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Multivariate Analysis of lithic industries: the influence of typology

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2.1 Introduction

Several examples have recently been published of multivariate analysis applied to the Mesolithic industries of north-west Europe. These analyses are distinguished by the statistical methods used (Principal Components or Correspondence Analysis) and by the typological frame of the description of the lithic industries. Concerning the archaeological interpretation of the results obtained by these authors, large differences among lithic industries are obvious but their significance and correlation with the chronology and/or regional trends or cultural differentiation differ greatly from one author to another.

The aim of the present study is to compare the results obtained by means of the two multivariate methods and to test the influence of the typology on these results. Our conclusions are that:

- Correspondence Analysis seems more suitable for the purpose of comparing frequency tables; and
- all typologies give similar results. Neither very refined lists of types nor comprehensive analysis, including common tools, improve the accuracy or the readability of the results.

2.2 Correspondence Analysis

Correspondence Analysis (CA) is a multivariate factorial analysis technique originating in France during the sixties (see references in Bølviken *et al.* 1982 and in Djindjian 1985). This is a method close to Principal Components Analysis (PCA) but two main differences distinguish them:

- CA applies to contingency tables and other comparable matrices (*i.e.* ones where marginal totals are meaningful). A matrix is transformed symetrically on rows and columns in order to allow dual analysis. Rows (observations) and columns (variables) may be projected onto the same plot and in the same axis; this point is of great interest for the interpretation of the axes.
- A distributional ('Chi-square') distance formula is used, which allows the analysis of discrete and presence/absence attributes.

The suitability of CA for the study of lithic assemblages has been demonstrated particularly by François Djindjian (1985).

2.3 Mesolithic typology

There is no general agreement about the typology used for the description of Mesolithic inventories as is the case for Palaeolithic ones. A preliminary distinction is made between common tools, like scrapers or burins, and microliths or armatures, which are more sensitive to change and seem, for that reason, more useful for analysis. In some cases, only microliths are published.

The second point concerns the refinement of the typological analysis. J.-G. Rozoy (Rozoy 1978) uses a long list of 132 types which include both common tools and microliths. Other researchers prefer shorter lists, with 20 or 30 types of artefact. In order to test if analysis can safely be conducted with only class-oriented typologies, I have chosen, for this work, a list of height classes of microliths, corresponding to the main subdivisions of Rozoy's list for microliths.

2.4 The analysis

The following examples may be compared:

1. Kozlowski *et al.* 1980 present the results of a PCA applied to European Palaeolithic and Mesolithic industries described with a 13-class typology, which includes all tools. (Microliths, for instance, pertain to class *K* but are not distinguished more precisely.) In this paper, only the broad results can be considered, especially for the Mesolithic, since the more sensitive artefacts for that period are not considered in detail by the original authors. Even so, however, they are able to show the main subdivision of the north-west European Mesolithic into three groups: Beuron-Coincy, Lower Rhein and Montbani (Kozlowski *et al.* 1980, Fig. 38).

2. Jacques Hinout (1984) studies 22 sites of the Paris basin by means of PCA. Two analyses were carried out: the first included all tools (list of 39 types) while the second was restricted to 27 types of microlith. The general outline of the results is the same in both cases but the second analysis gives a better separation of assemblage groups. Sites in the south and north of the Paris basin are separated on the first axis, the former being attributed to the Sauveterrian culture and the later to the Tardenoisian, with the distinction of a 'Mauregny' facies.

3. The same data were used in a Correspondence Analysis carried out by three students of F. Djindjian (Bouvet *et al.* 1985). They adopted the same typological list of 38 tools and armatures and tested again to see if analyses restricted to microliths could give divergent results. In fact, they obtained similar results to Hinout, especially on the first two axes, but with a more accurate view of the differences between geographical groups and a safer way of interpreting the remaining axis (owing to the fact that types and sites may be projected onto the same axis).

   Their observations lead to the conclusion that Correspondence Analysis is a better method for separating groups of industries and interpreting them in terms of chronology and regional trends. In particular, they show that CA can cope better with the problem of over-representation of exceptional artefacts in some sites.

4. Jean-Louis Slachmuylder (Slachmuylder 1985, Slachmuylder 1986) applies CA to the data collected and published by J.-G. Rozoy (Rozoy 1978) and P. Vermeersch (Vermeersch 1982) from eighteen late Palaeolithic and Mesolithic sites in Belgium and the Netherlands. The typology used is the long list (132 types) proposed by Rozoy but Slachmuylder conducted two analyses, the second restricted to the 58 types of microlith. The two analyses gave similar results but the second one presents a clearer picture of the differences between groups of sites. The author claims to see on the first-second axis projection a 'horseshoe' (Guttman) effect and interprets it in terms of chronological ordering, thus following the conclusions of Rozoy 1978. Moreover, Slachmuylder tries to give a mathematical extrapolation of the dating of the industries from their position on the parabolic curve.

5. I have myself applied Correspondence Analysis to the same data but with a strongly restricted typology, including only the microliths distributed into eight classes. I have excluded from the analysis the three oldest series of Slachmuylder's data, series which pertain to late Palaeolithic Tjongerian industries and do not contain any microliths comparable to those included in the Mesolithic assemblages. The results are similar to those obtained by J.-L. Slachmuylder except that rather than forming a parabolic curve on the first two axes, settlements are clustered on the plot (see Fig. 2.1). The first axis quite clearly separates Ahrensburgian (REM, Gxx) and Montbanian (WEx, OPR) series, which are related, respectively, to variables V8 (Ahrensburg points) + V1 (Zonhoven points) and V5 (trapezes). This clustering matches the chronological distribution of sites: the former are dated to Dryas III and the later to the early Atlantic period. The middle Mesolithic sites are scattered on the lower part of the plot, showing a gradient between V1 and V2 + V3 (base-retouched point and triangles).

   The Guttman effect hypothesized by Slachmuylder does not appear here. This is even more obvious if we neglect the two series of Lommel (LOG and LOM) which are probably mixed. The consideration of other plots (Figs. 2.2–2.3) reinforces this opinion.

6. A second set of analyses has been carried out on data from 21 settlements in the eastern part of Belgium (Ardennes—for the description of data, see Gob 1981). The same 8-class typology has been used and the results show a similar structure (Fig. 2.4):

   - there is a separation between late (on the left of the plot), early (upper right corner) and middle (lower left corner) Mesolithic; and
   - among middle Mesolithic settlements, there is no clear differentiation or ordering.

2.5 Comparison of the analyses

By comparing the results of these analyses in terms of statistical methodology, we can see that the first axis shows the dominant differentiation between sites and this clustering is generally strongly marked. It corresponds to up to 45% of the total variance of the population (with an 8-class typology). This first-order differentiation, which corresponds to major cultural or industrial differentiation, can be linked with geographical classification, as in the Paris basin, or chronological ordering, as appears in Belgium and the southern Netherlands.

The reduction of the typology refinement does not obscure the clustering but rather emphasises it by avoiding the general 'noise' introduced by the extremely high number of attributes and the

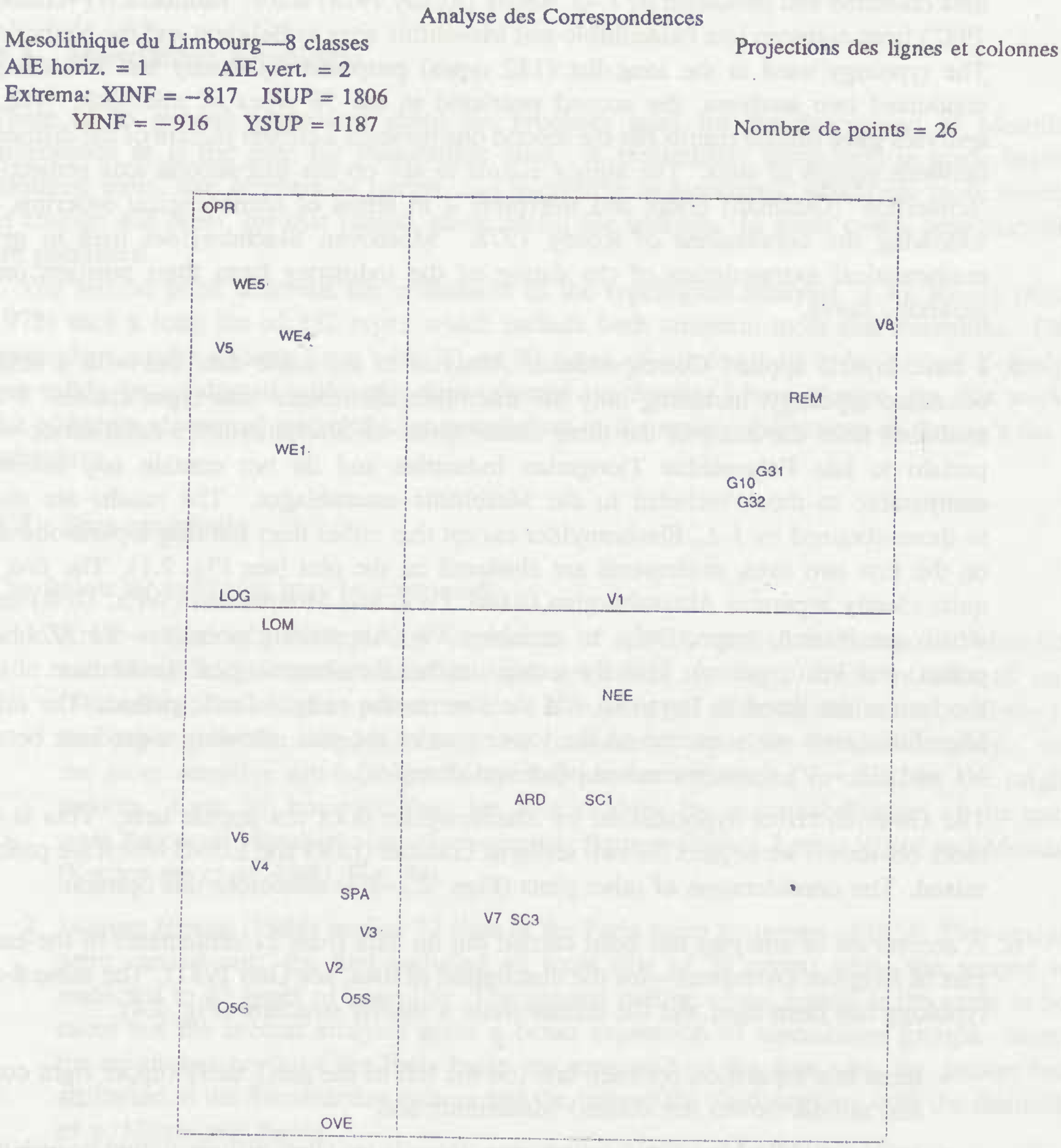

Fig. 2.1: Mesolithic of Belgian Limburg and southern Netherland.
Projection on axis 1–2

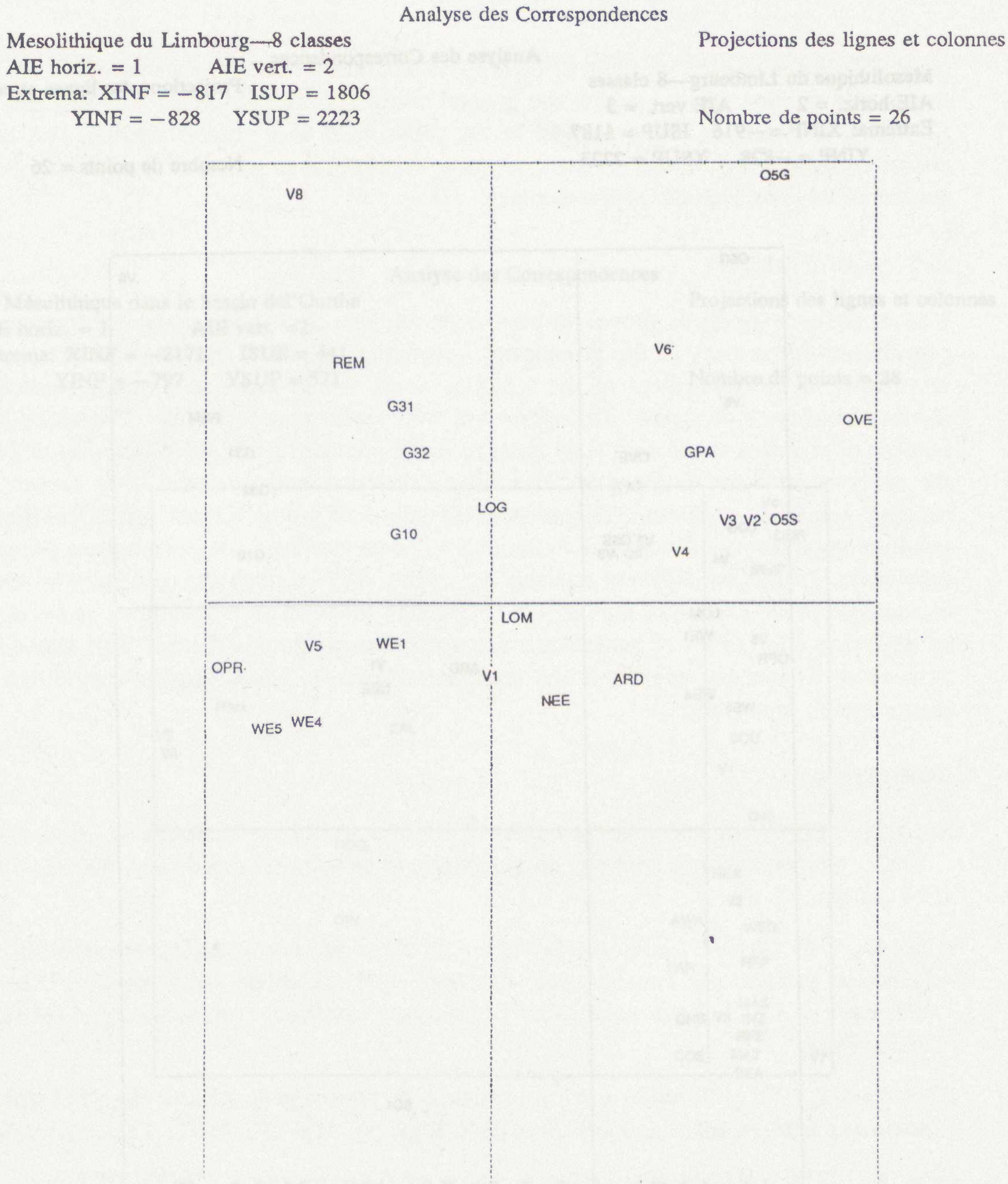

Fig. 2.2: Mesolithic of Belgian Limburg and southern Netherland.
Projection on axis 1–3

Analyse des Correspondences

Mesolithique du Limbourg—8 classes
AIE horiz. = 2 AIE vert. = 3
Extrema: XINF = −916 ISUP = 1187
YINF = −828 YSUP = 2223

Projections des lignes et colonnes

Nombre de points = 26

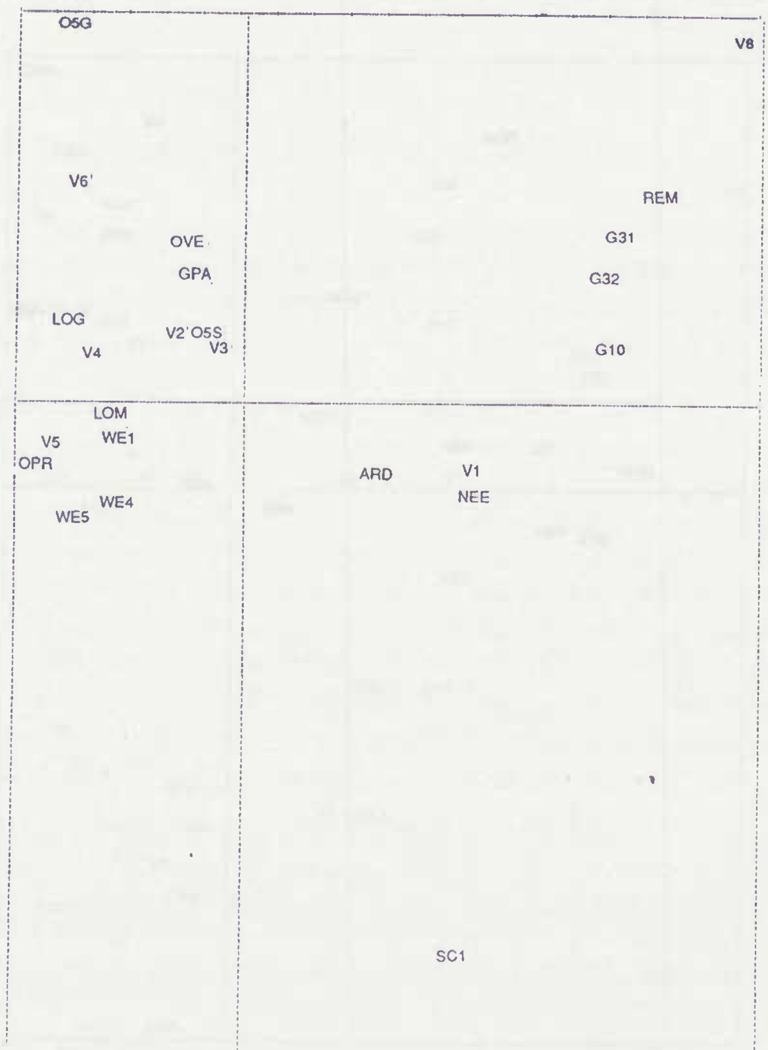

Fig. 2.3: Mesolithic of Belgian Limburg and southern Netherland.
Projection on axis 2–3

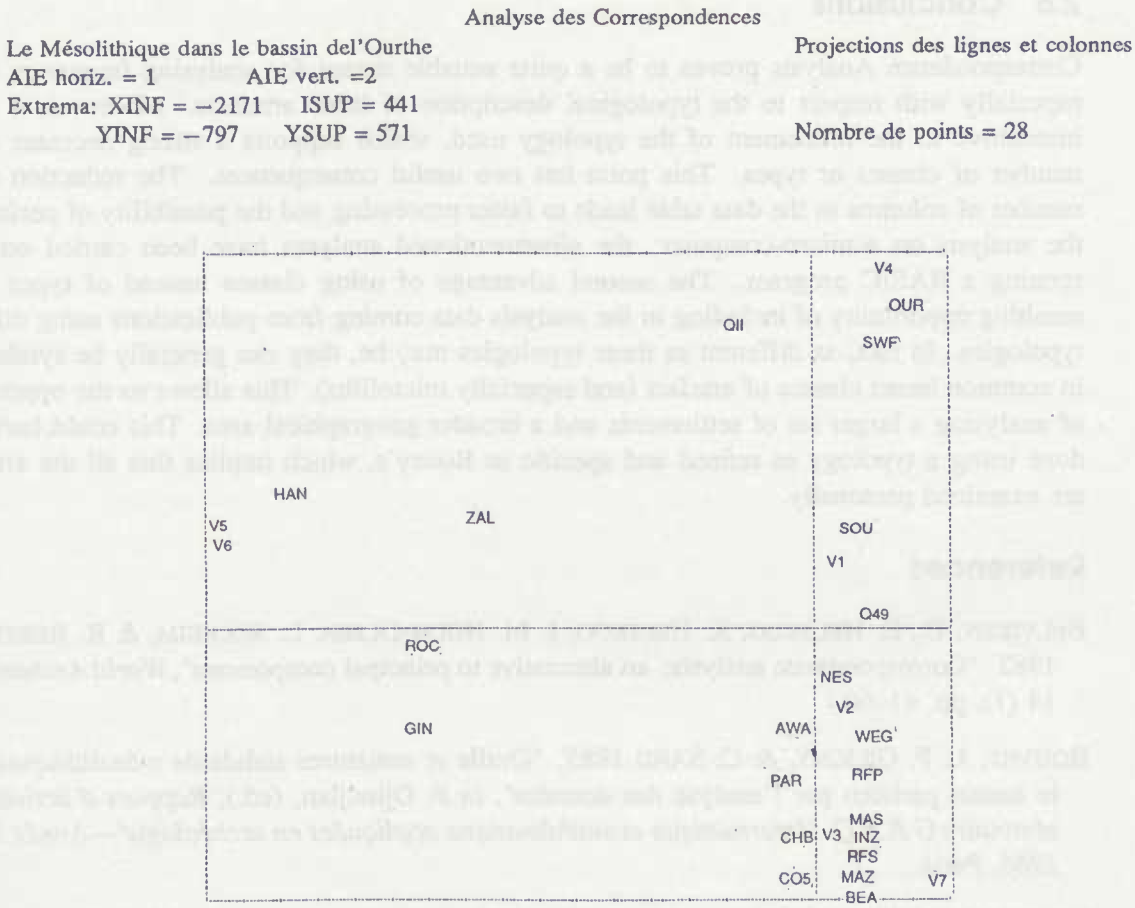

Fig. 2.4: Mesolithic of Ourthe basin (east Belgium)
Projection on axis 1–2.

quite peculiar versatility of some of them. The remaining axis gives a more detailed picture of the scatter of sites, while keeping the general outline. Correspondence Analysis and Principal Components Analysis, when applied to the same data, give similar results. But the former shows better the opportunity to interpret these results and to test their stability by designating some variables or sites as 'supplementary'.

2.6 Conclusions

Correspondence Analysis proves to be a quite suitable means for analysing frequency tables, especially with respect to the typological description of lithic artefacts. Moreover, it seems insensitive to the refinement of the typology used, which supports a strong decrease of the number of classes or types. This point has two useful consequences. The reduction of the number of columns in the data table leads to faster processing and the possibility of performing the analysis on a micro-computer: the aforementioned analyses have been carried on a PC running a BASIC program. The second advantage of using classes instead of types is the resulting opportunity of including in the analysis data coming from publications using different typologies. In fact, as different as these typologies may be, they can generally be synthesized in common broad classes of artefact (and especially microliths). This allows us the opportunity of analysing a larger set of settlements and a broader geographical area. This could hardly be done using a typology as refined and specific as Rozoy's, which implies that all the artefacts are examined personally.

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