From this, we propose that for the majority of the LBK people buried at Vedrovice, gender was elaborated into two spheres based on biological sex.

This result, however, is not inconsistent with the presence of strong variability patterns within those biologically determined groups. If the attention is focussed exclusively on grave good distribution, then only two genders will be broadly observed. However, the review of the isotopic and osteological stress markers suggests that, if these two genders broadly shaped lifeways as well, a presence of internal differentiated patterns can be identified within the female-sexed skeletons in terms of age, diet and mobility. These results remind us of the presence of other social identities that should be present in our interpretations, identities that in many cases could help us understanding how (two or more) genders, social hierarchies or cultural identities were shaped.

8.1. Male-sexed skeletons

Interpreting male mobility, dietary and funerary practices is complex since the male population corresponds to 28% (as opposed to women, who constitute 48% of the sample) and almost all belong to the “young adult” age range. This exceptional situation could be explained either by the fact that only a small proportion of men remained settled in the territory, while the rest migrated, and/or by the presence of undocumented funerary practices involving the male population. If such undocumented practices did exist, this would imply that our observations of the male inhabitants cannot be applied to all the men present in the area, and hence, that a bias must be taken into account when interpreting the results of the material analysis. If this unusual sex ratio can be explained by long-term male mobility or migration to other settlements, these could only be confirmed through more extensive strontium analyses as well as detailed isotopic baseline models predicting superficial geological variations. This degree of analytic accuracy is of course narrowed by the limits of strontium analysis applied on large areas of loess sediment, which signature is very homogeneous across most of LBK distribution.

On this basis, one of the central elements that distinguishes one sex from the other is the strong uniformity among the male grave goods as well as lower diet, mobility, health and spatial organisation variability, in comparison to the variability of female graves (Bickle in press).

Contrary to women, men were buried together in quite a compact cluster along a continuous straight axis, indicating once again that the space was clearly organised according to the sex of the buried individual. Men, with two exceptions, presented an isotopic signature coherent with a lifetime residential sedentism, as they come from SrCL4, non-adult. This may be interpreted as a reflection of the fact that those men buried in the cemetery were born, raised, grew up and died at the same place, suggesting a contrast from the more mobile female pattern.

In parallel, the nitrogen analyses indicate that men were likely to have consumed more meat and/or products of animal origin than women. Those differences, if significant, are actually very small in terms of δN parts per mill when compared with other non-Neolithic populations (Hedges et al. 2013, 361-364), indicating that that dissemblance could be the result of a more abundant food ingestion during shared meals rather than distinctly different diets. This fact is of importance since it suggests that the distribution of farming and/or hunting products was not exactly equal between the sexes. The main part of male individuals belonged to the clusters displaying higher nitrogen rates (NCL3-4), while 4 men were included in diet clusters 1 and 2, the ones with lower nitrogen values. However, no association between the protein ingestion and the quantity and variability of grave goods could be found.

Of the 21 males in the cemetery, 8 don't present PBAs, *Spondylus* or flaked tools among their grave goods. Of those, two burials (50/77 and 25/75) were rather disturbed, one (99/81) belong to a non-local individual and two more (108/84 and 82/79) to the only senile individuals in the cemetery. Once those somewhat unusual burials are removed, there are only 3 male graves left without grave goods: burial 63/78 (adult mature, NCL3), burial 73/79 (young adult, NCL4) and burial 23/75 (juvenile, NCL4), whose ages, origin and nitrogen rates do not allow to find any kind of pattern that distinguishes them from the remaining furnished male burials.

The grave good variability among men depended mainly on the individuals age, being young adults closely related to the presence of projectiles, ornaments and PBA with flat-cylindrical, triangular and "U"-shaped sections. Mature adults tended to be associated to PBA displaying triangular and "U"-shaped sections.

PBA found in the male graves show distinct uniformity in terms of the manufacturing techniques, morphometrical attributes and use-wear results. The PBAs not only present male-exclusive morphometrical characteristics and matching exogenous raw materials but have also been mainly associated with damage patterns that can only be interpreted to have resulted from animal butchering (symbolic or not) and/or warfare, of which considerable direct evidence has been found in other LBK settlements (Vencl 1999, Wild et al. 2004, Meyer et al. 2015). The same can be observed in the case of projectiles - a tool which is strongly related to both interpersonal violence (Ibidem) and acquisition of animal resources through hunting activities. A certain degree of standardisation of the technical and metric characteristics of the projectiles has been observed. Another important observation is the fact that none of them were used and that most of them were made from exogenous raw materials, meaning that they were gathered and made for the grave as a part of funerary ritual.

The idea of a technological and morphometrical standardisation of the strongest gender identity markers found within the LBK grave goods (i.e. PBAs and projectile points), together with the fact that

both can be traced to either interpersonal violence and/or the killing/processing of animals, is very suggestive and open to multiple interpretations.

This evidence opens several interpretative possibilities as to whether these differences were related to unequal participation in the livestock care and management or, fundamentally, to small biases in the product distribution resulting from other causes. In any case, more data is needed in order to gain a better understanding of the livestock practices: the aims of this production (meat, traction force, wealth accumulation, secondary products, etc.), technological traditions (grazing practices, size of the pastures, animal mobility) and the social implications of such practices (who was in control of this production), though significant advances have been achieved in other LBK areas (Gillis et al. 2017, Johnson 2016, Marciniak 2005).

8.2. Female-sexed skeletons

Female burials present a rather strong internal variability according to their grave goods, age, protein ingestion rates and mobility patterns. Those four variables constitute the main guidelines of the female diversity.

Female skeletons were dispersed throughout the entire cemetery. One of the most plausible explanatory factors of this distribution is age, as the burials of mature adult females were distributed at the centre / south of the centre of the cemetery, while those of senile, young adult and juvenile females were located along the borders. This suggests a certain amount of preplanning in terms of layout – even if only lasting for two or three generations, it would have been necessary to know what the centre/periphery or north/south were in the cemetery to add burials in this pattern at a later date.

Mature adult females were also the ones accompanied by a greater and more varied amount of grave goods than the rest, including senile, juveniles and young adults which suggests that they received different funerary treatment depending on their age, a phenomenon that has also been observed in other LBK cemeteries such as Aiterhofen (Hofmann 2009).

This means that not all females displayed the same range of grave goods, suggesting that here, again, heterogeneity can be identified within the female sample, as only a few (mainly females from grave goods clusters A and B) were buried together with stone tools, while the rest either had no grave goods at all or were buried exclusively together with *Spondylus* ornaments. There also exists a possibility that women's funerary codification may have included organic materials that had not been preserved, such as textile decoration and fabrics, wood artefacts or other kinds of items made with vegetal fibres (Neugebauer-Maresch and Lenneis 2013).

This is a very important element as means that the interpretations based on the grave good analysis, especially stone tools, are valid only for a small part of the female population. In particular, the stone tools were exclusively related to senile and mature adult women, all of which but one, were of local origin.

Stone tools found together with females are characterised by more morpho-functional variability than those found in men's burials, with non-specialised instruments (a PBA fragment, pebbles, a flat-convex PBA, different kinds of grinding stones and flint blades) generally related to skin/leather/hide work.

The fact that all the functionally- determined tools accompanying women are related to similar activities presents yet another topic of research that will require further attention, especially when the site's domestic areas are studied.

Female-sexed skeletons present quantitatively more variability than men as well as more internal strontium variation, possibly reflecting the fact that they had moved to a different location than their birthplace by the time they reached adulthood. This pattern has often been explained as a resulting of exogamy practices in a patrilocal system (Bentley 2007; Bentley et al 2012). Although this is a plausible hypothesis, more data is needed in order to dismiss other explanatory possibilities for women moving away as a result of being married out of their immediate community. Patrilocality itself is not an absolute self-explanatory category concerning women's living conditions, as a huge range of scenarios might arise around this kind of residence pattern (Bickle 2019). In any case, until baseline models predicting superficial geological variations have been fully developed, it is not possible to advance this discussion, as the degree of mobility cannot be ascertained. Wider research reconstructing' kindship through DNA analysis on an inner-community scale of interaction may also shed some light on this matter.

The female isotopic values indicate that all the female individuals belonging to NCL4 (the cluster with higher nitrogen values) are exclusively assigned with a lifetime residential sedentism (SCL4). Furthermore, the SCL2, the larger non-local mobility cluster is integrally formed by females with intermediate nitrogen ranges (NCL2-3). Finally, those female with lower protein ingestion (NCL1) appear in all mobility clusters but SCL2, so it seems like the origin of those women co-varied with the amount of protein that they ingested. Even if those protein ingestion differences were rather small, they may be indicative of the fact that women of different origin did not share the same meals nor received the same share in the distribution processes.

All the stone grave goods except for *Spondylus* beads and 1 grinding stone are concentrated exclusively at cluster SCL4 (the "local" cluster) in both male and female burials. It can thus be seen that not only were all the adzes documented at the site associated with local males (as previously proposed by Whittle et al 2013) but, in fact, all the other tools and ornaments studied in this paper, except for the ones mentioned above, were exclusively associated with individuals of local origin. This is a very important fact, as it suggests that only individuals displaying lifetime local residential sedentism were involved in funerary practices in which the rest of the population did not participate.

Furthermore, it is noteworthy that *Spondylus* beads, obtained through long-distance networks and strongly related to women, were the only items present regardless of whether the buried individual was of local or non-local origin as well as regardless of their protein ingestion rates. Answering the question as to whether or not these ornaments were indicators of social status beyond the local symbolic traditions observed in Vedrovice would require more extensive research.

A link between women and the vegetal world is suggested by the apparent prevalence of mixed and vegetarian diets among the studied women, as well as by their dental health which indicates that they are likely to have had a more cereal-related diet and may have been involved in food processing activities different from those performed by men.

In connection with the consequences of diet and health condition, female skeletons present internal differences concerning dental health. The women found in the north of the cemetery had a noteworthy absence of tooth decay, while those in the south were significantly affected by it. Although no relationship can be established between dental health and the isotopic or grave goods distribution, the women who were markedly more affected by tooth decay coincide precisely with the cluster of mature adult females whose burials are located to the south of the centre of the cemetery, which, at the same time, includes or has in its very vicinity almost all the non-adult burials.

This could be explained by the presence of two generations of women enjoying either different health condition or following different food production traditions, which is a plausible explanation since all the mature adults belonging to this cluster can be dated to the beginning of the necropolis occupation and have a very high statistical probability of being contemporaneous (5300-5225 cal BC, Acomb 193.6) (*vide* Online Resource 1. Chronology). Furthermore, with one single exception (burial 104), it is also very likely that the female burials outside this cluster were contemporaneous to one another and dated back to a period slightly after that of the cluster in question (between 5210-5075 cal BC, Acomb 102.5) (*vide* Online Resource 1. Chronology). Although this is a very interesting insight, more radiocarbon data are needed in order to fully assess this hypothesis.

To sum up, we have seen that female variability does respond to a series of patterned variables that could be indicating the presence of regular sub-identities within this sex group.

8.3. The non-adult individuals

The second factor determining the grave goods and spatial distribution is the age of the buried individuals. Perinatal and non-weaned babies were generally buried without grave goods as were most of the non-adult individuals. Moreover, perinatal babies were only present together with their mothers, while the rest of the children were mainly concentrated in the south-east of the cemetery, either isolated or close to females. This peculiar spatial distribution and association with women suggests that age was a significant variable explaining the spatial organisation the funerary space and that children were symbolically differentiated from adults.

Non-adult and young individuals present less abundance of grave goods than adults, while mature adults present more items than young adults, especially displaying a major density of objects acting as gender identity markers. This indicates that, indeed, the older the individual was, the more likely they were to have access to more numerous and more variable grave goods. However, among non-adults there is a spike in grave goods between c. 8-14 years old (non-adults II) and then a decrease until early adulthood, a pattern that had already been attested across the LBK by Siemoneit (1997) and Bickle and Fibiger (2014). This dynamic is broken in the senile population, who were mainly buried without accompanying grave goods. This fact, while intriguing, corresponds to other elements such as the spatial distribution of the graves of senile individuals, which were mainly situated at the borders of the cemetery.

The grave goods distribution duality identified between adult males and females can also be observed in the graves of 2 non-adult individuals, who display items such as projectiles or 2 non-used PBAs exhibiting techno-morphological characteristics only found in male graves. Furthermore, there is a PBA in a child's grave displaying morphometrical and functional characteristics very close to those

identified in a woman's grave. These data, although scarce, open the possibility of suggesting a binary socialisation of children around 5-years of age, distinguishing them between males and females. More cemeteries would need to be studied to confirm this trend. In order to attribute gendered grave goods assemblages to either girls or boys, the sex of the non-adult skeletons will also have to be determined (e.g. through DNA analysis).

9. Conclusions

The techno-functional approach has provided new information concerning the past uses of the stone tools deposited as grave goods at Vedrovice cemetery suggesting the presence of different productive spheres attributed to each sex. Male-sexed individuals' funerary symbolism was related to interpersonal violence, animal resource acquisition and/or carcasses processing, as well as to a strong technological standardisation of their tools, which varied according to the individuals age. Women were associated with craft activities involving different kinds of animal skin processing. Non-specialised artefacts exclusively related to mature adult women of local origin. Although no studies have been conducted to date on Vedrovice domestic areas, what we know of LBK community's subsistence and craft practices suggest that a huge amount of daily production processes are not reflected in the grave goods.

Diet data also indicate the presence of gendered lifeways since male-sexed skeletons were likely to have consumed higher amounts of meat and/or products of animal origin than women during shared meals. The uniformity in male diets matches their small degree of mobility, as most of them were born, raised, grew up and died at the same place. In contrast, female-sexed skeletons protein ingestion co-varies with their degree of mobility, being lifetime residential sedentary women more likely to receive higher amounts of animal proteins than those women who had moved to a different location than their birthplace by the time they reached adulthood.

The gendered differentiation in life as well as in the activities represented in their funerary tools was reinforced by the remaining grave good distribution patterns and the burial spatial organisation: male-sexed skeletons were buried with more numerous and more varied grave goods than females. Exclusively mature adult females were buried together with stone tools, and only *Spondylus* ornaments were present in female graves regardless of the buried individual origin and protein ingestion rates. Although Spondylus management is not the specific object of this paper, those results are quite revealing and should be addressed and interpreted in the future in relation to the documented mechanisms of long-distance exchange suggested by Windler (2018).

To conclude, the distribution of farming and/or hunting products was not exactly equal between the sexes nor was between women of different origin. The community deliberately accumulated more tools and ornaments in male burials than in females', as well as their tools representing differentiated spheres of production. While uniformity seems to be the norm between males, females exhibited offering differences according to their origin and age, consisting on inferior amounts of ornaments, tools and protein ingestion among non-local non-mature individuals.

The presence of exogamy practices in a patrilocal system could be one of the factors explaining those differences between local and non-local women, who received different treatment both during life and during death. We must also consider that only a small proportion of men have been documented

in the cemetery either because only a small part remained settled in the territory and/or by the presence of undocumented funerary practices involving the male population, being this a topic to be explored in the future if this picture of those early LBK communities is completed.

Attributing those differences to social hierarchies/inequalities or labour division/specialisation would be somewhat hasty in view of the scarcity of the evidence, but in no way can be considered as proof of their absence. On the contrary, they seem to indicate some kind of economic and symbolic separation of men and women, the degree and quality of which are still to be determined. The possible presence of patrilocality can be an indicator of lower status women, since it can reinforce women's dependence on potential male-husbands (Meillasoux 1981) as well as an increase of their insecurity as a consequence of the loss of her birth kinship network of social support (Cintas Peña 2018: 63).

The shortness of weaning periods (between 2 to 3 years) may be indicative of frequent pregnancies with consequential effects on juvenile and young women health, productive and symbolic attributions. In this sense the possible motherhood symbolic and economic changes derived from the Neolithic colonisation process should be addressed in depth in the area, as it is currently being done in other regions such as the Balkans (Stefanović 2019, Stefanović's BIRTH ERC-Funded project).

Analysing kinship through high-resolution genetic studies would certainly improve our ability to interpret the presence/absence of patrilineality. Furthermore, exploring family ties would also help us to better explain the observed gendered non-adult socialisation and the possible presence of heredity.

The possibility of a cultural labour division according to sex is not only suggested by the funerary practices: there is also evidence pointing to that direction in tooth wear. Osteological stress markers determination is a necessary goal to explore more deeply this matter, as well as to specify the range of activities performed by this community as part of a detailed study of the settlement remains. This procedure would lead to a better understanding of the value of the grave goods, determining the objective social value of each of these activities and exploring the reasons as to why such activities may have been absent from the funerary record.

Of course, Vedrovice is only representative of a short-time period of burial practices in a very particular area at the beginning of the LBK. More research is needed in order to investigate if the patterns observed in this cemetery are wide-spread in other regions of the LBK and how they may have changed through time and space. Of important relevance is to consider if the practices observed in this context display elements of continuity with the Early Bronze Age, when patrilocality and intra-household inequalities were more likely to have acted in female disadvantage (Mittnik 2019).

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12. Conflict of Interest disclosure statement

The authors declare that they have no conflict of interest.

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