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A.G. Kozintsev
Peter the Great Museum of Anthropology and Ethnography (Kunstkamera), Russian Academy of Sciences,
Universitetskaya nab. 3, St. Petersburg, 199034, Russia
Saint Petersburg State University,
Universitetskaya nab. 7–9, St. Petersburg, 199034, Russia
E-mail: agkozintsev@gmail.com

A Generalized Assessment of Cultural Changes at Stratified Sites: The Case of Chalcolithic Fortresses in the Northwestern Caucasus

A multivariate method for assessing cultural changes at stratified sites is proposed. The variables are technological properties of ceramics, and occurrences of various categories of flint implements. The method is applied to stratigraphic sequences of Chalcolithic fortresses in the northwestern Caucasus dating to the late 5th–early 4th millennia BC: Meshoko and Yasenova Polyana. The properties of ceramics include hardness (assessed on the Mohs scale), wall thickness, and frequency of fragments tempered with calcium carbonate. For Meshoko, S.M. Ostashinsky's data on the occurrence of implements made of high-quality colored flint, splintered pieces, and the total number of segments, points, inserts, scrapers, and perforators were used as well. Each parameter undergoes regular changes from the lower to the upper units of the sequence: ceramics progressively deteriorate, whereas flint industry becomes more and more sophisticated. These changes occur in parallel. Data were subjected to principal component analysis. The first principal component is regarded as a generalized measure of cultural change. The results support the view of the excavators: changes were caused by the interaction of two cultures differing in origin. The earlier culture, associated with the constructors of the Meshoko fortress, shows no local roots, and was evidently introduced from Transcaucasia. The one that replaced it was significantly more archaic (a few copper tools notwithstanding), and reveals local Neolithic roots. It alone can be termed the culture of ceramics with interior-punched node decoration. The ceramics of Yasenova Polyana, too, indicate cultural heterogeneity and two occupation stages; but cultural changes are more complicated there, probably because the site existed longer, and more than two cultural components were involved.

Keywords: *Chalcolithic, Northwestern Caucasus, Meshoko, Yasenova Polyana, ceramics, lithic industry.*

Introduction

It appears evident that cultural changes at stratified sites can be described more accurately if several quantitative indicators are used jointly, rather than separately. Therefore a single multivariate measure of changes is required. This task is akin to seriation—the arrangement of units in orderly sequences based on resemblance for the evaluation of relative chronology (O'Brien, Lyman, 2002; for details on multivariate seriation see (Peeples, Schachner, 2012)). In this case, however, we are faced with an inverse problem. The chronological sequence of units (layers) is known, whereas the directionality of cultural changes, provided it exists, must be revealed analytically. This approach appears very promising for studying cultural changes at fortified and stratified Chalcolithic settlements in the southern Kuban drainage, northwestern Caucasus, including first of all the fortress of Meshoko, excavated by A.D. Stolyar and A.A. Formozov in 1958–1959 and 1962–1965 (Stolyar, 1964, 2009a–e; Formozov, 1965: 69–70). In 2007, excavations were resumed by S.M. Ostashinsky (2012, 2014). The importance of this site stems from its cultural heterogeneity, which has been apparent ever since the beginning of the excavations. The lower layers contained a burnished Near Eastern type of pottery, mostly plain (less often, decorated with convex curvilinear designs), and a scarce and inexpressive lithic industry. The pottery from the upper strata is coarser, and is decorated mostly with interior-punched nodes; the lithic industry, on the other hand, is far more sophisticated and diverse. There are indications that similar changes were undergone by the culture of another fortified settlement south of the Kuban—Yasenova Polyana. This site, which is broadly contemporaneous with and culturally related to Meshoko, was excavated by P.A. Dietler, A.D. Stolyar, and A.A. Formozov in 1962–1966 (Formozov, 1965: 72, 97; Stolyar, 2009d; Dietler, Korenevsky, 2005–2009).

Already at the initial stage of the excavations, it had become evident that the nature of the cultural changes involved disagrees with the idea of cultural continuity and evolutionary replacement of obsolete technologies by more advanced ones (Stolyar, 1964; Formozov, 1965: 69). To all appearances, two sharply different cultural traditions were involved—but which ones? Stolyar and Formozov linked the lower strata of Meshoko with the Maikop culture, and the upper ones with the Novosvobodnaya culture (Ibid.). Later, settlements such as Meshoko, Yasenova Polyana, Svobodnoye, Zamok, etc. were attributed to the Chalcolithic pre-Maikop culture (Nekhaev, 1991, 1992). This view was challenged by Markovin (1994), Formozov (1994), and Rezepkin (1996, 2000). However, the appearance of radiocarbon dates evidently drew a line under the debate: these suggested that Svobodnoye as well as the lower horizons of Meshoko and Yasenova Polyana date to the second half of the 5th millennium BC, whereas the earliest Maikop and Novosvobodnaya sites are no earlier than 4000 BC (Trifonov, 1996; Zaitseva, Burova, Sementsov, 2004; Korenevsky, 2006; 2012: 63–64; Ostashinsky, 2014). The pre-Maikop age of the lower horizons of Meshoko and similar sites, which correlate with Tripolye BI and BI–BII, as well as with the Skelya (Novodanilovka) culture of the steppes of the northern Black Sea region, is documented by an unfinished cruciform mace head from Meshoko, and a fragment of a similar weapon from the middle layers of that site (Stolyar, 2009d: 161; Ostashinsky, 2012: 54, 56, 59; cf.: Govedarica, 2005–2009); by boar's-tusk plaques from Meshoko (Stolyar, 2009a: Fig. 19; cf.: Stolyar, 1955: Fig. 2); by a fragment of a zoomorphous stone scepter from Yasenova Polyana (Dietler, Korenevsky, 2005–2009: 570; cf.: Korenevsky, 2008); and by certain other finds.

Were cultural changes at Meshoko and Yasenova Polyana gradual or abrupt? This question is all the more important because despite marked cultural heterogeneity, no sterile layers or other boundaries between habitation horizons have been detected at either settlement. To resolve this issue and ensure a more detailed stratigraphic record, at each site control excavations were dug, in which habitation deposits were removed by 4–6 cm thick artificial units, rather than by 15–18 cm thick ones as before (Stolyar, 2009c, d). Finds from control excavation 2 at Meshoko were studied by A.D. Rezepkin (2005), who also examined ceramics from Yasenova Polyana (2000). He concluded that the culture of each of those settlements consisted of at least two components differing in several respects. Their proportion in the lower and upper horizons of either site is different, supporting the observations made by Stolyar, Formozov, and Dietler (see above). This appears to disagree with Rezepkin's view (2005) that "no genetic, cultural differences between them [horizons – *A.K.*] are observed". What he implied, apparently, was the gradual nature of the cultural changes.

Having analyzed the stone tools from Meshoko, Ostashinsky (2009: 236) concluded that "differences in lithic industry between the horizons concern all basic criteria: raw material, reduction technique, and composition of the tool assemblage. The dissimilarity between the lower and upper horizons is striking; in essence, they are not comparable". In Ostashinsky's view, the most likely reason is immigration. He believes that along with upper and lower horizons, intermediate ones can be separated (see also (Poplevko, 2010)).

Given that the units of the stratigraphic sequences are artificial and no boundaries between the layers could be discerned, how many stages in the culture of southern Kuban settlements can be separated on the basis of the technological and typological analysis? How should one interpret the striking differences apparent to everyone?

In 1965 and 1966, as an undergraduate, I took part in the excavations of Meshoko and Yasenova Polyana, under the guidance of A.D. Stolyar. In 1966–1968, I examined the ceramics from these sites; and in 1968, at the Leningrad State University Department of Archaeology I defended my Master's Thesis on that topic. It remained unpublished. In the course of half a century, some of its conclusions have become outdated, whereas others have been upheld by later studies. None of them will be touched upon here. In this article, I will focus on those findings which, in my view, remain nontrivially relevant to the questions raised.

Materials and methods

Virtually all ceramics from Meshoko and Yasenova Polyana available by 1968 were studied at the State

Hermitage Museum. For a quantitative evaluation of the cultural changes at both sites, material from control excavation 1 (1963) at Meshoko and from control excavation 1 (1964) at Yasenova Polyana was used. For comparative purposes, I studied ceramics from other settlements in the northwestern Caucasus: Nizhnne-Shilovskaya, Skala, Khadzhokh grottoes, and Dakhovskaya cave.

Because the ceramics are quite fragmented, owing to the fact that fortresses served as corrals, assessing changes in the size and form of vessels is very difficult. For each of the 14 layers of the control excavation at Meshoko and the 12 layers at Yasenova Polyana, the following parameters were evaluated: (1) average hardness on the Mohs scale, (2) average wall thickness, (3) percentage of fragments tempered with calcium carbonate. For this purpose, fifteen fragments were selected at random from each layer. The Mohs scale is nonlinear: grades 1 (talc), 2 (gypsum), and 3 (calcite) correspond to absolute hardnesses of 1, 3, and 9, respectively. Here, however, this is not critical, because the hardness of most fragments from the southern Kuban sites falls within the small interval from 1.5 (scratched by gypsum) to 3 (about as hard as calcite). I used a microscope with 150x magnification, a magnet, and hydrochloric acid. Color was assessed using E.B. Rabkin's *Atlas of Colors* (1956).

Frequencies of various categories of stone tools from Meshoko (Ostashinsky, 2009) refer to control excavation 2 of 1964, where the thickness of the habitation deposits is maximal and the number of layers is 21 (bottom layers, 22 and 23, are sterile). To compare these data with mine, relating to control excavation 1, where the habitation deposits are thinner and the number of layers is 14, Ostashinsky's data were adjusted in the following way. The number of lithics in layers 2, 5, 8, 11, 14, 17, and 20 of control excavation 2 was distributed equally between the overlying and underlying strata. As a result of this uniform "compression", the number of layers was reduced to 14, as in control excavation 1.

Before statistical analysis, data were transformed to improve normality and stabilize variances. In the case of relative frequencies, Anscombe's transformation was applied (Sjøvold, 1977: 18) using the FREQ function from B.A. Kozintsev's statistical package; in the case of absolute frequencies, the transformation was that of Box-Cox (Box, Cox, 1964) using Ø. Hammer's PAST package (http://folk.uio.no/ohammer/past/).

Data relating to various parameters were integrated using the principal component analysis based on Pearson's correlation coefficients. The first principal component, accounting for the largest share of the total variance, was regarded as a generalized measure of cultural change. Pairwise correlations between the variables and their correlation with the layer number were evaluated with Spearman's rank correlation coefficients. All these calculations were performed using the PAST software. The same package was used to smooth the curves by the three-point moving average method and to calculate exact probabilities for fourfold tables.

Results

Ceramics of Meshoko

Technological parameters. Unlike the Maikop people (Bobrinsky, Munchaev, 1966; Korenevsky, Kizilov, 2015), those of Meshoko used no throwing-wheels, apparently employing the paddle and anvil technique (Poplevko, 2015). The hardness of most fragments is low, ranging from 1.97 in layer 5 to 2.67 in layer 14 (Table 1). Ceramics with such hardness should be considered low-quality by world standards (Shepard, 1956: 114), despite the excellent burnishing practiced during the early period. The distribution of this parameter according to layers shows a significant negative tendency (Fig. 1): hardness progressively decreased on average. The coefficient of rank correlation (r_s) between this parameter and the layer number equals 0.89 ($p < 0.001$).

An indirect indicator of quality is wall thickness. It ranges from 4.3 mm in layer 8 to 7.1 mm in layer 4 (Table 1), increasing on average from the lower to the upper layers ($r_s = -0.71$, $p = 0.005$; Fig. 2).

The third technological parameter is frequency of fragments tempered with calcium carbonate. In certain cases, this is represented by oolitic limestone—amorphous soft grayish inclusions; in other instances, by crushed calcite, whose shiny particles, when examined microscopically, have a rhombohedral form caused by perfect cleavage. An additional proof that paste was heavily (30–40 %) tempered with calcite rather than quartzite, contrary to what Rezepkin (2005) and Poplevko (2015) write, is vigorous reaction with acid. Certain specimens reveal a mixture of oolitic and fragmental limestone. A good preservation of particles indicates firing at temperatures below 750 °C (Bobrinsky, 1978: 80). The color of shards is mostly orange or tawny (O 7/13 – O 6/14 according to Rabkin's tables), owing to oxidizing conditions; less often, brown (O 4/16) or dark gray (P 3/9, P 2/14, P 3/13)*. Calcite temper is yet another indication that those who constructed the Meshoko fortress had migrated from the south. Such temper was registered in ceramics from Ochazhny Grot (Grotto of Hearths) of Vorontsov Cave in Abkhazia (Soloviev, 1958: 143).

Both oolitic and fragmental limestone can occur as natural inclusions in clay, and in this case no tempering is required. However, ceramics from the lower layers contain virtually no other admixtures. The paste is finely levigated

*"O" stands for orange, "P" for purple.

Table 1. **Quantitative parameters of ceramics from Meshoko and Yasenova Polyana**

Layers	Meshoko				Yasenova Polyana			
	Average hardness, units of Mohs scale	Average wall thickness, mm	$CaCO_3$ temper, percent of fragments	First principal component scores	Average hardness, units of Mohs scale	Average wall thickness, mm	$CaCO_3$ temper, percent of fragments	First principal component scores
1	2.00	5.7	53.3	–1.70	2.33	6.1	66.7	0.24
2	2.27	6.1	46.7	–1.44	2.40	5.8	60.0	0.59
3	2.00	6.9	73.3	–2.00	2.27	6.4	73.3	–0.76
4	2.03	7.1	80.0	–1.89	2.27	5.9	66.7	0.63
5	1.97	6.9	73.3	–2.08	2.33	5.8	66.7	1.12
6	2.23	5.4	73.3	–0.48	2.23	5.8	53.3	2.46
7	2.27	5.1	80.0	–0.01	2.10	7.0	66.7	–0.86
8	2.33	4.3	100.0	1.41	2.13	6.4	66.7	–1.13
9	2.40	5.2	100.0	1.00	2.10	6.0	73.3	–0.61
10	2.63	4.9	86.7	1.18	2.07	5.6	33.3	0.50
11	2.43	5.3	100.0	1.01	2.23	6.2	86.7	–1.64
12	2.47	4.5	100.0	1.62	2.20	5.8	100.0	–0.54
13	2.63	5.3	100.0	1.50	–	–	–	–
14	2.67	4.9	100.0	1.85	–	–	–	–

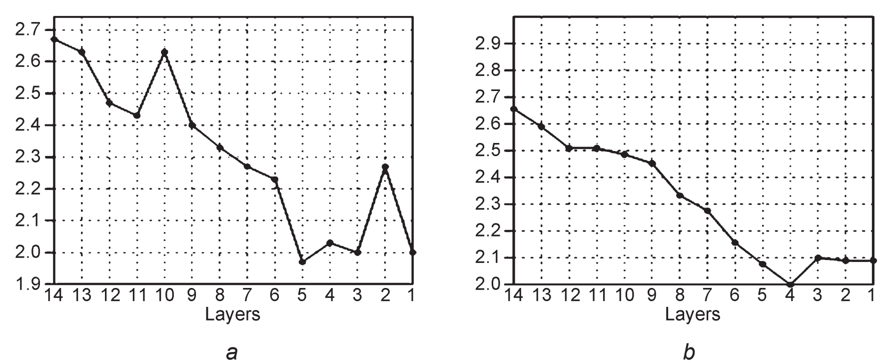

Fig. 1. Average hardness of ceramics in various layers of the Meshoko sequence, units of the Mohs scale.
a – plot based on crude data; *b* – smoothed plot generated by the three-point moving average method.

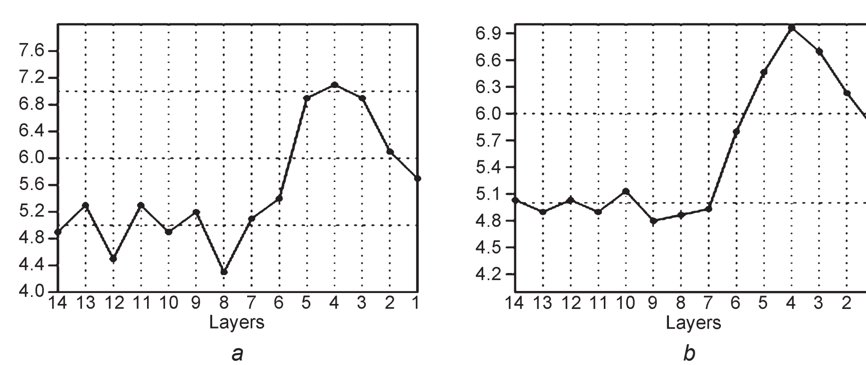

Fig. 2. Average wall thickness in various layers of the Meshoko sequence, mm.
a, *b* – see Fig. 1 for explanations.

and very homogeneous. Apparently limestone was added after the removal of natural inclusions such as sand, etc. The temper was thoroughly ground; the distribution of particles is very uniform. In all shards from the four lower layers, $CaCO_3$ is the only admixture. Its share decreases toward the upper layers (Table 1). The coefficient of rank correlation between the proportion of fragments tempered with limestone and layer number is 0.90 ($p < 0.001$; Fig. 3). Apparently, the main factor causing this change was less and less thorough surface treatment.

While I was unable to find a simple quantitative indicator of surface-treatment quality, there is no

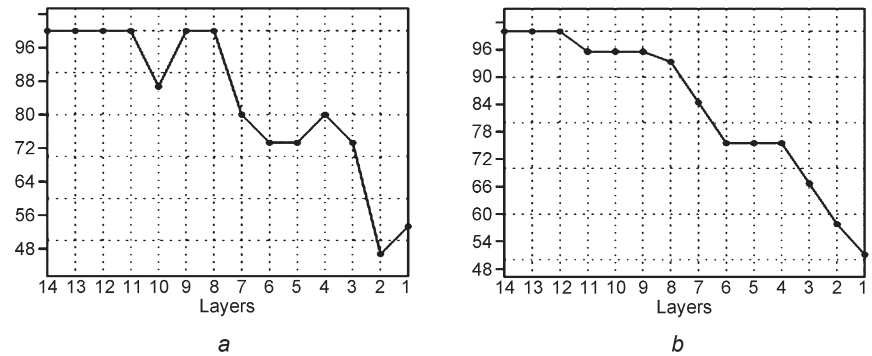

Fig. 3. Proportion of fragments tempered with calcium carbonate in various layers of the Meshoko sequence, percentage.
a, *b* – see Fig. 1 for explanations.

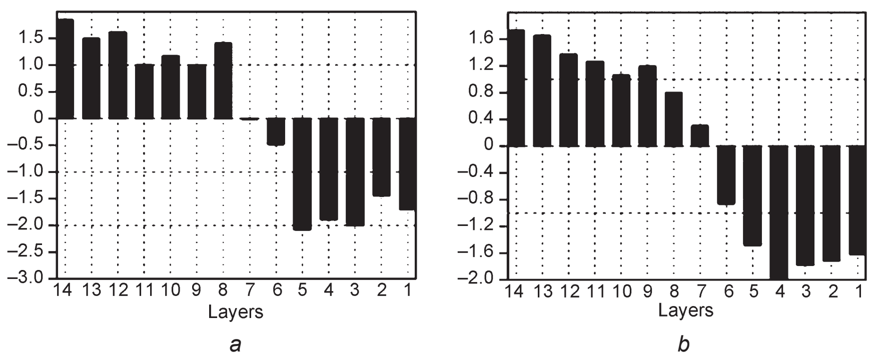

Fig. 4. First principal component based on three technological parameters of ceramics in various layers of the Meshoko sequence.
a, *b* – see Fig. 1 for explanations.

doubt that in this case, too, temporal changes were technologically counterintuitive. Instead of the expected improvement we observe degradation. The changes are especially marked on the interior surface, which, from the very beginning, was polished less thoroughly than the exterior surface, and appears pitted because temper grains had decomposed during firing (no such cavities are present either on the outside or in the fracture).

Beginning from layer 12, cavities become more and more numerous. As a result, the strength of the vessels decreased, causing the need for alternative temper such as fine sand and mica. Toward layer 8, burnishing becomes barely distinguishable, and eventually disappears. The predominant shades are grayish browns (O 5/13), whereas orange (O 7/13) is less common. Toward layer 5, calcite temper disappears, and amorphous limestone is less thoroughly ground: its grains are sometimes as large as 2 mm. Burnishing quality decreases to such an extent that limestone particles, even very coarse ones, often decompose even in the deep parts of the shards (given the low quality of the ceramics, this could not have been caused by higher firing temperatures). Porosity increases considerably, and strength decreases accordingly. Such vessels cannot be used for storing liquids.

In fragments from the two top layers, the decomposition of calcium carbonate is maximal. Sometimes its residues are present as small amounts of yellowish powder in pores. In about half of the cases, amorphous limestone is replaced by hard additions (from sand to grit with particles up to 2.5 mm large). Such ware was probably used for storing liquids. The color ranges from dark gray (P 3/9 – P 3/13) to orange (O 7/13). In layer 3, a fragment of a flat bottom was found (previously, most or all vessels were round-bottomed).

Two fragments from layer 2 contrast with the others. They are very thick (7.5–8.0 mm), and are tempered with hard particles of a different origin: small rounded pebbles, grit, mica, and hematite grains. The inside of each specimen is heavily sooted, probably intentionally. I have observed all these technological properties in ceramics from Nizhne-Shilovskaya, which has been traditionally dated to the earlier (Neolithic) period.

Generalized measure of changes. As seen above, each of the three technological parameters shows regular and highly significant diachronic changes. The correlation between them is accordingly highly significant as well:

Hardness – wall thickness	–0.74 ($p = 0.002$)
Hardness – limestone temper	0.78 ($p = 0.001$)
Wall thickness – limestone temper	–0.71 ($p = 0.005$)

If so, it can be expected that the integration of these parameters into a single generalized measure will allow us to reduce the effect of random fluctuations and reveal the overall tendency. Indeed, the first principal component shows a regular change from the early to the late stages, mirroring the general deterioration of the ceramics over time (Table 1; Fig. 4). It accounts for 79 % of the total variance, and its correlation with layer number is 0.89 ($p < 0.001$)—the same as with hardness and limestone temper. However, the generalized measure should be preferred to each of its constituents, because ignoring the others may distort the actual pattern to some extent.

The plot based on crude principal component scores (Fig. 4, *a*) reveals three stages: the period between layers 14 and 8 evidences slow deterioration; layers 8 to 5, rapid deterioration; layers 5 to 1, slight improvement. These periods are separated approximately because of random fluctuations. However, if the curve is smoothed using the three-point moving average (Fig. 4, *b*), the stepwise nature of the changes disappears, and the general tendency is that of steady regress (except for a small peak on layer 9), with some acceleration, between layers 14 and 4. After that, the quality of the ceramics improves to a small extent.

Northern ties and occupation length. Of special interest is a small group of fragments (about a dozen), sharply differing from others. They were found not in the control excavation, but in layers 2–4 of other excavation areas, where the stratigraphic record is less accurately subdivided. Layers 2–4 in those areas correspond to the middle horizons of the settlement, in which, notably, a fragment of a cruciform mace head was found (see above). The surface of the shards is glossy and somewhat "greasy" to the touch, possibly because an organic solution was added to the paste (Salugina, 2011). The color, both of the surfaces and of the fracture, is dark gray or brownish-gray, sometimes almost black (O 4/16, P 3/9, P 2/14, P 3/13), apparently because organic temper got charred and/or because smoke penetrated inside the pores during firing*.

The principal feature of those fragments is a very considerable number of crushed shells, undoubtedly added as temper. Firing was weak; the calcium carbonate shows no traces of decomposition. Most fragments are decorated with comb imprints—a feature that is quite unusual for Meshoko ceramics. In two specimens they are combined with interior-punched nodes. Three fragments of rims with pits or hatching along the lip belong to the same group. A shard with a "greasy" surface and shell temper was found in layer 11 of the control excavation at Yasenova Polyana. It is decorated with an applied bump, and wedge-shaped imprints (Stolyar, 2009d: 167, fig. 28, *8*). A fragment of rim without shell temper from layer 9 of this control excavation has a thickened edge decorated with oblique imprints of "Wickelschnur" (cord wrapped around a stick) on the lip (Rezepkin, 2000: 233, fig. 8, *17*). The Meshoko sample includes several shards without shell temper but with imprints of a denticulate stamp, sometimes combined with interior-punched nodes or incised lines (Rezepkin, 2005: Tab. 19, *10*, *11*; Dietler, Korenevsky, 2005–2009: Fig. 26, *14–20*). One of them comes from layer 11 in the middle of the stratigraphic sequence in control excavation 2 (1964), where the number of layers is 21.

Shell temper is very rare at Chalcolithic settlements of the piedmont zone south of the Kuban (it was also found in ceramics from the "Neolithic" horizon of Kamennomostskaya cave (Formozov, 1965: 63)*, but is very typical of the steppe zone. Having first appeared in the steppes as early as the Neolithic, in the beginning of the 6th century BC (Kotova, 2015: 58, 63), the tradition of tempering paste with crushed shells became a distinctive feature of Chalcolithic cultures of the steppe and forest-steppe—Sredni Stog (Kotova, 2006b: 158), Khvalynsk (Vasiliev, 2003: 66) and a number of later ones. It is one of the key indicators of the expansion of the steppe tribes. Ceramics very similar to those of Meshoko in technological parameters (gray or black color, abundant shell temper, "greasy" surface) were found at Repin and earlier (apparently Konstantinovsk-type) sites in the Don drainage (Sinyuk, 1981: 14; see also (Formozov, 1954: 138)).

Western researchers of Cucuteni-Tripolye have termed ceramics tempered with crushed shells the "Cucuteni C" type (Schmidt, 1932: 42). This type's first appearance in the Tripolye context is related to the Skelya (Novodanilovka) culture—an early version of Sredni Stog (Videiko, 1994; Rassamakin, 1999; see also (Movsha, 1961; Palaguta, 1998; Manzura, 2000)). The Skelya people migrated to the northwestern Black Sea region from the Lower Dnieper at the Tripolye BI stage (or even at the end of Tripolye A stage) in the second half of the 5th millennium BC, and introduced a ceramic tradition that was alien to Tripolye and more primitive (Palaguta, 1998; for a review of literature see (Kotova, 2006b: 14–17)). It survived in Tripolye at least until the BI–BII stage (late 5th millennium BC), having blended with the local tradition during the Late Tripolye stage.

In the pre-Maikop context of the piedmont settlements, ceramics tempered with crushed shells appears as unusual as in the context of Tripolye. In the more northerly lowland zone adjacent to the steppe, the situation was different. Shell-tempered pottery is quite common at the pre-Maikop settlement Svobodnoye (Nekhaev, 1992: 80), which is somewhat earlier than

*Dark shades of ceramics are often believed to be caused by a reducing atmosphere of baking, whereby ferrous oxide FeO or magnetic oxide Fe_3O_4 are formed. However, ferrous oxide is a very unstable substance; a magnet test of the crushed fragment shows that magnetic oxide plays no role here either. Open fire and primitive kilns seldom if ever provided conditions for a reducing atmosphere. In the vast majority of cases, dark color was caused by the non-oxidizing atmosphere of baking, whereby the organic matter in fuel and/or paste was carbonized (Lucas, Harris, 2012: 374–376).

*Later it is said to reappear at Novosvobodnaya (Popova, 1963: 18; Nikolaeva, Safronov, 1974: 179).

Meshoko (Korenevsky, 2012: 63), and shows marked parallels with the Chalcolithic sites of the steppe. N.S. Kotova (2006a) links the Svobodnoye ceramics with those from the latest Sredni Stog sites on the Don and Seversky Donets, believing that rare instances of interior-punched node decoration in those areas may be due to contacts with the pre-Maikop population of the northwestern Caucasus.

The combination of abundant interior-punched node design with comb imprints suggests that the shell-tempered pottery from Meshoko and Yasenova Polyana may indicate contact, not with Sredni Stog, but with some later culture such as that of the Mikhailovka lower layer—or, more likely, Repin (Sinyuk, 1981: Fig. 2, *4*, *7*; 3, *13*, *19*, and others; Kotova, 2013: 91, 368, fig. 212, *3*; cf.: Rezepkin, 2005: Tab. 19, *10*, *11*). The Repin culture emerged about 3700 BC (Kotova, 2013: 151) at the Tripolye CI stage, whereas the combination of comb and interior-punched node decoration became common for the Cucuteni C ware as early as the Tripolye BII stage (Movsha, 1961). Therefore, the upper radiocarbon dates of Meshoko and Yasenova Polyana do not contradict these parallels. Nor is there disagreement with the lower dates, which are supported by artifacts typical of Tripolye BI. Some of these were in use for a long time (Govedarica, 2005–2009; Korenevsky, 2008: 137; 2016: 52–53). Judging by an unfinished cruciform mace head from Meshoko (Stolyar, 2009d: 161), such artifacts were not relics.

Disagreement arises solely with the opinion of Stolyar (2009e: 204), who asserted that the fortress existed for only 150–200 years. The minimally possible range of calibrated radiocarbon dates (between the nearest points of confidence limits) is 340 years in the case of Meshoko (4040–3700 BC) and nearly 700 years in the case of Yasenova Polyana (4048–3357 BC)—even if the latest, aberrant date is disregarded (Korenevsky, 2012: 63–64).

The lithic industry of Meshoko

Absolute occurrences of various categories of lithics in various stratigraphic units of control excavation 2 are given in Table 2. The frequencies of three of the categories described by Ostashinsky (2009) show a significant correlation with layer number (I lumped segments, points, inserts, scrapers, and perforators into a single category "others" to make it numerically representative). The correlation coefficients (r_s) are as follows (all p-values are below 0.001):

tools made of high-quality colored flint	–0.89
pièces écaillées (splintered pieces)	–0.85
others	–0.83

Diachronic changes in the occurrence of lithics belonging to various categories are plotted in Fig. 5–7. While each of the plots is somewhat peculiar, the progressive sophistication of the lithic industry, both quantitative and qualitative, appears evident. The fourth category, laminar items, shows no significant correlation with layer number ($r_s = -0.45$, $p > 0.05$) and has been excluded from further analysis. Pairwise coefficients of

Table 2. **Occurrence of various categories of lithics from Meshoko (after (Ostashinsky, 2009), adjusted)**

Layers	Tools made of colored flint	Pièces écaillées	Others	First principal component (lithics)	First principal component (lithics + ceramics)
1	242	12.5	11	1.63	2.37
2	212	12.5	6	1.08	1.78
3	259	21.5	8.5	1.65	2.56
4	248	17.5	10.5	1.73	2.53
5	275	26	13	2.15	2.97
6	228	16	14	1.94	1.76
7	66	3.5	4	–0.16	–0.09
8	66	0.5	7	–0.30	–1.17
9	43.5	1.5	4.5	–0.51	–1.06
10	24.5	1.5	3.5	–0.82	–1.41
11	16	–	3	–1.43	–1.76
12	3	–	–	–2.35	–2.82
13	3	–	–	–2.35	–2.76
14	5	–	–	–2.25	–2.92

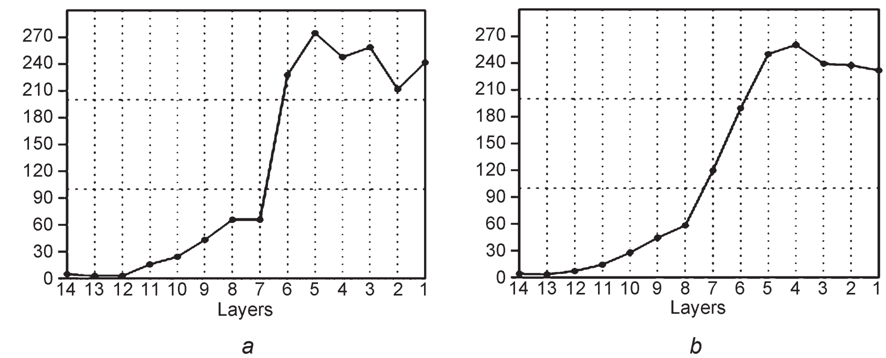

Fig. 5. Occurrence of tools made of high-quality colored flint in various layers of the Meshoko sequence.
a, *b* – see Fig. 1 for explanations.

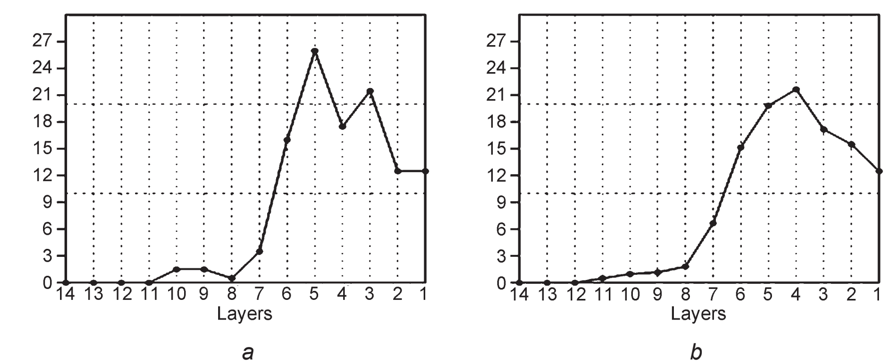

Fig. 6. Occurrence of *pièces écaillées* in various layers of the Meshoko sequence.
a, *b* – see Fig. 1 for explanations.

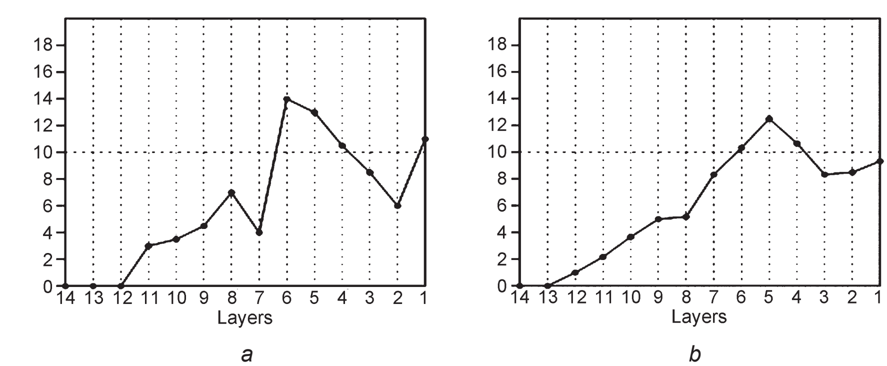

Fig. 7. Total occurrence of segments, points, inserts, end-scrapers, and perforators in various layers of the Meshoko sequence.
a, *b* – see Fig. 1 for explanations.

correlation between the three remaining categories are as follows (all are highly significant):

colored flint – pièces écaillées	0.96
colored flint – others	0.92
pièces écaillées – others	0.88

The generalized measure of changes was calculated in the same way as was done for ceramics. The coefficient of correlation between the first principal component (Table 2; Fig. 8) and layer number is negative and highly significant (r_s = –0.84, $p < 0.001$), although its absolute magnitude is no higher than for each category, and even lower than for colored flint. Nevertheless, in this case as in the case of ceramics, the generalized measure must be regarded as more informative than each of its constituents.

The plot based on crude values (Fig. 8, *a*) reveals four periods: in three bottom layers (14 to 12), both the quantitative and qualitative level of the lithic industry is steadily low; layers 12 to 7 show a gradual rise; and layers 6 and 5, an abrupt rise, after which a small regress is observed. The smoothed plot (Fig. 8, *b*) differs from the previous one by demonstrating a steady sophistication of the lithic industry between layers 13 and 5, followed by a slight deterioration as in the previous plot.

The parallel between the evolution of ceramics and that of the lithic industry is obvious: the degradation of pottery is paralleled by the sophistication of lithic industry, and vice versa. In certain cases, the parallel is no less close than that between parameters within a single category—as evidenced, for instance, by coefficients of correlation between the hardness of ceramics, on the one hand, and the occurrence of tools made of colored flint (–0.95) and of pièces écaillées (–0.90), on the other. A very high correlation is also observed between the two independent generalized measures of change (r = –0.92). This supports the conclusion formed by virtually all

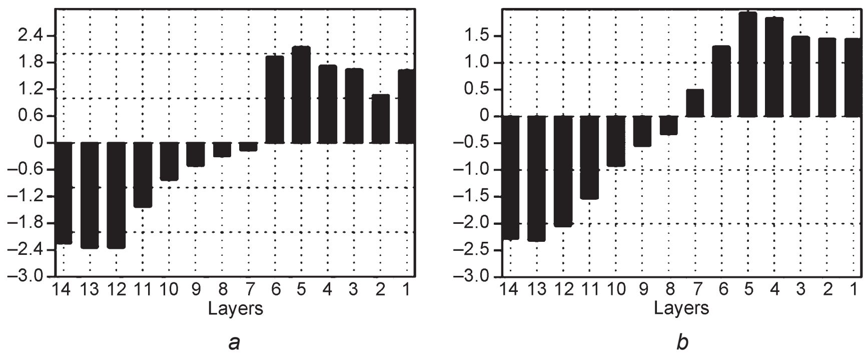

Fig. 8. First principal component based on the occurrence of three categories of lithics in various layers of the Meshoko sequence.
a, *b* – see Fig. 1 for explanations.

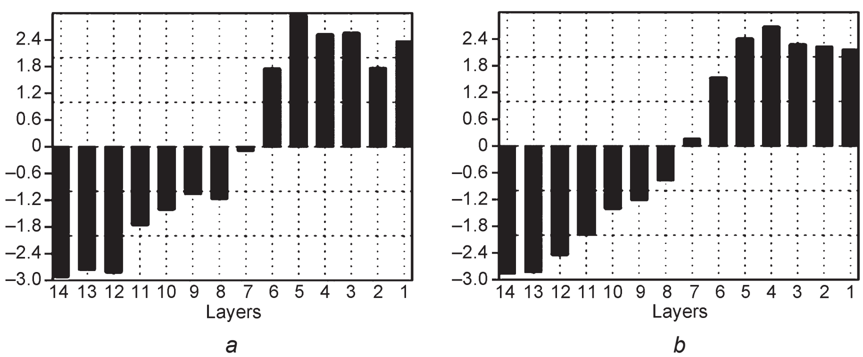

Fig. 9. First principal component based on three technological parameters of ceramics and the occurrence of three categories of lithics in various layers of the Meshoko sequence.
a, *b* – see Fig. 1 for explanations.

researchers who had studied the finds from Meshoko: parallels are caused not so much by technological factors as by historical ones.

Let us calculate the first principal component on the basis of all six parameters (Table 2). It accounts for 83.7 % of the total variance, and the factor loadings (coefficients of correlation with trait values) are as follows:

hardness of ceramics	–0.93
wall thickness	0.82
calcium carbonate temper	–0.86
tools made of colored flint	0.98
pièces écaillées	0.98
others	0.91

The correlation with the occurrence of lithics is somewhat higher than with the technological parameters of the ceramics. The probable reason is that all lithics within the control excavation area were studied, but only part of the ceramics. The correlation of the integral first principal component with the layer number (–0.91) is tighter than with either of the respective measures based on ceramics or lithics separately.

While the plot of the first principal component calculated on the basis of crude data (Fig. 9, *a*) still reveals some chaotic fluctuations, the smoothed plot (Fig. 9, *b*) demonstrates a very clear pattern, which appears to be closest to reality. The two lowest layers indicate stability: a comparatively high quality of ceramics and low quality of lithic industry. After that, over most of the sequence (layers 12 to 4) ceramics progressively deteriorate, whereas the lithic industry becomes more and more sophisticated. During the final period (three upper layers), a reverse tendency, albeit a less distinct one, is observed.

Ceramics of Yasenova Polyana

At Yasenova Polyana, as in Meshoko, no traces of using a throwing-wheel have been detected. Here too, material culture reveals diachronic changes (Stolyar, 2009d: 142–144; Formozov, 1965: 72, 79; Dietler, Korenevsky, 2005–2009; Rezepkin, 2000).

Vessels represented by fragments from the lower (12th) layer apparently resemble those from the lower units of Meshoko in both size and form. They were characterized by round bottoms, gentle outlines, and weakly everted rims. The only temper in any fragments is calcium carbonate in a likewise high proportion. In certain cases, it is a rather coarsely ground oolitic limestone; in others, crushed calcite. Natural inclusions are represented by fine sand, less often by hematite grains. Polishing is barely discernible. The combination of heavy limestone temper with insufficient burnishing of the inside produces the same negative result—the presence of numerous cavities from decomposed particles of temper. The color is usually a dark, brownish-gray (O 4/14, O 5/13, O 5/15); but orange shades occur as well, so the atmosphere of firing was oxidizing in some cases and non-oxidizing in others. Strength is about the same as in layers 9–7 of Meshoko. Fragments from layer 11 reveal different temper (sand and mica in two cases, ground oolite limestone and, much less often, crushed calcite in others). Thoroughly burnished fragments, similar to those from Meshoko layer 10, co-occur with cruder ones, resembling those from layers 6 and 5 of Meshoko.

None of the examined fragments from layer 10 reveals calcite temper; most contain grit and mica, others are heavily tempered with ground amorphous limestone, sometimes making up nearly half of the volume. Burnishing virtually disappears. The color ranges from brownish-gray to relatively bright orange shades. Four shards from layer 9 contained a hard admixture, others were tempered with oolitic limestone. In layer 8, as in overlying horizons, fragments of flat bottoms were found. One third of the fragments are tempered with grit, others with crushed amorphous limestone, which is often completely decomposed.

In layer 7, a fragment of a mug or beaker with a loop-shaped handle attached to the rim was found, reminiscent of vessels from Novosvobodnaya (Rezepkin, 2000: 232, fig. 7, *3*; Dietler, Korenevsky, 2005–2009: 557, fig. 12, *B3*). Surface treatment deteriorates, the temper to clay ratio is the same—1 : 2. In layer 6, nearly half of the fragments contain hard temper, and the surface becomes even coarser. In layer 5, the ratio of hard temper to amorphous limestone is 1 : 2. Grit is very coarse (up to 3 mm in size).

In layer 4, the temper ratio remains the same. Some grit particles are 7 mm in size, attesting to a very low level of technology. In layer 3, nearly three quarters of the fragments are tempered with amorphous limestone; the remainder contain hard temper. The quality of surface treatment is low; firing occurred, as before, under both oxidizing and non-oxidizing conditions. In layer 2, the hard-to-soft temper ratio is 2 : 3, and in layer 1 it is 1 : 2. The surface treatment and the decomposition of limestone differ, as in the underlying layer.

As we see, the ceramics of Yasenova Polyana, too, underwent changes over time; but understanding the nature of these changes is more difficult here than in the case of Meshoko. Only one of the technological parameters, hardness, demonstrates a directional trend, but its direction is opposite to that observed in the case of Meshoko: hardness progressively increases on average ($r_s = –0.76$, $p = 0.004$; Fig. 10). The correlation between the remaining two parameters and layer number is insignificant: wall thickness, –0.11; limestone temper, 0.36 (Fig. 11, 12). Accordingly, the correlation between those parameters is small and insignificant:

hardness – wall thickness	–0.11
hardness – limestone temper	–0.04
wall thickness – limestone temper	0.44

But even in such a situation, the generalized measure of change appears useful. The first principal component in this case accounts for only 43.4 % of the total variance as against 79 % in Meshoko, and its correlation between this measure and layer number is insignificant ($r = 0.41$). However, even the plot based on crude principal component scores (Fig. 13, *a*) makes it clear that the

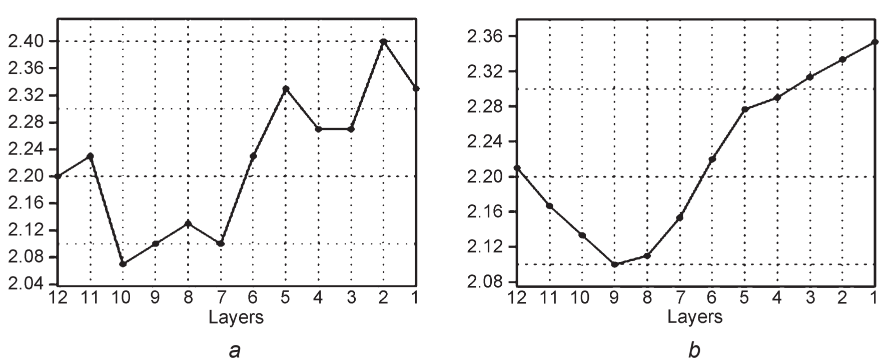

Fig. 10. Average hardness of ceramics in various layers of the Yasenova Polyana sequence, units of the Mohs scale.
a, *b* – see Fig. 1 for explanations.

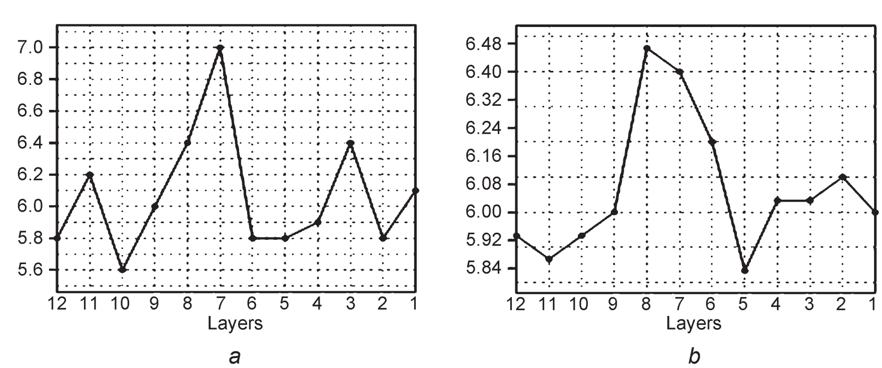

Fig. 11. Average wall thickness in various layers of the Yasenova Polyana sequence, mm.
a, *b* – see Fig. 1 for explanations.

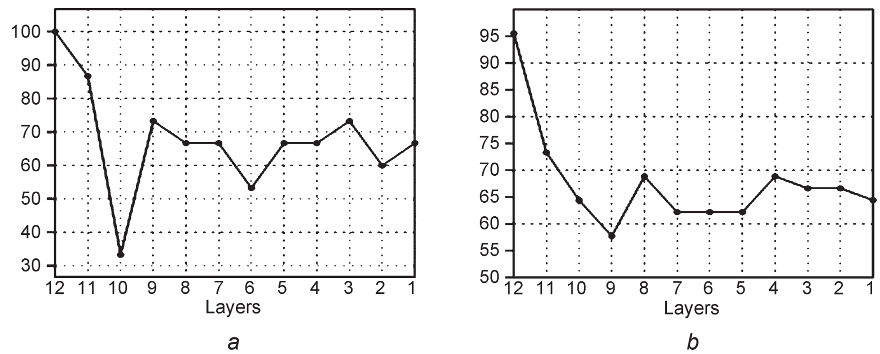

Fig. 12. Proportion of fragments tempered with calcium carbonate in various layers of the Yasenova Polyana sequence, percentage.
a, *b* – see Fig. 1 for explanations.

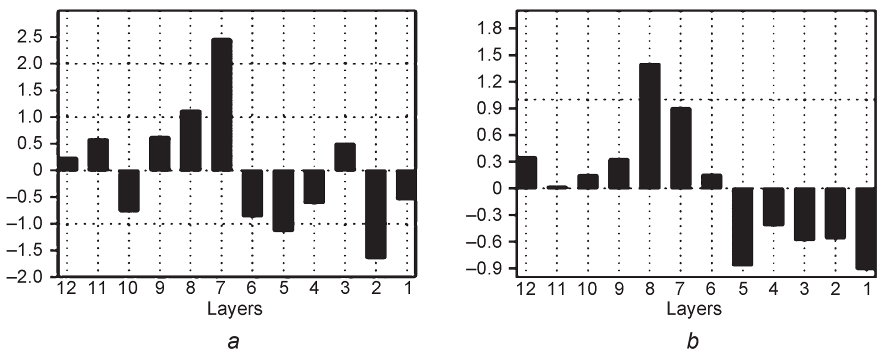

Fig. 13. First principal component based on three technological parameters of ceramics in various layers of the Yasenova Polyana sequence.
a, *b* – see Fig. 1 for explanations.

stratigraphic sequence is subdivided into two halves: layers 12–7, where five principal component scores are positive and only one is negative; and layers 6–1, where the relationship is reversed. The difference does not reach significance level (Fisher's exact test: $p = 0.08$). However, if the curve is smoothed (Fig. 13, *b*), the lower half of the sequence shows only positive values, whereas in the upper half, only one positive score is present ($p = 0.015$). Moreover, it corresponds to layer 6, which turns out to be intermediate between layers 7 and 5 not only stratigraphically but culturally as well.

The general pattern is less distinct here than in the case of Meshoko, and there is virtually no graduality. However, the regular nature of the changes is beyond doubt here as well. Detailed stratigraphic data about the occurrence of the lithics at Yasenova Polyana are unavailable.

Discussion and conclusions

Most researchers have noticed that the culture of Meshoko includes two very dissimilar cultural components. One of them, represented in the lower units of the stratigraphic sequence, is likely of southern origin, as mentioned both by the excavators and by other specialists (see, e.g., (Andreyeva, 1977: 44; Trifonov, 2001)). Being earlier than Maikop, this culture anticipates it in a sense. Like Maikop, it reveals no local roots. The culture that gradually displaced it can be termed the culture of ceramics with interior-punched node decoration—the term that is sometimes erroneously applied to the entire culture of Meshoko and related sites. The later culture is quite different from that of the lower horizons and, paradoxically, is much more archaic, despite a few copper tools, which are absent in the lower layers. This culture shows no southern roots, whereas local ones are quite evident (an unexpected and striking proof of this is the technological parallel between certain shards from the upper layers of Meshoko and the ceramics of Nizhne-Shilovskaya).

Extending the term "culture of ceramics with interior-punched node decoration" to all pre-Maikop sites of northwestern Caucasus, as certain researchers do, is unwarranted. Fragments with this decoration are absent in the three bottom horizons of Meshoko—they first appear only in layer 11 of the control excavation, and initially their number is quite small. The ceramics of Yasenova Polyana display the same regularity: the interior-punched node design is present only on pottery from the middle and upper layers (Dietler, Korenevsky, 2005–2009: 556; Rezepkin, 2000: 226). The same is true of Khadzhokh, though this site has been attributed to the Maikop culture (Rezepkin, 2000: 234).

The introduction of the interior-punched node decoration parallels the gradual degradation of ceramic technology and the sophistication of lithic industry, which, at the late stages of Meshoko, experienced a true renaissance after a complete decline at the early stage. In other words, both cultural components characterize different stages in the evolution of the material culture. Their succession might be considered a natural evolutionary process—as Korenevsky put it, "certain early technological devices growing out of use" (Dietler, Korenevsky, 2005–2009: 576)—if the actual course of events were not the reverse: the culture of the late period was more archaic than the preceding one in terms of both ceramic technology and lithic industry.

What can have caused this unusual phenomenon—the gradual nature of the changes, despite a striking contrast between the two cultural components of Meshoko? The answer must be sought in the nature of the contacts between immigrants from Transcaucasia, who built the southern Kuban fortified settlements, and the natives, against whose raids those fortresses were apparently meant to protect. All the cultural contrast and all the impressive fortification notwithstanding, their relationships were evidently not altogether hostile. Even so, it might be expected that cultural symbiosis would have resulted in the eventual displacement of a more archaic (the leading excavator, in fact, used the term "barbaric", see (Stolyar, 2009b: 75)) culture by a more advanced one. Actually the opposite process is observed. A possible reason is the numerical superiority of the natives over the immigrants. Stolyar (Ibid.: 72) may have been right in suggesting that the latter were eventually assimilated by the former. This, however, is only guesswork.

Before radiocarbon dates of southern Kuban settlements became available, A.A. Formozov (1994: 47–48), arguing against A.A. Nekhaev (1991, 1992), who had claimed that those sites predated Maikop, wrote that the acceptance of this idea would lead to a strange (as Formozov believed) idea of wave-like cultural process whereby certain cultural traits emerged and then disappeared only to reappear later. It looks as though such a process actually occurred. Whereas the people who built the Chalcolithic fortresses in the southern Kuban drainage might be regarded as the first wave of migrants from the south, the Maikop people were the second wave. Like their predecessors, they had to maintain complex relationships with the natives of the northwestern Caucasus and with the steppe tribes—relationships that we don't yet understand properly. Possibly by that time the relationships had become closer and more peaceful; indeed, the Maikop people did not fortify their settlements.

Diachronic changes and cultural heterogeneity do not necessarily result in high correlation between various quantitative traits; such a correlation should be expected only when two components, whose proportion changes over time, are involved. This, to all appearances, is the situation with Meshoko, disregarding a very small steppe component represented by ceramics tempered with crushed shells; this had no effect on the general pattern.

Yasenova Polyana is a more complex site than Meshoko. Firstly, the range of radiocarbon dates is wider there: two of the five pertain to the late 5th–early 4th millennium BC, two fall within the middle and second half of the 4th millennium, and one, even within the 3rd millennium BC (Korenevsky, 2012: 63–64). This agrees with the opinion of Rezepkin (2000) that Yasenova Polyana is at least partly contemporaneous with the Maikop and Novosvobodnaya cultures. Indeed, at Yasenova Polyana, Chalcolithic pottery co-occurs with that reminiscent of Maikop and Novosvobodnaya (Ibid.). Secondly, changes in the technological parameters of ceramics at that site do not match those observed at Meshoko. Thirdly, Yasenova Polyana is a site with a slope stratigraphy, where some displacement of units is possible (Dietler, Korenevsky, 2005–2009: 551–552). In addition, no exact statistics relating to the changes of lithic industry are available. Therefore in this case, on the basis of our analysis, we can only support the idea of the cultural heterogeneity of Yasenova Polyana, separate two approximately equal periods of its occupation, and, for the time being, confine ourselves to these modest conclusions.

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