Mezmaiskaya Cave: A Neanderthal Occupation in the Northern Caucasus
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Source: *Current Anthropology*, Vol. 40, No. 1 (February 1999), pp. 77-86
Published by: The University of Chicago Press on behalf of Wenner-Gren Foundation for Anthropological Research
Stable URL: http://www.jstor.org/stable/10.1086/515805
Accessed: 05/11/2015 22:59

Reports

Did Indo-European Languages Spread Before Farming?[1]

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The question of how the Indo-European family of languages came to occupy a broad swath of Europe and western Asia has long attracted discussion. The actual range that the Indo-European family of languages had achieved by early historical times is uncertain, but they were certainly present in central and northern Europe, southeastern Europe, Anatolia, and parts of the Near and Middle East. Celtic, Germanic, and Slavic migrations may have produced a relatively late overlay of Indo-European languages in parts of western and northern Europe, though without written records of the preexisting languages it is impossible to say what was widespread before then. Migrations and conquest may likewise have carried Sanskrit and Tocharian farther east shortly before early historical times. While acknowledging that these identifiable movements of cultures and peoples contributed to the later spread of the Indo-European languages, scholars have long discussed what events before this time might have led to the group's present distribution.

Recent discussion of the prehistoric spread of the Indo-European language group has generally concentrated on two sets of hypotheses. On one hand there is the view that migrations of warlike peoples (e.g., the Kurgan or Battle-Axe culture) (Childe 1950, Gimbutas 1980) had spread the languages through conquest of relatively passive farming populations. A more recent alternative view (Renfrew 1987, 1992) is that the main event in the spread of the western branch of these languages was the initial spread of farming out of the Near East, providing a population "wave" (due to the increased carrying capacity of the farming lifeway) that swamped the non-Indo-European languages of the hunter-gatherer groups that had previously existed in the area. This idea has received some support from genetic evidence of a southeast to northwest gradient in gene marker frequencies across Europe (Cavalli-Sforza, Menozzi, and Piazza 1994), but it has been argued that other (earlier or later) population movements could have followed the same track.

While both the battle-axe and the farming-wave hypotheses have much to recommend them, they may not be the only reasonable explanations in terms of what is known of the prehistory of Europe and western Asia against a background of environmental changes. The possibility that the initial dispersal event of the Indo-European languages involved not Neolithic farmers or Bronze Age warriors but Mesolithic hunter-gatherers has been mentioned briefly by several writers (e.g., Renfrew 1987), but no one seems to have given the idea more than a passing thought. Here we aim to discuss this idea in greater depth, examining what is known of the climatic and the archaeological record, together with general ecological principles of populations, to determine whether it stands up to more detailed analysis.

CLIMATE INSTABILITY AND LANGUAGE SPREAD

The past 100,000 years have been marked by many dramatic climate oscillations (Van Andel and Tzedakis 1996), each of which would have been capable of causing changes in human population density as the resource base shifted. Episodes of relatively low population density—for example, during intense cold and dry phases—would have been followed by rebound periods in which humans could expand in range and in numbers across the region. As well as acting as a source of genetic shifts in population composition, the "sampling error" caused by contraction of populations followed by exponential expansion out of refuge areas could have produced the spread of waves of linguistic and cultural uniformity across the region. Just such a wave of population out of the Near East may have carried Indo-European languages across much of Europe and some distance into Central Asia.

Following a climate phase marked by low human population densities across the region, any one group that acquired both the general cultural traits that caused it to spread rapidly out of a refugium and the technology to enable it to do so would have experienced rapid exponential population growth in an environment relatively free of competition from other hunter-gatherer groups. Such a group, spreading out northward and westward and possibly eastward as well, would have made a disproportionate contribution to the genetic and linguistic legacy of Europe and parts of the Near East. Other groups even a few centuries slower in expanding in size and range in response to the climate change would have been numerically dominated by the earlier colonists as they left their refugial homelands, given the likely exponential growth rates of these populations. Even at the relatively low densities that hunter-gatherer populations would have been capable of achieving, competition or at least interaction between groups would eventually have become more frequent, and the less numerous (non-Indo-European-speaking) groups would have been much more likely to lose their cultural and linguistic identity among a larger wave of Indo-European-speakers. This scenario may explain the existence of the Basque language group, which may have been a "potential" European dominant that narrowly failed to expand before the Indo-European-speakers became abundant in central and eastern Europe, southeastern Europe, and possibly also most other parts of Europe. The extinct Etruscan, Ligurian, and Iberian language groups may be regarded as further examples of the same. As the hypothetical Indo-European wave spread out in each direction, it can be expected to have gathered up the genetic and linguistic legacies of scattered smaller populations it encountered along its way as each of these began a slightly later spread out of southern European refugia. This process of gathering up may explain some of the current east-west and north-south genetic gradients which now exist in Europe and some of the differences between the present-day branches of the Indo-European family of languages.

It is thus possible that much of the initial (mid-Holocene) range of the Indo-European languages across central and northern Europe, the Balkans, and the Near East was achieved by the rapid spread of a sparse hunter-gatherer wave out of either southern Europe, the Levant, Anatolia, or western Asia, preceding the farming wave.

THE POTENTIAL IMPORTANCE OF THE YOUNGER DRYAS COLD PHASE

An obvious candidate for an environmental change which could result in rapid and widespread change in languages, cultures, and genetic composition of human populations is the Younger Dryas cold event (about 10,800–10,000 ^{14}C years ago), which returned much of western Asia to cold semidesert conditions (Huntley and Birks 1983, Starkel 1991, Landmann, Reimer, and Kempe 1996, Jalut et al. 1988, Rossignol-Strick and Planchais 1992, Velichko 1993), apparently through a series of rapid stepwise cooling events (see table 1). The transition to the Holocene is marked by noticeable changes in technologies (to the Mesolithic) and in human skeletal morphology across this region, possibly suggesting an immigration event. Reviewing the evidence for hunter-gatherer carrying capacities in different environments, Steele, Adams, and Slukin (1998) suggest that temperate forest and moist steppe have a much higher overall carrying capacity than either semidesert or arctic environments.

Drawing on a variety of sources, Rossignol-Strick (1995) suggests that in many areas of Greece and across Turkey the Younger Dryas period was even more arid than the most extreme part of the last glacial, with semidesert predominant. Conditions across most of the rest of Europe are variously thought to have resembled open cold forest steppe or possibly (at some stages) semidesert (Starkel 1991). A priori, such conditions may be expected to have resulted in some change in human population densities and distribution, though it is difficult to demonstrate or disprove this idea given the limitations of the archaeological record for the Younger Dryas period. In Europe and most of the Near East the record of human occupation during the Younger Dryas is ambiguous, with the age plateau in radiocarbon ages adding to the confusion (10,000 years ago in radiocarbon terms can mean anything between 11,200 and 12,200 "real" years ago). In northern and central Europe, the record is perhaps detailed enough to suggest a complete or almost complete depopulation during the Younger Dryas. However, in the Levant conditions seem to have remained relatively moist (Rossignol-Strick 1995), with relatively strong signs of continuity in human settlement (the Natufian) (Henry 1989). Even in this area, for instance, in the Jordan Valley, aridity and a large decrease in food plants are accompanied by smaller human populations clustered around relatively moist "oases" (Wright 1993). Following the Younger Dryas, warm, moist Holocene conditions seem to have returned rapidly all across Europe and western Asia, taking only a few decades according to the latest ice-core indicators of regional climate (Taylor et al. 1997).

Given the magnitude of the change in environments across the region, the earlier climate transition (about 12,000 ^{14}C or 14,500 calibrated years ago) to the much colder, arid Younger Dryas could well have eliminated much of the previous Late Palaeolithic population of northern and central Europe or at least drastically reduced interior population densities, and (from available indications of the carrying capacity of temperate forest environments for hunter-gatherers [Steele, Adams, and

TABLE 1
Sudden Climate Changes in Europe and the Near East during the Past 15,000 Years

Calibrated Years Ago	Climate
14,500	Warm and moist; rapid deglaciation
13,500	At least as warm and moist as today's
13,000	Cold (Older Dryas)
12,800 ± 200	Transition to cold, dry (Younger Dryas)
11,500 ± 200	Transition to warm and moist (Holocene, or isotope stage 1)
9,000	Warmer and often moister than today's
8,000	Slightly warmer and moister than today's
5,900	Cold (corresponding to "elm decline")
4,500	Becoming fairly similar to present
2,600	Relatively wet/cold in many areas

SOURCES: Adams (1998), Adams, Maslin, and Thomas (1998).

Slukin 1998]) the rapid return of warm conditions would have provided an opportunity for rapid human population expansion to fill this gap.

Renfrew (1987, 1992) has vigorously attacked the techniques of linguistic dating and has found broad support among archaeologists if not among linguists. He makes the point that linguistic dating (based on degree of similarity in vocabulary and the use of specific "technology" words to pin down the culture of the earliest Indo-Europeans) is potentially subject to great imprecision. If one takes Renfrew's view that linguistic dating of language history is unreliable, then an earlier divergence relating to hunter-gatherer recolonization after the Younger Dryas may be more plausible for a spread of Indo-European languages by this type of mechanism. An error of about a factor of two in the estimated rate of divergence taken from the earliest written records would be sufficient to push the point of common origin back several thousand years from the early-to-mid-Holocene to the earliest Holocene. Given that during this time there was dramatic cultural change to relatively sedentary Neolithic farming (with lesser changes in trade patterns and technology) all across the region, one must ask whether the linguistic chronology is accurate. One can suggest, for instance (M. Fraser, personal communication), that relatively mobile hunter-gatherer populations moving across large areas of the European continent would have retained their cultural and linguistic unity more readily than denser and more sedentary farming populations.

We do not claim that this particular hypothesis has any more merit than either the battle-axe hypothesis or the farming-wave hypothesis, but it should be seriously considered (given the uncertainty about the early linguistic history of the region) alongside these as another possible scenario. Further light might be shed on this matter if the archaeological record of the region improved, allowing this hypothesis to be subjected to more rigorous testing. For example, good evidence of severe depopulation of most of Europe and western Asia during all or part of the Younger Dryas or the early Holocene cold phase would lend support to it, while lack of any depopulation might be seen as evidence against it.

A plethora of population waves in the late glacial and holocene?

The post–Younger Dryas colonization hypothesis is only one of a range of potential scenarios, suggested by the paleoenvironmental and archaeological record, leading to the spread of Indo-European languages or of higher-order language groups such as the paired Indo-European/Uralic familes or the still broader and more heterogeneous Nostratic superfamily. Another event that might have affected the spread of Indo-European by either hunter-gatherers or early farmers or both is the widespread cold, dry event at 8,200 calibrated years ago (table 1). This event seems to have been about half as severe as the Younger Dryas (Adams, Maslin, and Thomas 1998) and to have come on (and also ended) over at most a few decades, lasting in total about 200 years. Here again, a decline in human population densities across much of the region seems plausible from the extent and the suddenness of this event. Turnover in population or in cultural identity among hunter-gatherers resulting from this disruption might well have initiated or added to the spread of the Indo-European languages.

Estimates of the linguistic chronology of the Indo-European languages have been used to suggest that much of their common vocabulary has a more recent origin (about 7,000 years ago) (Swadesh 1972) than the early Holocene divergence that this sparse-hunter-gatherer-wave hypothesis (and Renfrew's farming-wave hypothesis) would seem to require (about 10,000–11,000 years ago). In this sense, the more likely candidate is the later, less severe cold event 8,200 years ago.

There is also a possibility (though it conflicts still more strongly with the linguistic dating) that the population increase causing the initial spread of the Indo-European languages occurred at the earlier warming event at the end of the Last Glacial Maximum (about 14,500 years ago), with the onset of the Younger Dryas itself, or perhaps at an even earlier event (Otte 1994). One can also envisage scenarios combining aspects of each of the three hypotheses. Quite independent of climate change, a more effective "Mesolithic" technology might have led directly to a population wave of increased carrying capacity analogous to that associated with the Neolithic transition. As pointed out above, another major cold and arid event—lasting perhaps 200 years—affected Europe and western Asia around 7,400 ^{14}C 8,200 calibrated years ago (Alley et al. 1997) (table 1). An initial early Holocene sparse-hunter-gatherer-wave spread of the Indo-European languages might have been followed by a period of relatively long-distance cultural and linguistic exchange (with possible spread of innovations in the language, continually updating aspects of the general substratum of Indo-European languages [*sensu* Sherratt 1996]) by relatively mobile hunter-gatherer groups and later farming and warrior groups.

A major refuge of population in the Europe-West Asian region during the Younger Dryas seems to have been the area of the Jordan Valley, where populations clustered in moist sites in which wild nuts and grains could be gathered. It is interesting to consider that this region, having the general characteristics of a source region for a sparse wave of hunter-gatherers, was also a key source for the farming wave. The Indo-European languages might thus have been propelled out of this source region by two successive population waves, first one of hunter-gatherers and then a slower one of farmers.

The idea that a phase of colder, drier conditions might have led to a regional decline in population density depends crucially on the cultural habits and cultural flexibility of the hunter-gatherer inhabitants of the region. One might hypothesize (as mentioned above) that an opening-up of the returning woodlands due to cold and/or aridity would have favoured hunting of large animals, making possible an increase in population density. This could merely push the dating of the necessary population wave slightly farther back in time. However, animal protein is not a principal source of food outside arctic and coastal environments, so it would be unlikely to result in anything other than a net decrease in population elsewhere as the plant food availability from wild grasses and nut-bearing trees declined with a shift towards cold steppe and semidesert conditions. The upshot of the complexity of human behaviours is that different cultural groups of humans might have responded to the same change in opposite ways, and such a pattern of simultaneous decline of one group and expansion of another might have produced a pattern of linguistic spread. In any case, overall population density seems likely to have declined during cold, arid events, and the archaeological evidence from the Near East supports this.

Thus, if climate events were rapid and intense enough to disrupt hunter-gatherer (and/or farming) populations, they may have been responsible for population or cultural replacements which helped to spread languages. Since the most intense events (the Younger Dryas and the cold event of 8,200 years ago) precede the Neolithic across most of the Europe/Near East region, hunter-gatherers may have been the vectors of the Indo-European languages.

This is merely speculation, but laying out possible scenarios is important to show that the situation in the region could well have been more complex than has generally been thought. The very variable environmental record of the Late Glacial and Holocene suggests that there would have been ample opportunities for population and cultural/linguistic replacement quite unrelated to agriculture or migrations of warriors on horseback.

CONCLUSION

The paleoenvironmental record suggests various times over the past 15,000 years at which major changes in hunter-gatherer population density *could* have occurred on a regional scale as a result of environmental changes. Such population shifts would be difficult to detect in a sparse archaeological record subject to large ^{14}C anomalies, but they remain a distinct possibility given the magnitude of the climate and ecological changes recorded from across the region. While the ending of the Younger Dryas event seems particularly likely to have resulted in population waves in the approximate time range of the origin of the Indo-European languages, any one of these prehistoric changes could have initiated the spread of the Indo-European language group (and in a broader sense the linked Indo-European/Finno-Ugric group). Given the existing dating and the detailed linguistic analysis suggesting a divergence time around 7,000 calibrated years ago, a somewhat later climate change (early-to-mid-Holocene; e.g., the cold event of 8,200 or that of 5,900 calibrated years ago) would seem more consistent with observations. A change 8,200 years ago could have promoted the spread of Indo-European languages by either hunter-gatherers or farmers or both.

Alternatively, climate change may have had little or no role in the spread of the languages by farmers or post-Neolithic warriors. Different processes could coincidentally have aided the spread of the Indo-European language family at different times. It may be that an initial sparse wave of recolonizing hunter-gatherers carried this group of languages part-way into central Europe and western Asia, with later processes such as the spread of farming and migrations of warrior cultures being responsible for its further spread.

Our hypothesis that climate change promoted the spread of Indo-European languages by causing changes in the population density of hunter-gatherer groups may be difficult or impossible to test. Given the a priori case which can be made, it seems fairly plausible, although like Renfrew's farming-wave hypothesis it contradicts paleolinguistic analyses. The severity of this weakness is uncertain, however, as Renfrew (1987, 1992) has pointed out various grounds on which the paleolinguistics can be doubted.

The general hypothesis that past climate changes strongly affected linguistic patterns can also merge into more traditional explanations; sudden climate change could have been the primary cause of migrations of Indo-European-speaking Neolithic farmers or horse-riding warriors. If one accepts the paleolinguistic view that such "technology" words as "wheel" and "copper" were initially present at the point of divergence of Indo-European languages and that they applied to items such as a fully formed wheel or worked copper, then the 8,200- or 5,900-year climate event (rather than the Younger Dryas) could have been more important, respectively influencing migrations of farming groups or of horse-riding warriors. The fact that one can so readily add and interchange alternative hypotheses concerning the spread of the Indo-European languages (and other language groups, all of which have formed in the highly variable world of the Late Quaternary period) should perhaps be seen as reason for scepticism regarding any prospect of understanding the true nature of the initial spread of the Indo-European languages. Finding out what one does not know is, however, a vital part of the scientific process; it is always better to realise that there are grounds for uncertainty than to hold an unfounded belief that one knows the answer. This uncertainty is reason for open-mindedness as to the causes of the spread of Indo-European rather than any sharp division into entrenched views.

References Cited

ADAMS, J. M. 1998. Global land environments since the last interglacial. MS, Oak Ridge National Laboratory. http://www.esd.ornl.gov/ern/qen/nerc.html.

ADAMS, J. M., M. MASLIN, AND E. THOMAS. 1998. Sudden

climate transitions during the Quaternary. *Progress in Physical Geography.* In press.
ALLEY, R. B., P. A. MAYEWSKI, T. SOWERS, K. C. TAYLOR, AND P. U. CLARK. 1997. Holocene climatic instability: A prominent, widespread event 8200 yr ago. *Geology* 25:483–86.
CHILDE, V. G. 1950. *Prehistoric migrations in Europe.* Oslo: Aschehoug.
CAVALLI-SFORZA, L. L., PAOLO MENOZZI, AND ALBERTO PIAZZA. 1994. *The history and geography of human genes.* Princeton: Princeton University Press.
GIMBUTAS, M. 1980. The Kurgan wave migration (c. 3400–3200 B.C.) into Europe and the following transformation of culture. *Journal of Near Eastern Studies* 8:273–315.
HENRY, D. O. 1989. *From foraging to agriculture: The Levant at the end of the Ice Age.* Philadelphia: University of Pennsylvania Press.
HUNTLEY, B., AND H. J. B. BIRKS. 1983. *An atlas of past and present pollen maps for Europe: 0–13,000 years ago.* Cambridge: Cambridge University Press.
JALUT, G., V. ANDRIEU, G. DELIBRIAS, M. FONTUGNE, AND P. PAGES. 1988. Palaeoenvironment of the Valley of Ossau (western French Pyrenees) during the last 27,000 years. *Pollen et Spores* 30:357–94.
LANDMANN, G., A. REIMER, AND S. KEMPE. 1996. Climatically induced lake-level changes at Lake Van, Turkey, during the Pleistocene/Holocene transition. *Global Biogeochemical Cycles* 10:797–808.
OTTE, M. 1995. *Diffusion des langues modernes en Eurasie préhistorique.* Comptes Rendus de l'Académie des Sciences, Paris, 31, série IIa.
RENFREW, C. 1987. *Archaeology and language.* Cambridge: Cambridge University Press.
———. 1992. The emerging synthesis. *Man* 27:445–78.
ROSSIGNOL-STRICK, M. 1995. Sea-land correlation of pollen records in the eastern Mediterranean for the glacial-interglacial transition: Biostratigraphy versus radiometric time-scale. *Quaternary Science Reviews* 14: 893–915.
ROSSIGNOL-STRICK, M., AND N. PLANCHAIS. 1989. Climate patterns revealed by pollen and oxygen isotope records of a Tyrrhenian Sea core. *Nature* 342:413–16.
SHERRATT, A. 1997. Climatic cycles and behavioural revolutions: The emergence of modern humans and the beginning of the Neolithic. *Antiquity* 71:271–87.
STARKEL, L. 1991. Environmental changes at the Younger Dryas–Preboreal transition and during the early Holocene: Some distinctive aspects in central Europe. *The Holocene* 1: 234–42.
STEELE, T. J., J. M. ADAMS, AND T. SLUKIN. 1998. Modelling Paleoindian dispersals. *World Archaeology.* In press.
SWADESH, M. 1972. *The origin and diversification of language.* New York: J. Sherzer.
TAYLOR, K. C., P. A. MAYEWSKI, R. B. ALLEY, E. J. BROOK, A. J. GOW, P. M. GROOTES, D. A. MEESE, E. S. SALTZMAN, J. P. SEVERINGHAUS, M. S. TWICKLER, J. W. C. WHITE, S. WHITLOW, AND G. A. ZIELINSKI. 1997. The Holocene-Younger Dryas transition recorded at Summit, Greenland. *Science* 278:825–27.
VAN ANDEL, T. H., AND P. C. TZEKAKIS. 1996. Palaeolithic landscapes of Europe and environs, 150,000–25,000 years ago: An overview. *Quaternary Science Reviews* 15:481–500.
VELICHKO, A. A. 1993. *Evolution of landscapes and climates of northern Eurasia: Late Pleistocene-Holocene elements of prognosis.* Vol. 2. Moscow: Nauka.
WRIGHT, H. E. JR. 1993. Environmental determinism in Near Eastern prehistory. CURRENT ANTHROPOLOGY 34:458–69.

Mezmaiskaya Cave: A Neanderthal Occupation in the Northern Caucasus[1]

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Mezmaiskaya Cave, located in the Northern Caucasus, has yielded new facts about the life and death of Neanderthals in Eastern Europe. The cave contains a stratified sequence of Middle and Upper Paleolithic levels dating to the Last Glacial. It has produced the partial skeleton of a Neanderthal infant representing an almost certain example of intentional burial. It also contains evidence of significant technological change during the Middle Paleolithic, perhaps in response to Last Glacial climatic oscillations. Exceptionally well-preserved faunal remains have provided much information on the economy. Mezmaiskaya Cave has also yielded the first dated early Upper Paleolithic assemblage in the Northern Caucasus and provides our first glimpse of the Middle-to-Upper-Paleolithic transition in this part of Europe.

The Northern Caucasus lies on the southeastern boundary of Europe and represents one of the routes by which modern humans may have entered the continent from the adjoining Near East. The region is characterized by a mild climate and a rich supply of plant and animal life. Although Paleolithic remains were initially discovered in the Northern Caucasus a century ago at the Il'skaya site (Zamyatnin 1929), a clear picture of Pleistocene settlement history was slow to emerge owing to the lack of well-stratified and dated sites (Lyubin 1977). In recent years, the discovery of deeply stratified sites at Matuzka Cave in the northwestern Caucasus and Myshtulagty lagat (Weasel Cave) in the north-central Caucasus altered this situation (Golovanova, Levkovskaya, and Baryshnikov 1990, Hidjrati et al. 1997). In addition, new excavations at two previously known sites in the northwestern Caucasus (Barakaev-

1. The research reported here was made possible through financial support from the Russian Academy of Sciences, L. S. B. Leakey Foundation, National Geographic Society, and National Academy of Sciences. We gratefully acknowledge the assistance of V. B. Doronichev, S. A. Kulakov, and G. M. Levkovskaya (Institute of the History of Material Culture, Russian Academy of Sciences, St. Petersburg), G. F. Baryshnikov and O. R. Potapova (Zoological Institute, Russian Academy of Sciences, St. Petersburg), and R. L. Burgess (U.S. Air Force, Scott Air Force Base, Ill.). We also thank R. G. Klein for comments on an earlier draft of the manuscript.

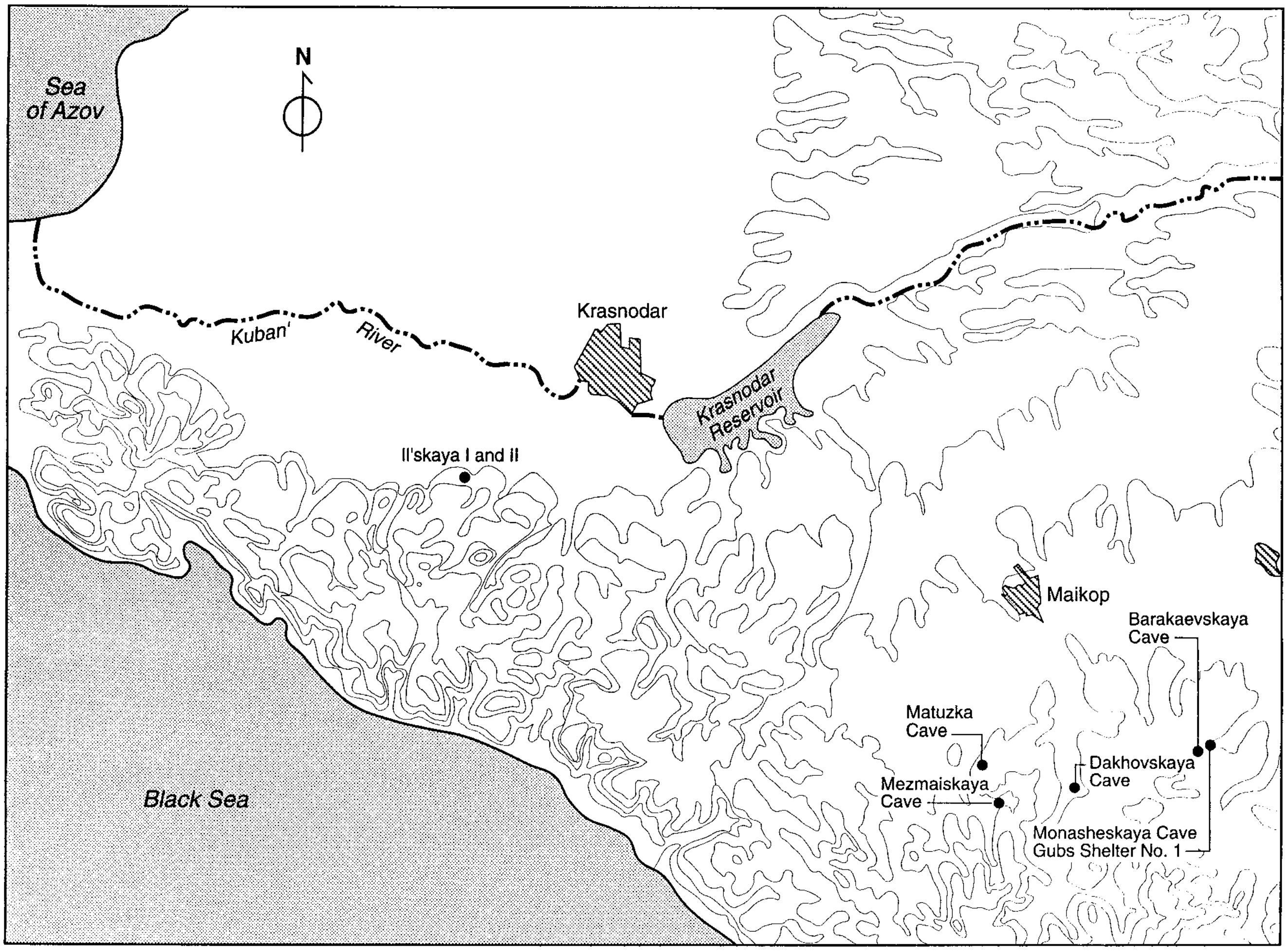

FIG. 1. *The location of Mezmaiskaya Cave and other Middle Paleolithic sites in the Northern Caucasus mentioned in the text.*

skaya Cave and Monasheskaya Cave) yielded human skeletal remains and other information about the Paleolithic inhabitants of the region (Belyaeva 1992, Lyubin 1994). The discovery and excavation of Mezmaiskaya Cave has contributed further to filling the gaps in our knowledge about this remote but important area in Eastern Europe.

GEOGRAPHIC SETTING AND RESEARCH HISTORY

Mezmaiskaya Cave is situated in the northwestern Caucasus approximately 50 km south of the city of Maikop (fig. 1). The cave is found at an elevation of 1,310 m above mean sea level at 44°10′ N 40°00′ E, in the Azish-Tau Range, which is part of the Lagonak Upland. It overlooks the right bank of the Sukhoi Kurdzhips (a small tributary of the Kurdzhips River). Mezmaiskaya Cave is a solution cavern formed in Jurassic dolomite and is approximately 35 m in length, 8.5–9 m in height, and up to 25 m in width (at the entrance, which faces southwest).

Paleolithic remains were first discovered at Mezmaiskaya Cave in 1987. Excavations directed by the senior author were conducted during 1987–97 and have exposed a total of over 40 m^2. Several thousand artifacts and many thousands of well-preserved faunal remains have been recovered from four Middle Paleolithic and three Upper Paleolithic occupation levels. Excavated sediment from occupation layers was water-sieved for recovery of small artifacts and bone fragments. In 1993 a partial human skeleton was found in the lowermost Middle Paleolithic layer, and in 1994 additional skeletal fragments were encountered in the uppermost Middle Paleolithic layer (Golovanova 1994, Golovanova and Romanova 1995).

STRATIGRAPHY AND DATING

Mezmaiskaya Cave contains a deep succession of clay, loam, and rubble deposits that date to the Holocene, Late Pleistocene, and possibly earlier (fig. 2). The uppermost layer (layer 1) is a sandy loam with small weathered rubble and contains a mixture of faunal remains and redeposited artifacts of Paleolithic and post-Paleo-

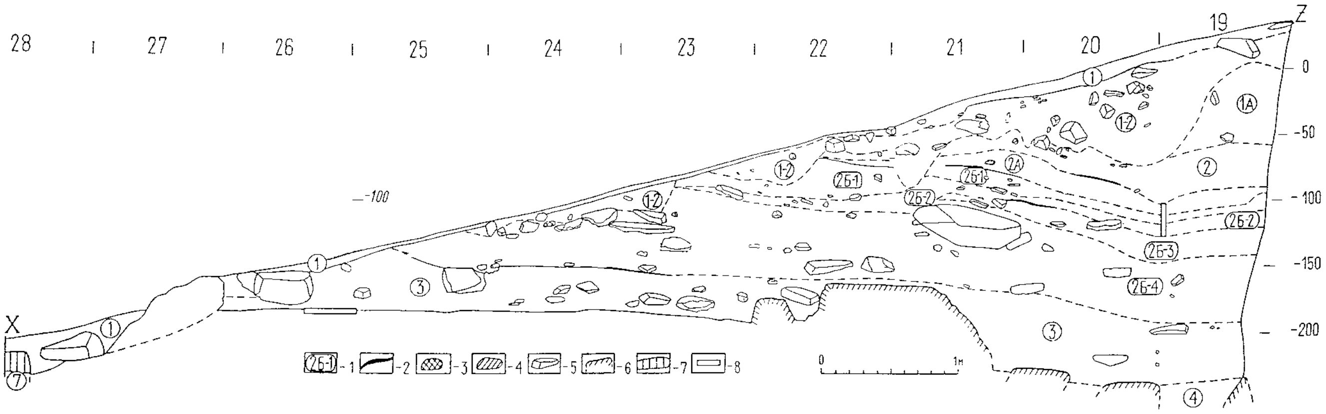

FIG. 2. *Stratigraphy of Mezmaiskaya Cave (upper layers only).* 1, *layer number;* 2, *ash lens;* 3, *krotovina;* 4, *block,* 5, *rock;* 6, *limestone;* 7, *stalagmite floor;* 8, *location of human skeletal remains.*

lithic age. The underlying levels (layers 1A, 1B, and 1C), which consist of a loam with little rubble, contain Upper Paleolithic artifacts. These levels have been disturbed by both erosion and rodent burrowing. While layer 1A may date to the final Late Pleistocene, layer 1C yielded an assemblage of typical early Upper Paleolithic artifacts and an AMS radiocarbon date (obtained on wood charcoal from a former hearth) of 32,000 years B.P. (table 1).

Beneath these layers lie approximately 2 m of deposits containing Middle Paleolithic occupation levels and human skeletal remains. The upper Middle Paleolithic levels (layers 2 and 2A) are composed of clay and clay loam with small to large angular rocks and pebbles. In these layers, the predominance of alpine meadow forms among the rodent fauna and the high proportion of nonarboreal taxa among the pollen spectra indicate significantly cooler climatic conditions than at present. The lower Middle Paleolithic levels are made up of a silt-to-clay loam with small to large angular rocks and numerous small pebbles (layer 2B) and a clay with occasional small to large angular rocks (layer 3). The rodent fauna from these layers exhibits a more balanced mixture of forest and alpine forms, and climatic conditions appear to have been somewhat milder than during the deposition of layers 2 and 2A, although nonarboreal pollen is still predominant. All of the layers containing Middle Paleolithic artifacts yield comparatively high levels of organic matter and phosphorus, which probably reflect the effects of human occupation (Baryshnikov, Hoffecker, and Burgess 1996:314–16; Golovanova et al. 1998).

The Middle Paleolithic occupation levels appear to date to the Middle Pleniglacial (oxygen-isotope stage 3), although the lowermost remains could be older (possibly oxygen-isotope substages 5a–5d). Radiocarbon dates from layers 2, 2A, and 2B all fall within the later part of oxygen-isotope stage 3, but these dates, obtained on bone and clearly lying at or beyond the effective range of radiocarbon dating, should be treated as minimum estimates. The date from the lowest Upper Paleolithic level suggests that the Middle-to-Upper-Paleolithic transition at Mezmaiskaya Cave is probably synchronous with the transition in other areas of Europe (Klein 1989, Mellars 1996). The uppermost Middle Paleolithic level at Myshtulagty lagat (Weasel Cave) in the north-central Caucasus recently yielded a wood charcoal AMS date of 36,000 years B.P. (L. R. Kimball, personal communication, 1998).

The layers that underlie the Mousterian occupations have thus far failed to yield any evidence of human habitation. The uppermost unit (layer 4) contains a major rockfall horizon that may date to the Early Pleniglacial cold peak (oxygen-isotope stage 4); alpine meadow taxa

TABLE 1
Radiocarbon Dates from Mezmaiskaya Cave

Layer	Date	Lab No.	Material Dated
1C	32,010 ± 250	Beta-113536	Wood charcoal
2	32,230 ± 740	LE-4735	Bone
2A	35,760 ± 400	Beta-53896/CAMS-2999	Burned bone
2A	36,280 ± 540	Beta-53897/ETH-9817	Burned bone
2B	40,660 ± 1,600	LE-3599	Bone
3	> 45,000	LE-3841	Bone

predominate among the rodent fauna. A reddish-yellow zone at the base of this layer may reflect forest soil formation during the preceding Early Glacial (oxygen-isotope substage 5a?). The basal levels (layers 5–7), which are represented by clay loam and clays with varying quantities of rubble and pebbles, also appear to have accumulated under milder climatic conditions and probably date to the earlier Late Pleistocene (oxygen-isotope stage 5) or earlier. The consistently high levels of potassium in these layers may reflect repeated forest soil formation (Baryshnikov, Hoffecker, and Burgess 1996:316).

PALEOLITHIC ARTIFACT ASSEMBLAGES

Over 5,000 artifacts have been recovered from the Paleolithic occupation layers in Mezmaiskaya Cave. These layers may be subdivided into three Upper Paleolithic levels (layers 1A, 1B, and 1C), and four Middle Paleolithic levels (layers 2, 2A, 2B, and 3). Significant differences exist among the assemblages both within and between the Middle and Upper Paleolithic.

The Upper Paleolithic artifacts, many of which were excavated during 1997, have not yet been described in detail. The assemblages from layers 1A and 1B are chiefly comprised of unretouched blades and flakes. Retouched lithic items include endscrapers, backed blades, and Gravette points. Nonlithic tools include bone awls and bone and ivory points (ivory was probably imported from lower elevations). These assemblages are similar to those from previously reported Upper Paleolithic sites in the Northern Caucasus that are believed to date to the final Upper Paleolithic (Amirkhanov 1986). The assemblage from layer 1C is different and contains endscrapers on massive flakes and large blade fragments, dihedral and multifaceted burins, points (including points on microblades), and backed blades. Nonlithic implements include bone awls and points. On the basis of both typology and radiocarbon dating, layer 1C appears to be an early Upper Paleolithic industry. Although the undated assemblage from Kamennomostskaya Cave, which is located approximately 20 km northeast of Mezmaiskaya Cave and exhibits some similarities to the layer 1C assemblage, was tentatively assigned to the earlier Upper Paleolithic on typological grounds (Amirkhanov 1986), Mezmaiskaya Cave has produced the first reliable evidence of an industry in this time-range in the Northern Caucasus.

A total of 3,645 lithic artifacts were recovered from the Middle Paleolithic occupation levels during 1987–95 (table 2). The cores exhibit a pattern of parallel flaking on slightly convex surfaces. Cores were rejuvenated by creation of a new striking platform and continued flaking on the same surface; two-sided cores are rare. A preliminary analysis of striking platforms indicates that retouched platforms are uncommon, although the quantity of retouched platforms increases in the upper levels. True blades are very rare in the lower levels but more common in the upper levels.

Tools from all levels reflect the predominance of lateral sidescrapers, which range from 24% in layer 3 and 32% in layer 2B (fig. 3) to 40–50% in layers 2A and 2 (fig. 4). Canted sidescrapers are also numerous in all layers, but double and transverse forms are less common. The majority of sidescrapers were prepared on flakes or bladelike flakes. Mousterian points, often with thinned backs (fig. 3, *3*), and endscrapers (fig. 3, *10*) are also present in all levels. Denticulates are rare.

The most significant contrast between assemblages from the lower and upper Middle Paleolithic layers is the high proportion of bifacial tools in the former. These include bifacial sidescrapers, which are plano-convex and typically have butts; only isolated examples have been found in the upper layers. The lower layers contain small handaxes (fig. 3, *2*) and bifacial foliate points, which are represented by two fragments in layer 3 and a complete specimen in layer 2B (fig. 3, *1*). Limaces and "Chokurcha triangles" (bifacially worked triangular tools found in the Crimean cave site of Chokurcha I) are also present. Endscrapers in the lower layers exhibit partial bifacial working. Layers 3 and 2B also contain a large number of tools with converging edges, although most of these are unifacial or possess alternating retouch.

The assemblages from the lower levels (layers 2B–3) are similar to those in many other Middle Paleolithic sites in Central and Eastern Europe. This industry is sometimes referred to as the "East European Micoquian" (Bosinski 1967, Gábori 1976) or simply the "East European Mousterian" (Praslov 1984). Although bifacial implements were recovered from Il'skaya I (Zamyatnin 1929), the assemblages from layers 2B–3 at Mezmaiskaya Cave represent the first well-defined example of this industry in the Northern Caucasus. The assemblages from the upper levels (layers 2–2A) are comparable to those from several Middle Paleolithic sites in the northwestern Caucasus (Monasheskaya Cave, Gubs Shelter No. 1, and Barakaevskaya Cave) which have been grouped together as the "Gubs Mousterian Culture" (Lyubin 1977, 1994). As at Mezmaiskaya Cave, these assemblages (especially at Monasheskaya Cave and Gubs Shelter No. 1) are thought to date relatively late in the sequence of local Middle Paleolithic industries.

HUMAN SKELETAL REMAINS

Human remains recovered to date from Mezmaiskaya Cave include a partial skeleton from the lowermost Mousterian level (layer 3) and cranial fragments from the uppermost Mousterian level (layer 2). The partial skeleton was found in quadrant M-26 near the cave entrance, where layer 1 lies unconformably over layer 3. The skull was partly damaged, especially in the facial area, and displaced. The left scapula, humerus, and radius were preserved in anatomical sequence, as well as much of the vertebral column and ribs. The leg bones were fully displaced. The body had been deposited on the right side, the head oriented to the north and the left arm extended along the trunk but flexed slightly at

TABLE 2
Artifacts from the Middle Paleolithic Layers at Mezmaiskaya Cave (1987–95 Excavations)

	Layer/Horizon						
	2	2A	2B-1	2B-2	2B-3	2B-4	3
Cores	19	8	2	5	4	42	58
Worked fragments	48	12	1	4	2	39	55
Small fragments	27	1	–	–	1	13	55
Chips	73	22	1	2	23	142	843
Flakes	139	72	14	6	23	340	602
Blades	73	17	2	4	4	35	51
Pebbles	1	2	1	–	–	–	8
Tools	(52)	(18)	(9)	(5)	(27)	(216)	(422)
Endscrapers	3	–	–	–	1	–	2
Burins	2	1	–	–	–	1	–
Splintered pieces	1	–	–	–	–	–	–
Denticulates	4	1	–	–	3	6	24
Sidescrapers							
Lateral	20	12	4	3	7	74	153
Transverse	2	2	2	–	2	17	14
Double	4	–	–	1	–	8	7
Canted	5	1	–	–	1	31	29
Convergent	3	–	1	–	4	9	26
Points	3	1	–	–	2	19	30
Limaces	–	–	–	–	–	4	6
Bifacial tools							
Leaf-shaped	–	–	–	–	–	2	1
Points	1	–	–	–	–	–	9
Handaxes	–	–	–	–	–	10	25
Sidescrapers	–	–	–	–	–	10	14
Triangles	–	–	–	–	–	1	4
Utilized flakes	2	–	1	–	1	1	3
Choppers	1	–	–	–	–	1	7
Tool fragments	–	–	–	–	4	12	33
Retouched flakes	1	–	1	1	2	10	35
Total	432	152	30	26	84	827	2,094

the elbow; the position of the legs could not be determined. The skeleton occupied an area of 20 × 40 cm; no traces of a burial pit were observed, and no artifacts or faunal debris were found in the immediate vicinity of the remains. However, small charcoal fragments (2–3 mm in diameter) were recovered from the sediment surrounding the skeleton (fig. 5).

The age at death of the layer 3 skeleton was estimated on the basis of dental development. Fourteen dental crowns derived from deciduous teeth were recovered. Given that formation of the occlusal surface of the crown of the second deciduous molar was incomplete and that the remaining teeth did not exhibit neck and root development, the infant probably died between the age of a foetus of seven months and a newborn of two months.

Among the cranial remains, three bones (frontal, occipital, and sphenoid) have been described and compared with those of a modern human infant of similar age. The squama of the frontal bone is denser and the frontal eminence less pronounced than in a modern infant. The zygomatic process is substantially thicker where it adjoins the lateral orbit. The occipital bone is differentiated from that of a modern human by greater dimensions, thickness, and density and by its rectangular form. The interior surface is only slightly concave and has several small, deep fossae. The intrajugular process is absent, but the paramastoid process is distinctly expressed, and the sulcus for the sigmoid sinus is present although weakly expressed. The paramastoid process is not round but extended in shape. The condyloid fossa is larger and more fully expressed than in a modern infant. The margin of the foramen magnum also exhibits differences from that of a modern infant; it varies in thickness and is slightly curved, apparently reflecting a foramen magnum of extended oval form (pear-shaped in a modern infant). A fragment of the right upper portion of the squama of the occipital was preserved and may be differentiated from that of a modern infant by a significantly smaller degree of curvature. The sphenoid bone is more massive than in a modern infant as a function of the greater size of several transverse dimensions and other features. The anterior clinoid process is comparatively large and more medially placed than in a

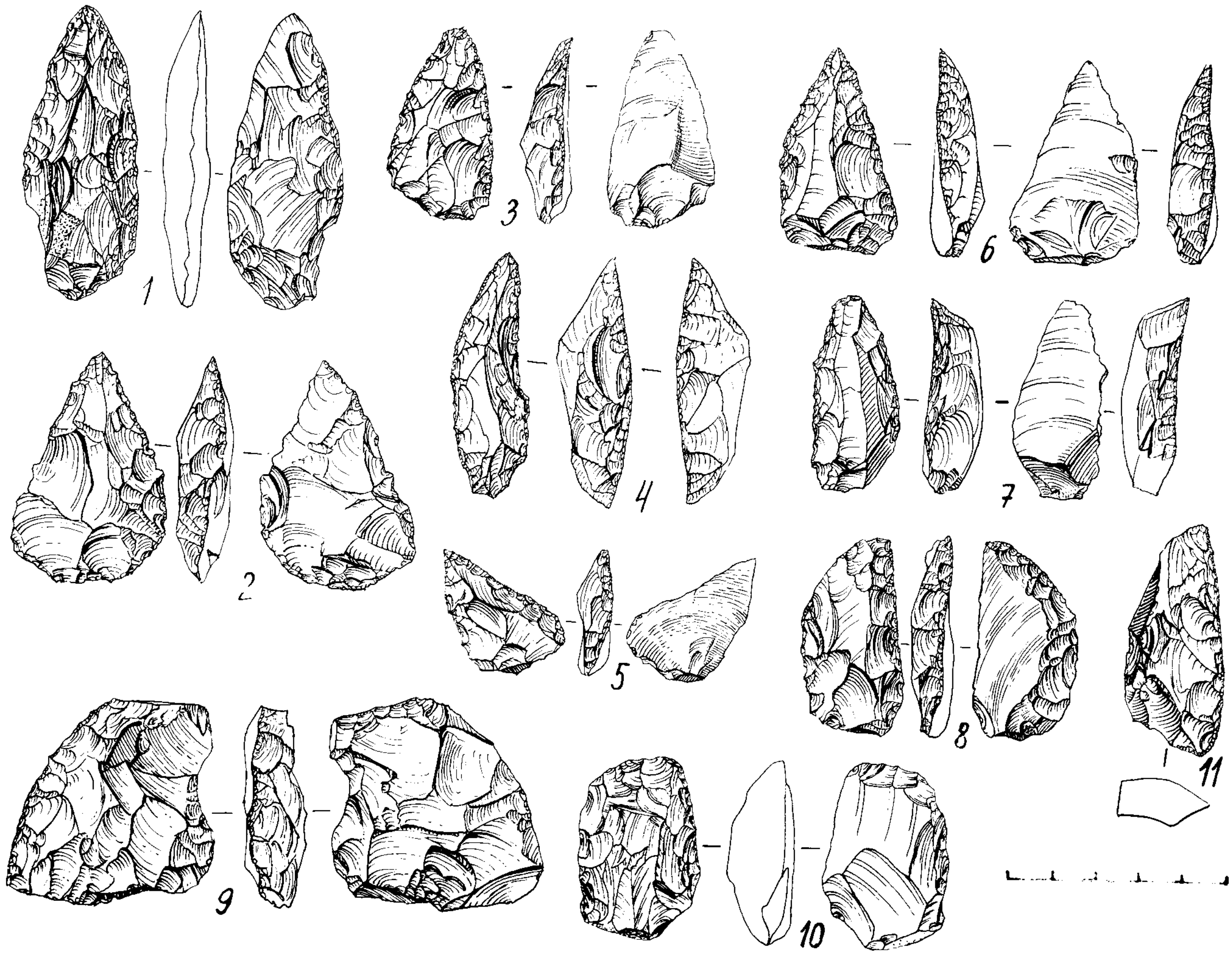

FIG. 3. *Artifacts from the lower Middle Paleolithic levels (layers 3 and 2B).*

modern specimen. The tuberculum sellae is rectangular, not partly circular, in form. The chiasmatic groove is deeper, and the carotid sulcus and lingula are massive. The greater wing displays a thicker zygomatic margin and the pterygoid process a broad base.

The postcranial bones also exhibit some significant differences from those of a modern infant. The distal segments of the limbs (radius, tibia) are relatively shorter than the upper segments (humerus, femur). Radiographic analysis indicates that the medullary cavities of the limb bones are large. Three postcranial bones (femur, radius, and ulna) have been described and compared with those of a modern infant of similar age. The femur is large, and the curvature of the diaphysis is reduced owing to the increased transverse and sagittal dimensions. The linea aspera is less pronounced and the distal end especially large. The intertrochanteric crest is comparatively small, reflecting the enlarged sagittal and transverse dimensions of the proximal diaphysis. The radius is massive; the transverse dimensions are greater at all points, and the sagittal dimension is especially great on the proximal portion of the bone. The distal portion of the diaphysis exhibits a large transverse diameter that affects its shape, and the proximal end of the diaphysis also exhibits differences from that of a modern infant. The radial tuberosity is well expressed and shifted medially and posteriorly because of the small curvature of the bone around the vertical axis. The position of the nutrient foramen is shifted towards the center of the diaphysis. The ulna is somewhat broader at all points, but the most striking differences from that of a modern infant specimen lie in the structure of the proximal diaphysis. The transverse and sagittal dimensions of the olecranon are greater, and the irregular trapezoid shape of the upper end differs from the subrectangular form in a modern specimen. The medial surface of the proximal end is somewhat convex, in contrast to the concavity along the medial edge between the coronoid process and the olecranon in a modern infant. The specimen exhibits a small degree of curvature.

The cranial fragments from layer 2 were found in a small pit (40 × 20 cm) located in quadrant N-19 that was covered with a limestone block and extended into layer 2A and 2B to a total depth of up to 50 cm. It was

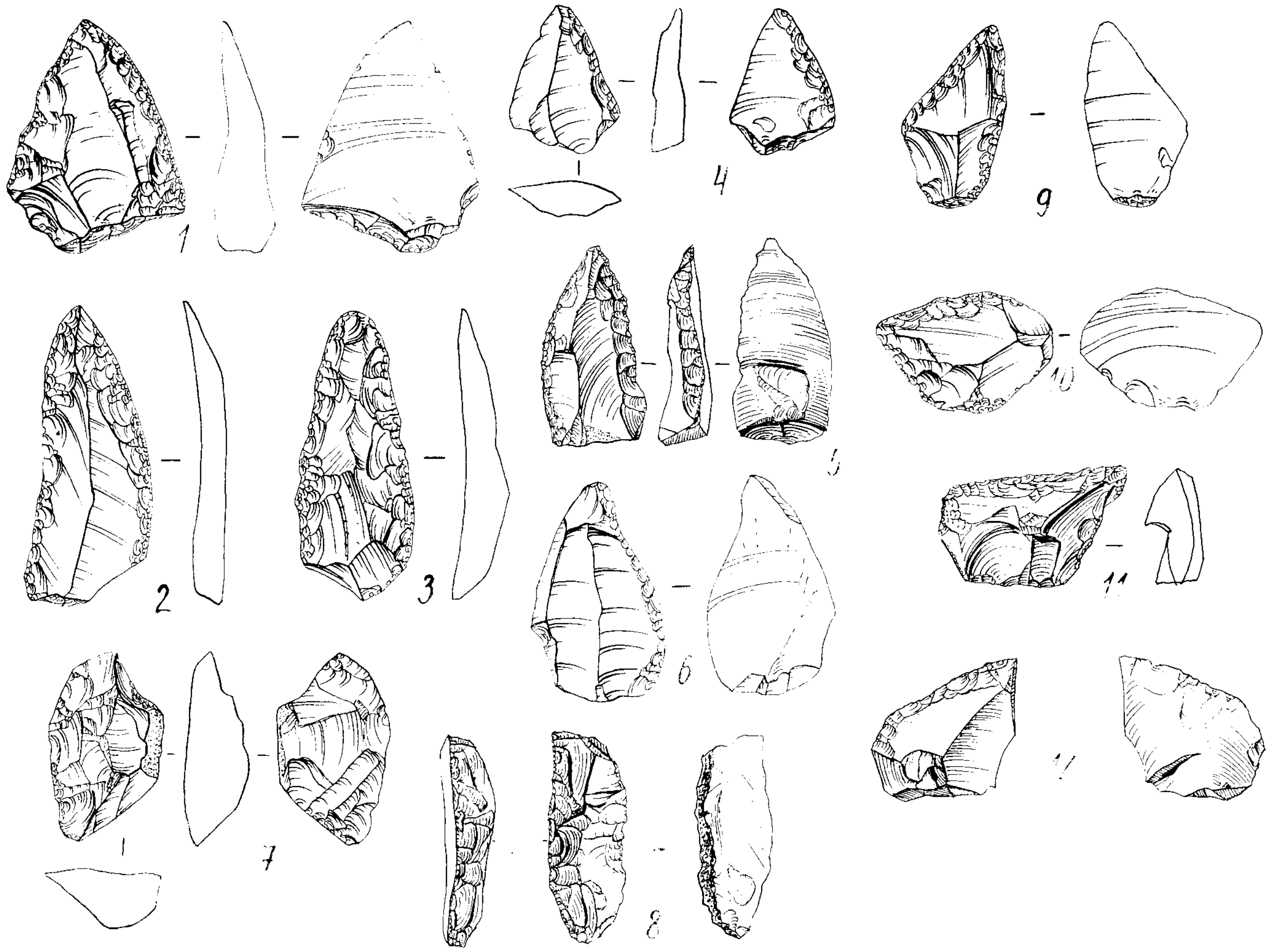

FIG. 4. *Artifacts from the upper Middle Paleolithic levels (layers 2A and 2).*

not possible to determine if this pit had been excavated by the inhabitants of the cave or had been formed by the impact of the limestone block. A total of 24 fragments were recovered from the pit. The fragments represent portions of the frontal and adjoining left and right parietal bones. The presence of an anterolateral fontanelle (sphenoid fontanelle) indicates an age at death of 1–2 years. The cranial fragments are characterized by a small degree of curvature, apparently due primarily to the effects of postdepositional deformation.

The partial skeleton from layer 3 may be classified as an archaic human with clear affinities to the Neanderthals of Western and Central Europe (*Homo neanderthalensis* or *H. sapiens neanderthalensis*). Among the traits exhibited by the cranial and postcranial remains, the developed paramastoid process, oval shape of the foramen magnum, and short distal limb segments are especially significant (Trinkaus 1981; Rak, Kimbel, and Hovers 1994, 1996). Skeletal remains found in association with other Middle Paleolithic occupations in the Northern Caucasus (Barakaevskaya Cave, Monasheskaya Cave, and Matuzka Cave) are also derived from Neanderthals (Lyubin et al. 1986, Belyaeva 1992, Golovanova et al. 1995). Despite the proximity of this region to the Near East, where modern humans are associated with some Middle Paleolithic occupations, there is currently no indication that modern humans manufactured any of the Middle Paleolithic industries of the Northern Caucasus. Moreover, the recent redating of the Starosel'e child in the Crimea has eliminated any compelling evidence for Middle Paleolithic modern humans in Eastern Europe as a whole (Marks et al. 1997).[2]

The remains from layer 3 are consistent with the hypothesis that the Neanderthals intentionally buried their dead but typically without evidence for accompanying ritual. Although no traces of a burial pit were observed around the human remains, the presence of a partial skeleton is unique in the Mezmaiskaya Cave de-

2. An isolated molar (left M^2) recovered from the Mousterian site of Rozhok I (horizon 4), located on the Sea of Azov coast, lacks archaic features and may be derived from an anatomically modern human but according to A. A. Zubov cannot be firmly assigned to either modern or archaic *Homo sapiens* (Praslov 1968:83–84).

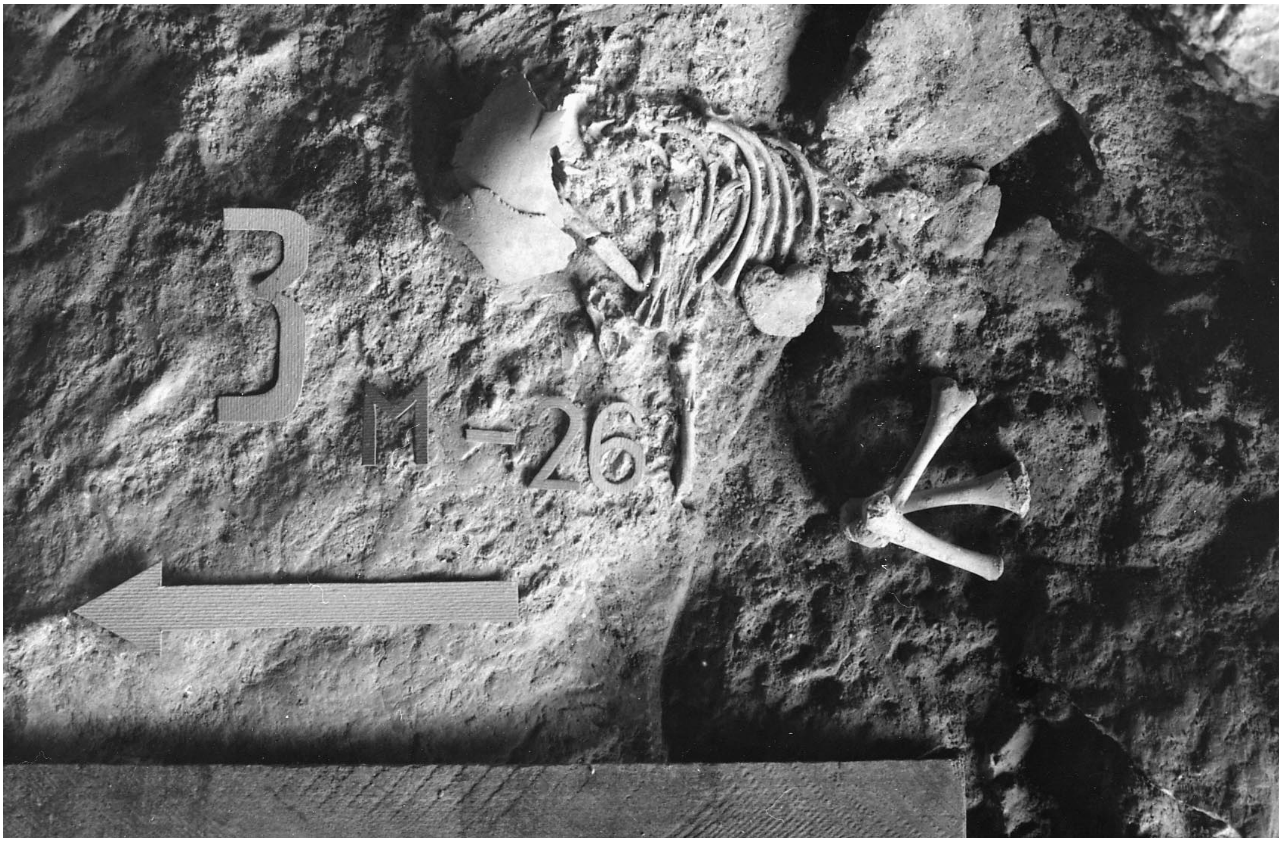

FIG. 5. *Partial skeleton from Middle Paleolithic layer 3.*

posits. All other skeletal remains, including those of animals that died of natural causes in the cave (e.g., cave bear), were dispersed and fragmented, although in rare instances several bones were found in anatomical sequence (Baryshnikov, Hoffecker, and Burgess 1996). Much of the layer 3 skeleton was protected from the processes of dispersal and breakage, probably by intentional burial; the absence of evidence for a burial pit may be the result of erosion, which has affected portions of layer 3 in this part of the cave (i.e., near the entrance). Careful examination of the sediment surrounding the skeleton failed to reveal any material evidence of ritual behavior that might have been associated with the burial (e.g., grave goods, red ochre).

FAUNAL REMAINS

Many thousands of exceptionally well-preserved vertebrate remains have been recovered from all levels of Mezmaiskaya Cave, and their analysis has yielded much information about the paleoecology of the site (Baryshnikov and Hoffecker 1994, Baryshnikov, Hoffecker, and Burgess 1996). Taxonomic classification of remains recovered during the 1987–89 excavations revealed predominance of steppe bison (*Bison priscus*), Caucasian goat (*Capra caucasica*), and Asiatic mouflon (*Ovis orientalis*) among medium-sized and large mammals in the Middle Paleolithic occupation layers (table 3). Bison was especially common in the lower Middle Paleolithic levels, ranging from 52% to 76% of the total number of identified specimens in layers 3 and 2B. Less common taxa include red deer (*Cervus elaphus*), Kudaro cave bear (*Ursus deningeri kudarensis*), and marmot (*Marmota paleocaucasica*). Few data are currently available on the faunal remains from the Upper Paleolithic levels.

In order to assess the degree of preservation, a sample of large mammal bones ($n = 479$) was classified according to the five weathering stages defined by Behrensmeyer (1978). Ninety percent of the sample fell into either the "stage 0" or the "stage 1" category, indicating a very low degree of weathering. Breakage was characterized according to categories established for long bones by Shipman, Bosler, and Davis (1981). A sample of large mammal long bones ($n = 134$) reflected predominance of spiral, sawtooth, and V-shaped fractures, indicating that the majority of the bones were broken in a relatively fresh condition. Many of the bones from the Mousterian occupation levels exhibit traces of carnivore damage and stone-tool cut marks. Carnivore marks were observed on 5% of the bison bones and 10% of the goat and sheep bones; these percentages are low for carnivore accumulations (Baryshnikov, Hoffecker, and Burgess 1996:328–29). Stone-tool cut marks were ob-

TABLE 3
Medium-Sized and Large Mammal Remains from Mezmaiskaya Cave (1987–89 Excavations)

	Layer(s)						
	1–2	2	2A	2B	3	4	5–7
Marmota paleocaucasica	1	2/1	15/2	11/2	–	1	–
Canis lupus	–	–	–	1	–	–	–
Vulpes vulpes	3/1	1	11/2	5/1	3/1	–	–
Ursus deningeri kudarensis	2/1	2/1	7/1	5/2	4/1	–	17/2
Martes sp.	–	–	–	1	–	–	–
Panthera spelaea	–	–	–	–	1	–	–
P. pardus	5/1	–	3/1	–	–	–	–
Equus hydruntinus	1	–	–	–	–	–	–
Sus scrofa	–	1	–	1	–	–	–
Rangifer tarandus	–	–	1	–	1	–	–
Capreolus capreolus	–	–	1	–	–	–	–
Cervus elaphus	1	–	5/2	11/2	15/2	7/2	–
Bison priscus	2/1	5/1	32/5	216/9	119/3	2/1	–
Saiga tatarica	–	1	–	–	–	–	–
Capra caucasica	6/1	5/1	7/1	13/2	8/2	8/3	8/2
Ovis orientalis	2/1	8/2	11/3	10/2	5/1	2/1	–
Capra/Ovis	17/3	60/4	99/4	138/6	–	–	–

served on 7% of the bison bones and 5% of the goat, sheep, and red deer bones. The cut marks occur on a variety of axial and appendicular skeletal parts and reflect multiple stages of the butchering process, including dismemberment and filleting (Baryshnikov, Hoffecker, and Burgess 1996:330).

Measurement of dental crown heights on lower third molars provides an age (mortality) profile for bison (n = 19) from layers 3 and 2B and a combined sample of goat and sheep (n = 22) from all of the Middle Paleolithic occupation levels. These taxa yield a profile dominated by prime-age adults (or "prime-dominated" mortality profile [Stiner 1994]). Remains of juveniles (teeth and bones) are almost completely lacking among the bison sample. Such a profile is not consistent with the pattern of scavenged remains, and these data, in conjunction with the tool cut marks, indicate that most of the bison, goat, and sheep remains represent animals hunted by the inhabitants of Mezmaiskaya Cave. Given the elevation of the site, much if not all of this hunting activity seems likely to have occurred during the warmer months (a hypothesis supported by some seasonality data) (Baryshnikov, Hoffecker, and Burgess 1996).

CONCLUSIONS

Several important observations and conclusions can be reported from the excavation and analysis of remains from Mezmaiskaya Cave:

1. A Middle Paleolithic industry containing a high proportion of bifacial implements is present in the Northern Caucasus. Lithic assemblages with bifacial tools have been documented in other parts of Eastern Europe, including the Crimea and the East European Plain, where they are sometimes referred to as the Eastern Micoquian. Although bifacial tools have been recovered previously from Middle Paleolithic contexts in the Northern Caucasus (e.g., Il'skaya I [Zamyatnin 1929]), the assemblages from layers 3–2B of Mezmaiskaya Cave represent the first definitive evidence of such an industry in this part of Eastern Europe. Moreover, the stratigraphic position of these assemblages indicates that this industry occurs relatively early in the Middle Paleolithic sequence of the Northern Caucasus (although absolute dating remains problematic) and during an interval of mild climates.

2. A different Middle Paleolithic industry characterized by a comparatively high proportion of blades, predominance of sidescrapers, scarcity of bifacial tools, and presence of some typical Upper Paleolithic tools overlies the bifacial industry (layers 2A–2). Both the stratigraphic position and the accompanying absolute dates indicate that this industry is late in the Middle Paleolithic sequence of the Northern Caucasus and probably dates to the later part of oxygen-isotope stage 3. Similar lithic assemblages have been recovered from other sites in the region (classified as the Gubs culture [Lyubin 1977]), and these assemblages also appear to date to the late Middle Paleolithic. The significance of the contrast between the two industries at Mezmaiskaya Cave is unclear but may be related to climatic differences and associated changes in the use of the site.

3. The hominids who manufactured the bifacial industry at Mezmaiskaya Cave (layers 3–2B) were archaic representatives of *Homo* with close affinities to the Neanderthals of Western and Central Europe. Human remains associated with the later Gubs culture assemblages (layers 2A–2) lack diagnostic features and cannot be assigned to archaic or modern *Homo.* However, skeletal remains found in association with other Gubs culture assemblages in the Northern Caucasus (Barakaevskaya Cave, Monasheskaya Cave) are classified as Neanderthals (Lyubin et al. 1986, Belyaeva 1992). At the present time there is no compelling evidence that modern humans manufactured any of the Middle Paleolithic industries of Eastern Europe.

4. The Neanderthal occupants of Mezmaiskaya Cave probably buried their dead. It is difficult to account otherwise for the partially intact skeleton recovered from layer 3. There is no evidence of grave goods or other traces of associated ritual behavior, and the motive for burial remains unknown.

5. In the context of other Middle Paleolithic sites in the Northern Caucasus, Mezmaiskaya Cave offers insights into the ecology of the Neanderthals. These sites, which are found at elevations ranging from 100 to 1,500 m above sea level, appear to have been used to exploit seasonally available resources in different altitudinal zones. Mezmaiskaya Cave seems to have been occupied during warmer months for the hunting of medium-sized and large mammals, including bison, sheep, and goat. The regional pattern of site use probably indicates planning and scheduling of movements and activities and also suggests substantial niche overlap with the modern humans who subsequently appeared in Europe (Hoffecker and Baryshnikov n.d.).

6. An Upper Paleolithic assemblage (layer 1C) overlies the youngest Middle Paleolithic level at Mezmaiskaya Cave. The assemblage contains large blades, microblades, endscrapers on flakes, burins, bone awls, and other typical Upper Paleolithic implements and has yielded a radiocarbon date of 32,000 years B.P. This represents the first reliable evidence of an early Upper Paleolithic industry in the Northern Caucasus and suggests that the Middle-to-Upper-Paleolithic transition occurred here at roughly the same time as elsewhere in Europe.

References Cited

AMIRKHANOV, K. A. 1986. *Verkhnii paleolit Prikuban'ya.* Moscow: Nauka.

BARYSHNIKOV, G., AND J. F. HOFFECKER. 1994. Mousterian hunters of the NW Caucasus: Preliminary results of recent investigations. *Journal of Field Archaeology* 21:1–14.

BARYSHNIKOV, G., J. F. HOFFECKER, AND R. L. BURGESS. 1996. Palaeontology and zooarchaeology of Mezmaiskaya Cave (northwestern Caucasus, Russia). *Journal of Archaeological Science* 23:313–35.

BEHRENSMEYER, A. K. 1978. Taphonomic and ecologic information from bone weathering. *Paleoecology* 4:150–62.

BELYAEVA, E. V. 1992. "Novye issledovaniya Monasheskoi peshchery na Gubse," in *Voprosy arkheologii Adygei,* pp. 182–93. Maikop: Adygeiskii Nauchno-Issledovatel'skii Institut Ekonomiki, Yazyka, Literatury i Istorii.

BOSINSKI, G. 1967. *Die Mittelpaläolithischen Funde im Westlichen Mitteleuropa.* Köln: Fundamenta Reihe.

GÁBORI, M. 1976. *Les civilisations du Paléolithique moyen entre les Alpes et l-Oural.* Budapest: Akadémiai Kiadó.

GOLOVANOVA, L. V. 1994. "Otkrytie pogrebeniya na must'erskoi stoyanke v Mezmaiskoi peshchere," in *Arkheologicheskie otkrytiya 1993 goda,* pp. 110–11. Moscow: Institut Arkheologii.

GOLOVANOVA, L. V., G. F. BARYSHNIKOV, G. M. LEVKOVSKAYA, AND S. A. NESMEYANOV. 1995. *Rossiskaya Arkheologiya* 3–4:105–18.

GOLOVANOVA, L., J. F. HOFFECKER, S. NESMEYANOV, G. LEVKOVSKAYA, V. KHARITONOV, G. ROMANOVA, AND I. SVEJENCEVE. 1998. Une site micoquien est-européen du Caucase du Nord (Résultats préliminaires de l'étude de la grotte Mezmaiskaya, les fouilles des années 1987–1993). *L'Anthropologie* 102:45–66.

GOLOVANOVA, L. V., G. M. LEVKOVSKAYA, AND G. F. BARYSHNIKOV. 1990. Le nouveau site moustérien en grotte de Matouzka, Caucase septentrional (Résultats des fouilles de 1985–1987). *L'Anthropologie* 94:739–62.

GOLOVANOVA, L. V., AND G. P. ROMANOVA. 1995. "Novye antropologicheskie nakhodki na must'erskoi stoyanke v Mezmaiskoi peshchere (Severo-Zapadnyi Kavkaz)," in *Arkheologicheskie otkrytiya 1994 goda,* pp. 160–61. Moscow: Institut Arkheologii.

HIDJRATI, N.I., L. R. KIMBALL, T. KOETJE, AND A. DEINO. 1997. Weasel Cave: 15 years of archaeological investigations in the Middle Palaeolithic of the north-central Caucasus, North Ossetia, Russia. Paper presented at the 62d annual meeting of the Society for American Archaeology, Nashville, Tenn.

HOFFECKER, J. F., AND G. F. BARYSHNIKOV. n.d. "Neanderthal ecology in the northwestern Caucasus: Faunal remains from the Borisovskoe Gorge sites," in *Quaternary paleoecology in the Northern Hemisphere.* Edited by J. J. Saunders, B. W. Styles, and G. F. Baryshnikov. Illionis State Museum Scientific Papers 27. In press.

KLEIN, R. G. 1989. *The human career: Human biological and cultural origins.* Chicago: University of Chicago Press.

LYUBIN, V. P. 1977. *Must'erskie kul'tury Kavkaza.* Leningrad: Nauka.

———. 1994. *Neandertal'tsy Gupsskogo ushchel'ya na Severnom Kavkaze.* Maikop: Meoty.

LYUBIN, V. P., P. U. AUTLEV, A. A. ZUBOV, G. P. ROMANOVA, AND V. M. KHARITONOV. 1986. Otkrytie skeletnykh ostatkov paleoantropa na Barakaevskoi stoyanke (Zapadnyi Kavkaz). *Voprosy Antropologii* 77: 60–70.

MARKS, A.E., YU E. DEMIDENKO, K. MONIGAL, V. I. USIK, C. R. FERRING, A. BURKE, J. RINK, AND C. MC KINNEY. 1997. Starosele and the Starosele child: New excavations, new results. CURRENT ANTHROPOLOGY 38: 112–23.

MELLARS, PAUL. 1996. *The Neanderthal legacy: An archaeological perspective from Western Europe.* Princeton: Princeton University Press.

PRASLOV, N. D. 1984. "Rannii paleolit Russkoi ravniny i Kryma," in *Paleolit SSSR,* pp. 94–134. Moscow: Nauka.

RAK, Y., W. H. KIMBEL, AND E. HOVERS. 1994. A Neandertal infant from Amud Cave, Israel. *Journal of Human Evolution* 26:313–24.

———. 1996. On Neandertal autapomorphies discernible in Neandertal infants: A response to Creed-Miles et al. *Journal of Human Evolution* 30:155–58.

SHIPMAN, P., W. BOSLER, AND K. L. DAVIS. 1981. Butchering of giant geladas at an Acheulian site. CURRENT ANTHROPOLOGY 22:257–68.

TRINKAUS, E. 1981. "Neanderthal limb proportions and cold adaptation," in *Aspects of human evolution.* Edited by C. B. Stringer, pp. 187–224. London: Taylor and Francis.

ZAMYATNIN, S. M. 1929. Statione moustérienne a Ilskaja province de Kouban (Caucase du Nord). *Revue Anthropologique* 7–9:282–95.

Imitative Ritual in Proto-Bactrian Mortuary Practice[1]

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Imitative ritual was very widespread in the mortuary practice of Bronze and Early Iron Age societies in the process of social stratification. It is particularly striking in the Southern Uzbekistan complexes of the Proto-Bactrian Sapalli culture, 18th–10th century B.C. (Askarov 1977; Askarov and Abdullaev 1983; Ionesov 1990, 1992, 1993). This study is an attempt to determine the role of this ritual in the social life and mortuary practice of protostate society through the analysis of recent archaeological data from the site of Djarkutan, the largest of the early Proto-Bactrian urban centers.

By an imitation I mean a substitute for or a replica of a thing or event, and its meaning emerges from the particular way in which that thing or event is symbolically modeled. This modeling has three aspects, objective, physical/behavioral, and verbal, and its form (votive objects, signs, symbols, gestures, invocations, weeping, etc.) is determined by the critical need that the society is trying to meet by ritual means.

The Sapalli culture, being in a transitional phase of its historical development, required a regulative-compensatory mechanism for social adaptation. Its symbolic attributes can be viewed as filling the gaps in cultural life created by the conflict between old and new power institutions in a period of transition. Drawing on Ural-Altaic mythology, A. M. Sagalaev (1991: 132) suggests that "archaic thought strives to compensate for reality at turning points: the vanishing material object is replaced by its analogy." In the midst of epochal transformations, humans constantly extended "the limits of reality through the observation of unreality" (Beylis 1983:29).

A lengthy process of institutionalization of secular and sacred power preceded the spread of imitative ritual in the Sapalli culture and culminated in the establishment of the palace and temple complexes at Djarkutan. Its Temple of Fire seems to reflect the incorporation of the novel imitative ritual subsystem into traditional practice. Almost all of the various evidences of imitation in burials (votive replicas, cenotaphs, sacrifices, etc.) are represented in the temple. Moreover, the temple itself was the embodiment of the imitative-ritual system; the complex and multileveled world of religious symbols was clearly reflected in its architecture, plan (fig. 1, *i*), and contents (Askarov and Shirinov 1991). It seems to have regulated in detail the sacred life of the community. Its plan includes a treasury or reliquary, a storehouse for sacred ashes, wineries, a corral for sacrificial animals (sheep), and a workshop for the manufacture of votive objects of bronze and clay. Half-finished votive miniatures, crucibles containing the remains of molten metal, anthropomorphic clay figurines, censers, portable ceramic altars, and ritual vessels make up the temple assemblage.

Imitative ritual in Sapalli-culture burials is seen in the use of anthropomorphic clay figurines, models of altars, sacrifice areas, methods of grave construction, burials of animals, and urn burials. The most distinctive of these features are the cenotaphs and the votive bronze replicas of tools and weapons.

More than 250 cenotaphs have been discovered in the cemeteries of the Sapalli culture (fig. 1, *e*). Typologically they can be divided into six main groups: (1) those with figurines made of wood or cloth; (2) those with clay anthropomorphic figurines and other ritual objects; (3) those with roof-shaped vessels; (4) those with immolated sheep; (5) those with sheep and figurines; and (6) those without grave goods. The social and ritual significance of these cenotaphs has been explored elsewhere (Ionesov 1992). The proportions of funeral complexes represented by cenotaphs vary over time: Sapallitepa (1700–1650 B.C.), 7.9%; Djarkutan 1 (1650–1550 B.C.), 10.4%; Djarkutan 2 (1550–1350 B.C.), 3.1%; Kuzali (1350–1200 B.C.), 16%; Molali (1200–1050 B.C.), 17%; Bustan (1050–950 B.C.), 27.6%. The ritual of this final stage of the Sapalli culture is the most complex; its cenotaphs contained traces of ritual fire (23.9%) and animal sacrifice (47.8%).

More than 300 bronze miniatures have been recovered from approximately 150 Sapalli-culture burials at the sites of Sapallitepa, Djarkutan, and Bustan (fig. 1, *d*). They include tools (e.g., knives, adzes, chisels, mattocks, shovels, ladles, sickles), weapons (e.g., daggers, swords, points, celt-adzes), household articles (e.g., ladders, spoons, plates), toilet articles (e.g., mirrors, razors), and unfinished or indeterminate votive artifacts. All these articles were made especially for burials and not for household use. They were made mainly by smithing of thin bronze wire.

The regulation of ritual by the temple gradually developed into domination of the whole community by the centralized religious ideology. The features and disposition of anthropomorphic clay figurines from Djarkutan and Bustan cenotaphs appear to model mortuary rites. For example, in cenotaph 12, Djarkutan 4B, two such figurines were placed in front of a miniature clay altar precisely replicating the round altars of the temple. The cenotaph also contained a miniature clay vessel with a tiny spoon and several cone-shaped clay objects (fig. 1, *b*). Apparently prayer by mourners was being represented here.

Votive miniatures are found in the cult centers of other societies. For example, bronze replicas of swords, arrowheads, and vessels have been discovered at contemporary Meligeli 1 in eastern Georgia (Pitshelauri 1979:52) and at Shilda, dating to the 14th–13th century B.C. (Pitshelauri 1982:58–59). A collection of votive miniatures (vessels, anthropomorphic figurines, warders) was found in the so-called burnt building at Tepe

1. 0011-3204/99/4001-0006$1.00. I thank Andrew Pelcin for his encouragement and support.

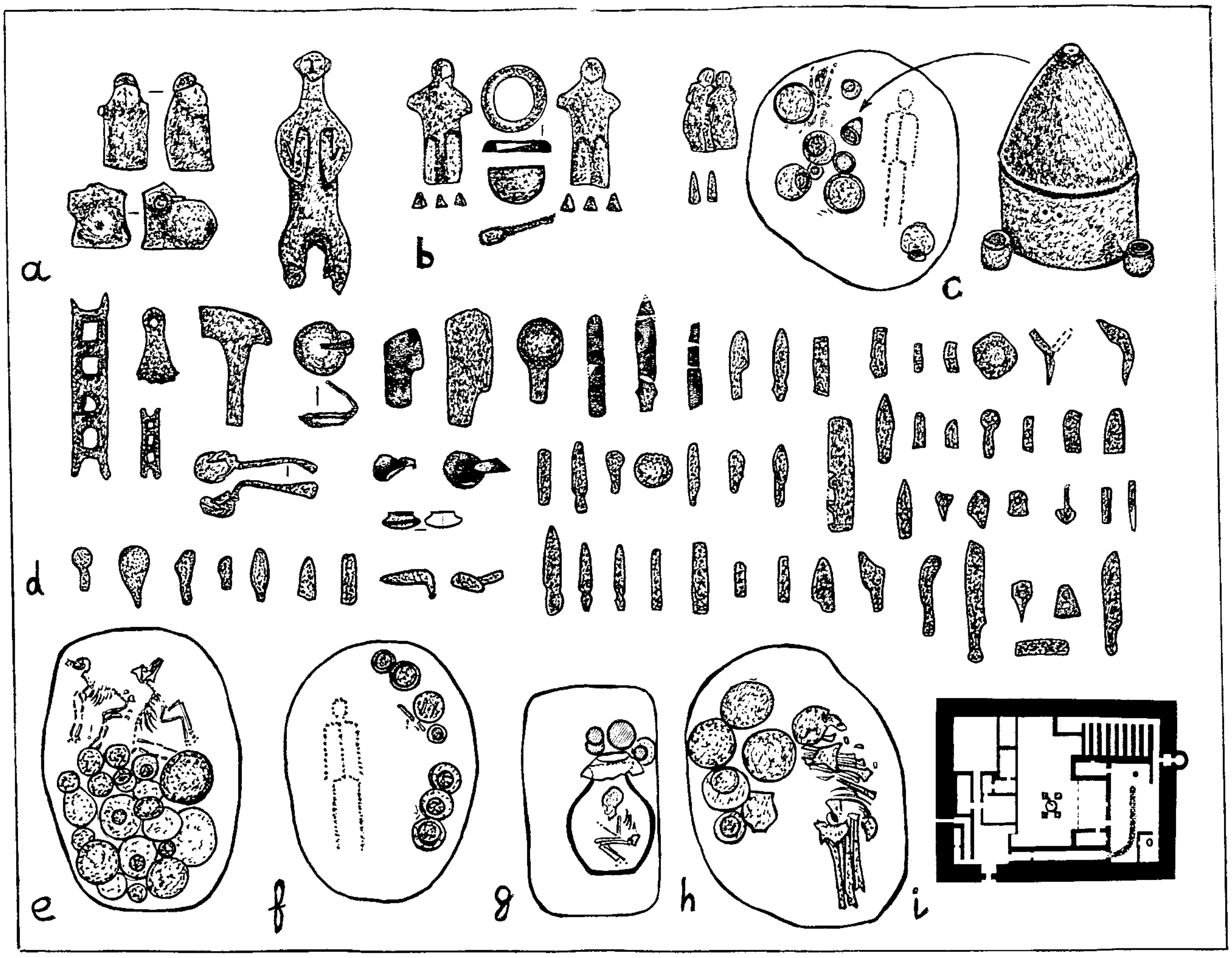

FIG. 1. *Archaeological manifestations of imitative ritual in the Sapalli culture.* a, *anthropomorphic clay figurines;* b, *anthropomorphic figurines, miniature clay altar and clay vessel with spoon, cone-shaped objects;* c, *cylindrical vessel with roof-shaped lid and hand-made cups, with plan showing disposition in grave;* d, *miniature tools and weapons;* e, *burial with immolated sheep;* f, *cenotaph with wood or cloth figurine (tool);* g, *urn burial;* h, *burial with disarticulated bones;* i, *plan of the Temple of Fire at Djarkutan.*

Hissar in northern Iran. The emergence of such symbols in mortuary rites is connected, according to Dyson (1986:91), with the increasing differentiation of the society. Bronze votive objects were very common in the Luristan archaeological complex, dating to the end of the 2d and the early 1st millennium B.C. (Dandamaev and Lukonin 1980:61–67). The materials from the Roman cemetery at Osteria dell'Osa, with its votive bronze tools and weapons, miniature anthropomorphic figurines of clay, ritual vessels, and other objects, demonstrate clear analogies with the imitative articles at Djarkutan (see Bietti Sestieri 1994).

To all appearances, the Djarkutan religious elite used imitative symbols in mortuary rites as a way of representing the class/prestige of the deceased. Indeed, sociocultural change in Sapalli society began with the upper stratum of the community. For example, the innovative types of tools and weapons, the novel forms and ornamentation of the vessels, and the practice of disarticulating corpses were characteristic of the graves of the prosperous. Moreover, with the Sapalli culture for the first time bronze replicas of axes, adzes, chisels, and ladders appear in three rich burials (graves 85 and 89 at Sapallitepa and 31 at Djarkutan 5). The emergence of the Temple of Fire greatly expanded the sphere of imitative ritual activity, for the temple became a powerful accumulator of religious ideas. The monumental temple and palace, bronze votive replicas, cult vessels, anthropomorphic clay figurines, and models of altars testify to the development of an elite culture within Djarkutan society.

Interpreting the mythological content of imitative ritual is a complex issue. Using the Sapalli culture as an example, closer attention might be paid to a further very important aspect of the mythological semantics of mortuary rites—the development of beliefs about the afterlife. Here the imitative rites stressed the spheres of life and death in the mythological-ritual area representing the world. This intention is clearly evident in Djarkutan's historical topography and the development of its cemeteries. In the period just before the construction of the temple, the cemeteries were located on a mound outside the settlement, separated from it by a river that is interpreted as the personification of the sacred element of water, the mythical boundary between life and death.

Ideas of rebirth after death were originally reflected in the Sapalli culture by interments of disarticulated bones. At least ten burials of this kind have been recognized in the Djarkutan and Bustan cemeteries. The earliest such burial, dated to the late Kuzali phase, ca. 1250—1200 B.C., is Djarkutan 4B grave 7 (fig. 1, *h*). In these burials the human bones are carefully arranged on the floor of the grave and accompanied by a large number of ceramic vessels and bronze replicas of tools and weapons. The skeleton was usually sprinkled with red ochre. Male skulls are laid on their left side and female skulls on their right. These burials contrast sharply with traditional Sapalli-culture burials, reflecting an intentional violation of the usual rules. Disarticulation of the skeleton is an element of ancient myths from a wide variety of cultures. It is usually deities and heroes—for example, Buddha, Adonis, Osiris, Zagrey, Dionysos, Pentheus, Orpheus, and Jima—that are cut into pieces in these myths; the heroes die in order to become the object of cult (Propp 1986:96).

Urn burials are another kind of imitative rite (fig. 1, *g*). Of the 27 such burials excavated at Sapalli sites, 21 are of children and juveniles. Some of them contain a large assortment of bronze objects, ceramics, and animal bones. For example, 13 bronze objects and 1 gold one, dozens of stone beads, 2 miniature marble bowls, 2 baskets, 19 ceramic vessels, and a number of animal bones were found in female burial 82 at Sapallitepa. It is possible that the vessels represented the mother's womb, the house of eternal life and well-being. The decoration of the vessels was often connected with a cult of earth and water. In addition, urn burials may be a reflection of ritual sacrifice; it is perhaps not coincidental that they involve mainly children.

Cylindrical vessels with roof-shaped lids were discovered in some burials at Djarkutan and Bustan (fig. 1, *c*). Some 20 such vessels are currently known. They were unfired but colored with red pigment. They have holes in their sides and were usually associated with minute handmade cups. They are probably models of a home for the soul of the deceased. Some archaeologists interpret them as prototypes of the much later Zoroastrian ossuaries. Small pieces of charcoal were found in some of these cenotaphs, and the recent discovery of cylindrical vessels with roof-shaped lids inside a crematory at Bustan 6 is particularly significant (Avanessova 1995). Cenotaphs including such vessels may exceptionally have contained the ashes of the deceased.

It is obvious that the votive objects were magical things; through them people tried to influence their immediate environment, and "on being included in ritual they began to play an active social role" (Iordanskij 1982: 46). The increase in the social importance of the means of production in the technological process gradually gave magical power to tools. The data from Sapallitepa, Djarkutan, and Bustan, however, confirm Propp's (1986:192) thesis that the earliest such magical objects were animal parts, with the part standing for the whole and the idea replacing the image. In the first stage of the Sapalli culture the human corpse was imitated by the body of a lamb or sheep in the majority of cenotaphs (fig. 1, *e*). At this point the animal may have played the dual role of double of the deceased and animal helpmate. Afterwards, there were dolls and anthromorphic figurines and then votive replicas of clay altars, ritual vessels, bronze tools, etc.; in short, one imitation led to another.

The development of imitative ritual was determined primarily by the emergence of a new system of values. Through social transformation a special system of symbolic communication was created in the mythological-ritual area. This process reflected the historical conditions of a transitional stage in the development of ancient civilization.

References Cited

ASKAROV, A. 1977. *Drevnezemledel' cheskaja kultura epokhi bronzi iga Uzbekistana*. Tashkent: Fan.

ASKAROV, A., AND B. ABDULLAEV. 1983. *Dzharkutan.* Tashkent: Fan.

ASKAROV, A., AND T. SHIRINOV. 1991. "La temple du feu de Dzharkutan de le plus ancien centre culturel de la Bactriane septentrionale," in *Histoire et cultes de l'Asie Centrale préislamiques,* pp. 129–36. Paris.

AVANESSOVA, N. 1995. Bustan VI, une nécropole de l'âge du Bronze dans l'ancienne Bactriane (Ouzbekistan meridional): Témoignages de cultes du feu. *Arts Asiatiques* 50:31–46.

BEYLIS, V. A. 1983. "Teorija rituala v trudakh Viktora Turnera," in *V. Turner: Simvol i ritual,* pp. 7–31. Moscow: Nauka.

DANDAMAEV, M. A., AND V. G. LUKONIN. 1980. *Kultura i ekonomika drevnego Irana.* Moscow: Nauka.

DYSON, R. H. 1986. "Povtornoe izuchenie Tepe Gissara," in *Drevnie civilazicii Vostoka,* pp. 85–92. Tashkent: Fan.

IONESOV, V. 1990. Stanovlenie i razvitie ranneklassovykh otnoshenij v osedlozemledel' cheskom obshchestve Severnoj Baktrii (abstract). Samarkand.

———. 1992. O kenotafakh v pogrebal'noj praktike sapallinskoj kultury. *Obshchestvenye Nauki v Uzbekistane* 2:52–58.

———. 1993. "Imitatsija i obrjad," in *Uzbekistan v drevnosti i srednie veka,* pp. 14–17. Samarkand: Institut Arkheologii.

———. 1995. La cenotafoj en la antikvaj socioj. *Monato* 3:16–17.

IORDANSKIJ, V.B. 1982. *Khaos I garmonija.* Moscow: Nauka.

PITSHELAURI, K. N. 1979. *Vostochnaja Gruzija v kontse bronzovogo veka.* Tbilisi: Academy of Sciences of Georgia.

———. 1982. "Arkheologicheskie issledovanija v zonakh novostroek Kura-Alazanskogo bassejna 1975–1979," in *Arkheologicheskie issledovanija na novostrojkakh Gruzinskoj SSR,* pp. 54–64. Tbilisi: Academy of Sciences of Georgia.

PROPP, V. I. 1986. *Istoricheskie korni volshebnoj skazki.* Leningrad: Izdatel'stvo Leningradskogo Universiteta.

SAGALAEV, A. M. 1991. *Uralo-Altajskaja mifologija: Simvol i arkhetip.* Novosibirsk: Nauka.

The Use of Stone Tools to Determine Handedness in Hominids[1]

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The evolution of handedness at the population level was an important event in the history of hominids. It has recently been investigated with respect to tool-related activities not only in hominids but in other primates (e.g., McGrew and Marchant 1992, Sugiyama et al 1993, Westergaard and Suomi 1996). This is especially significant because handedness has been associated with cerebral lateralization (Frost 1980), the evolution of language (Westergaard 1994), and even bipedalism (as related to throwing and reaching in chimpanzees [Hopkins et al. 1993]), three other important events in hominid evolution. Two points need to be addressed in reconstructing the evolution of handedness through the study of stone tools: (1) the role of the shape of the raw material in the process of flintknapping and (2) the possibility of flake selection in archaeological assemblages.

The mechanism for and timing of the evolution of handedness in hominids are not well understood. There is evidence of brain lateralization in various primates as well as fossil hominids (Falk 1987, Hamilton and Vermiere 1991, Holloway 1981, Holloway and de la Coste-LareyMondie 1992), mainly in the form of petalia patterns on fossil endocasts. However, these patterns can be vague and difficult to interpret (Holloway and de la Coste-LareyMondie 1992). In addition, a structural asymmetry does not necessarily indicate a functional or biochemical asymmetry (Bradshaw and Nettleton 1983). Various aspects of Paleolithic art have been cited as evidence for the evolution of handedness. For example, most prehistoric handprints are of the right hand (Uhrbrock 1973), while painted hand silhouettes are usually of the left hand, suggesting that they were drawn with the right (Magoun 1966). In addition, most of the human and animal heads found in cave paintings face left, and it is assumed that, since modern right-handed artists draw profiles this way, earlier hominids did also (Wilson 1885, Bradshaw and Nettleton 1983).

Toth (1985) has proposed that there is evidence for right-handedness as far back in the archaeological record as the Lower Pleistocene, 1.9–1.4 million years ago, pointing to the patterns of cortex on flakes. When a flake platform is oriented upwards and the exterior surface faces the viewer, flakes "with cortex only on the right side of the flake ('right-oriented' flakes) suggest that the hammerstone delivered a blow to the right of the previously struck flakes" (p. 608). Toth found three samples of tools directional at a significant level, all right-oriented, or right-handed: flakes with cortex visible from Koobi Fora, Kenya (1.9–1.4 million years old), were 57% right-handed, those from Ambrona, Spain (400,000–300,000 years old), were 61% right-handed, and experimentally produced flakes were 56% right-handed.

Patterson and Sollberger (1986) discuss some valid criticisms of this study. They note that Toth's (1985) hypothesis depends on right-handed flintknappers' using serial flaking from left to right and rotating the core clockwise while flintknapping. There is no need to assume that this is the way in which stone tools were made. The geometric configuration of a core is probably more important than the direction of core rotation with respect to the last flake removed (Patterson and Sollberger 1986). This implies that the raw material of which the tools are made probably dictates the shape as well as the presence and pattern of cortex on the flake. Patterson and Sollberger also assert that left-handed flintknappers do not always produce left-handed flakes (and vice versa). In their experiment, Sollberger, who is left-handed, produced 56% right-handed flakes.

For this analysis, seven right-handed University of Pennsylvania students produced a total of 284 flakes during multiple flintknapping sessions. I was not involved in the flake production but merely looked at the resulting flakes as one would an archaeological assemblage. Some of the cores had been spray-painted yellow so that the original core surface would be easily recognizable on the flakes. For each flintknapping session, the individual flintknapper and date were recorded and all flakes produced were collected. Only 96 of the flakes could be categorized as right- or left-handed, and of these 58 were right-handed (60%) and 38 left-handed (40%); 109 flakes had no cortex present, and 79 flakes had cortex present but it was either on both the right and left sides of the flakes or on the platform or another area that was not a side.

Of the seven individuals, four were judged to be right-handed by Toth's criteria when the data from all of their individual flintknapping sessions were combined. However, the percentages of right- and left-handed flakes that each individual made were often different on different days. For instance, one flintknapper made six right-handed flakes in one session, two right-handed and two left-handed flakes in another session, and one right-handed and four left-handed flakes in another session. (More than this small number of flakes were actually made, but these were the only ones that could be identified by side.) Two flintknappers produced equal numbers of right- and left-handed flakes when the data from all of their flintknapping sessions were combined (n = 7 and 8). Also, during eight different flintknapping sessions, one of the right-handed individuals (not the same individual each time) produced only left-handed flakes.

While the sample is relatively small, these data suggest that on an individual level this technique of assessing handedness from percentages of flakes with particu-

TABLE 1
Proportion of Left- or Right-Handed Flakes from Experimental and Archaeological Samples

Site or Flintknapper(s)	Total Number of Flakes Assigned to Left- or Right-Handed	Proportion of Right-Handed Flakes	Proportion of Left-Handed Flakes
Ambrona	79	61	39
University of Pennsylvania students (experimental)	96	60	40
Koobi Fora	303	57	43
Toth (experimental)	386	56	44

lar cortex patterns may not be totally accurate. Within a single individual, neither a single flintknapping event nor a combination of multiple flintknapping events shows handedness corresponding to the flintknapper's handedness. Since presumably the conditions, flintknapper, and flintknapper's ability were constant for each flintknapping session, raw-material shape and perhaps individual flintknapping style instead of core rotation pattern dictates much of the variation seen in the cortex patterns of the tools made by individual flintknappers. Further experiments are needed in this area to test some of these ideas.

Even though all of the samples considered separately show a statistically significant dominance of right-oriented flakes at the 0.05 confidence level, it is also noteworthy that as the sample size increases, the proportion of right- to left-handed flakes gets closer to 50:50 (see table 1). This suggests that larger samples might show no significant evidence of handedness.

Some sites may produce flakes with more cortex because of the particular raw material employed. Also, it is possible that the flintknappers would have removed some of the cortex from cores at the place where they found them before carrying them away from the site in order to lessen their transportation load. What we find may simply be flakes struck from a variety of core shapes, sizes, and possible flintknapping events or time periods, with no end product in mind.

Another point to consider is whether the evidence we see in the archaeological record is an accurate portrayal of the past. If the flakes recovered in an area are only debitage or waste material and more right-handed flakes are recovered, it is possible that the flintknappers preferentially curated left-handed flakes. The resulting assemblage could then be interpreted as being made by right-handed toolmakers.

Davidson and Noble (1996) have recently challenged some of Toth's assumptions and were not convinced of his argument "on theoretical, methodological or empirical grounds" (p. 170). For instance, they suggest that if the prehistoric flintknappers were producing flake tools and not core tools, the flintknappers would be more likely to discard a core after they removed a flake they wanted and not remove a sequence of flakes from a core in a nonrandom pattern (presumably to get a specific core shape). They argue that cores are not always struck from above and cite evidence that in a sample of 100 flakes from Australian archaeological sites, 51 flakes are right-oriented and 49 are left-oriented; yet there is direct and indirect evidence that prehistoric Australians were predominantly right-handed.

Is examining flakes with cortex present really the way to evaluate handedness in the archaeological record? Modern humans are right-handed at a frequency of about 90%; in both the archaeological and the experimental samples in this analysis right-handed flakes are present in much lower frequencies, and these frequencies may simply be an artifact of sample size. It may be more appropriate to consider hominids as displaying *hand preference* (some or all individuals exhibit personal laterality) rather than *handedness* (the population is predominantly lateralized to one side) as is described for termite fishing activity in chimpanzees (McGrew and Marchant 1992), although patterns of the acquisition of handedness through development seem to be different in different primates (Westergaard and Suomi 1996). The notions that the shape of the core may be more important than the way the core is rotated during flintknapping and that there is some selection of flakes at archaeological sites must be considered.

References Cited

BRADSHAW, J. I., AND N. C. NETTLETON. 1983. *Human cerebral asymmetry.* Englewood Cliffs: Prentice Hall.

DAVIDSON, W., AND I. NOBLE. 1996. *Human evolution, language, and mind.* Cambridge: Cambridge University Press.

FALK, D. 1987. Brain lateralization in primates and its evolution in hominids. *Yearbook of Physical Anthropology* 30:107–25.

FROST, G. T. 1980. Tool behavior and the origins of laterality. *Journal of Human Evolution* 9:447–59.

HAMILTON, C. R., AND B. A. VERMIERE. 1991. "Functional lateralization in monkeys," in *Cerebral laterality: Theory and research.* Edited by F. L. Kitterle. Hillsdale, N.J.: Lawrence Erlbaum Associates.

HOLLOWAY, R. 1981. Volumetric and asymmetry determinations on recent hominid endocasts: Spy I and II, Djebel Irhoud I, and the Salé *Homo erectus* specimens, with some notes on Neandertal brain size. *American Journal of Physical Anthropology* 55:385–93.

HOLLOWAY, R., AND M. C. DE LA COSTE-LAREYMONDIE.

1982. Brain endocast asymmetry in pongids and hominids: Some preliminary findings on the paleontology of cerebral dominance. *American Journal of Physical Anthropology* 58:101–10.

HOPKINS, W. D., K. A. BARD, A. JONES, AND S. L. BALES. 1993. Chimpanzee hand preference in throwing and infant cradling: Implications for the origin of human handedness. CURRENT ANTHROPOLOGY 34:786–90.

MC GREW, W. C., AND L. F. MARCHANT. 1992. Chimpanzees, tools, and termites: Hand preference or handedness? CURRENT ANTHROPOLOGY 33:114–19.

MAGOUN, H. W. 1966. "Discussion of brain mechanisms in speech," in *Brain function: Speech, language, and communication,* vol. 3. Edited by E. C. Carterette. Berkeley: University of California Press.

PATTERSON, L. W., AND J. B. SOLLBERGER. 1986. Comments on Toth's right-handedness study. *Lithic Technology* 15: 109–11.

SUGIYAMA, Y., T. FUSHIMA, O. SAKURA, AND T. MATSUZAWA. 1993. Hand preference and tool use in wild chimpanzees. *Primates* 34:151–59.

TOTH, N. 1985. Archaeological evidence for preferential right-handedness in the Lower and Middle Pleistocene, and its possible implications. *Journal of Human Evolution* 14:607–14.

UHRBROCK, R. S. 1973. Laterality in art. *Journal of Aesthetics and Art Criticism* 32:27–35.

WESTERGAARD, G. C. 1994. Language, tools, and neurobehavioral laterality. *Behavior and Brain Science* 17:360–61.

WESTERGAARD, G. C., AND S. J. SUOMI. 1996. Hand preference for stone artefact production and tool-use by monkeys: Possible implications for the evolution of right-handedness in hominids. *Journal of Human Evolution* 30:291–98.

WILSON, D. 1885. Paleolithic dexterity. *Proceedings and Transactions, Royal Society of Canada,* 3:119–33.