Peer Community In Archaeology

# Questioning Final Palaeolithic and early Mesolithic cultural taxonomy with a data-driven statistical approach

***Anaïs Vignoles*** *based on peer reviews by* ***Dirk Leder*** *and 2 anonymous reviewers*

Felix Riede, David N. Matzig, Miguel Biard, Philippe Crombé, Javier Fernández-Lopéz de Pablo, Federica Fontana, Daniel Groß, Thomas Hess, Mathieu Langlais, Ludovic Mevel, William Mills, Martin Moník, Nicolas Naudinot, Caroline Posch, Tomas Rimkus, Damian Stefański, Hans Vandendriessche, Shumon T. Hussain (2023) A meta-analysis of Final Palaeolithic/earliest Mesolithic cultural taxonomy and evolution in Europe. Zenodo, ver. 3, peer-reviewed and recommended by Peer Community in Archaeology.
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Cultural taxonomies are an essential tool for archaeologists working with prehistoric material cultures as they have historically been used to create the basic analytical units for studying cultural evolution through time (de Mortillet, 1883 ; Breuil, 1913). This approach has its limits as the taxonomic units are essentially etic constructions, *i.e.*, they are defined in a cultural context exterior to the one that produced the material culture on which they are based (*e.g.*, Pesesse, 2019). But to approach questions related to cultural evolution, one has to define archaeological units with clear geographic and chronological delineations in order to be compared synchronically and diachronically (*e.g.*, Willey and Philips, 1958). In « *A meta-analysis of Final Palaeolitic/Earliest Mesolithic cultural taxonomy and evolution in Europe* », F. Riede and colleagues propose a novel and interesting approach to question the end of the Palaeolithic and beginning of the Mesolithic's « named archaeological cultures » (NACs) analytical pertinence (Riede *et al.*, 2023). In this particular context, NACs are indeed very numerous ($n$ = 86) and result from complex and regional research histories. It seems thus pertinent to question the extent to which the said NACs chronological and geographic patterns result from past cultural diversity and evolution, and are not artefacts of research.

To do so, the authors adopted a data-driven approach that they describe in detail in the paper. First, they gathered an European data base of lithic tool-kit composition, blade and bladelet technology and armature

morphology at 350 key sites considered representative of NACs, dated between 15 and 11 ka (Hussain *et al.*, 2023). These data were then analyzed using geometric morphometrics and a set of statisticaal tests in order to 1) test the coherence of these taxonomic units, and 2) test the chronological change in artefact shape variation. The authors conclude that the data set is partially biased by reasearch practices and histories, as their data-driven approach has only partially replicated traditional NACs for the european Late Palaeolithic/Early Mesolithic. However, their analysis of armature shape evolution has shown a tendency to diversification overtime, a pattern that was already observed in more « traditional » approaches.

This study is, in my opinion, an excellent contribution for a significant step in macro-regional approaches to the archaeological record: defining discrete archaeological units that serve as a basis for subsequent analyses aimed at delineating cultural evolutionary processes. The authors propose a carefully designed and statistically grounded procedure in order to achieve these definitions in the most replicable and explicit possible manner. Taking advantage of drawings as a primary source of information is also very original despite several limitations of this approach (such as the necessary selection of most typical artefacts to be represented, the incompleteness of data publication or the difficulty to access all published work across such a large geographic area). The results of the study are convincing enough to allow the authors to discuss the pertinence of European Late Paleo/Early Mesolithic NACs, the potential epistemological and historical factors that could affect this taxonomic framework, as well as to give more weight to the traditional hypothesis of lithic cultural diversification towards the end of the Pleistocene/beginning of the Holocene in Europe.

I would also like to underline the authors' important efforts to ensure transparence and replicability of their study, as well as the accessibility of the data, thanks to extensive supplementary data and a data paper describing their data set in detail.

Anaïs L. Vignoles

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# Reviews

## Evaluation round #1

DOI or URL of the preprint: https://doi.org/10.5281/zenodo.8195587
Version of the preprint: 1

### Authors' reply, 03 December 2023

Please see the attached response letter.
**Download author's reply**
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### Decision by Anaïs Vignoles, posted 23 October 2023, validated 23 October 2023

**Accepted with revisions**

Dear Authors,

After having read the paper and the evalutation provided by three independent reviewers, I have decided to accept your article considering minor revisions.

The reviews are overall very positive, but point out some discussion aspects that are worth addressing in my opinion. They also suggested several modifications or additions that will surely serve to improve your paper.

I would like to add that I found the methodology and approach well described and argumented. The authors are transparent and careful in their interpretation, which is very positive. Moreover, I could replicate the figures and analysis using the provided code and data. However, I would like to point out that many packages used in your analyses are deprecated, or even not available on CRAN anymore. I think it could help the replicability to either 1) change the code so that it uses packages that are still available, or 2) provide a file with all deprecated packages to be downloaded together with the supplementary.

Attached are some minor comments that were not pointed out by the reviewers as well as a few remarks on the code.

Best regards,

Anaïs Vignoles **Download recommender's annotations**

### Reviewed by anonymous reviewer 2, 18 October 2023

The Manuscript is well written, and the description of the rationale are clear and comprehensive.

The title is clear and reflect the content of the article. The abstract presents the findings concerned in the analysis. The introduction clearly explains the motivation for the study and the research question is well presented. According to the authors the aim of this research « has been to meta-analytically assess the validity of current cultural taxonomic schemes for the Final Palaeolithic and earliest Mesolithic (15-11 ka cal. BP) in Europe and on this basis to infer patterns and processes of material culture diversification, cultural transmission, and adaptation». I subscribe to the need of performing such analysis.

The methods and analysis are described with detail, however my lack of knowledge on data analysis, R or learning machine methods doesn't allow me to detect flaws in the design of the research or in the analysis. But the raw data are available and other researchers can replicate the analysis. The geographic units used seem logic, however, I would like to have more information on the archaeological sites chosen. We don't have information on the identity of the «regional experts» and despite Figure 3 captions says, «A detailed breakdown of key sites can be found in SI Table 2», I only had access to the type of site: open air, cave or rock shelter. The reader cannot check which sites were used for each region. I suggest that Figure 3 caption includes the list of the sites targeted in the analysis.

Interpretation of the results is caution and seemed to be adequately supported by the results. The mentioned «diversification of material culture in the realm of armature shapes towards the end of the Palaeolithic» was already observed but conventional analysis but it is interesting to prove it using these methodologies.

The references are appropriate and accurate. Regarding the Figures 5a, 5b and 5b and 7a and 7b are difficult to read. Unfortunately, I have no suggestions to improve them in order to became more easily read.

The paper presents valuable research that will be of significance to scholars working on this subject all over the Europe. Furthermore, the authors might considerer raising a minor question regarding the influence of the French school during the during the 19th and first half of the 20th centuries. Some of the NACs were identified by French scholars abroad or by local archaeologists seeking for similarities with the classical Perigord sequence (mainly for the late Pleistocene phases). Some cultural taxonomic denominations can be explained by the influence of the French school?

Some minor corrections could be done to improve this paper, but this work will be an important contribution to the Pleistocene-Holocene transition.

## Reviewed by anonymous reviewer 1, 19 October 2023

The manuscript "*A meta-analysis of Final Palaeolithic/earliest Mesolithic cultural taxonomy and evolution in Europe*" by Mr Riede and co-authors, which has been submitted to PCI Archaeology uses a meta-analysis approach to evaluate the efficacy and replicability of contemporary cultural classifications of prehistoric cultural taxonomies focusing on the Final Palaeolithic and the earliest Mesolithic in Europe (c. 15,000 to 11,000 BP). To achieve this aim, the authors used a high-level computational approach on a large spatiotemporal scale, combining a set of statistical tests designed to accumulate research results on novel integrated dataset including key sites, lithic toolkit composition, blade and bladelet production technology as well as lithic armatures.

Overall, the manuscript is well written. Data collection is adequately and openly presented in sufficient detail with additional information structured into chapters provided in the supplementary information. The literature cited is very informative and relevant to the topic of the current manuscript. All figures are appropriate and the statistical tests are displayed with accuracy. The argumentation is well stated as it is clearly indicated in the abstract.

The main point of this study is that the results of meta-analysis provide better estimates of the relation in the population than single studies, especially when integrating operational chain analysis to resolve cultural taxonomic questions. While I overall agree with their findings and these data is potentially be of great interest for a broad readership, the presented manuscript would benefit from some clear information/discussion that I have resumed in two main points:

**Selected studies and dataset**

This study emphasizes to us the coherence of the various NACs groupings and the existence of a cultural diversification tracked over time. However, considering the large spatiotemporal scale, the inclusion of a limited set of studies biases estimates about the effect sizes in the population, since the results do not identify all possible studies on the phenomenon.

**Data inconsistencies**

The selection of reliable key sites identified as those that hold rich information on lithic typo-technology well published by regional experts in prestigious journals, might influence meta-analysis results and lead to misleading inferences about the issue of taxonomic designations. Furthermore, considering the fact that typical specimens are usually selected for drawing because they are representative of taxonomic entities, the inclusion of complete specimens rather than fragments might biases the estimates about the effect sizes in the population.

**Minor remarks:**

Line 24: do you mean domain or module? Please correct accordingly in the text.

Line 55: unretouched components are excluded from the meta-analysis, though Belloisian and Laboraian unretouched knives, *identified as an important production goal*, were included in the dataset. The exclusion of unretouched components, which might biases the meta-analysis results, needs to be explained.

Line 286: the authors stressed that the Epigravettian macro-unit stands apart with a distinct laminar technological organization and suggested that this might be a bias of limited data from the long-lived Epigravettian. This very important point in this study seem to be mentioned as a side note here and needs to be more clarified in discussion.

Line 573: The discussion would have benefit from the integration of other aspects of material culture such as bone/ivory technology, genetic data, cave art, burials … This would have strengthen the argumentation.

**Download the review**

## Reviewed by Dirk Leder, 19 October 2023

**Aim of the paper:**

The manuscripts aims to tackle the traditional construct of archaeological cultural units in Europe at 15-11 ka cal BP by employing a meta-data analysis based on material culture (lithics). The study investigates the underpinnings and coherences of 86 named archaeological units (taxa) using multivariate statistical analyses. The objective is to clean up a taxonomic mess that evolved during more than a century of academic research and debate.

**General observations and minor issues:**

The abstract clearly lays out the topic of interest, whereas the results formulated therein lack clarity. It may be worthwhile considering to be a bit more straightforward stating, e.g. "Our data analysis suggests that 20 of the 86 analysed taxa are not distinct enough and therefore should undergo revision [or something in that area]".

The introduction is well written, clearly states the geographic and temporal scope of the work as well as the issue at hand and the subjects (NACs) involved. Also, different research traditions/schools and political agendas are appreciated in brief and the motivation to write this text is clearly stated. However, after all the justified criticism of NACs in general, it seems advisable to state in brief why grouping individual assemblages might be beneficial still, if at all. Is there any benefit to it? Should we speak of different time slots instead, or are there other ways to communicate Palaeolithic cultural units, e.g. to students?

The materials used and the methodology are clearly described and the various statistical analyses iterated and referenced well. A few minor points should be addressed though.

- How many sites per region are included in this study?

- The usage of discrete data (presence/absence) in comparison to continuous data /e.g. percentage) might prove disadvantageous, but testing this would be a project for the future.

- Please explain the reasoning behind the usage of millennial-scale time slices over climate-driven time slices.

- I am not sure raw material economy is a relevant indicator of culture-taxonomic differences in general, e.g. Baltic flint has been used intensively at different times, and locally available raw materials likely were used more intensively across time-boundaries than exotic one in general.

- Is there a reason SES was preferred over p-values?

- In respect to armature outlines the authors mention, "The subsampling was conducted in a stratified way using the splitstackshape R package [146], where we chose two outlines per NAC whenever available." How did you ensure, these two outlines are representative of all armatures in that NAC? Assuming, some assemblages may encompass e.g. rectangular, triangular and bipointed/lunate shaped armatures. Please clarify/specify.

Discussion and Conclusion are clearly formulated and some interesting results of the data analyses are highlighted and contextualised well.

Given recent genetic evidence (Posth et al. 2023) of population movements around 14 ka cal BP from south to north, it would seem important to highlight potential connections between Late Epigravettian and Azilan/FMG based on the analysis.

The authors comprise an international team that worked together according to a previously agreed upon standardized data frame. This step is crucial, as it allows for the accumulation of vast data facilitating inter-regional comparisons of archaeological material. The study is therefore a major improvement over previous studies wherein selected sites/regions have been analysed by just a few authors and results are based on a much smaller database. On the other hand, regionally differing research traditions might have introduced a bias into the study as the authors rightfully points out. By that token, the same tool might therefore be classified differently based on established research frameworks. This however, is a potential bias that will have to be checked in the future by researchers investigating 'foreign' assemblages from geographically distant regions.

**Main concern:**

As the authors rightfully point out the plurality of named archaeological cultures (NACs), rely on learned scientific traditions rather than data-driven inters-site correlations. The current paper was written in the spirit of breaking up these 'classic' cultural groupings and critically re-evaluate their coherence based on the analysed data. While I agree with the various analytical steps and selected statistical methods in general, my main concern lies in the base units selected in the various statistical analyses. The data was collected on the basis of 350 sites (with varying data qualities), which for the purpose of the analyses are then lumped back together into NACs and even macro-units. This to me seems like the very definition of a hermeneutic circle and naturally leads to redundancies with well-established expectations of the NACs defining criteria. It is puzzling then why the authors did not choose sites as the base unit of their analysis instead. The latter approach would have permitted a less biased approach in detecting clusters defined by material culture attributes rather than by already established NACs and macro-units.

Another issue arising from the lumping of sites arises when tool types and technological variables are present only in few cases among these groups. By lumping them with sites that lack such traits, these exceptional occurrences all of a sudden become a standard component (attribute) of this group in the analysis. For example, the majority of Late Magdalenian sites lacks bipoints and zinken that might however be present at few exceptional sites. By lumping all these sites into a single package, the entire macro-unit Magdalenian now has the named tools as a characteristic feature used in further analyses. Naturally, they would then overlap with the Azilian on the hand and the Hamburgian on the other.

Once this issue has been addressed, I think there is much potential in this paper that has the advantage over other publications of relying on solid database with relevance on a large geographic scale.

**Specifics:**

'Low Countries' might be an expression not familiar to most readers and I had to search for it too. Benelux might be an option instead.

Table 1: The time slices should be equipped with ages cal BP for better orientation.

Table 2. The * in the table caption does not show up in the table itself.

Figure 3. The map displays country boundaries where one would expect to see boundaries of the defined regions instead. This should be adjusted.

Figures 5A-C. Text and figure captions should clearly state that NACs form the analytical base unit herein, not macro-units.

I assume Zinken were subsumed under borers, and wonder whether this is a good idea, as it is one of the signature tools of the Hamburgian?

Lines 262. Have all artefact outlines been used in this analysis or two per NAC as above? Please specify.

Lines: 373-377. The authors suggest, "the place of Bromme in the Terminal Pleistocene and its relationship with ABP-associated complexes requires critical re-valuation…". In my understanding, this perfectly fits expectations of the Bromme phase emerging from FMG, but with tanged points (TPC) while foreshadowing

developments eminent in the following FBT/LBI. Please clarify.

Lines 579-584. “Overall, the results of our macro-archaeological analyses are complex, surprising, and to some extent sobering”. “…our results confirm the broad heuristic utility of some traditional named cultural taxonomic groupings…” (e.g. the Magdalenian, the Ahrensburgian). As mentioned above, I suspect this is in part the result of the data-lumping into NACs and macro-units.