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DISCRIMINANT FUNCTION ANALYSIS (DFA) OF MIXED LITHIC SCATTERS IN THE NORTH-EAST OF ENGLAND: A CASE OF MISCLASSIFIED IDENTITY?

by R. Young and D. Kay

In 1985, at the conference 'Breaking the Stony Silence' held in Sheffield, one of the present authors (RY) gave a paper entitled 'Mixed Lithic Scatters and the Mesolithic-Neolithic Transition in the North-East of England: a Speculation' (Young forthcoming). In this it was argued that the growing number of sites coming to light in the north-east which show basic Mesolithic-type assemblages in surface association with typologically later material (predominantly leaf-shaped and barbed and tanged projectile points) might represent late, if not the latest, Neolithic sites in the area, standing right at the interface of the local Mesolithic/Neolithic transition.

This contention was argued in detail in Sheffield and, as the paper is to be published, there seems little need to rehearse the main points here. However, the contribution did cause some interesting discussion, with some colleagues arguing that the mixture of material was fortuitous, the product of re-use of favourable locations over a long period of time or the end result of ploughing or other erosional factors.

Spurred on by this kind of discussion, we determined to try to test our theory statistically, if possible. To this end a discriminant function analysis (DFA) was conducted on material from the Wear Valley area of Co. Durham (Young 1987) to examine the extent to which simple measurements of length, breadth, thickness, weight and angle of retouch, on a variety of categories of lithic material, could provide 'objective' measurements of discrimination between Mesolithic and Neolithic/Bronze Age assemblages in the area.

The categories of material included cores, scrapers, miscellaneous retouched/utilised flakes and complete 'waste' flakes. The approach was inspired by the research of Pitts and Jacobi on postglacial lithic material from excavated contexts in the south of England (Pitts 1978; Pitts and Jacobi 1979). Their work and earlier analyses by Maca (1959) and Smith (1965) among others, shows that it is possible, for southern England at least, to distinguish between Mesolithic, Early, Middle and Late Neolithic and Bronze Age assemblages of waste flakes. This is done on the basis of variation in length and breadth determinations and ratios, with flakes tending to become squatter through time. These observed changes in waste flake shape have proved useful in categorising southern assemblages which have produced no 'diagnostic' artefacts and, mindful of Pitts' warning that things may be different in other areas of Britain, we were anxious to see if a similar situation prevailed in the area of study.

This is the first time that such an analytical programme has been carried out on north-eastern material, and it was hoped that, if it proved possible to discriminate between Mesolithic and Neolithic/Bronze Age material on these bases, then, by broadening the scale of the analysis to include mixed assemblages, we might be able to say whether these latter had more of an affinity with either Mesolithic or Neolithic/Bronze

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Age groupings. Thus a possible mechanism for testing some of the ideas expressed in the Sheffield paper might be generated.

As Table 1 and Figures 1 to 3 illustrate, the situation was indeed different in the north-east of England. DFA proved incapable of distinguishing material from sites of known date as suggested by the presence of diagnostic tool types. The results of the analyses are presented and the implications of the results for the north-east are discussed below.

Discriminant Function Analysis

The technique of DFA requires data from object groups of known origin (or in this case broad date). This information is used to define a discriminant function which can be applied to mixed groups of objects of unknown origin (date) with the aim of classifying them into predicted groups (Norusis 1985). It is thus essential that any calculated discriminant function is shown to be capable of discriminating between objects of known origin (date) before it is applied to material from indeterminate groups (in this case the mixed lithic assemblages). This primary step in the analysis is usually accomplished by applying the calculated function to the groups from which it was calculated (Mesolithic and Neolithic/Bronze Age assemblages) and then examining the number of objects 'misclassified' by the calibrated discriminant function. An object is said to be misclassified when, on the basis of the discriminating criteria being applied, the computer can place it in either group under analysis (e.g. Mesolithic or Neolithic/Bronze Age).

The percentage of misclassified objects offers the simplest criterion on which to judge the efficiency of a discriminant function. The high proportions of misclassification among all artefact types studied (Table 1) renders it likely that the level would be even higher if the model was applied to a new sample from the same population of objects (Lachenbruch 1975).

Examination of the function canonical correlation co-efficients and the Wilk's lambda values in Table 1. Wilk's lambda offers a measure of the degree of discrimination between groups, and ranges from zero to 1. A value close to 1 indicates that the mean discriminant score is similar for all groups, i.e. the model offers only poor discrimination value.

<table>
<thead>
<tr>
<th>MAT. &amp; VARIABLES</th>
<th>GROUP NUMBERS</th>
<th>MISCLASS.</th>
<th>FUNCTION CANONICAL CORRELATION</th>
<th>WILK'S DEGREES</th>
<th>SIGNIFICANCE</th>
<th>LAMBDAA</th>
<th>COEFFICIENT</th>
<th>FREEDOM</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEO/BA</td>
<td>NEO/BA</td>
<td>NEO/BA</td>
<td>NEO/BA</td>
<td>NEO/BA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CORES L.B.T,W</td>
<td>61</td>
<td>34</td>
<td>21(34)</td>
<td>14(41)</td>
<td>0.1783</td>
<td>0.9682</td>
<td>2</td>
<td>0.298</td>
</tr>
<tr>
<td>SCRAPERS L,B,T,A</td>
<td>39</td>
<td>19</td>
<td>13(42)</td>
<td>5(56)</td>
<td>0.2313</td>
<td>0.9465</td>
<td>2</td>
<td>0.361</td>
</tr>
<tr>
<td>WASTE FLAKES L.B</td>
<td>451</td>
<td>185</td>
<td>166(37)</td>
<td>99(54)</td>
<td>0.1127</td>
<td>0.9873</td>
<td>2</td>
<td>0.0175</td>
</tr>
<tr>
<td>MIS.RETouched/UTILISED FLAKES L.B</td>
<td>78</td>
<td>19</td>
<td>28(36)</td>
<td>11(58)</td>
<td>0.1557</td>
<td>0.9758</td>
<td>2</td>
<td>0.3156</td>
</tr>
</tbody>
</table>

Table 1. Statistical results of DFA on various categories of lithic material from Mesolithic and Neolithic/Bronze Age sites in the Wear valley area of County Durham.

The poor performance of each of the discriminant functions calculated for the Wear valley material is evident from an examination of the function canonical correlation co-efficients and the Wilk's lambda values in Table 1. Wilk's lambda offers a measure of the degree of discrimination between groups, and ranges from zero to 1. A value close to 1 indicates that the mean discriminant score is similar for all groups, i.e. the model offers only poor discrimination value.

Fig. 1. Diagramatic representation of computer misclassifications for Mesolithic and Neolithic/Bronze Age waste flakes.

Only the complete 'waste' flake data produced a Wilk's lambda value which is statistically significant at the 95% level (Table 1). The test of significance merely indicates that the group's means are significantly different. It does not guarantee satisfactory discrimination.

The values of the function canonical correlation co-efficients confirm the overall picture of poor discriminant functions. These also take values of zero to 1 and they quantify the association between the groups and the discriminant scores. In the two group case presented here the coefficient is the equivalent of a Pearson correlation coefficient and it can be
seen that there is little statistical association between
discriminant scores and groups. Hence the discrimination
produced by the model is poor.

Clearly the inability of DFA to provide acceptable
discriminating criteria and the high number of misclassified
objects in this instance raises many questions. Without
diagnostic tool types, what mechanisms can be used to place
north-eastern lithic assemblages into broad date categories? In
response to this problem, it was hoped that the
retouched/utilised/objects discriminant scores produced
from Mesolithic and Neolithic/Bronze Age sites might show some useful change through time which
could be applied to more diagnostic sites but again, as Table 1
shows, this was not the case.

Through time, a point which may be supported by the DFA carried
out on cores from the area. As a result the diagnostic
technological changes visible in the work of Pitts et al. may
not have taken place in the north-east region. Thus the size of
cores may constrain variables such as length of flake.
Similarly, flake and core breadth may be constrained by working
techniques and the nature of the raw material. Even features
which seem unrelated to raw material, such as angle of retouch
on scraper edges, seems to show no statistically discernible
variation through time.

Fig. 3. Diagramatic representation of computer misclassifi-
fications for Mesolithic and Neolithic/Bronze Age cores

Conclusion and Future prospects

Analysis of northern English surface-collected lithic
material using DFA seems to be of little practical
applicability. If DFA cannot discriminate between assemblages
possessing diagnostic artefacts then it cannot be applied to the
mixed assemblages in an attempt to resolve the problem of their
closest affinities.
This may seem a pessimistic note on which to end, but we have shown that the detailed observations made by earlier researchers in the south of England may have no validity in the northern regions where similar work has not been previously undertaken.

We do not feel that the conclusions put forward in the Sheffield paper, referred to above, have in any way been invalidated by our statistical analyses. Indeed we would welcome feedback from colleagues with an interest in the statistical analysis of lithic material with a view to applying further discrimination tests to our sample.

Perhaps the only real test of the speculations set out in the first part of this paper would be to excavate, and date by 14C, undisturbed Neolithic, Neolithic/Bronze Age and mixed sites in situ. However, therein lies the main problem, for the presence of these sites is only indicated after ploughing and/or erosion, which ultimately destroys stratigraphical relationships, has taken place.

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REVIEWS


To echo Rae in his introductory article, this publication is a 'very worthwhile addition' to the literature of the Old Stone Age in this country. It addresses a theme which has otherwise tended to be treated as peripheral in the face of the overwhelming preponderance of flint in the collections preserved in Britain's museums. The book undoubtedly faces up to this need, therefore. But, more than is usually the case, it may also be seen as a sort of social document reflecting the very diverse character of Palaeolithic occupation in this country ... which is largely responsible for the book's form and content, and indeed both its strengths and its weaknesses. It gives an insight, valuable and also unusual in a single volume, into the range of activity and of the practitioners themselves, amateur and professional. Its chapters are correspondingly diverse in their approach and presentation. They give the impression of having been edited with a fairly light touch, too, so the personalities of the contributors have not been reduced to a common shade of academic grey.

The book is divided into a number of parts, some represented by a single chapter, others by several. It ends with a Gazetteer of known non-flint artefacts.

Wymer offers a brief reassessment of the geographical range of the British Lower Palaeolithic, mapping finds from above the Severn-Wash line and concluding that the picture has changed rather little since a similar essay by Boyd Dawkins in 1910. This is followed by two papers on experimental flint Manufacture. The first is by Moloney, Bergman, Newcomer and Wemban-Smith and is based on Bunter quartzite pebbles as raw material. The results are set against British and continental archaeological data. The second is written by Moloney alone, looking at eight different rock types, and is even more carefully documented. Among other conclusions, it was found that the initial selection of the block of raw material is more critical for hard rocks than it is for flint.

The volume then develops a 'regional' structure, with four papers on the Midlands of England, six on the Upper Thames, and one on Southern England. Within this scheme, though, there is great diversity. Saville describes the Waite collection from the Nunstanton area, followed by Shotton on Wolstonian geology and north Warwickshire finds. MacRae then undertakes a brief historical synthesis of research in Warwickshire; the section is concluded by Whitehead, who catalogues finds from the Severn-Avon valley.

Consideration of the Upper Thames starts with a useful account of the area and its quartzite implements, by MacRae, who has done much good work collecting thereabouts. This includes an extended description of the third largest, handaxe in Britain - actually of flint, from Stanton Harcourt and christened the "Giant of Gravelly Guy" (for the benefit of aficionados: the length is 269 mm). A short note by Wallis then