Typometric Characterisation of the Lithic Industry

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Introduction

The term *typometry* includes different sections, that can be assigned under the title of *Archaeometry*. To be precise, typometry should be understood to be all the susceptible aspects, of the measuring of typologisable objects, or structures. This definition includes a very wide range of measurements. However, in Archaeology, a more restricted conception of the concept has come to be admitted, applied exclusively to the diverse dimensions of objects recovered, during the course of archaeological activity. In this sense, the collection of typometric data constitutes one of the most routine, and scarcely, scientifically redeemable tasks of investigation. This paper will include the presentation of some examples, relative to series of lithic data, systematically collected, in all the typological studies, that can be undertaken.

Despite the fact that some of the most outstanding phenomena of a cultural evolution are framed, within definitions of a typometric nature (like the Leptolithisation process, during the Upper Palaeolithic, or the Microlithisation process, during the Epipalaeolithic), empirical observations, regarding their mathematical correlation (the degree of leptolithisation, or microlithism, of the lithic blanks) are usually insufficiently documented or contrasted. The aim of this work lies in proposing some alternative methods, sustained in computing, to optimise the typometric information, obtained from a lithic series.

The most frequent typometric analysis is based on an abbreviated interpretation of the Bagolini proposal (Bagolini, 1968), expressed, in concrete terms, in the representation of a cloud of points that crosses the length and width of the whole lithic blanks. In a study of this nature, it is not normal to include the respective representations, of the division of the cloud of points, into thirty-six dimensional modules in histograms, despite being associated with the Bagolini proposal. As regards the established findings in this field, by other authors, such as Bohmers, Moberg, Morelon (Morelon & Vilain, 1971), or Laplace, and others (Laplace, 1974, 1976 and 1977; Lesage, 1973), they have practically fallen into oblivion, with the exception of some of Laplace´s observations, about certain typometric indexes (lengthening or careenage).

The typometric section, of lithic studies and publications, is not in the habit of being very detailed, to the extent, that the method of data collection, itself, is rarely described, despite the fact that diverse systematics, which obtain very different data, exist to measure objects. Our proposal includes the development of new methods of approximation to the typometric phenomenon, starting from series of data, obtained using homogeneous methodology, and centred on a period from the Palaeolithic (the origin of the Leptolithic), characterised by new technometric habits and behaviour. From the methodological point of view, computer data support is fundamental, in order to mathematically synthesise, and graphically represent the results of the analysis. However, the depth of the problem treated goes beyond the proposed period, and even the framework, of the lithic series: new methods of approximation, to the problem of typometry, may generate proposals of interest, for their application in other types of industry, or archaeological remains, in series with sufficiently wide measurements.

General objectives and methodology applied

The principal objective of this paper is to raise the question of whether to use alternative formulae, rather than classical typometric analysis, in such a way, so that results of the enormous measuring tasks, carried uot on lithic series, can be obtained, in a more efficient manner. Often, exclusively intuitive models, of typometric analysis, have been used. Over the course of the last few years, we have been trying out the application (Arrizabalaga, 1994, 1995, and 1997), within this field, of procedures characteristic of so-called, "Spatial Archaeology", considering the dispersion of points, on Bagolini's classic cloud, in terms of the dispersion of archaeological objects, on the surface of the site (Hodder & Orton, 1990; Koetje, 1987; Simek, 1984 or Whallon, 1984).

To this end, the application of the ARCHANAL packet has been particularly useful, in the distribution of points, on the typometric cloud.The first step, in the employment of this method, is measuring the lithic elements and entering them into a database, compatible with ARCHANAL. Depending on the subsequent uses, that this database will be employed for, the materials will subsequently be exported, to the SCAT, GRID, KMEANS or KOETJE programmes, within the aforementioned packet. Following this, the treatments, that different lithic series, from the early stages of the Cantabrian Leptolithic period, have been subjected to, and their respective interpretative potential, will be described superficially.

In the sites and levels reviewed (early stages of the Upper Palaeolithic, in the Western Cantabrian area), all the complete lithic remains (not retouched, or retouched, provided the retouching didn't greatly affect the general dimensions of the blank) were measured. The measuring procedure constituted the one, described as a "minimal rectangle", by Georges Laplace (Laplace, 1977, page 35), with some variants, sufficiently described in a recent publication (Arrizabalaga, 1997). Once the corresponding measurements were taken, they were included in a simple database (Dbase format), from which the data was subsequently exported (Arrizabalaga & Iriarte, 1994), to the ANTANA format (which is required by the ARCHANAL Packet).

Graphic analysis of hierarchical variables

The ranking of variables, and their subsequent graphic analysis, constitutes a treatment, that is extremely adequate, for relating the typometric structure of the lithic industry to other variables, and, in such a way, that some patterns of technical behaviour, for the studied sample, can be established. We can guide ourselves, by way of an example (level 10 of the Morín Cave), in which a significant presence, of different raw materials (of silex) is in evidence. If we rank the "raw material" variable, and observe the disposition of the different, whole blanks (Figures 1 to 5) on the typometric cloud, we will be able to intuit some patterns of typometric behaviour, for each of the materials analysed. These can, in turn, be interpreted, in accordance with the dominant presentation of this raw material, in the surroundings; and the technological interest, then leads human beings to carry out this work, decide which instruments should be used to do the work, etc.

The same treatment can be employed, in the case of any other variable (varieties of butts, typological groups for assignation of implements, etc.), that may have some kind of interconnection, with typometric structure, or, that may be interpreted in this sense. In short, it is a matter of differentiating, between the relative position of different variables, within the cloud of typometric points, that are considered to be significant, or, whose possible significance might need to be contrasted. Given the versatility of the method, in the space of only a few minutes, the typometric implication, of any collected variable, can be subjected to examination.

Employment of trend surface analysis

The classic, dimensional representation, of a lithic series, is formulated through the tedious task of manually ploting a cloud of points, in which we are confronted with the paradox, that a presence, in excess of 250 or 300 elements, progressively hinders the possibility for reaching any conclusion about the produced diagram. Furthermore, it seems quite debatable, whether or not this kind of representation allows for an extensive objective analysis, and, therefore, the proposal to classify the blanks, into 32 dimensional modules, is not usually completed; the considerations, that are obtained, tend to be extracted, directly from the cloud of points. Or, what is even worse, the cloud of points, itself, is converted into an objective, with the potentiality of the typometric analysis, being considered as exhausted, in a barely eloquent representation.

In this section, we have tested a method, that permits the study of the dispersion of remains on the dimensional plane to be put into objective terms, shaping it like isolines of equal density of representation. In a synthetic manner, minimal conventions have been established, so that all the analyses are comparable to each other, in such a way, that an automated recount, of the volume of remains, present at different points on the dimensional plane, can be carried out. Interpolating the data, where necessary, a reading of the density of points, in the form of isolines or trend surfaces, can be obtained.

General criteria. In order that the proposed method functions, with a certain degree of versatility, it has been necessary to establish a series of criteria, from the outset, which have been upheld, in a prior empirical analysis. According to the criteria established, debris of minimal dimensions (whose dimensions do not exceed one centimetre) have not been measured, so as not to excessively slant the gravitational tendency, of the cloud of points, towards the origin of the co-ordinates (in ideal conditions, and on a closed ensemble, knapping gives rise to much more small debris than large remains). On all the possible polygons, that cover a surface in a regular manner, the squared form has been selected for the cells, that will serve as the basis for the recounting of the points, present in each unit of surface, on the typometric cloud. Some dimensions, from the side of this 5mm reticle, have also been selected, although the units with sides, measuring 10mm, have also proved to be highly reliable. Finally, a conventional threshold, of 100 remains, has been agreed upon, given that, below this, it is not convenient to carry out this analysis, since fully comparable results are not obtained (as well as an advised interval of isolines, in a graded series of 5 to 10 remains per concentric surface).

Formalisation. Once the corpus of typometric data, that is to be analysed, is available, this data should be exported, from the database in question, to the GRID programme, within the ARCHANAL packet. This programme will attend to the matter, of carrying out the recounting of points, in each of the cells, defined within the typometric cloud, according to the dimensions of said clouds. With some, minimum formal adaptations (the elimination of the first two lines of the archive, and the inclusion of sample dimensions), the recount, obtained by the GRID programme, can be exported, directly to another programme, such as SURFER, which will reconstruct the dispersion map of the findings described above, in terms of density isolines (Figure 6).

In any of the employed programmes (they normally correspond to programmes, prepared to carry out topographic surveys, translating altitudinal readings to contour lines), like SURFER, it will be necessary to establish criteria, for the interpolation of isolines, since they will always be arranged, at regular intervals. A method, based on the inverse distance between the points, has been preferred to the alternative procedure, based on the interpolation procedure, by Kriging. This method is adjusted, in an excessive manner, to the literality of point dispersions, when, in actual fact, what needs to be done, to provoke the points, most isolated from the nucleus of the cloud, is to slightly correct the dispersal effect. In this sense, the inverse distance method implies a less exact image, but a more average vision of reality (with the aim that this deviation, of the literal dispersion, is not excessive; it has only interpolated, with the square of the inverse distance; since, as the exponent increases, the correction, of the accuracy of dispersion, is more pronounced).

Once the dispersal effect of points, isolated in zones, very far away from the nucleus of the cloud, has been corrected, the first isoline indicates the outside limit, of the regular distribution of points. The last isoline indicates the area of dispersion, in which the average finding of points is the highest. The laminarity threshold (in this case, Lengthening Index = 1'618) has also been highlighted, in our diagrams, in such a way, that the typological cloud, or the trend surface analysis, can be found perfectly, with regard to this typometric condition (Figures 6 to 8).

Interpretation. The potentiality of the described method of representation requires the interpretation of three different sections, of the trend surface analysis: dimension, disposition, and design. The first section refers to the maximum area of dispersion, although this surface must always be considered as the result of statistical correction, depending on the distance, to the nucleus, of the dispersion: the isolated and very distant points will not be reflected. The dimensions of the minimum area are less relevant, although it is interesting to observe the velocity of the gradation of density, or the proximity at certain points, of the isolines. A slow gradation indicates greater homogeneity in the dispersion. If, on the contrary, the isolines tend to be distanced from each other, in a brusque manner, the nucleus of the distribution (its minimum area) groups together the remains, in a very relevant way, and will exist in the technical behaviours, that the sample generates, in a very persistent typometric module.

The disposition of the trend surfaces can be assessed through lateral guides, expressing the dimensions of the sample in centimetres. The organisation of the maximum area, in relation to the laminarity axis or threshold, supplies us with an approximate reading, of the laminarisation of the sample. To this end, the position of the minimum area of dispersion is also significant, with regard to this same reference.

Finally, the design, of the trend surfaces, provides highly interesting data, in different cases. On occasions, various trends, in the distribution of the series, exist (various different nuclei of the trend surface analysis), which reflect a certain degree of heterogeneity in the sample, and possibly a complementary factor, such as the use of different raw materials, the mixture of different stratigraphic units, or the lack of part of the lithic record (perhaps because of a deficient sift), etc. The morphology of the maximum area is also significant, since it can be rounded up, or present different appendices, which are wont to indicate the use of co-dominant raw materials. Vectors or trend lines that protract, cutting across different isolines, and at times, stretching from the distribution knot to the maximum area, are also frequently observed. This is a matter of phenomena, that indicate a certain degree of heterogeneity, within the typometric distribution of the sample (although, they are much more common than the aforementioned, polymodal distributions).

Distribution of non-hierarchical variables

A third technique exists, which permits the typometric analysis to be carried out in objective terms, and whose use has been reserved for those cases, in which the previous methods of analysis (exactly as they have been shown, or combined with one another) do not permit sound judgements (nor do they provide the simple observation of one typometric cloud, with hierarchical variables). The interpretation of the grouping together of points, or clusters, generated on the cloud, according to a non-hierarchical criterion, at times, enables this problem to be resolved (Figures 9 to 11).

The computing procedure, in order to obtain this data, is the following: the same original database for this study (without indicating the variable, since in the non-hierarchical analysis, all information, which is not situated in the heart of the cloud, is going to be done away with) is subjected to the KMEANS programme, from the ARCHANAL packet, which, depending on the distances, measured between each point and all the others, creates as many clusters, as the archaeologist asks it to (in this case, tests will normally be carried out with two or three clusters). Each cluster will include the points that are closer to the centre of the cluster, itself, than to the respective centres of the other clusters. It is then, that, now including the ranked variable, and by using the KOETJE Programme, we can find out how many elements, corresponding to each variable, are physically situated within each established unit. In this way, we will be able to use the squared contingency criterion, or any other criterion, that is based on the X^2 method (Tables 1 and 2), in order to assess whether, or not, it is possible to obtain an archaeological conclusion (if the resultant distribution is significant, the studied variable has repercussions, from the point of view of the typometric result obtained). Since the base data are always the same (the co-ordinates of the dimensions of each of the whole lithic remains), it is only necessary to carry out a Kmeans analysis, with the possibility to carry out as many revisions, of the randomness of the dimensions, as desired, applying different variables, and performing the detailed study, using the Koetje programme, each time.

	Flint	**Other**
Cluster 1:	283	23
Cluster 2:	58	31

Table 1. Level VI in Amalda. Raw material (2 clusters)

	Unret.	**Ret.**
Cluster 1:	271	35
Cluster 2:	51	38

Table 2. Level VI in Amalda. Blanks (2 clusters)

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