

# Some Aspects Of The Evolution Of The Gravettian Culture In The Eastern Balkans

Tsoni Tsonev

## Abstract

Recent archaeological excavations in northern Bulgaria have revealed one of the longest Gravettian sequences known so far. It has been established that there are significant shifts of raw materials supply within various occupation levels. There seems to be no coherent methodology for interpretation of such data. A formal approach is suggested for fitting and modelling these data and their possible archaeological interpretation.

The Gravettian culture sequence in the Temnata Cave, where 10 cultural levels have been defined, shows a widespread network of raw materials supply. The amount of high quality flints imported from distant outcrops (sources from Greece, Southern Bulgaria, Eastern Serbia, North-eastern Bulgaria have been identified) increases from bottom to top levels as can be seen from the linear model presented elsewhere (Tsonev in press). The differences between extralocal and local amounts of flints ( $X$  - values) are set against the standardised mean values of the length/width ratio of blades ( $b_d$ ). The solution of this linear model shows that there is some covariation between these two values. The hypothesis  $H_0: b_d = 0$  can be considered with some caution as statistically significant at 0.95 significance level. From an archaeological point of view this means that with the increased import of high quality flints there is some change in the knapping techniques.

Further, it is possible to approximate this change by using simple optimisation criteria from the standpoint of the behaviour of the Gravettian communities. For simplicity's sake let us suppose that only two artisans work on a given set of blades from local and imported materials. It is reasonable to suppose that the two workmen differ in their skills, and that for the production of a set of blades of local flints they need a certain amount of time and effort which will be denoted by coefficients  $a$  and  $b$  respectively. The time and effort for production of the same quantity of blades from imported materials will be denoted by coefficients  $c$  and  $d$ . The benefit from the produced set of blades of local flints is  $e$  and the benefit of the other set of blades made of imported flints is  $f$ . The necessary hours for work for the first artisan are  $p$  and for the second one are  $q$ .

The following algebraic model can be written:

$$(1a) aX + cY \leq p$$

$$(1b) bX + dY \leq q$$

$$X \geq 0, Y \geq 0$$

where  $X$  and  $Y$  are the amounts of the local and imported flints respectively. The problem of optimisation consists of finding the points  $(X_0, Y_0)$  where the function of benefit  $eX+fY$  reaches a maximum.

The two inequalities (1a) and (1b) of the model define the domain of the admissible values. The point  $(X_0, Y_0)$  of this domain of admissible values which renders a maximum of the benefit function is found to be one of the summits of the polygon (Bartsch 1990). In this particular case, these are the points  $P_0$  and  $P_1$  (see Fig.1). From the two inequalities two straight lines are easily found whose intersection  $P$  renders maximum benefit. The equations of the two straight lines are the following:

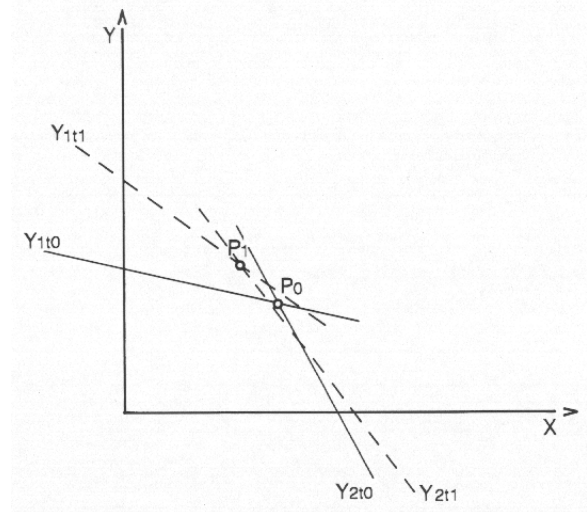
$$(2a) Y_1 = \frac{p-aX}{c}$$

$$(2b) Y_2 = \frac{q-bX}{d}$$

According to our data from the Temnata Cave, the coefficients  $c$  and  $d$  are greater at the bottom part of the sequence of levels, while at the upper part they tend to decrease. Because of the stable cultural tradition in the area we may consider the other coefficients ( $a, b, p, q, e, f$ ) to be constant over time.

From a geometrical point of view, at the beginning of the sequence  $t_0$  the slope of lines  $Y_1$  and  $Y_2$  will be at a certain angle. When coefficients  $c$  and  $d$  decrease, the values of  $Y_1$  and  $Y_2$  increase. The slopes of lines

$Y_1$  and  $Y_2$  become steeper and their intersection point moves upwards. In other words, these straight lines outline a polygon whose summits mark the maximum benefit gained by the Gravettian communities from the import of high quality flints. From an archaeological point of view this formal approach confirms the idea that changes in raw materials procurement patterns are not arbitrary fluctuations. They mark the increasing contacts and exchange mechanisms with distant areas. And these changes were maintained at an optimal level.



**Figure 1. Linear optimisation. The summits defined by the straight lines mark the maximum of the function of benefit.**

## Bibliography

Bartsch, H J, 1990 in Nauka i Iskustvo, Sofia (eds.), *Matematicheski formuli*, 492-496 (translation in Bulgarian of Bartsch, H.J. 1984, in Veb Fachbuchverlag, Leipzig (eds.) *Mathematische Formeln*)  
 Tsonev, T S, in press Evolution of the Gravettian Sequence in Temnata Cave, *Archaeology in Bulgaria* 1.

## Contact details

Tsoni Tsonev  
 Institute of Archaeology and Museums  
 2 Saborna str., 1000 Sofia  
 BULGARIA  
 e-mail: mkoleva@bgearn.acad.bg