

## ASTRONOMICAL ORIENTATIONS OF GRAVES AND SKELETONS IN GOMOLOVA AND MOKRIN

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**Abstract.** The orientations of 25 skeletons in Gomolova cemetery, and 146 graves and 171 skeletons in Mokrin cemetery has been determined. On the bases of the presented method their angular distributions has been studied. We found that the bodies at Gomolova were oriented toward the azimuths of sunrise on the day of death or burial, while our results for Mokrin show that the graves and skeletons were oriented in N-S direction and it appeared that the dead faces pointed toward the point of sunrise.

### 1. INTRODUCTION

The non-random azimuthal orientation of graves and skeletons in some prehistoric cemeteries has been shown by several researchers (e.g., Schlosser and Čierny, 1982, Barlai, 1992, Barlai and Bognár-Kutzián, 1995). The azimuthal distribution of graves and skeletons is cultural dependent (see, e.g., Schlosser and Čierny, 1982). The graves and skeletons often were oriented toward the cardinal points of azimuth (N, S, E, W) or toward the azimuth of the sunrise or sunset on burial day (Barlai, 1980). Our aim in this paper is to show a method for ascertaining of burial cult on the bases of measurements of azimuthal distribution of graves and skeletons, and to present some results of the method in the case of Mokrin and Gomolova cemeteries.

### 2. THE METHOD

By analysing of the angular distribution of orientations of the skeletons (skull to pelvis) and/or graves we are able to determine whether the burial rites were linked with the actual sunrise or with the cardinal points of azimuth. In the former case the width of the angular distribution at its base is equal (of course within error limits) to the difference of azimuths of summer and winter solstices.

The azimuth ( $A$ ) of sunrise (sunset) is given by

$$\cos A = -\frac{\sin \delta}{\cos \phi}, \quad (1)$$

where  $\delta$  is the declination of the sun and  $\phi$  is the geographical latitude of the site. As the declination of the sun change during a year between about  $+23.^\circ 5$  (summer

solstice) and  $-23.^\circ5$  (winter solstice) the azimuth of sunrise (sunset) will vary between its maximum and minimum values that depend on geographical latitude of the site. If we consider a sunrise/sunset burial cult the orientation of graves and/or skeletons will be distributed between these maximum and minimum azimuth values. This fact is in the basis of the method of determination of (sunrise/sunset) burial cult.

A sophisticated analysis of angular distribution of garves and/or skeletons may give information on the rate of mortality during a year. For such kind of analysis it is necessary to know the link between angular velocity of sunrise/sunset azimuth and the date during a year.

The angular velocity of the sunrise (sunset) azimuth ( $\omega_A$ ) is obtained from equation (1) as

$$\omega_A = \frac{dA}{dt} = \frac{\cos \delta}{\cos \phi \sin A} \frac{d\delta}{dt}.$$

Since  $\frac{d\delta}{dt} \neq const.$  the azimuth of sunrise (sunset) vary in non-uniform way during a year. If we suppose that the rate of mortality is constant during a year we shall get a non-uniform azimuthal angular distribution of the number of graves and/or skeletons (ideal distribution).

For analysis of azimuthal distribution of graves and/or skeletons very often are used histograms. It has to be pointed out that the shape of the histogram of an ideal distribution depends on the chosed azimuth interval value (Fig. 1).

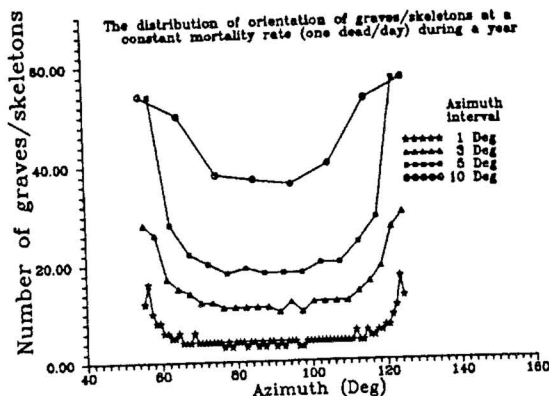


Fig. 1. The azimuthal distributions of orientation of graves/skeletons at a constant mortality rate during a year for different azimuth box intervals.

### 3. MOKRIN

Necropolis Mokrin from the period 2300-2100 B.C. is located in the Northern Banat, East of village Mokrin. Its geographical coordinates are  $45^\circ 55'$  latitude North and  $20^\circ 22'$  longitude East. For our analysis we used the drawings of graves and skeletons given by Girić (1971). We analysed the angular orientation for 171 selected skeletons and 146 graves. The results are presented on histogram in Figure 2a. The distribution

of graves show two narrow peaks at azimuth of  $180^\circ$  and  $0^\circ$  (or  $360^\circ$ ). These two peaks coming from the burial custom that the males were oriented in North-South (N-S) direction (head to south), and the females in opposite direction (South-North (S-N)). There are only a few exceptions from this role.

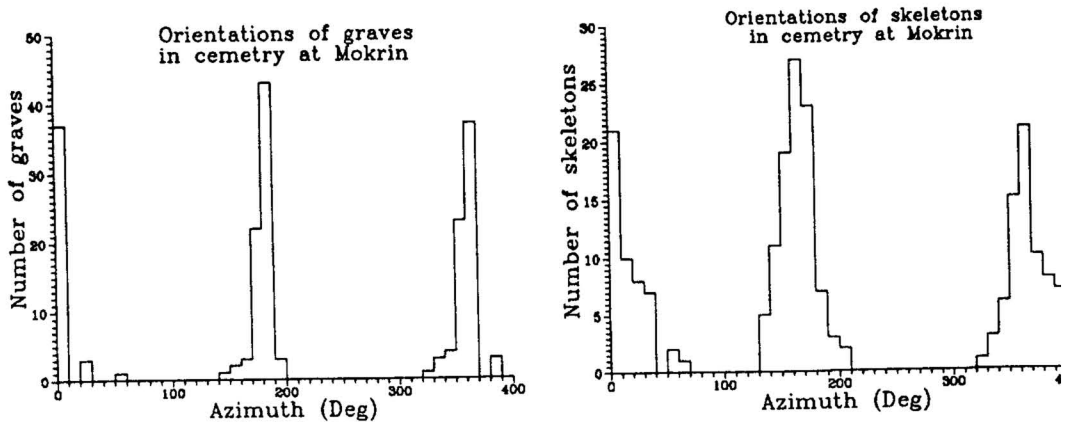


Fig. 2. The angular distributions of grave (a), and skeleton (b) orientations.

As the N-S orientation in principle has not intrinsic angular distribution (e.g., sunrise orientation) we conclude that the measured angular dispersion is originated from different random errors made by prehistoric gravedigger and archaeologist who measured the grave orientation. From this we estimate the upper limit of the accuracy of N-S direction determination by Bronze Age people. As for this question the difference between N-S and S-N orientations is not important, we joint these two distribution into one and find that its gaussian width is equal to  $7.^\circ 5$ . This value we can take for upper limit of N-S direction determination error made by prehistoric gravedigger.

In general, for skeletons we can conclude the same as for graves (Figure 2b.) except that its width is much larger. The gaussian width of distribution is  $25.^\circ 9$ , which is 3.4 times larger than the width of graves distribution. This we can explain with larger errors in orientation of bodies than the graves or with intentionally orientation of their faces toward the sunrise azimuth (and their bodies angular distribution around the N-S direction), i.e., the face was turned to east with some deviation which depends on the season. This last assertion is supported by the fact that the angular width of skeleton distribution at its base is even larger than the difference of sunrise azimuths at summer and winter solscities ( $\approx 60^\circ$ ).

#### 4. GOMOLOVA

Gomolova settlement from the period 4600-4500 B.C. is located near the willage Hrtkovci in Srem. Its geographical coordinates are  $44^\circ 54'$  latitude North and  $19^\circ 45'$  longitude East. In Gomolava there are excavated only 25 graves.

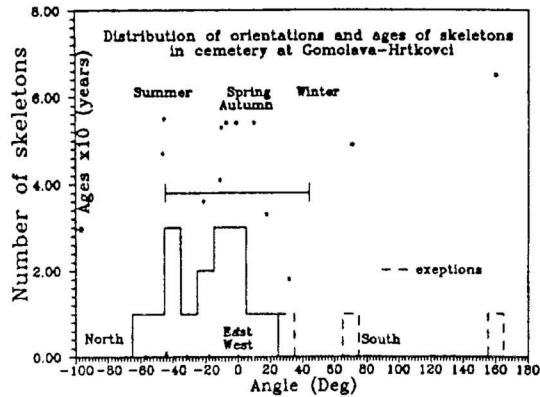


Fig. 3. The angular distribution of skeletons and the age of deads.

The angle of skeleton orientations was measured, on the map of burial site, (skull to pelvis) from East North-wise (-) and South-wise (+). The number of skeletons and the age of deads (Brukner, 1980) versus angle are presented on the Figure 3.

As one can see the skeleton angular distribution show a preferred E-W direction with two peaks (Summer and Spring/Autumn). Exceptions are the skeletons in graves No. 16. ( $160^\circ$ , note that he is the oldest dead) and 17. ( $32^\circ$ ) They were probably throw into a pit without any orientation. The skeleton in grave number 11. is oriented in direction  $71^\circ$  with a comment of author (Girić, 1980) that the orientation is not sure. Spring/Autumn mortality peak is due mostly to older inhabitants. This support the hypothesis that the mortality rate is higher during Spring and Autumn (see, e.g., Barlai, 1980). It is interesting to point out the winter shortage in mortality distribution. The width of distribution at its base is larger than the difference of sunrise azimuths at summer and winter solstices (the horizontal bar on Fig. 3.). This result support the hypothesis that the bodies were oriented toward the azimuths of sunrise or sunset at the day of death or burial.

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