THE PALEOLITHIC OF CRIMEA, II

THE MIDDLE PALEOLITHIC OF WESTERN CRIMEA, VOL. 2

Edited by

Victor P. Chabai and Katherine Monigal

ERAUL 87

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ETUDES ET RECHERCHES ARCHEOLOGIQUES
DE L'UNIVERSITE DE LIEGE

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CONTENTS

PART I: MIDDLE PALEOLITHIC SUBSISTENCE STRATEGIES

PART II: PALEOENVIRONMENTS OF WESTERN CRIMEA

PART III: PALEOECONOMY AND TOOL FUNCTION STUDIES

PART IV: SYNTHESES AND INTERPRETATIONS

PREFACE

In 1940, G. A. Bonch-Osmolowski published the first volume in the three-volume series, *Палеолит Крыма* (*The Crimean Paleolithic*). All three volumes were devoted to the description of his outstanding investigations at the eastern Crimean Middle Paleolithic site of Kiik-Koba. Bonch-Osmolowski's volumes were unusual for the time; his series covered not just the description of cultural material, but also incorporated extensive geological, environmental, and physical anthropological research. The new series *The Paleolithic of Crimea*, in which this is the second volume, is a continuation of the multi-disciplinary studies begun by G. A. Bonch-Osmolowski. The volumes in this series present the results of recent field investigations of the Middle and Upper Paleolithic of Crimea and how they impact our understanding of prehistoric processes, in both regional and chronological aspects. While there is a vast literature published in Russian on the subject, this series is unique in providing the non-Russian-speaking audience a comprehensive survey of the history, excavations, and multi-disciplinary investigations of the Crimean Paleolithic.

This volume supplements the artifactual, geological, and chronological studies presented in Volume 1 for three Middle Paleolithic sites of western Crimea: Starosele, Kabazi II, and Kabazi V. The chapters of Part I focus on the substantial faunal remains recovered from these three sites, while those of Part II provide a reconstruction of the paleoenvironment based on microfaunal, malacological, and palynological analyses. The results of use-wear and residue studies presented in Part III offer unique insight into stone tool use and paleoeconomy over and above that available by traditional means of artifact analysis. Part IV concludes the book with a synthesis of the preceding chapters and addresses the problems of climatic dynamics, environmental evolution, subsistence, and landscape use over nearly 100,000 years of Late Pleistocene Crimean prehistory.

Given the exceptional complexity of the Crimean Middle Paleolithic, the two volumes of *The Middle Paleolithic of Western Crimea* obviously cannot provide a conclusive statement on this period or area. Furthermore, the field investigations of Kabazi II and Kabazi V are ongoing, so the chapters dealing with these two sites should be viewed as the first step in their multi-disciplinary analysis. Although the field investigations of Starosele are complete and the fauna, malacofauna, microfauna, micro-wear, and residue studies could be viewed as the final reports, we do not deceive ourselves in thinking that our interpretations of these will not change as new data for other sites become available.

The work reported here was made possible by generous grants from the United States National Science Foundation to A. E. Marks (SBR-9307743 and SBR-950691) and from INTAS (International Association for the Promotion of Cooperation with Scientists from the Newly Independent States of the former Soviet Union) to M. Otte and V. Chabai to support V. Chabai's excavations at Kabazi II and A. Yevtushenko's excavations at Kabazi V during 1995 and 1996 (INTAS-93-203 and 93-203-ext). The extensive faunal studies were supported by a grant from the Social Sciences and Humanities Research Council of Canada (Standard Research Grant #410-95-0840). The publication of this series, *The Paleolithic of Crimea*, is made possible by Dr. Marcel Otte of the Université de Liège, INTAS, and ERAUL publications.

Numerous people have generously donated their time and assistance to make the specialist studies reported in this volume come to fruition. For the studies of the faunal material from Kabazi V and Starosele, Dr. P. Crabtree (New York University) and Dr. M. Patou-Mathis (Musée National d'Histoire Naturelle, Paris) both aided in the identification of bones; Dr. R. Morlan (Archaeological Survey of Canada) assisted with the identification of butchery and carnivore markings; Dr. J. Mlikovski (Dept. of Paleontology, Charles University, Praha) identified bird remains; Dr. R. Harington at the National Museum of Nature, Canada, facilitated access to the collections there; Dr. M. Patou-Mathis generously provided access to the collections and library of the Institut de Paléontologie Humaine, Paris; Prof. E. Vangengeim facilitated Dr. A. Burke's visit to the Laboratory of Quaternary Geology (Moscow); Dr. A. Sher facilitated her visit to the Institute of Ecology and Evolution, RAS (Moscow); and Dr. A. Markova kindly hosted her stay in Moscow. In the field and laboratory, Dr. A. Burke was aided by D. Ens, I Moravetz, V. McKinley, and K. Peach. Ms. Ludmilla Strokova did the initial laboratory preparation of faunal material from Kabazi II and Kabazi V. Dr. C. Mikhailesku was assisted in the field by Mr. Gavril Gylku (Institute of Geography, Moldova). We would especially like to thank Dr. Anthony Marks, who displayed great patience in allowing the editors the time to work on this volume during their stay in Portugal, and who generously reviewed the manuscript and offered many insightful comments.

Victor P. Chabai and Katherine Monigal

Chapter 1

BUTCHERING AND SCAVENGING AT THE MIDDLE PALEOLITHIC SITE OF STAROSELE

ARIANE BURKE

INTRODUCTION

The Starosele collection of animal bones from Alexander Formozov's original excavations in 1952-1956, originally reported by Formozov (1958) and subsequently re-analyzed (Vereshchagin and Baryshnikov 1981; Gvozdover et al. 1996), is heavily dominated by *Equus hydruntinus*. Traces of butchering activity are mentioned in the original report, as is the presence of bone retouchers. As a result of the obvious numerical importance of horse, and the location of the site in a steep-sided box canyon, Starosele has been referred to in the literature as a communal hunt, or jump-site (Lioubin and Barychnikov 1984: 227), and as an example of highly specialized hunting practices (Vereshchagin 1967; Gábori 1976: 133).

Formozov thought that the Middle Paleolithic occupation of Starosele took place during the Riss-Würm Interglacial (Formozov 1958: 47). The presence of arctic fox and reindeer in these deposits, as reported by Formozov, was taken by Klein (1965: 48), however, as indicative of a glacial epoch. Gábori (1976: 123) described Middle Paleolithic faunas from Crimea as generally steppic in character—with the exception of Shaitan-Koba and Starosele, which contained sub-arctic indicator-species. Recently excavated faunal assemblages from Starosele, discussed in this research, are also generally indicative of steppic conditions with chronological changes in the microenvironment of the site. Climatic conditions at the site also evolve over time, with glacial (or sub-arctic) indicators in the lowermost levels (Table 1-1; Chapters 4 and 5).

During his excavations at Starosele, Formozov distinguished two "levels" below and above a significant rock-fall, which differed in a clustering of artifacts and bones in the lower level, versus more thinly and evenly distributed material above it (Klein 1965: 47). He considered these two levels, however, as essentially the same in all respects and described all of the materials as a single unit in his 1958 monograph on the site (Demidenko 1998). Consequently, the faunal remains resulting from Formozov's excavations are always reported in the literature as a single assemblage. Recent re-excavation of the site has revealed the existence of *four* distinct archeological levels dated to the Middle Paleolithic (Marks et al. 1998). There is a very high probability that the faunal assemblages described in Formozov (1958) and discussed later in the literature derive from more than one level. This is supported by the author's 1997 inspection of a small portion of the original faunal collection from Starosele, housed at the Institute of Geology RAS, Laboratory of Quaternary Geology, in Moscow. The state of preservation of the bones would appear to confirm that several levels are conflated as one. Some of the bone clearly derived from what is now recognized as Level 2, while some clearly derived from either Levels 3 or 4. Community structure and paleoenvironmental reconstructions based on these earlier reports should therefore be treated with a great deal of caution.

In the new faunal analysis, based on the 1993-1995 excavations of Starosele, the overall similarity in taxonomic representation between levels at Starosele is offset by significant differences in depositional history and cultural context. Spatial analyses of the faunal assemblages are restricted in this report, due to the fact that the modern excavations were necessarily limited in extent, and represent an unknown sample of the original site area. Nevertheless, several characteristics of the faunal assemblages, examined in detail below, allow us to interpret the sequence of human and animal occupations at the site, relative to major landscape events and transformations. Finally, the large mammal fauna from Starosele, in conjunction with microfauna and malacofauna data, help build a picture of the local and regional environments (Chapter 7). While steppic habitats were clearly dominant, the site itself is located in a box canyon within which a riparian microenvironment existed at times.

THE RECENT FAUNAL COLLECTION FROM STAROSELE

Faunal assemblages from four archeological levels (Levels 1 to 4) are described in detail below. A mixed assemblage (Level 0), derived from disturbed levels above the uppermost Middle Paleolithic occupation level (Level 1), is also briefly described. Fauna was also collected from archeologically sterile soils below Level 4, and this collection is referred to as "Below 4."

A large percentage of the total collection from Starosele was identified in the field. Faunal remains from recent excavations at Starosele number 10,979 pieces in total, excluding the small collections from archeologically sterile levels and the microfaunal and malacological assemblages (see Table 1-1). Just over thirty percent of the collection is identifiable to either

TABLE 1-1
Starosele, NISP and MNI (in parentheses) by Level

	Level 4	*Level 3*	*Level 2*	*Level 1*	*Level 0*	*Below 4*	*Total*
Equus (all)	326 (4)	380 (8)	182 (3)	1108 (12)	69	164	2229
Saiga tatarica	1 (1)	25 (2)	5 (1)	31 (2)	1	–	63
Cervus elaphus	– –	7 (1)	– –	8 (2)	–	–	15
Rupicapra rupicapra	– –	1 (1)	– –	2 (1)	–	–	3
Cervus sp.	2 (1)	10 (1)	2 (1)	9 (1)	–	–	23
Bos/Bison	3 (1)	8 (1)	2 (1)	37 (1)	6	1	57
Rangifer sp.	– –	1 (1)	– –	– –	–	–	1
Sus scrofa	– –	1 (1)	– –	– –	1	–	2
Ovicaprid	– –	– –	– –	– –	1	–	1
Hyena crocuta	– –	6 (1)	3 (1)	3 (1)	1	–	13
Ursus sp.	– –	2 (1)	– –	2 (1)	–	–	2
Vulpes vulpes	– –	31 (2)	– –	1 (1)	1	–	33
Canis sp.	– –	7 (1)	– –	17 (1)	3	–	27
Canis lupus	– –	1 (1)	– –	– –	–	–	1
Unidentified Carnivore	– –	8 (1)	– –	2 (1)	–	–	10
Subtotal							*2480*
Small Mammal	–	20	1	4	2	–	27
Medium Mammal	5	20	14	35	3	2	79
Small artiodactyl	3	63	14	116	4	1	201
Large artiodactyl	25	23	2	74	5	–	129
Equus/Bos Sized Mammal	21	164	30	175	14	21	425
Megafauna	–	–	–	2	–	–	2
Subtotal							*863*
Unidentified Mammal	246	4650	548	1898	14	–	7356
Total	*632*	*5426*	*803*	*3524*	*125*	*469*	*10979*

taxon, or minimally, to element and size class. Size classes used for this research are: *Equus*/Bos-sized (OXO); Large Artiodactyl, i.e., Cervus-sized (LAR); Small Artiodactyl (SAR); Medium Mammal (MM); and Small Mammal (SM). Rib and vertebral fragments are generally identifiable only to size class.

Fragmentation in each level is measured on identified elements only: each bone is scored in terms of completeness using a scale of 1 to 4 (less than 25%, 25-50%, 50-75%, 75-100%). Results are discussed in the appropriate sections below, but it is clear that fragmentation is both extensive and intense (Lyman 1994: 333).

Unidentifiable fragments of bone were sorted into two size classes—under 2 cm and over 2 cm—before being counted and weighed in the field (by D. Ens, I. Moravetz, V. McKinley, and K. Peach). The total number of unidentified fragments over 2 cm long is 3,896. The total number of unidentified fragments under 2 cm in length is 3,121. A portion (N=619) of the unidentifiable fragments was not sorted by size class. The total weight of unidentifiable fragments over 2 cm long is 12.905 Kg. The weight of unidentifiable bone fragments under 2 cm could not be calculated since many of the entries (N=60) weighed less than 10 grams (the minimum limit of the scales available for use in the field).

TAXONOMIC IDENTIFICATION

The majority of the identifiable bone in the Starosele collection belongs to *Equus hydruntinus*, confirming original findings (Formozov 1958). *Equus hydruntinus* is defined by small, relatively primitive teeth, generally small body-size and by the elongation and antero-posterior thickening of its metapodials, considered an adaptation to arid conditions (Eisenmann 1992: 48). This small Middle to Late Pleistocene Equid is generally distributed across the Eurasian Steppes and is often referred to as a "wild ass," despite its closer relationship with the Stenonid horses of Europe than to either Asinus or Hemionus (Forsten 1986; Eisenmann 1992). In this study, metrical analysis of the dental remains, in conjunction with the examination of enamel patterning, confirms the identification of the Equid remains as *Equus hydruntinus* (Eisenmann and Patou 1980; Eisenmann 1992). Post-cranial Equid bone is assigned to *Equus hydruntinus* on the basis of overall size. The metapodia also show the characteristic elongation and antero-posterior thickening. The only other Equid present in the collection, in very small numbers, is the wild horse (*Equus caballus*)—a much larger-bodied species with a similar geographic distribution during the Late Pleistocene. Caballine remains were mostly fragmentary and were defined on the basis of size.

The second most important species in the collection is *Saiga tatarica* (Table 1-1 and figs. 1-1, 1-2). In this study, *Saiga tatarica* follows the usual definition of Pleistocene Saiga (Vereshchagin 1959; Harrington 1981; Barychnikov and Tikhonov 1994) and is the taxonomy adopted here. Identification was made on the basis of recent comparative post-cranial material from the Museum of Nature, Hull (Quebec) and recent cranial material from the Manitoban Museum. Published descriptions, particularly of cranial material (Barychnikov and Tikhonov 1994), were also helpful. Because of the fragmented nature of the Starosele remains, no attempt was made to establish its precise taxonomic status (relative to *Saiga borealis*, for example).

All other mammalian taxa were identified using reference collections of both recent and archeological specimens housed at the Institut de Paléontologie Humaine (I.P.H., Musée National d'Histoire Naturelle, Paris). The bovid remains were too fragmentary to ascribe to either *Bos primigenius* or *Bison priscus*. The single specimen of *Rangifer* (probably *R. tarandus*) is not out of place in a Late Pleistocene context in Crimea. The hyena is defined as *Crocuta crocuta* on the basis of its close similarity with specimens at the I.P.H. The fox is defined as *Vulpes vulpes*; no specimens of arctic fox were identified. *Canis lupus* is identified

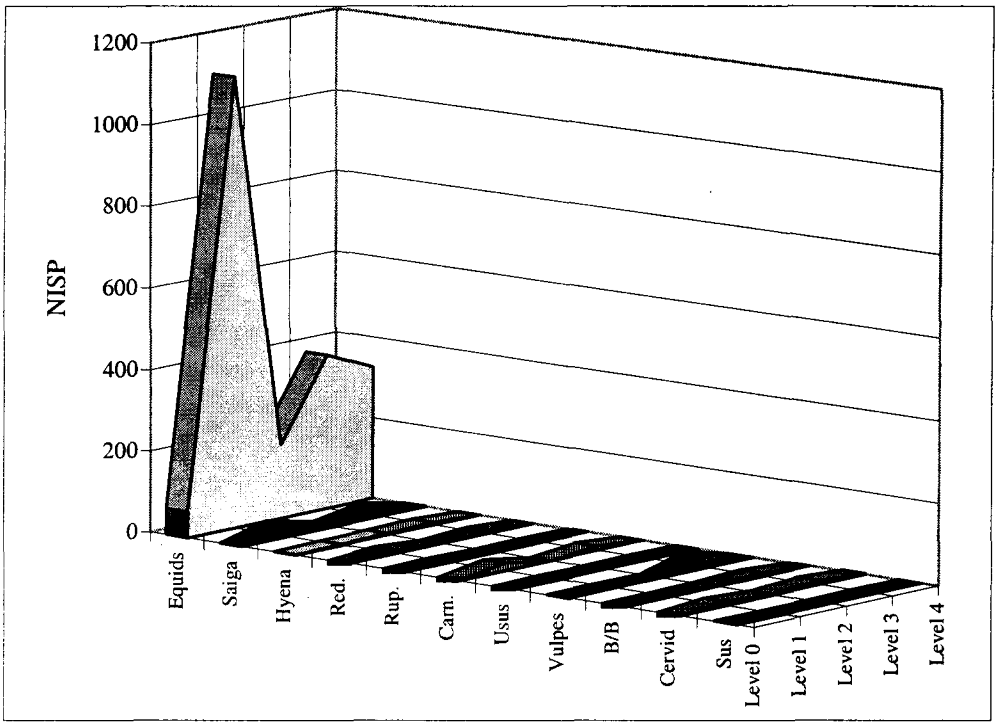

Fig. 1-1—Starosele, relative taxonomic abundance (NISP per taxon) by level.

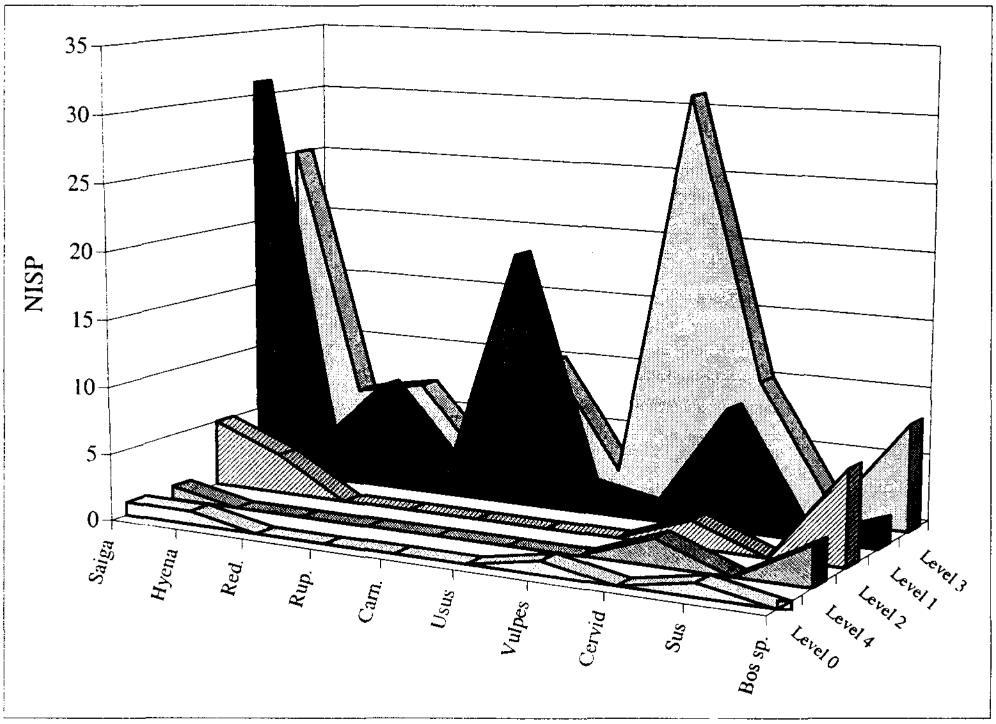

Fig. 1-2—Starosele, taxonomic abundance of all mammals, excluding equids.

in one case. Among the unidentified carnivores (Table 1-1) is at least one suspected Felid in Level 1 (a second phalanx). The total list of species represented at Starosele is quite typical of Pleistocene animal communities described for Crimea (e.g., Vereshchagin 1959; Patou-Mathis 1993; Barychnikov and Tikhonov 1994). The presence of each animal, and its environmental significance, is covered in more detail in Chapter 7.

Bird bone was recovered in small quantity (N=21) and was identified by Dr. J. Mlikovski (Charles University, Praha). There were eight identifiable fragments. Species identified include a grey partridge, alpine swifts, jackdaws, and red-billed choughs in Level 2 (N=7), and a single jackdaw specimen from Level 1. The swifts, jackdaws, and choughs are all cliff-nesting species, and the presence of newly fledged birds indicates that these species were probably nesting in proximity to the site. Grey partridge, a cold-steppe dweller, is not out of place in Level 2, a generally steppic fauna. All of these species are preyed upon by foxes (Mlikovski, personal communication 1997), although the partridge may have been preyed upon by humans, too.

STATISTICAL ANALYSES

The equid bones from Levels 4 through 1 were subjected to the following analyses: a first null hypothesis of no human patterning of the assemblage (that is, natural attrition, or element survivorship patterns) was established using equid bone collected from the archeologically sterile sediments excavated in Stratum F, below Level 4. This collection (Below 4), which contains at least 5 individuals, was used to establish expected values for each bone element, which were then compared to observed element representations (MNE) for each level using a Chi-square test. A second null hypothesis of carnivore ravaging was run using Hill's (1975) data (cited in Binford 1981, as Hill 1978) for hyena kills of zebra, an equid equivalent in size to *Equus hydruntinus*. Hill's data actually represent surface collections over a large area (Potts, personal communication 1998). As such, they represent an unknown number of kills, with no real control over the effects of trampling, weathering, or scattering. Nevertheless, for this test, Hill's data (as reported by Binford 1981: 214-215) were converted to MNE values; based on the working hypothesis that the most numerous element (mandibles) gives an accurate picture of MNI, the ratio of MNI to MNE was calculated. This ratio was used to generate expected values of MNE for each element per level at Starosele. Expected and observed values were then tested for each level using a Chi-square test.

A series of regressions was run to establish to what extent patterns in the assemblages are explainable as the result of economic decisions predicated on meat, marrow, or an index of food utility (FUI). In other words, the regressions were used to establish whether or not bone element survivorship patterns could be predicted by: meat value (the meat-weight normally associated that element), marrow value (the quantity of marrow contained in the bone), or on the basis of a food utility index (FUI) calculated using both meat and marrow weight (and which therefore reflects the total economic value of associated tissues). These values are reported for equids by Outram and Rowley-Conwy (in press). Another regression was used to establish whether or not element survivorship was related to bone density. Density-mediated bone destruction has been established as an important determinant of relative abundance (e.g., Lyman 1985; Grayson 1989) and must be discounted before element representations are interpreted in terms of human behavior. Results for each test will be presented below in the appropriate sub-section.

Linear and non-linear (natural log-transformed) regressions were run for both NISP and %MNI for each level, against equid meat weight, marrow weight, and food utility index (FUI) values for each bone element (Outram and Rowley-Conwy, in press). Another set of regressions was run for NISP against equid bone density values (Lam et al. unpublished ms).

Bone density values were originally calculated for *E. caballus*, but it seems reasonable to expect that the relative density of equid bone elements is similar between species. For this analysis, the epiphyseal bone scans were averaged to produce single values for the proximal and distal epiphyses; mid-shaft scans were already single values. Linear regression models for bone density did not yield satisfactory results: the residuals tended to be non-normally distributed, and/or were heteroskedastic. Heteroskedasticity was measured visually, and confirmed using Spearman's rank correlation coefficient (testing the residuals against logdensity). Log-transformed models were slightly better: residuals were normally distributed for all levels but Level 3, but were still heteroskedastic. Adding one to the variables before the log transformations, so as to avoid complications caused by zero entries, resulted in a much more satisfactory statistical model.

OTHER ANALYSES

In addition to these statistical analyses, element representations are compared with Voorhies's (1969) fluvial transport categories. Since Level 4 and Level 3, in particular, are interbedded with fluvial deposits, it is necessary to establish whether or not these bone assemblages were affected by water-transport. Voorhies (1969) groups elements according to their susceptibility to water transport. Bones with large surface to weight ratios, or less density, are more susceptible. The presence or absence of the Voorhies Groups, therefore, is an indication of possible water transport and strength of flow.

Since hyena and other carnivores are present in all levels at Starosele, the possibility of carnivore patterning of the element representations must be explored as thoroughly as possible. Binford (1981) defined the parameters of element survivorship (on the basis of the ratio of proximal to distal epiphyseal survivorship) that are characteristic of carnivore ravaging (the "ravaging zone") and element representations are compared with these. This particular analysis is hindered by the fact that few epiphyseal elements are present in any of the Starosele assemblages.

Finally, equid mortality patterns (the age and sex structure of the death assemblages) are used to reconstruct herd-structure and to reconstruct seasonal mortality patterns, where possible. The extent and type of fragmentation and the direct actions of predators and/or scavengers (cut marks, gnawing) are also described. Butchering and gnawing marks were examined using a low-powered light microscope. This method of observation has been shown in a recent study (Blumenschine et al. 1996) to be perfectly adequate for discriminating between butchering, percussion marks, and gnaw-marks.

Element representations for equids, and equid-sized animals (recorded as OXO cf. Equus), are expressed in the tables as follows: number of identified specimens (NISP); minimum number of individuals (MNI); MNI for each element expressed as a percentage of the maximum MNI value (%MNI), and minimum number of elements (MNE). For most elements, except for long-bone shafts, the minimal animal units (MAU, *sensu* Binford 1981) are equivalent to MNE due to the method chosen to calculate MNE and therefore are not displayed in these tables. The addition of equid-sized bone (OXO cf. Equus, i.e., bone not identifiable as *Equus hydruntinus*, but identical in size) to the equid bone counts is deemed logical, since no other similar-sized animal is present in the assemblage and some bone elements, such as vertebrae and ribs, were typically only identifiable to a size category. NISP is a standard calculation tabulated for ends, or epiphyseal portions (proximal, distal) and for mid-shaft and epiphyseal fragments together (shaft + ends) for each long bone category (Tables 1-3, 1-6, 1-8, and 1-10). MNI was calculated using two methods: first using epiphyses alone, and then using both long-bone shafts and epiphyses. MNI values were calculated on epiphyses alone by segregating left and right-sided elements and segregating fused and unfused elements, finally summing the proximal and distal epiphyses. MNI was calculated using shafts by summing the portions (entered as 25%, 50%, 75% and 100%) without segregating by side or age; thus producing a minimum number of elements (MNEu) which was then divided by the number of times the element normally occurs to produce an MNI (shaft) count. Dental remains were only used in the calculation of MNI when they were associated with bone, in which case teeth were scored as jaw or mandible portions. Single teeth were not used. Foetal individuals are discussed separately and were not used to calculate MNI or MNE. MNE was calculated (1) as the sum of unsided epiphyses, and (2) as described above (the sum of all bone portions, divided by 100). Percent MNE (%MNE) is calculated as: MNE (observed)/ MNE (expected).

RESULTS: LEVEL 4

Level 4 is deposited at the top of geological stratum F, which consists of large boulder gravels, interbedded with fine-grained sediments. The depositional history of stratum F is clearly an episodic sequence of high-energy stream flow, with intermittent periods of low-energy deposition (Marks et al. 1998). Sediments in Level 4 are red and clayey, deposited by a low-energy stream. These sediments have resulted in a characteristic surficial color on the bones. Erosion from the plateau above the canyon resulted in the addition of colluviated sediments to the alluvium. The sedimentary environment in Level 4 has resulted in very good bone preservation.

Only a small sample of lithic artifacts was recovered from Level 4. Although the bones were recovered in conjunction with lithic artifacts, there were no identifiable clusters of either bone or tools. An oval area of burned soil and wood charcoal is described by the excavators (Marks et al. 1998) but is not securely identified as a hearth. Neither the lithics nor the bones cluster significantly near the putative hearth. The excavated area, however, appears to have been on the extreme margin of a denser occupation excavated by Formozov (Marks et al. 1998, Marks and Monigal 1998).

Several alternative hypotheses present themselves. The original hypothesis of a communal hunt, involving a herd of horses driven into the box canyon or over the cliffs above the site, should be considered. Animals carried away by floodwaters could also have been deposited on top of stratum F, and subsequently been scavenged by humans travelling into the canyon along the stream margins, before being covered by the fine-grained sediments of Level 4. Alternatively, a temporarily dry and stable land surface above stratum F could have been occupied for a short time by humans transporting bone to the site. Finally, individual bones may have been transported and left behind by receding waters, humans subsequently occupying the drying surface. Each of these hypotheses is considered in detail below.

The dominant component of Level 4 fauna is *Equus hydruntinus*, based on both NISP and MNI values. Species diversity is extremely limited in this level and other components (*Saiga tatarica*, *Cervus sp.*, and *Bos sp.*) are represented by very small NISP values (Table 1-1, fig. 1-2). Minimum numbers of individuals (MNI) in this level are highest for equids (MNI=4, based on mandibles) and low (MNI < 3) for each of the other species (Table 1-2).

Because the modern excavations are limited in extent, it is difficult to judge how much of the original Level 4 occupation surface(s) has been sampled. Furthermore, because Formozov (1958) did not recognize four archeological levels, it is impossible to know how many of the 287 horses reported by him for the entire site (Formozov 1958) belong to Level 4. Given the probably truncated sample from Level 4 then, an attempted reconstruction of equid population structure (for the recent excavations) is not a fruitful avenue of research.

Lack of taxonomic diversity could be used to support a hypothesis of specialized hunting, or the communal hunting of horse herds at Starosele, Level 4. The presence of other species

TABLE 1-2
Starosele, Level 4, Element Representation of Equids

	NISP	*MNE*	*MNI*	*%MNI*
Skull	3	3	3	0.75
Mandible	9	6	4	1
Atlas	–	–	–	–
Axis	–	–	–	–
Cervical Vertebra	–	–	–	–
Thoracic Vertebra	–	–	–	–
Lumbar Vertebra	–	–	–	–
Sacrum	–	–	–	–
Pelvis	1	1	1	0.25
Ribs	–	–	–	–
Scapula	1	1	1	0.25
Humerus, proximal	–	–	–	–
Humerus, distal	–	–	–	–
Radius, proximal	–	–	–	–
Radius, distal	–	–	–	–
Ulna	2	2	1	0.25
Carpals	–	–	–	–
Metacarpal, proximal	5	5	2	0.5
Metacarpal, distal	2	2	1	0.25
Accessory Metacarpals	1	1	1	0.25
Femur, proximal	–	–	–	–
Femur, distal	–	–	–	–
Tibia, proximal	1	1	1	0.25
Tibia, distal	1	1	1	0.25
Tarsal	–	–	–	–
Astragalus	–	–	–	–
Calcaneus	–	–	–	–
Metatarsal, proximal	5	5	4	1
Metatarsal, distal	1	1	–	–
Accessory Metatarsals	1	1	1	0.25
First Phalanx	4	3	3	0.75
Second Phalanx	–	–	–	–
Third Phalanx	–	–	–	–
Upper Teeth	47	N/A	2	0.5
Lower Teeth	55	N/A	5	1.25

in small numbers could be the result of incidental hunting of animals encountered while pursuing this strategy. The lack of species diversity could also reflect the ephemeral nature of the human occupation of Level 4, indicated by the paucity of lithic artifacts (Marks and Monigal 1998). The lack of taxonomic diversity in Level 4 is also consistent with a hypothesis of flash flooding—trapping horse herds in the canyon and the resultant deposition of drowned animals on the gravels of stratum F. The taxonomic abundance recorded for this level (figs. 1-1, 1-2) would, therefore, be a measure of the relative abundance of various species in the local animal community at the time of flooding.

TABLE 1-3
Starosele, Level 4, Equid Long Bone Representation

	NISP	*SUMu*	*MNEu*	*MNIsh*	*%MNI*	*SUMs*	*MNEs*	*MNIe*
Humerus	6	175	2	1	0.25	100	1	0
Radius	9	225	3	2	0.5	175	2	0
Metacarpal	8	300	3	2	0.5	150	2	2
Femur	2	50	1	1	0.25	25	1	0
Tibia	10	250	3	2	0.5	200	2	1
Metatarsal	8	250	3	2	0.5	175	2	4

NISP includes both shafts and epiphyses
(SUM)u = unsided element portions (shafts and epiphyses)
MNIsh–based on MNEu/N of each element in the body
(SUM)s = sided element portions (shafts and epiphyses)
MNIe–based on epiphyses only

TABLE 1-4
Starosele, Evidence of Fluvial Transport (categories after Voorhies 1969)

	Group I *easily moved*	*Group I & II*	*Group II* *gradually removed*	*Group II & III*	*Group III* *lag deposit*
	rib, vertebra, sacrum, sternum	scapula, phalanx, ulna	femur, tibia, humerus, metapodial, pelvis, radius	ramus	skull, mandible
Level 4	present	present	present	present	present
Level 3	present	present	present	present	present
Level 2	present	present	present	absent	present
Level 1	present	present	present	absent	present

Element Representation in Level 4

Equid element representation in Level 4 does not indicate fluvial transport of bones, or the presence of a lag deposit of bones following flood subsidence. Voorhies (1969) fluvial transport groups are all present with the possible exception of Group I (Table 1-4). If one considers the *Equus*/Bos size-class, however, it becomes apparent that Group I bones (ribs, vertebrae, sternal and sacral elements) are present, but were not definable as *Equus hydruntinus*. It seems logical, therefore, to state that bones from each of the different Voorhies Groups are present, indicating that fluvial transport has probably not patterned element representation in this level. This does not mean that water action is not responsible for the presence of equids—merely that water is not responsible for differentially transporting elements of the equid skeletons. A flash flood could still have stranded the carcasses of drowned animals at the high-water mark. A subsequent period of low-energy receding waters could have deposited the fine-grained sediments of Level 4, thus protecting the remains.

A Chi-square test of element representation for this level against the Below 4 collection (the null hypothesis) proved significant at the a=0.05 level. Although this test was run for all levels, it is probably best for the Level 4/Below 4 test, since Level 4 and deposits below Level 4 are part of the same general depositional environment (Stratum F). In other words, human presence in Level 4 (attested by the presence of cultural materials) can be demonstrated to have patterned the element representation in this level in a meaningful way.

A significance test between Hill's zebra kill data and Level 4 did not indicate a significant relationship, that is, the presence of hyena does not explain a significant percentage of the variation in element representation. Linear and non-linear regressions of equid bone against meat weight and marrow weight were inconclusive. This indicates that selective transport of elements by humans (or hyenas) did not occur, at least on the basis of either of these criteria. Non-linear regressions (data+1, log transformed) against bone density show significant results at the a=0.05 level: 42.4 % of the variation is explainable using bone density (r^2=0.424, p-values<0.001); residuals are normally distributed and homoskedastic.

Fragmentation in Level 4

The mean size of identified bone in Level 4 is 58.9 mm. The extent of fragmentation is high in this level (fig. 1-3) and the ratio of whole to fragmentary bone is 22:646. Whole or nearly whole bone represents only 5.5% of the identified bone total (N=400) and most of the complete bones are individual teeth or podial elements, such as phalanges. More than half of the identifiable bone samples for which portion sizes were scored (N=217) scored 25% or lower (fig. 1-3). Evidence of green fracture is not uncommon, and dynamic loading on bone producing bone flakes, though rare, is present. Green-bone fractures are not reliably attributable to human agencies alone (Johnson 1985), but do offer corroborating evidence in the presence of butchering marks and other evidence of human activity.

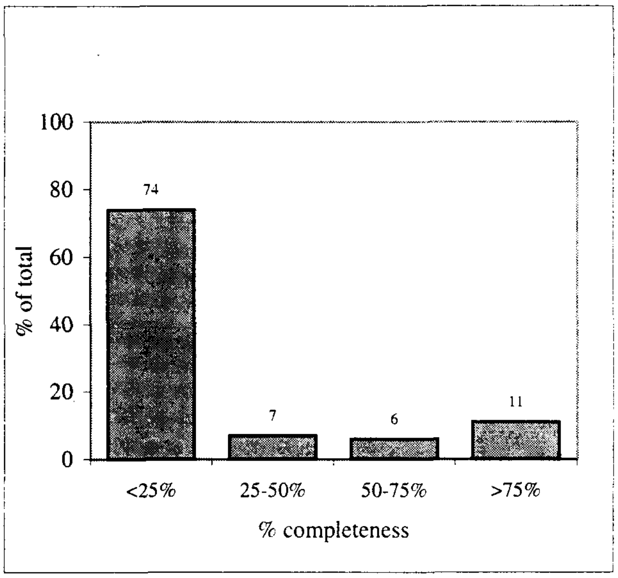

Fig. 1-3—Starosele, Level 4, fragmentation patterning.

Diagenesis in Level 4

Despite the generally good surficial preservation of the bones, some erosion and/or pitting is visible. The damage is generally due to rootlets, indicating that an active humus layer formed over flood deposits. This is consistent with the geologist's description of the top-most soils in stratum F (Marks et al. 1998). Root damage is fairly pervasive (N=103) but generally mild (1 on a scale of 1-3). Weathering, on the other hand, is rarer (N=11) and bones do not appear to have lain exposed on a ground surface for significant amount of time. All of the above confirms the archeologists' impression that artifacts are not rolled or damaged by stream action (Marks and Monigal 1998) and that Level 4 represents a momentary lull in the high energy depositional contexts above and below it.

Human Agency in Level 4

Two kinds of bone damage attributable to human agency have been identified in this level. A small number of bones bear evidence of having been cut and/or chopped, others are battered in a manner consistent with their use as retouchers in lithic tool production. Cut or chop marks are rare: only 10 bones (0.015 % of NISP; 0.25% of identified bone) show clear evidence of butchering scars. Five of the butchered bones are large mammal bone fragments. Three of the remaining butchered bones are long bone midshaft fragments. Two bones are related to dismembering: one equid acetabulum was chopped, and one equid ulna was cut at the oleocranon. One cut bone is particularly informative since tooth marks clearly overlie cutmarks, highlighting the sequence of events in this level. Humans clearly had prior access to the animal remains, and were succeeded by a large scavenger, probably hyena. Battered bones which are clearly diagnostic of an intentional pattern of scarring (striae accompanying the battering scars and consistent with their use as retouchers) are not common (N=3); three additional bones have indeterminate battering scars.

Other Predator/Scavenger Agency in Level 4

Three size classes of scavengers have left signs of their activities in Level 4. Gnawing scars consistent with a large carnivore/scavenger (hyena-sized) is observed on 5 bones. A

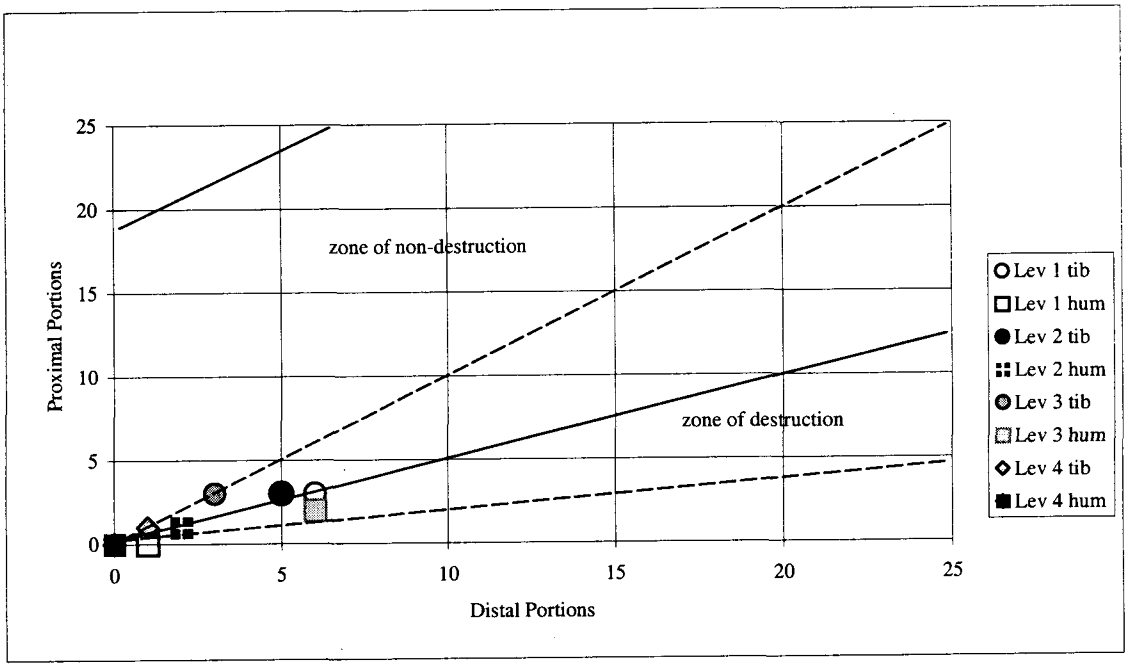

Fig. 1-4—Starosele, evidence for carnivore ravaging based on epiphyseal survivorship of tibiae and humeri.

smaller scavenger (fox or mustelid-size) was also present (N=3) and a single bone showed evidence of rodent gnawing. A polished bone flake may have resulted from hyena gnawing on green bone, and subsequent swallowing and partial digestion of the flake. No carnivore/ scavenger remains were identified in the assemblage. These results are consistent with lack of evidence, based on Binford's (1981) "carnivore ravaging" data, for extensive damage to the assemblage due to carnivore gnawing (fig. 1-4).

Equid Herd Structure and Seasonality in Level 4

Post-cranial remains yield an MNI of four equids: one juvenile, and three adults (Table 1-2). Assuming a herd structure to similar to caballine horses in the wild, the juvenile horse would normally be expected to live with a family, or harem, herd. There are too few well-represented categories of complete teeth to warrant using crown heights to establish the age structure of this assemblage.

Discussion: Level 4

The element representation for equids in Level 4, and the results of the tests performed on this assemblage, in conjunction with evidence for human butchering and some gnawing of bone, indicate that whole carcasses were present at the site. There is no direct evidence for the transportation of bone either to or away from the site. Whole carcasses were summarily butchered by humans, probably during a short stay at the site, and then scavenged by hyenas. The extent of bone fragmentation, much of it occurring on green bone, indicates that human butchering probably included smashing of bone for marrow.

RESULTS: LEVEL 3

Level 3 is contained in a gravelly silt layer interbedded in the large boulder gravels of stratum D. The faunal assemblage is relatively large (N=5,312) and more complex than Level 4 and species diversity is greater. This last fact is partially attributable to sample size, but probably also reflects a more complex human occupation of this level. Equids dominate the assemblage once again, but Saiga are present in greater number (N=25), as are fox (N=31), hyena, and bear (Table 1-1, figs. 1-2, 1-6). Chamois (*Rupicapra rupicapra*), red deer (*Cervus elaphus*), bovids (*Bos sp.*), pig (*Sus sp.*), and reindeer (*Rangifer tarandus*), as well as several species of bird, add to the diversity. The environment around the site can be partially reconstructed on the basis of this fauna, which is unevenly divided between riparian (*Sus sp., Cervus elaphus*), steppic (*Equus, Saiga, Bos/Bison*), and boreal (*Rangifer*) environments. The sure-footed chamois is not out of place in the Crimean Mountains, or the locally rocky terrain around Starosele.

Bone distribution in Level 3 generally coincided with lithic distributions and clustered weakly around an amorphous fireplace (Marks et al. 1998). The assemblage is clearly not a flood or lag deposit, as confirmed by element representation patterns which show representation of all of the Voorhies Groups (Table 1-4). Preservation is generally good and bird bones, as well as foetal equid bones, have survived burial. Fox (*Vulpes vulpes*) remains (NISP=31, MNI=2) are concentrated around Squares F20/G20. The fox remains are very well preserved, and some of the more fragile bones, such as scapulae, are present. It seems likely that this small scavenger denned among the rocks after humans and hyenas had departed.

TABLE 1-5
Starosele, Level 3, Element Representation of Equids

	NISP	*MNE*	*MNI*	*%MNI*
Skull	3	1	1	0.17
Mandible	8	8	6	1
Atlas	–	–	–	–
Axis	–	–	–	–
Cervical Vertebra	5	2	1	0.17
Thoracic Vertebra	1	1	1	0.17
Lumbar Vertebra	–	3	–	–
Sacrum	–	–	–	–
Pelvis	1	1	1	0.17
Ribs	15	7	2	0.33
Scapula	1	1	2	0.33
Humerus, proximal	2	2	2	0.33
Humerus, distal	6	4	3	0.5
Radius, proximal	4	4	2	0.33
Radius, distal	1	1	1	0.17
Ulna	2	1	1	0.17
Carpals	–	–	–	–
Metacarpal, proximal	4	4	3	0.5
Metacarpal, distal	3	3	1	0.17
Accessory Metacarpals	1	1	1	0.17
Femur, proximal	2	2	2	0.33
Femur, distal	3	3	2	0.33
Tibia, proximal	3	2	2	0.33
Tibia, distal	3	2	2	0.33
Tarsal	–	–	–	–
Astragalus	–	–	–	–
Calcaneus	–	–	–	–
Metatarsal, proximal	2	2	1	0.17
Metatarsal, distal	–	–	–	–
Accessory Metatarsals	2	2	1	0.17
First Phalanx	–	–	–	–
Second Phalanx	2	2	1	0.17
Third Phalanx	1	1	1	0.17
Upper Teeth	47	N/A	2	0.33
Lower Teeth	75	N/A	4	0.67

TABLE 1-6
Starosele, Level 3, Equid Long Bone Representation

	NISP	*SUMu*	*MNEu*	*MNIsh*	*%MNI*	*SUMs*	*MNEs*	*MNIe*
Humerus	31	750	8	4	0.67	600	3	3
Radius	27	1075	11	6	1	475	5	3
Metacarpal	9	300	3	2	0.33	75	1	3
Femur	20	625	7	4	0.67	425	5	2
Tibia	40	1125	12	6	1	450	5	2
Metatarsal	11	225	3	2	0.33	125	2	1

NISP includes both shafts and epiphyses
(SUM)u = unsided element portions (shafts and epiphyses)
MNIsh–based on MNEu/N of each element in the body
(SUM)s = sided element portions (shafts and epiphyses)
MNIe–based on epiphyses only

Element Representation in Level 3

Fluvial transport is ruled out as a significant source of bias in this assemblage, due to the presence of all four Voorhies Groups (Table 1-4). Element representation does not indicate heavy carnivore ravaging of the assemblage (Table 1-5), but equid humeri do fit into Binford's (1981) "ravaging zone" (Table 1-6; fig. 1-4), indicating some patterning due to carnivore action. Gnaw marks observed on some of the bones (see below) confirm the presence of hyena at the site. A Chi-square test against Hill's hyena kill data fails to indicate a correlation, however. As stated above, the null hypothesis (no human agency responsible for patterning) based upon comparison with the Below 4 collection is probably not as instructive for the levels above Level 4, since the depositional environment changed significantly. A Chi-square test confirmed that element representation patterns in the Level 3 equid assemblage are significantly different from the collection which accumulated naturally in stratum F.

Linear and non-linear regressions of Level 3 element representation, expressed both as NISP and as %MNI against meat-weight, showed no significant patterning. Regressions of NISP against marrow weight were also inconclusive. A linear regression of %MNI against marrow, however, was significant at the a=0.10 level, and explains 39.11% of the observed variation in %MNI for this level (r^2= 0.3911, residuals are normal and there is no evidence of heteroskedasticity). The implication is that marrow weight was a significant factor in establishing the pattern of element representation in Level 3. This has interesting implications in terms of scavenging and transport behaviors when combined with the results of the regression against FUI. Regressions of FUI (Outram and Rowley-Conwy in press) against NISP and %MNI did not reveal any significant patterning based on food utility. Element patterning in Level 3, therefore, can support a hypothesis of differential transport biased in favor of high marrow-weight elements (for equids). The ratio of upper to lower teeth in this assemblage also indicates a differential representation of skulls and mandibles, probably due to the transportation of mandibles to the site. Bone density failed to explain a significant proportion of the variation in bone elements in Level 3 (in any of the regressions).

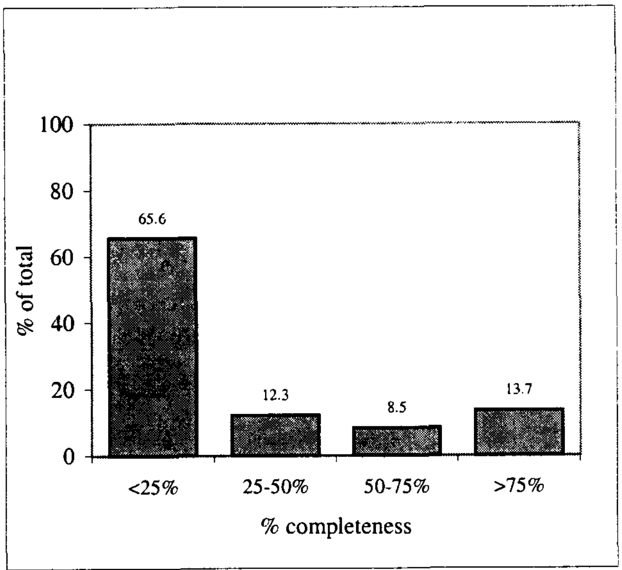

Fig. 1-5—Starosele, Level 3, fragmentation patterning.

Fig. 1-6—Starosele, Level 3, *Vulpes vulpes* femur, atlas, scapula, and radius.

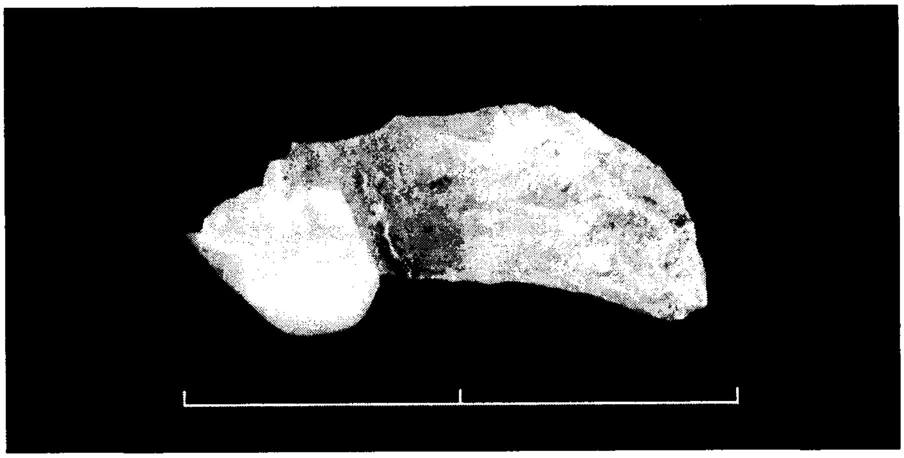

Fig. 1-7— Starosele, Level 3, *Ursus sp.* molar with cut mark.

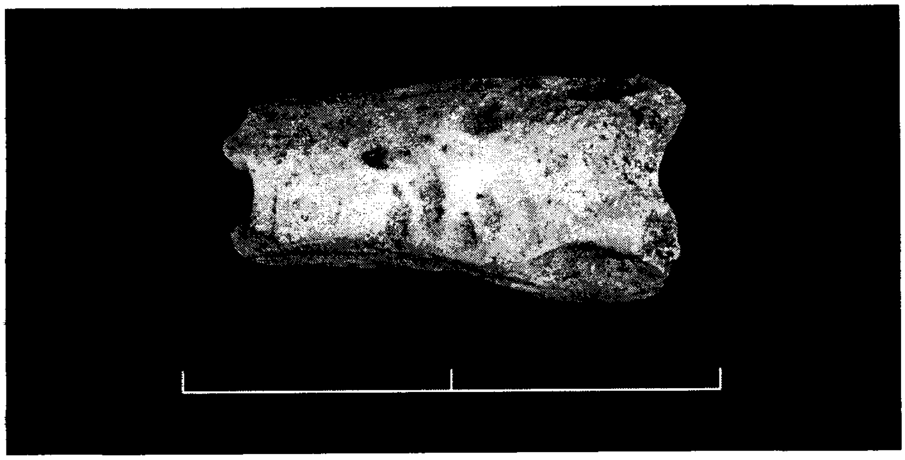

Fig. 1-8— Starosele, Level 3, Saiga first phalanx with tooth furrows from a small-sized scavenger.

Fragmentation in Level 3

The extent of fragmentation in Level 3 is high: the ratio of whole to fragmentary bone is 72:5312. Average fragment size of identified bone in this level is 55.24 mm. Whole bone represents 10% of the identified bone total (N=700) and most of the whole bones are individual teeth or small, dense post-cranial bones (with the exception of the bird and fox remains). Seventy percent of the bone samples for which portion sizes were scored (N=594) scored 25% or lower (fig. 1-5).

Green bone produces a characteristic spiral fracture when it is dynamically loaded (Johnson 1985). Spiral green-bone fractures are not necessarily indicative of human agency, however (e.g., Haynes 1983). Green-bone fractures are relatively frequent in the assemblage. In addition, one bone flake and a bone fragment with a clearly flaked edge are recorded. Like spiral fractures, flaking is indicative of dynamic loading on green bone (Johnson 1985), potentially due to butchering, but also attributable to hyenas which are equally capable of producing high loading on bone with their jaws. How much of the breakage observed in this level is due to human agency, and how much is the result of hyena activities cannot be discerned.

Diagenesis in Level 3

Rootlet etching is common (N=2,007, or 38%) though generally mild (scored as 1 on a scale of 1 to 3). Weathering is not common (N=35) and is not severe (scored 1 or 2 on a scale of 1 to 3). It appears that the bones lay on the surface long enough to be scavenged by hyena and fox before being buried in a humus zone for some time.

Human Agency in Level 3

Butchery marks in the form of cutting and chopping of bone are identified in this level (Cut N=36, Chop N=8). Twenty-four of the butchered bones are large or unidentifiable mammal bone fragments. A single skull fragment (of a small to medium sized mammal) displays a cut mark. The remaining butchered bone, most of which is equid or "OXO" sized (N=13) includes six mid-shaft tibia fragments, three mid-shaft humerus fragments, one proximal-medial radius fragment, and one rib. One cut mark was observed on a fragment of a bear molar (fig. 1-7). Battering (retouching use-wear) is visible on 11 bones (of which three are indeterminate in origin).

Other Predator/Scavenger Agency in Level 3

Gnaw marks are common (N=38) and several bones are partially digested (N=6). Hyenas, whose remains are found in this level, are the most likely agents of this bone modification. It seems likely that much of the breakage may also be assigned to hyenas. One Saiga first phalanx is marked by a series of fine, parallel grooves across the diaphysis which are probably tooth furrows of a small (fox-sized) scavenger, though they superficially resemble skinning marks (fig. 1-8). Gnaw marks left by a small scavenger, perhaps a fox, are not frequent and in one case clearly overlie cut marks. Human bone modification clearly preceded scavenging in this level, as well.

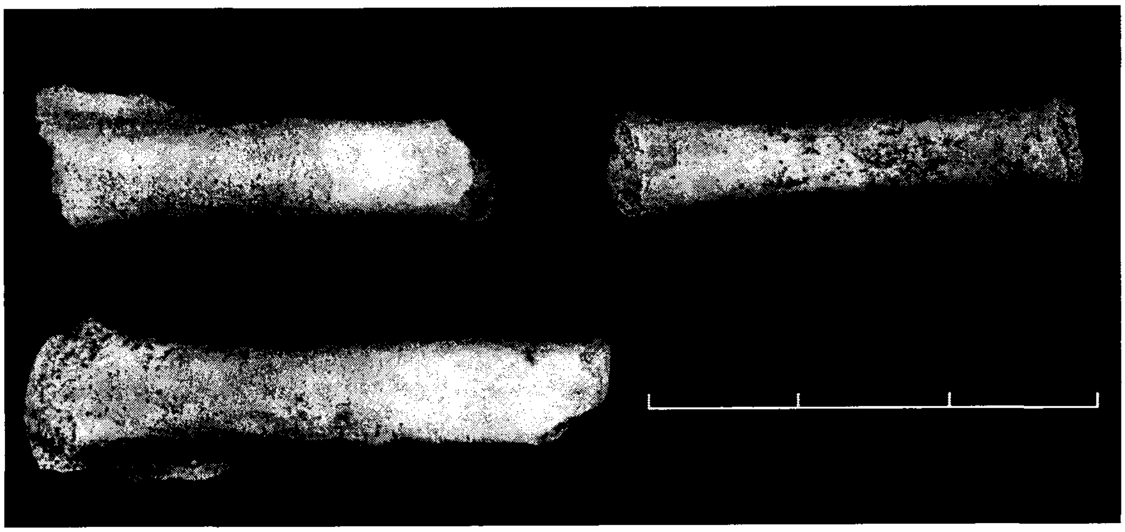

Fig. 1-9—Starosele, Level 3, fetal *Equus hydruntinus* femora and metacarpal.

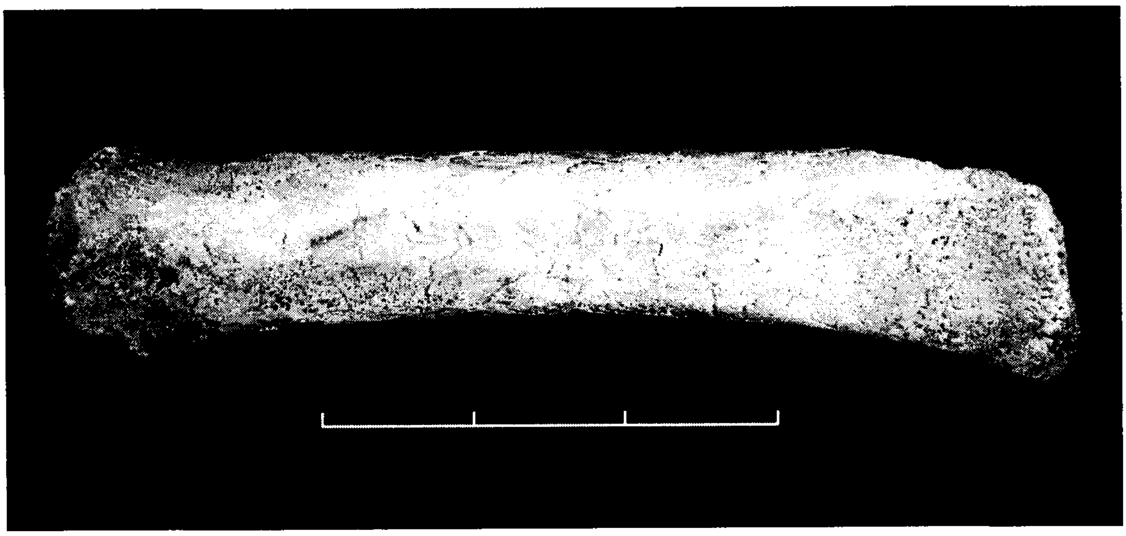

Fig. 1-10—Starosele, Level 3, fetal *Equus hydruntinus* radius.

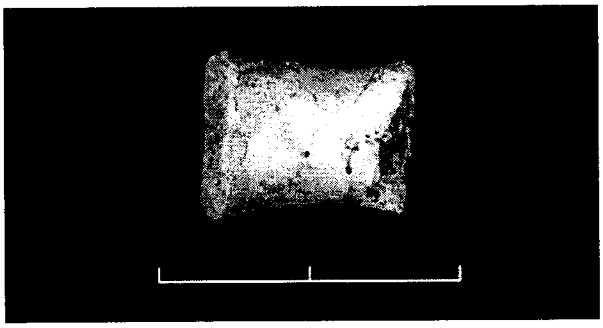

Fig. 1-11—Starosele, Level 3, fetal *Equus hydruntinus* phalanx.

Equid Herd Structure and Seasonality in Level 3

Six equid individuals—five adults and a juvenile (unfused tibia, metacarpals, and phalanges)—can be identified in this level on the basis of post-cranial elements. At least two juveniles are represented on the basis of individual dental remains (single dP2's); single teeth were not used to calculate MNI in any of the assemblages, however, unless associated with bone.

Foetal remains identified in Level 3 (N=23) include ten bones clearly identifiable as equid. Of these, five provide estimates of age. At least two equid foetuses are present on the basis of these bones, which are spatially distributed in squares H22, F20, and I21. The age at death of these animals is estimated on the basis of a comparison with published x-rays of foetal hoses (Ginther 1979: fig. 9.51); comparing the size of the fossil elements with modern horse foetuses results in estimates of foetal age. The normal foaling season for horse (*Equus caballus*) is April. Mares gestate for about 325 days. Assuming similar developmental rates between *Equus hydruntinus* and modern horses, the fossil foetal femora and accompanying metacarpal (fig. 1-9) belonged to a foetus between 100-160 days old, probably much closer to 100 days. The fossil radius (fig. 1-10) is approximately 160 days of age, or somewhat older, as is the phalanx (fig. 1-11). The foetal equids in Level 3, therefore, indicate a potential occupation span of one to three months (maximum) during late summer/fall (assuming the mares conceived at the end of May).

Discussion: Level 3

Based on the observations made above, it seems reasonable to suggest that humans were the primary agents of bone destruction, and probably accumulation, in Level 3. Furthermore, there is evidence of the differential transportation of bone onto the site, with elements selected according to their marrow content. The site was occupied in the late summer or fall. Further destruction of bone (and, potentially, additions to the assemblage) by hyenas and foxes occurred after humans had left the site. Long bones in the Level 3 assemblage clearly suffered a high degree of fragmentation, most likely due to human action, and may have been processed for marrow. Given the relatively large number of lithic artifacts associated with Level 3, the presence of a hearth and butchering marks, evidence of taxonomic diversity, and the foetal development stages, it is likely that Level 3 was occupied for a longer time, and site function was relatively more complex, than the other levels sampled in these excavations.

RESULTS: LEVEL 2

Level 2 contains a small faunal assemblage, badly altered by post-depositional dissolution. The archeological deposits themselves are more restricted in their distribution than the preceding levels and contain fewer tools (Marks et al. 1998). Level 2 lies in Stratum C, which formed amongst the detritus of several rockfalls originating from the limestone cliff overhanging the site. The land surface upon which Level 2 formed sloped to the west and south. Slopewash probably was promoted by local spillway erosion from the cliffs above. Bones cluster on the western edge of the site (Marks et al. 1998). The faunal assemblage was probably affected by slope-wash during deposition, and subsequently by water infiltration.

As in previous levels, Level 2 fauna is dominated by equids. Despite the small size of the assemblage, however, there is considerable taxonomic diversity. Saiga, hyena, bovids, and cervids are all represented, though they are not numerous.

TABLE 1-7
Starosele, Level 2, Element Representation of Equids

	NISP	*MNE*	*MNI*	*%MNI*
Skull	9	3	2	0.67
Mandible	3	3	3	1
Atlas	–	–	–	–
Axis	–	–	–	–
Cervical Vertebra	2	1	1	0.33
Thoracic Vertebra	–	–	–	–
Lumbar Vertebra	5	4	1	0.33
Sacrum	–	–	–	–
Pelvis	3	1	1	0.33
Ribs	5	2	1	0.33
Scapula	1	1	1	0.33
Humerus, proximal	1	1	1	0.33
Humerus, distal	2	2	2	0.67
Radius, proximal	2	2	1	0.33
Radius, distal	1	1	1	0.33
Ulna	2	1	1	0.33
Carpals	1	1	1	0.33
Metacarpal, proximal	2	2	1	0.33
Metacarpal, distal	3	3	2	0.67
Accessory Metacarpals	–	–	–	–
Femur, proximal	–	–	1	0.33
Femur, distal	1	1	–	–
Tibia, proximal	3	3	3	1
Tibia, distal	5	5	3	1
Tarsal	2	2	1	0.33
Astragalus	–	–	–	–
Calcaneus	1	1	1	0.33
Metatarsal, proximal	4	4	3	1
Metatarsal, distal	2	2	2	0.67
Accessory Metatarsals	2	2	1	0.33
First Phalanx	5	4	2	0.67
Second Phalanx	2	2	1	0.33
Third Phalanx	4	3	1	0.33
Upper Teeth	20	N/A		
Lower Teeth	23	N/A		

TABLE 1-8
Starosele, Level 2, Equid Long Bone Representation

	NISP	*SUMu*	*MNEu*	*MNIsh*	*%MNI*	*SUMs*	*MNEs*	*MNIe*
Humerus	9	200	2	1	0.33	175	2	2
Radius	12	325	4	2	0.67	175	2	1
Metacarpal	6	200	2	1	0.33	100	1	2
Femur	4	200	2	1	0.33	100	1	2
Tibia	14	350	4	2	0.67	200	2	3
Metatarsal	7	300	3	2	0.67	175	2	3

NISP includes both shafts and epiphyses
(SUM)u = unsided element portions (shafts and epiphyses)
MNIsh–based on MNEu/N of each element in the body
(SUM)s = sided element portions (shafts and epiphyses)
MNIe–based on epiphyses only

Element Representation in Level 2

Equid element representation does not indicate heavy carnivore damage (fig. 1-4, Tables 1-7, 1-8) or water transport (Table 1-4). The equid remains are relatively intact, and the ratio of lower to upper equid teeth is almost 1:1, indicating that complete heads (and perhaps carcasses) are present. There is no tangible evidence for slope-action affecting element distribution. Post-depositional water infiltration of this level can be presumed to be responsible for the diagenetic changes observed (see below), but not for altering the element representations of the equids. For all other taxa, podial elements are the best-represented bone category.

There is no significant relationship between element representation in this level and either Hill's hyena kill data (as reported in Binford 1981) or the pattern of bone representation in Below 4. Regressions of MNI and NISP against meat weight, marrow weight, and FUI were inconclusive. Bone density, on the other hand, explains 31.1% of the variation in equid element representation (data+1 log transformed regression, normally distributed, homoskedastic residuals). It seems likely that these elements are illustrative of the preferential survivorship of denser bones—whether humans or hyenas were responsible for these additions to the record is unclear.

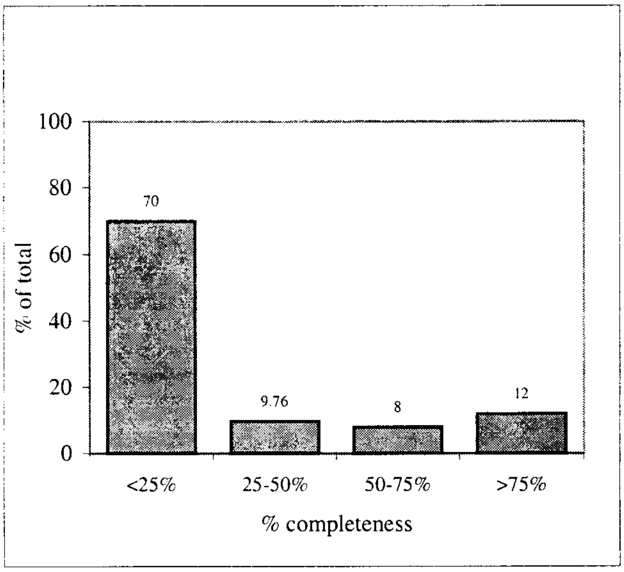

Fig. 1-12—Starosele, Level 2, fragmentation patterning.

Fragmentation in Level 2

The Level 2 assemblage is less fragmented than the other levels. The ratio of whole to fragmentary bone is 29:805. Whole bone represents 11% of the identified bone total (N=258). Once again, bones scored as complete are usually individual teeth or small, dense post-cranial bones such as podial elements, patellae, etc. Mean fragment size (identified bone only) is 51.62 mm. Two-thirds of the bone samples for which portion sizes were scored (N=212) ranked 25% or lower (fig. 1-12). Average identifiable fragment size is 51.62 mm.

Green fractures are present, judging by the frequency of spiral fractures on shaft fragments. One bone flake removal scar is noted.

Diagenesis in Level 2

Chalky, white concretions coated many of the bones in Level 2, obscuring surface features. These concretions are attributable to carbonate depositions caused by water infiltration. Pedogenic carbonates characterize the overlying deposits of Stratum B (Marks et al. 1998). Some of the bones are marked by dissolution cavities (N=7) which may be attributable to this process, rather than to carnivore actions (digestion). Sediment abrasion (N=5) may be the result of rolling, or, perhaps, trampling. One bone shows polishing, attributable to a variety of processes including water action, licking by canids, or, perhaps, some form of use-wear. Generally mild rootlet damage is not infrequent (N=75, or 29% of identified bone) and weathering (N=12, or 4.6% of identified bone) is also noted.

Human Agency in Level 2

Surficial preservation of bone in this level is generally poor, potentially masking signs of human modification. Sedimentary abrasions—due to erosion, slope movement, or trampling—further obscure the bone surfaces. A single definitive cut mark has been identified. Only two bones were "battered," but the battering is indeterminate in nature (i.e., not identifiable as purposeful). One bone flake removal scar is noted, as are numerous green fractures, all evidence of dynamic loading on fresh bone, though not necessarily through human action. The archeologists have reported finding partly articulated mammal remains in this level and a relatively small lithic artifact sample, with no discernible clustering (Marks and Monigal 1998). This seems in keeping with the general lack of evidence for extensive human processing of the bones.

Other Predator/Scavenger Agency in Level 2

Clear evidence of gnawing is infrequent (N=2). One sample (which also has dissolution cavities) is possibly gnawed.

Equid Herd Structure and Seasonality in Level 2

There are two adult equids, one sub-adult, and one foetus (foetal NISP=2, MNI=1) in the Level 2 assemblage. The two adults and the sub-adult are aged using dental wear stages. The presence of a mare carrying a foetus, approximately 80-100 days in age, once again indicates a late summer occupation of the site.

Fledgling birds indicate a mid- to late-summer deposition for Level 2 (Mlikovsky, personal communication 1997). In stark contrast to other levels at Starosele, there are several bird species in this otherwise small assemblage of bird-bones (NISP=7). Identified taxa include alpine swifts, red-billed choughs, jackdaws, and grey partridge. Most of the birds are unlikely to have been human prey given their size, the fact that they are cliff-dwellers (and would probably have been nesting in the limestone cliffs above the site—natural deaths would have occurred at the foot of the cliffs), and their state of preservation. The exception may be the grey partridge, but no butchering marks were found on any of the bird bones. The grey partridge is an indicator of cold, steppic (but not necessarily glacial) conditions.

Discussion: Level 2

The pattern of element representation is somewhat skewed in favor of podial elements and heads (Table 1-7). The presence of partly articulated podial elements was reported by the archeologists (Marks et al. 1998). A bias towards heads and distal limbs would support a hypothesis of transported, scavenged elements. Regressions against meat/marrow or food utility show no significant relationship, supporting a scavenging hypothesis. The fact remains that bone density played an important part in structuring element representation in this assemblage, as indicated by statistical tests discussed above. Diagenesis, therefore, is a possible cause of the apparent bias towards less meat-rich elements, since these denser elements are also the least valuable in terms of meat or marrow.

The agency, or agencies, responsible for patterning Level 2 fauna are not readily identifiable. Humans occupied Starosele Level 2 during the same seasonal time frame as Level 3, but the occupation appears to have been less structured and more ephemeral. The assemblage is too small and badly preserved to yield much more in the way of useful interpretation.

RESULTS: LEVEL 1

Level 1 is probably a palimpsest deposit, formed in the fine-textured sediments of Stratum B, and characterized by the formation of pedogenic carbonates (Marks et al. 1998). Level 1 is up to 30 cm thick in places, and may be the result of a single activity set or of multiple, though ephemeral, occupations of similar nature (Marks and Monigal 1998). The land surface upon which Level 1 formed slopes to the west and the south and may have resulted in an aggradation of the original level. Artifacts cluster densely around a distinct hearth in Squares I23 and J23, around which concentrations of bone charcoal are also reported (Marks and Monigal 1998). Bone distribution correlates well with both lithic distribution and the location of the hearth.

Level 1 contains a large (N=3,652), and diverse faunal assemblage (Table 1-1, figs. 1-1, 1-2). The observable species diversity is partially attributable to sample size. Species diversity may also reflect the palimpsest nature of Level 1. The limited activity set implied by the lithic patterning and the nature of the tools (Marks and Monigal 1998) lends itself more to an interpretation of a single, short-term (possibly single-season) hunting and butchering camp, however.

Bone preservation is generally fair in this level, though dissolution cavities are frequent. Dissolution may be due to chemical processes in the soil, rather than to the digestive juices of carnivores. Sediment abrasions, rolling, and trampling are evident and consistent with movement along the sloping surface of the level. There is good evidence for gnawing (hyena), as well as human butchering activities, and limited bone modification. Despite these preservation biases, some bird-bone is preserved in this assemblage, as indicated by the presence of a single jackdaw (NISP=1).

Element Representation in Level 1

Element representation patterns in Level 1 cannot be attributed to carnivore ravaging, either by comparison with Hill's data (as reported in Binford 1981) or with Binford's (1981) "ravaging zone" data (fig. 1-4, Tables 1-9, 1-10). Although humeri ostensibly fall inside the "ravaging zone," a single humeral epiphysis was recovered in this level. Regressions on meat, marrow, and FUI failed to establish any significant correlation. The ratio of upper to lower equid teeth indicates that mandibles and skulls were both present in roughly equivalent numbers. On the other hand, bone density explains 35.3% of the variation in element representation in a data+1, log transformed regression, with normally distributed, homoskedastic residuals. Preservation, therefore, played the most visible role in patterning element representations.

TABLE 1-9
Starosele, Level 1, Element Representation of Equids

	NISP	*MNE*	*MNI*	*%MNI*
Skull	13	3	3	0.25
Mandible	13	13	8	0.67
Atlas	–	–	–	–
Axis	–	–	–	–
Cervical Vertebra	6	2	1	0.08
Thoracic Vertebra	1	1	1	0.08
Lumbar Vertebra	5	5	1	0.08
Sacrum	1	1	1	0.08
Pelvis	9	3	3	0.25
Ribs	4	2	1	0.08
Scapula	3	1	1	0.08
Humerus, proximal	–	–	–	–
Humerus, distal	1	1	1	0.08
Radius, proximal	7	7	4	0.33
Radius, distal	6	6	4	0.33
Ulna	7	5	2	0.17
Carpals	7	7	2	0.17
Metacarpal, proximal	8	8	5	0.42
Metacarpal, distal	6	6	4	0.33
Accessory Metacarpals	5	4	1	0.08
Femur, proximal	2	2	2	0.17
Femur, distal	5	5	2	0.17
Tibia, proximal	3	3	2	0.17
Tibia, distal	6	6	4	0.33
Tarsal	6	3	2	0.17
Astragalus	2	1	1	0.08
Calcaneus	3	3	2	0.17
Metatarsal, proximal	20	20	12	1
Metatarsal, distal	5	5	3	0.25
Accessory Metatarsals	12	11	2	0.17
First Phalanx	15	7	2	0.17
Second Phalanx	8	8	2	0.17
Third Phalanx	12	11	3	0.25
Upper Teeth	194	N/A	5	0.42
Lower Teeth	183	N/A	5	0.42

TABLE 1-10
Starosele, Level 1, Equid Long Bone Representation

	NISP	*SUMu*	*MNEu*	*MNIsh*	*%MNI*	*SUMs*	*MNEs*	*MNIe*
Humerus	26	1150	12	6	0.5	500	5	1
Radius	37	950	10	5	0.42	575	6	4
Metacarpal	21	625	7	4	0.33	350	4	5
Femur	33	950	10	5	0.42	475	5	2
Tibia	45	1250	13	7	0.58	575	6	4
Metatarsal	40	1150	12	6	0.5	500	5	12

NISP includes both shafts and epiphyses
(SUM)u = unsided element portions (shafts and epiphyses)
MNIsh–based on MNEu/N of each element in the body
(SUM)s = sided element portions (shafts and epiphyses)
MNIe–based on epiphyses only

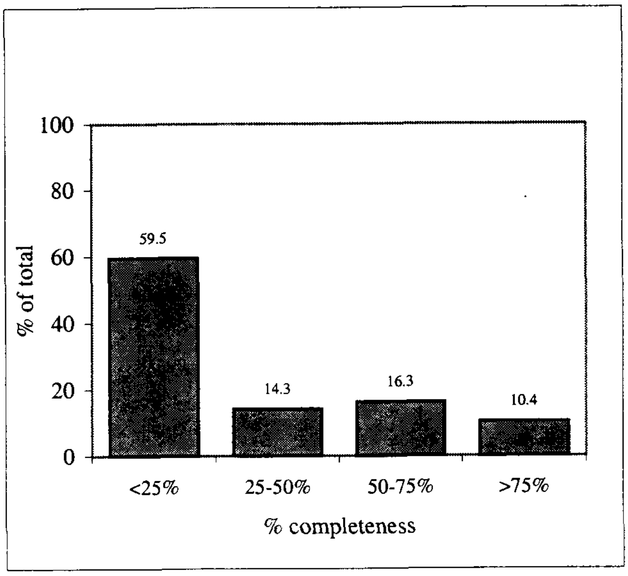

Fig. 1-13—Starosele, Level 1, fragmentation patterning.

Fragmentation in Level 1

The extent of fragmentation is very high in this level, and the ratio of whole to fragmentary bone is 178:3652. Two-thirds (N=1,170) of the bones for which portion size was recorded (N=1,587) scored 25% or lower (fig. 1-13). Only 10% of the recorded bone was whole. Whole bone is mostly represented by individual teeth. Long bones were typically fractured spirally, and the presence of some bone flakes indicates that bones were intentionally smashed to expose the marrow cavity. Hyenas were active in this level, visiting the site after humans departed based on one bone with tooth marks overlying cut marks. Evidence of the further reduction and destruction of bone due to hyenas is apparent in the number of digested bone fragments (N= 6).

Diagenesis in Level 1

Dissolution cavities are a fairly common occurrence in this level (N=50, unassociated with traces of gnawing). These may be the result of natural, sedimentary processes rather than digestive processes. Several bones also show surficial polishing (N=6); whether due to water action or canid gnawing, digestion, or licking, is unknown. Some gnawed bones show signs of dissolution and polishing.

Root damage (N=138, 7.3% of identified bone) and weathering (N=42) are not infrequent. The weathering is scored relatively high (2-3 on a scale of 1 to 3). Sedimentary abrasions are identified in 8 cases (plus one indeterminate case) and are probably due to post-depositional movement in the downsloping deposits.

Human Agency in Level 1

Definite signs of battering (percussors) are visible on equid, equid-sized, and saiga bones (N=10). Cut (N=8, plus 3 indeterminate) and chop (N=5, plus 1 indeterminate) marks are visible. Two of the butchered bones are large mammal fragments, one Saiga first phalanx has a cut mark; the other butchering scars are distributed on a wide variety of equid or 'OXO' sized bones, including one acetabulum (cut), one proximal femur, a scapula, two mid-shaft tibia fragments, a proximal ulna fragment (chop), two proximal metapodia, and one vertebral fragment. Battering is identified in 10 cases. Some bone fragments are burned (N=11). In conjunction with the lithic evidence and strong clustering around a distinct hearth, the faunal remains would indicate butchering and processing activities taking place on site.

Other Predator/Scavenger Agency in Level 1

Gnawing is visible (N=34) and probably due to the activities of hyenas or similar-sized scavengers. Dissolution attributable to partial digestion is identified in 3 cases.

Equid Herd Structure and Seasonality in Level 1

Post-cranial remains yield an MNI of 12 individuals, based on proximal metatarsals (Table 1-1), to which one foetal horse must be added (foetal NISP=5). Two right deciduous upper P4's are juveniles. As many as 7 sub-adult individuals are present in this assemblage based on right upper deciduous P4's, if the remainder of the dP4's, which are fragmentary, are treated as portions, added together, and divided by 100. Difficulties in estimating portion sizes of broken teeth make this a rather risky estimate, however. Moreover, single teeth have not been used to calculate MNI's for any assemblage in this study. Six adults (five mature, one senescent) are also identified on the basis of dental remains. It is clear, regardless of how one treats the dental remains, that juveniles are present, possibly even in equal numbers to adults. Foetal development indicates late summer. Age representation of equids in this level implies either a family herd type of social group and, perhaps, deliberate selection of juveniles, regardless of the number of hunting episodes this palimpsest deposit may represent.

Discussion: Level 1

The ratio of skulls to mandibles indicates the probable presence of whole horse heads (and potentially, therefore, whole carcasses) in this level. This is consistent with the archeologists' interpretation of a toolkit in this level as an indicator of primarily butchering activities (Marks and Monigal 1998). A hypothesis of scavenging can be rejected on the grounds that Level 1 lies in a stratum that did not accumulate due to flooding episodes (such as stratum F), the thalweg having gradually become deeply incised over time. Drowned animals would not have occurred naturally at the site during the time of deposition of Level 1. It is unlikely that complete horses (or even horse heads) would have been transported any distance by scavenging people.

The accumulated archeological and zooarcheological evidence points to a primary strategy of hunting equids, probably by driving animals up the box-canyon in which the site is situated. Deaths probably occurred very near the site, otherwise economic decisions predicated on meat weight, marrow content, or food utility values would have governed the transport of portions of the horse carcasses. While carrying out this strategy, and during the human occupation of the site, other, typically smaller-bodied prey such as Saiga (see fig. 1-2) were hunted as encountered locally.

RESULTS: LEVEL 0

The small faunal collection (N=131) designated as Level 0 was collected from the disturbed sediments in Stratum A. This unit is composed of modern colluvial loams and contained debris from A.D. eighteenth century quarrying and pit and hearth construction. In a few areas, pit construction and burials disturbed the Level 1 deposits, so that Paleolithic-age artifacts were mixed in with recent human burials, domesticated animals, and ceramic sherds (Marks et al. 1998: 76; Monigal et al. 1998). In spite of the disturbances, the Paleolithic-age faunal material was easily distinguished from modern material by color and density, and was set aside as Level 0. Equids are still dominant in this level, but species diversity is high relative to other levels (figs. 1-1, 1-2). This is probably due to the mixed nature of the deposits and the collection strategy. Analysis of this collection was not attempted beyond a basic, descriptive level.

Two juvenile equids (dP4's worn) are present. A single foetal rib is difficult to assign to a developmental stage, but is probably consistent with foetal development in other levels. One bovid metatarsal is unfused distally, as is a saiga-sized metapodial. Root damage (N=23) is generally moderate (scored 2, out of 1-3). Weathering is not frequent (N=12) but is severe when it occurs, supporting the archeologists' description of this assemblage as mixed (Marks et al. 1998). The Level 0 faunal collection probably formed over a relatively long period of time, with some bone lying exposed for much longer periods of time than the rest of the assemblage. A single bone shows indeterminate signs of battering. Scavenger activity is attested, there is evidence of gnawing (including rodent gnawing) but it is rare. A single bone flake shows signs of having been passed or partially digested by a carnivore.

CONCLUSIONS

The general lack of evidence of carnivore gnawing and the small quantity of carnivore remains found at Starosele confirms that these animals were not the primary bone collectors. The presence of tooth furrows overlapping butchering marks in Level 3, for example, indicates that a "swing-shift" of hyena moved in and scavenged residual bone after the human occupation of the site. Hyena was present in all levels except Level 4 and probably accounts for some of the fragmentation and element representation patterning observed.

During the period of accumulation of the lowermost Stratum F, humans traveled up the box canyon in which Starosele is situated, walking along the gravel and boulder-strewn thalweg after floodwaters had receded. They briefly occupied the site, leaving behind a living floor, or find-horizon: Level 4. The Level 4 occupation may not have been an isolated event, but it is a happy accident for the archeologists that the find horizon was preserved by the subsequent deposition of a fine, protective layer of clayey sediments. This level may record one of a series of forays into the gorge, undertaken with the specific purpose of scavenging the stream banks after flash flooding. The alternative interpretation is that herds of horses were driven into the box canyon and killed on the site. The general lack of species diversity in Level 4 lends more support to the hunting hypothesis. The presence of apparently naturally deposited equid bones (and almost total absence of other species) in the archeologically sterile deposits below Level 4 lends some support to the scavenging hypothesis, however. There is no clear seasonal evidence in the Level 4 fauna.

Level 3 also formed in a generally turbulent depositional environment (Stratum D), although the thalweg was more deeply incised than in Stratum F and the land surface around the site may have been more stable (Marks et al. 1998). Sediment deposition following the occupation of Level 3 occurred in a relatively calm, low-energy regime. In this level, coincident with a distinct change in lithic technology and in the composition of the lithic toolkit (Marks and Monigal 1998), there appears to have been a shift in site function. Differential transport of marrow-rich elements to the site is apparent when one considers the element representations for horse in this level, and the correlation between elements present and marrow indices. Species diversity in Level 3 supports a longer-term, more complex occupation of the site, as does evidence for two distinct stages of early foetal development.

Whereas in all other levels, the site appears to have been briefly occupied as a butchering station, Level 3 appears to be a base camp, occupied for a longer period of time, where primary butchering co-occurred with bone transport and secondary butchering. The change in site function in Level 3 does not detract from the overall impression of a local economy based on the exploitation of equids—probably during seasonal migratory movements.

Level 2 is a short and somewhat quixotic occupation: a small number of relatively complete equid carcasses are present in this small, poorly preserved assemblage. There is no single, clear agent of bone accumulation, or any explanation for the pattern of element representation in this level beyond natural preservation biases (that is, bone density clearly played a role in determining survivorship patterns). In this level, as in Levels 4 and 1, human activities were apparently restricted to the butchering and processing of equid bone, either from scavenged carcasses found locally, or from animals driven up the box canyon and killed there.

Level 1, a palimpsest, is a relatively large assemblage, with considerable taxonomic diversity (probably partially as a result of assemblage size). Juvenile equids appear to have been well represented, indicating that family herds, and perhaps juveniles preferentially, were selected as prey. Whole carcasses were being butchered at the site during the accumulation of this level—the palimpsest nature of the horizon makes further definition of the function of the site impossible. The combined archeological and zooarcheological evidence for Level 1 points to a primary strategy of hunting equids, probably by driving animals up the box-canyon in which the site is situated. Other taxa, relatively well represented in this level, were probably hunted singly on an encounter basis.

MIDDLE PALEOLITHIC HUNTING STRATEGIES

Equid remains heavily dominate the recently excavated fauna at Starosele, confirming the results first reported by Formozov (1958). This could be interpreted as evidence for a deliberate prey-selection strategy, or specialization, on the part of the Middle Paleolithic occupants of the site. Saiga, which dominates other Middle Paleolithic fauna in the region (see Chapter 2), is present in three levels, as are small numbers of other prey species. Species diversity has been used elsewhere to support a hypothesis of unsystematic hunting by Middle Paleolithic people (Mellars 1989). The significance of the correlation between element representation and marrow, together with the high ratio of lower to upper equid teeth, might indicate active scavenging in Level 3, but probably indicates that hunting episodes took place in different locations, at some distance from the site.

Enough data exist to support claims of a primary, systematic, and long-term strategy of horse (*Equus hydruntinus*) procurement at Starosele, whether hunted or scavenged. In almost all levels (Levels 4, 2, and 1), it appears that whole equid carcasses were being dismembered at the site, and bones were probably smashed for marrow. Seasonal indicators indicate the site was occupied during late summer or fall, at least in Levels 3, 2, and 1. Bearing in mind that the precise size of the original assemblages will never be known, the age structure of the death assemblages for Levels 4 to 1 (recent excavations only) point to the exploitation of family herds (composed primarily of mares and juveniles). Seasonal, late summer/fall exploitation of horses is indicated in Levels 3 and 1, based on foetal development. The seasonal evidence indicates that humans were probably taking advantage of predictable, migratory herd movements along the main Bakchisarai valley to drive small groups of equids into the Starosele canyon. Given their numerical lack of importance, other prey species present (in Levels 3, 2, and 1) probably represent opportunistic hunting, or scavenging, while carrying out this primary strategy.

Chapter 2

KABAZI V: FAUNAL EXPLOITATION AT A MIDDLE PALEOLITHIC ROCKSHELTER IN WESTERN CRIMEA

ARIANE BURKE

INTRODUCTION

Kabazi V is a collapsed rockshelter in the line of limestone cliffs bordering the Alma River valley and its tributary valley, the Kalinovaya. First discovered in 1983, the site is currently being excavated by A. I. Yevtushenko. Although the lithic assemblages from Kabazi V have been extensively analyzed and published (Kolosov et al. 1993; Yevtushenko 1995, 1998), the faunal assemblages have not. The Kabazi V faunal assemblages described in this report were excavated during the 1986, 1990, 1993, and 1994 field seasons. Occupation levels at Kabazi V occur within four major stratigraphic units: Units I, II, III, and IV (Yevtushenko 1998a). These stratigraphic units correspond to major depositional sequences whose evolution is largely shaped by the history of the rockshelter, its collapse, and subsequent slope formation processes (Yevtushenko 1998a). Archeological levels are numbered sequentially within each stratigraphic unit (e.g., Level I/1 is the first archeological level in Unit I, and so on). A total of eighteen archeological levels have been excavated to date. The excavator has also grouped the occupation levels into cultural complexes on typological grounds (Yevtushenko 1998).

The faunal collection analyzed in this report derives from stratigraphic Units I, II, and III. Sediments from Unit I are disturbed, and little fauna was recovered from archeological Levels I/1 and I/2. Unit II corresponds to geological stratum D, a period of rapid deposition of soils over the collapsed rockshelter by colluvial and possibly eolian sedimentation processes (Yevtushenko 1998a). A series of six archeological levels containing heavily fragmented faunal remains is preserved in Unit II. The base of Unit II (stratum D) is composed of limestone blocks, resulting from the rockshelter collapse. Unit III is therefore sealed. Unit III corresponds to stratum E, which was divided by geologist C. R. Ferring into three sub-strata on the basis of an erosional disconformity (Yevtushenko 1998a). This unit is composed of a series of thin deposits, or living floors, containing hearths, which accumulated under the rockshelter and yielded somewhat more fragmentary bone assemblages than those of Unit II. Levels III/1, III/1a, III/2, and III/3 of Unit III are examined in this report.

Taphonomically, the three stratigraphic units of Kabazi V present the researcher with three distinct problem sets. As a result, and due to the generally small size of bone assemblages from each level, assemblages from the same units are grouped into collections for most of the following discussion except where noted.

Taxonomic identifications were done using modern reference collections at the University of Manitoba, and modern and paleontological reference collections at the Institut de Paléontologie Humaine (Musée National d'Histoire Naturelle, Paris) and at the Canadian Museum of Nature (Hull, Quebec). The basic methodology for establishing taxonomic identifications is outlined in Chapter 1.

RESULTS

A total of 7,292 faunal remains were processed from Unit I (155 remains), Unit II (4,856), and Unit III (2,281). As a whole, 24.5% of the collection (NISP = 1,787) was identifiable to taxon, or minimally, to size class. Of the sample, 8.9% (N = 650) was identifiable to taxon/ size category and element. Size classes used for this research are: *Equus*/Bos-sized (OXO); Large Artiodactyl sized, i.e., red-deer sized, (LAR); Small Artiodactyl (SAR); Medium Mammal (MM); and Small Mammal (SM). Rib and vertebral fragments are generally identifiable only to size class. The OXO class is probably dominated by equids (*E. hydruntinus*) and the SAR class is likely dominated by *Saiga tatarica* (compare fig. 2-1 and fig. 2-2).

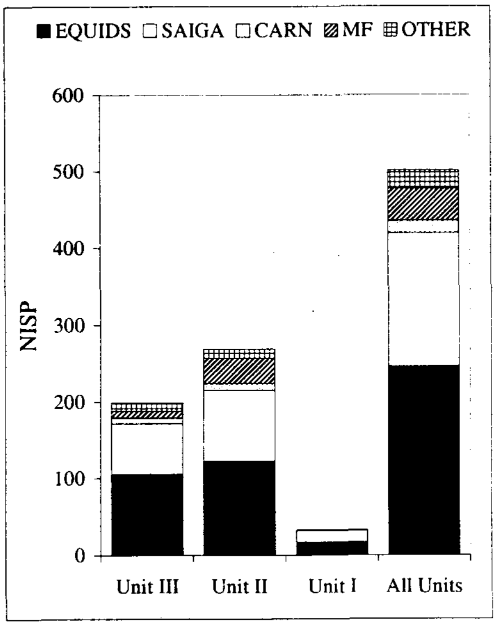

Fig. 2-1—Kabazi V, identified taxa per unit.

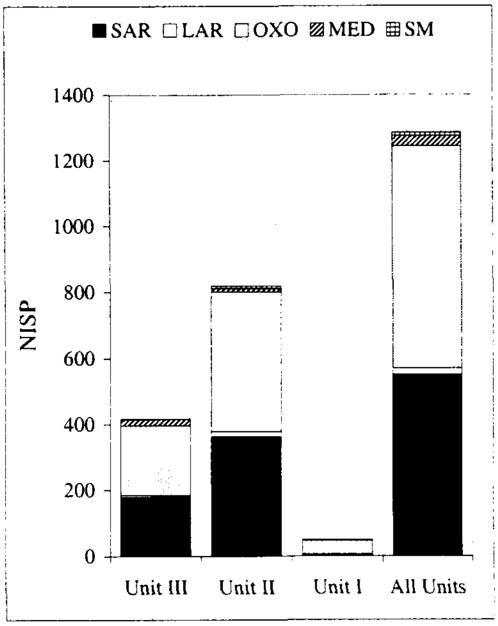

Fig. 2-2—Kabazi V, size class representation.

The remainder of the bones was counted and sorted according to size (greater or less than 2 centimeters). Most of the unidentifiable bone fragments are shaft fragments and 95.5% of the fragments are under 2 cm maximum length.

TAXONOMIC IDENTIFICATION

The Kabazi V faunal collection is globally dominated by *Saiga tatarica* and equids, including *E. hydruntinus*, *E. caballus*, and *Equus sp.* (Tables 2-1, 2-2; fig. 2-1). Other taxa are significantly less numerous than *Equus* and Saiga and include, in order of importance, *Cervus elaphus, Crocuta crocuta, Bos/Bison sp., Sus sp., Vulpes cf. vulpes, Ursus sp.*, a large artiodactyl *cf. Rangifer*, an ovicaprid, and very fragmentary megafaunal elements (some of which are attributable to Coelodonta). In addition, a small number of bird bones are present and have been identified as raptors.

Together, Saiga and the SAR class fragments represent 40.4% of the total identifiable specimens (fig. 2-2). Saiga alone represents 9.7% of NISP. The equids and the OXO class represent 54.2% of NISP. Bones definitely attributable to *E. hydruntinus* represent 3% of

NISP. Carnivores, often represented only by teeth, comprise 0.8% of NISP. The ratio of MNI to NISP is very low overall.

Relative taxonomic abundance does not change much from unit to unit, if sample size and its probable effect on taxonomic diversity are taken into consideration. A very small collection from Unit I, Levels I/1 and I/2 (disturbed deposits) yielded only 83 taxonomically identifiable bones, dominated by Saiga and *Equus hydruntinus* (Tables 2-1, 2-2). No other species could be identified from this unit. Unit II is dominated by Saiga and *E. hydruntinus*, as is Unit III. Both Unit II and Unit III contain other, less numerically important taxa, in similar proportions. Carnivores are present in Units II and III, and represent 0.8% and 1.1% of the total NISP per unit, respectively (fig. 2-1). Carnivores include hyena (the most numerous taxon present), fox, a medium-sized canid, and bear.

TABLE 2-1
Kabazi V, Identified Taxa (NISP)

	Unit I	*Unit II*	*Unit III*
Equus hydruntinus	11	23	20
Equus caballus	1	2	–
Equus sp.	5	98	86
Saiga tatarica	15	92	66
Bos/Bison sp.	–	3	2
Cervus elaphus	–	2	1
Capreolus capreolus	–	–	2
Sus scrofa	–	2	2
Cervus sp.	1	3	–
Ovicaprid	–	1	–
cf. Rangifer	–	–	1
Coelodont	–	12	3
Crocuta crocuta	–	3	–
Ursus sp.	–	2	1
cf. Vulpes	–	1	–
Canid	–	2	5
Unidentified carnivore	–	1	1
Lepus sp.	–	–	1
Aves (Raptor)	–	1	3

TABLE 2-2
Kabazi V, Minimum Number of Individuals[1]

	Unit I	*Unit II*	*Unit III*
Equids	2	8	7
Saiga	3	8	8
Carnivores[2]	1	4	3
Levels sampled (N)	2	5	4

[1] For species other than *E. hydruntinus* and Saiga, MNI = 1 (see Table 2-1).

[2] Includes all carnivores; in all levels MNI = 1.

ENVIRONMENTAL SIGNIFICANCE OF THE IDENTIFIED TAXA

The fauna of Kabazi V is generally dominated by an open, steppic component composed of Saiga and *Equus*. Other taxa—in some cases indicative of very different environmental conditions—are also present in Units II and III, however (Table 2-1). The presence of pig (*Sus* sp.) and red deer (*Cervus elaphus*) indicates that the environment near the site during the time of human occupation of Units II and III included a closed (woodland/forest) humid component, as well as an open steppic component. Wild pig and red deer, well-attested elsewhere in the region, though never numerous (Vereshchagin 1967), indicate both the presence of tree cover and ready access to water. In all probability, these taxa inhabited the river valleys below the site where both water and tree cover must have been available, at least seasonally. Paleoenvironmental reconstructions for Kabazi V must take into consideration the position of the site at the interface between what were two distinct environmental zones: the open plain, or cuesta above the site, and the river valley below.

The single large artiodactyl specimen identified potentially as *Rangifer tarandus* (from archeological Level III/1) might indicate a rigorous cold period. *R. tarandus* is reported in small numbers in other Middle Paleolithic sites in Crimea (e.g., Kolosov 1986; Gvozdover et al. 1996; Chapter 1, this volume). At Kabazi V, however, it occurs with the more mesic suid, and therefore could be a member of a remnant population on the brink of extirpation.

The presence of raptors in Units II and III is easily explainable due to the location of the site below a prominent limestone cliff (part of the Kabazi massif), which provides ideal nesting sites for numerous bird species. A variety of hawks, and even eagles, are frequently seen drifting high above the site to this day.

HUMAN EXPLOITATION OF THE ENVIRONMENT

In all probability, the people using Kabazi V rockshelter during the formation of Unit III, or camping on the slope covering the collapsed shelter during the formation of Unit II, were exploiting both the cuesta above, and river valley environments below the site. The clear dominance of steppe-dwelling fauna (saiga and equids), however, indicates that the focus of hunting activities by humans was on steppic species, rather than on species dwelling in the river valley. Although other climatic indicators seem to point to changes in the local and regional environment of the site during the formation of Units I, II, and III (see Chapters 4-6), changes in the dominant prey species are not apparent. Faunal exploitation patterns at Kabazi V did not change much over time, despite an evolution in the local landscape and climate.

TAPHONOMY OF THE KABAZI V FAUNAL ASSEMBLAGES

Based on observations made on identifiable bones at Kabazi V, post-depositional taphonomic factors differ in Units I, II, and III, and we may expect bone preservation to reflect these differences. In Unit I, sediments accumulated on a distinct slope, and were reworked as a result of slope-wash, rolling, and redeposition. In Unit II, the archeological horizons were deposited in the open-air, on a relatively stable slope, but in a context of relatively rapid sedimentation rates (Yevtushenko 1998a). Deposits accumulating rapidly over the Unit II occupation levels should have provided some protection from trampling, weathering, and rolling—though weathering should still have played an important role in bone preservation. Soil formation over archeological occupations in Unit III was relatively slow (due to the rock-shelter), hypothetically leaving bones exposed to trampling, but the protected nature of the depositional context should have limited weathering effects.

Weathering

Weathering effects (cracking, exfoliation, root etching) were scored on identifiable bone only. The collection from Unit I is too small to evaluate properly, but bone preservation appears generally poor. Unit II shows expected signs of weathering on bone surfaces; cracking and exfoliation are apparent, as well as root etching. These weathering effects appear to have been slight, however. The most affected archeological levels are Level II/3 (weathered bone, N=28) and Level II/4 (weathered bone, N=7). In all, 3.3% of the NISP for Unit II showed distinct signs of weathering and 1.3% of the NISP was etched. Visual appraisal of the overall condition of the unidentifiable bone confirms that bone from Unit II was generally mildly weathered and root-etched, as well as showing traces of carbonate adhesions. This pattern of mild weathering in an open-air locale can be attributed to the fairly rapid rate of sedimentation noted above. Lack of root etching in Unit II is at least partly attributable to the sloping nature of the deposits, which were exposed to erosional processes and would not have been favorable to vigorous plant growth.

The pattern of weathering in Unit III is somewhat more severe and runs counter to expectations. Surficial damage was noted in 4.8% (N=30) of NISP, and root damage occurs in 3.4% (N=21) of the identifiable bone. Most of the weathering and root damage, however, occurs in archeological Levels III/1a (weather, N=13; root, N=2) and III/1 (weather N=11, root N=16). Unidentified bone from these levels is generally unaffected by root and weather damage. Levels III/2 and III/3 show few signs of weathering. Since this was a sheltered locale, weathering was not expected to be severe in Unit III. An analysis of the horizontal distribution of weathered bone in Unit III (Levels III/1a and III/1) reveals that most of the weathered bone is situated towards the front and to the south of the rockshelter.

Trampling

Unit II bone shows little sign of trampling (surficial polish or multiple parallel abrasions). Only 1.0% (N=11) of identified bone showed signs of polish or abrasions attributable to trampling. Unit III bone also shows little sign of trampling, only 1.8% of identifiable bone (N=11). The generally slight evidence of trampling in these collections may indicate that the site was either occupied only briefly, or only occupied by a small number of people. In all probability, the intervals between successive occupations were sufficiently long to allow protective layers of sediment to be deposited on the abandoned living floors. In the case of Unit III, where sedimentation was slow, this may even indicate relatively long occupational hiatuses (e.g., more than one year).

Bone Destruction by Non-Human Agents

The presence of various carnivores at the site, particularly the presence of *Crocuta*, requires that bone survivorship must be assessed in the light of possible bone destruction by agents other than humans. Evidence of carnivore gnawing, and leached or polished bone resulting from exposure to gastric juices, is found in Unit II (gnawed N=3, regurgitated N=7) and in Unit III (gnawed N=1, regurgitated N=3). In total, 0.9% of identifiable bone in Unit II was carnivore damaged, and 0.7% of the bone in Unit III. Most of the gnawed and regurgitated bone in Unit II is found in Level II/4, where a partial hyena mandible was also found (fig. 2-3). Rodent gnawing was only identified in two cases, in Unit I and in Level II/4, which accords well with the relatively small microfaunal assemblage recovered from the site (Chapter 4).

Given the archeological context, and the relative scarcity of carnivore-induced trauma, human agents are the most likely agents of bone accumulation and destruction at Kabazi V, with the scavenging activities of other carnivores being carried out peripherally, probably after the site was abandoned by its human inhabitants.

Bone Destruction by Humans

Evidence of hearths occurs in all levels of Unit II. According to the excavator, large quantities of burned bone were recovered from these levels (Yevtushenko, personal communication 1996). In Unit III, hearths were found in each level, and burned bone was also recovered in quantity. No wood charcoal was recovered in either Unit II or Unit III (Yevtushenko, personal communication 1996). It is therefore likely that bone was used as a combustible and will have affected bone survivorship patterns. Even if bone was not being used as fuel, but was burned as a result of food preparation or the disposal of cooking refuse, patterns of bone survivorship at Kabazi V will have been affected by a variety of factors including burning. Burning affects the degree to which carnivores/scavengers further damage bone (Lupo 1995) and may partly explain the general lack of evidence of gnawing.

A detailed study of bone survivorship patterns is hampered by the degree of fragmentation and the unknown quantity of bone charcoal discarded prior to this study. The pattern of element survivorship does not appear to change much between Units II and III, however (Table 2-3). It should be borne in mind that teeth have inflated NISP counts relative to other elements, due to their natural abundance and generally high survivorship. It is apparent that podial elements (metapodials, astragali, calcanei, phalanges) and crania (skull fragments and teeth) dominate the element distribution (Table 2-3). Globally, skull fragments and teeth represent 39.0% of the total number of identified elements (N=650) in Table 2-3. Podial elements represent 31.5% of the total. Scapulae, ribs, vertebrae, and other elements are all clearly under-represented in this distribution.

The relative over-representation of feet and skulls could indicate that a "gourmet" strategy—whereby only choice, meat-bearing bones are transported to the site—was not employed (Binford 1981). Perhaps Saiga and the relatively small *Equus hydruntinus* were easily transported in large portions—maybe even as complete carcasses in the case of Saiga. It seems more likely, however, in light of other taphonomic indicators, that bone destruction during processing and the use of long-bones for fuel resulted in the differential preservation of meat and marrow-rich relatively less dense limb-bones, as well as the relatively fragile and meat-rich elements such as ribs and vertebrae.

Cutmarks are not common in the Kabazi V assemblage, though this is probably a result of the pattern of bone destruction documented (both fragmentation and burning). In Unit I, no marks were identified. In Unit II, few (N = 8) bones bore clear cutmarks, and in Unit III only 9 bones with cutmarks and 4 bone flakes (potentially the result of human butchering) were identified (0.57% of the total NISP). Cut marks are concentrated on podial elements, such as phalanges, astragali, and calcanei. Bone fragments used as retouchers (to shape and re-sharpen flint tools) at Kabazi V are reported elsewhere (Yevtushenko 1995, 1998b).

Bone Refitting

In all three units, some bone refitting was possible. In Unit I, two series of first and second Saiga phalanges articulate. In Unit II, Level II/4, two equid molars refitted into a mandibular fragment; in Level II/4a two equid molars refitted; in Level II/7, an equid distal tibia articulated with a metatarsal and an accessory metatarsal, and a Saiga calcaneus articulated with an astragalus. In Unit III, Level 1, three equid teeth could be refitted. These refits indicate that entire lower limbs (feet, metapodia, and distal tibia) were brought to the site. In

TABLE 2-3
Kabazi V, Element Representation, for All Taxa[1]

NISP	*Unit I*	*Unit II*	*Unit III*
Skull	3	31	33
Upper tooth	5	41	18
Lower tooth	8	59	56
Sub-Total	*16*	*131*	*107*
Sesamoids	1	6	9
Carpals/tarsals	2	23	10
Astragalus	2	8	3
Calcaneus	0	5	0
First phalanx	5	21	9
Second phalanx	2	3	2
Third phalanx	4	5	10
Metapodia	2	42	31
Subtotal	*18*	*113*	*74*
Humerus	0	9	23
Radius/ulna	1	18	24
Femur	0	11	6
Tibia	2	18	17
Patella	2	1	0
Subtotal	*5*	*57*	*70*
Pelvis	0	5	1
Scapula	0	6	2
Vertebra	0	15	4
Ribs	1	13	12
Subtotal	*1*	*39*	*19*
Total	*40*	*340*	*270*

[1] Excluding *Aves*; includes only bones identifiable both to element and to taxon or size class; excludes teeth unassignable to upper or lower tooth rows, tooth fragments, incisors.

[2] Includes skull fragments unidentifiable to taxa, and mandibular fragments.

all probability, whole mandibles, if not whole skulls, were also transported to the site.

Taphonomy: Conclusions

The pattern of bone survivorship observed at Kabazi V is likely a result of the combined effects of human transport decisions, food preparation patterns, discard and post-depositional processes including non-human ravaging, and weathering factors related to the topographic location of the site. All of these factors will have acted to increase the relative representation of denser bones, such as podial elements and teeth. Given the archeological context and the relative lack of evidence of carnivore activity, processing by humans is the most likely cause of fragmentation at Kabazi V. The degree of fragmentation of the assemblage is high overall: 95% of the indeterminate bone has a maximum length of less than 2 cm. The remainder of the indeterminate bone ranges between 2 and 5 cm in length. High fragmentation, together with a quantity of burned bone, indicates intense bone processing took place in all units. This would be consistent with the identification of the site as a base camp. Here, bone was

Fig. 2-3—Kabazi V, *Crocuta crocuta* lower molars.

Fig. 2-4—Kabazi V, fetal *Equus hydruntinus* femur.

probably processed for both grease and marrow, food preparation occurred, and bone may have been used as fuel.

SEASONALITY AND AGE

MNI counts per species in each level rarely exceed single individuals (Table 2-2). Mortality profiles are therefore not available. Adults and juveniles of both Saiga and *Equus hydruntinus* were hunted in both Unit II and Unit III, however; fetal bone is present in both of these units. In Level II/4, a fetal equid femur can be estimated as slightly more than 100 days old (fig. 2-4). (Age of fetal elements was estimated using data obtained from x-rays of modern horse fetuses at various gestation stages, see Ginther 1979: fig. 9.51.) Equids in the wild typically conceive within a well-defined period, gestating over the winter and giving birth in April. As a result, these fetal elements can be used to estimate the season of occupation for Level II/4 as late summer or perhaps early fall. Other fetal bone, of indeterminate species, is present in Levels II-A, II/4, II/7, and III/1a. Since these most likely belong to Saiga or *Equus*, they suggest a roughly late summer to winter death. The presence of fetal bone, some of it probably Saiga, would support Barychnikov's conclusion (Barychnikov et al. 1994) that Saiga was reproducing in Crimea. Unfortunately, none of the indeterminate fetal bone is definitively identifiable as Saiga. In Level II/3, a partial fetal radius and femur, both probably equid, are similar in age to the Level II/4 individual. Aging data tend to support a hypothesis of late summer/fall occupation, though less concretely. Juvenile Saiga occur in Levels I/2, II-A, II/4, II/4a, II/7, III/1 and III/2, based on epiphyseal fusion. Teeth were rarely complete enough to permit aging using use-wear schedules, unfortunately. Since Saiga give birth within a short window from mid to end-April (Bannikov et al. 1961), these juvenile animals may be summer/late summer, or perhaps winter deaths. In Unit III, Levels III/1 and III/2, Saiga metapodia with unfused distal epiphyses indicate juvenile (in both cases probably late summer) mortality.

CONCLUSIONS

Site Function

Kabazi V was apparently used as a base for the processing of animal carcasses for meat, marrow, and/or grease, judging by the intensity of bone breakage patterns and the location of cut-marks. Whole carcasses may have been brought onto the site, but element representation patterns are too biased by a combination of human processing, burning, and post-depositional damage, to test this possibility.

Occupations appear to have been short-lived, or consisting of small numbers of occupants. Fetal equid and juvenile Saiga indicate a series of late summer/early winter occupations of Kabazi V. It is also clear from the data that gravid horses were hunted in the fall/early winter, or perhaps in late summer. The fact that bone was being burned for fuel supports an advanced season of occupation (fall/early winter), when the south-facing slope on which the site is situated would not have provided enough radiant heat for comfortable sleeping and ambient temperatures would have been lower. Intervals between re-occupations were sufficient to allow the accumulation of sediments which protected living floors from further trampling and/or weathering, especially in Unit II, and in Levels III/2 and III/3. The timing of occupations, site function, and prey selection patterns seem to have been fairly consistent throughout Units II and III. Changes in cultural complex do not appear to have had much impact on animal exploitation patterns.

Patterns of Animal Exploitation at Kabazi V

Kabazi V is well-situated geographically to monitor two distinct ecosystems: the open grasslands/steppes (or cuestas) above the site and the more humid, possibly forested, river valleys below it. The Middle Paleolithic occupants of Kabazi V hunted primarily steppe-dwelling Saiga and *Equus hydruntinus*. This does not mean that the inhabitants of the site hunted primarily on the steppes, however. Kabazi V is also well-situated to monitor the movements of animals in and out of major river valleys such as the Alma, which would have acted as channels to movements during migration periods, or refuges and sources of scarce water during periods of rigorous cold or drought.

Both of the dominant prey species at Kabazi V prefer dry, open grasslands, with Saiga in particular being intolerant of uneven, broken ground (Bannikov et al. 1961; Sher 1969) and therefore unlikely to be found on the slopes around the site. *Saiga tatarica* is a migratory species, gathering in vast herds during spring and late fall migrations, when their movements can be very unpredictable (Bannikov et al. 1961). Herds move hundreds of kilometers overnight and migration patterns can be very difficult to predict from one year to the next. During certain times of the year, however, water and snow are important limiting factors on their movements (Bannikov et al. 1961; Sher 1969), and are thus good predictors for their behavior. During dry winters, and during unusually dry summers when steppe plants are desiccated, saiga seek permanent water sources, or patches of snow (Sher 1969), often venturing into river valleys that they otherwise shun.

Equus hydruntinus may have behaved like steppe dwelling equids (such as *E. Kuon*) today, migrating in large herds across vast distances. Like saiga, equids generally prefer stable ground, avoiding steep slopes and uneven footing. However, feral horse herds in mountainous regions today make use of valley bottoms for their winter ranges, sheltering from the wind, and use valley slopes where snow is not deep (Waring 1983).

In their study of Paleolithic predation on saiga in Crimea, Barychnikov et al. (1994) uncovered a pattern of early summer/summer mortality in a number of Mousterian sites. Nevertheless, the authors also note the presence of late fall/winter deaths at Prolom II (Barychnikov et al. 1994: 468). They suggest a general pattern of winter predation focussed on males weakened by the rut (a hypothesis originally advanced by Rakov 1963), which cannot be confirmed here given the fragmentary nature of the Kabazi V assemblage. The prevalence of males is confirmed at a number of Middle Paleolithic sites in Crimea, other than Prolom II. The presence of fetal bones tentatively attributable to saiga suggests females also were preyed upon during the period following the rut, however. The stage of gestation is not advanced enough for them to be described as hampered in any way by their gravid state; that is, they would not have been easier prey. Barychnikov et al. suggest that, due to its rapid unpredictable movements, saiga is unlikely to have been selectively hunted by tracking. Hunting saiga with the aid of deadfalls and ambushes is proposed (Barychnikov et al. 1994: 468).

Thus, hunters taking saiga and horse, like the Middle Paleolithic hunters at Kabazi V, could have encountered their prey in the valleys or in the cuestas, depending upon the season. The seasonal evidence for Kabazi V seems to indicate a repeated pattern of late summer/fall occupations. This would support the identification of the site as a home base, occupied during fall migration seasons, and situated to take advantage of the presence of two major prey species in the valleys below the site. Whether the animals were hunted collaboratively, or selectively tracked by individuals, cannot be determined with the present data. Evidence for the probable occupation of Kabazi V by a small number of people for relatively short periods of time does not infer one or the other behavior. Other prey species, less abundant naturally (a result of their ethology, e.g., pigs and red deer) were probably hunted as encountered in the valley below the site—but were probably not a major factor in human decisions regarding site emplacement.

Chapter 3

ARCHEOZOOLOGICAL ANALYSIS OF THE MIDDLE PALEOLITHIC FAUNA FROM SELECTED LEVELS OF KABAZI II

MARYLÈNE PATOU-MATHIS

INTRODUCTION

This study analyzes the Middle Paleolithic fauna of four archeological levels of Kabazi II. Two of theses levels are from Unit II: Levels II/7E and II/8C, and two from Unit IIA: Levels IIA/1 and IIA/2. In all of these levels, the dominant species is *Equus hydruntinus*.

This small equid was identified originally by Regalia in 1904 (Stasi and Regalia 1904) and its characteristics defined in 1907 (Regalia 1907). It presents numerous features of the stenonids of Europe (Forsten 1990) and differs from asinines and hemiones, in spite of similar proportions. It descends from *Equus altidens* (Eisenmann 1992) and is found from Western to Eastern Europe up to Azerbaijan (Binagady), from the Middle Pleistocene (end of Cromerian) to the Holocene (Eisenmann and Patou 1980). Morphological analysis of the teeth reveals the following characteristics: a slight folding of the enamel characteristic of grazers, there is a double knot (asinine type) on the lower cheek teeth, with a long vestibular groove on the molars, convex inner edges on the protoconid and hypoconid, a v-shaped lingual groove, convex inner edges of the metaconid and metastylid, and a very deep vestibular groove without the caballoid plication. On the upper cheek teeth, there are very prominent styles, which are wide and simple; flat or slightly concave interstylar faces; a short protocone, which is globular and very developed on the mesial side; simple infoldings; and a poorly developed caballoid plication. The morphometric analysis shows a very marked microdontia. The measurement of the width of the protocone, and, when possible (many of the teeth are fragmented), the calculation of the protoconic index, emphasizes that if the mesio-distal diameter of the upper premolars is within the range of *Equus hydruntinus minor*, the protoconical index is higher, as the length of the protocones are larger (Table 3-1 and fig. 3-1). The small equid of Kabazi II is, perhaps, closer to the more evolved *Equus hydruntinus davidi* or *Equus hydruntinus hydruntinus* (Prat 1968).

The bones of the post-cranial skeleton are fragmented and measurements are impossible to take in most cases. However, based on a complete metacarpal III found in Level II/7E, the height to the withers of one of the adult equids is estimated to be 1.39 m (maximum total length (21.8 cm) x weighted Kieswalter coefficient, 1888 (6.41)/100). The weight of an adult, according to P. Auguste (1995), is probably around 188 Kg.

LEVEL II/7E FAUNA

The faunal material recovered from Level II/7E of Kabazi II comprises 3,749 pieces, of which 80.8% are unidentifiable. The identifiable remains (19.2% of all pieces) principally consist of a small horse: *Equus hydruntinus* (94.7% of identified remains; Table 3-2). Other species which are present are Saiga antelope (4.45%), Bos/Bison (0.14%), and cave lion (0.28%). The total weight of bone splinters is 10.685 Kg, of which 1.465 Kg, or 13.7%, are

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Translated from the French by K. Monigal.

TABLE 3-1

Kabazi II. Measurements of Upper Cheek Teeth of *Equus hydruntinus*: Minimum-Mean (number of teeth)-Maximum

	MDDof	*VLDof*	*MDDPtP*	*VLDPtP*	*Protocone L*	*PIof*	*PIPtP*
P^2	28	21	24	21	5.3-6.5(6)-7	22.5	30
P^{3-4}	22.8-24.1(9)-26	14.6-21.1(8)-23.8	21.5-23.1(8)-26	14-21.2(8)-24	8-9.5(13)-11	30.7-39.4(6)-48.2	33.3-41.6(5)-50
M^{1-2}	—	—	—	—	8-8.9 (5)-10	—	—
M^3	21-22(4)-23	17-19.2(4)-20.5	20-22.1(4)-23	18-19.2(4)-20.5	9-9.8(6)-11	40-48.3(4)-61.7	40-45.1(4)-52.5

MDDof–Mesio-distal diameter at occlusal face
VLDof–Vestibular-lingual diameter at occlusal face
MDDPtP–Mesio-distal diameter taken at point P
VLDPtP–Vestibular-lingual diameter taken at Point P
L–Length of protocone
PIof–Protocone index, occlusal face
PIPtP–Protocone index, Point P

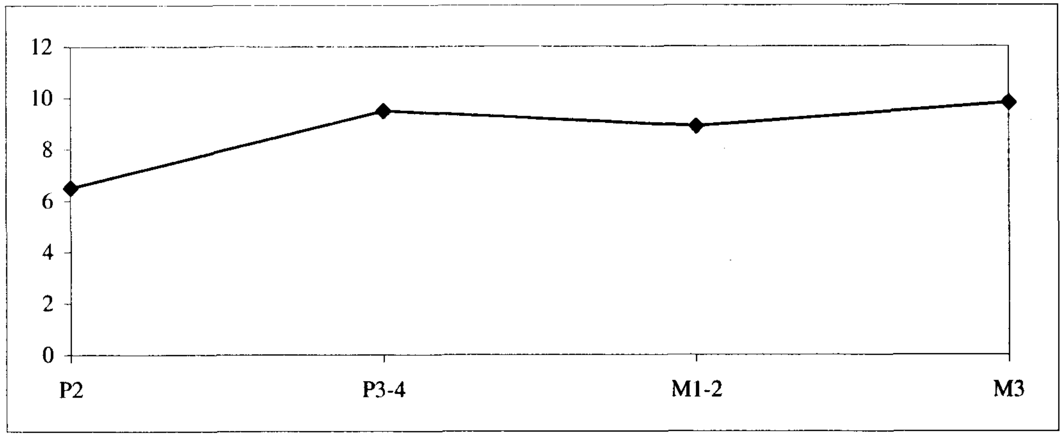


Fig. 3-1—Kabazi II, length of protocone of upper cheek teeth of *Equus hydruntinus* (in mm).

TABLE 3-2
Kabazi II, Level II/7E, Number of Species Present

	NR	*MNE*	*MNIc*
Equus hydruntinus	681	473	18
Saiga tatarica	32	32	3?
Bos/Bison	1	1	1
Equids or Bos/Bison	1	1	–
Artiodactyla Ind.	2	2	–
Panthera (Leo) spelaea	2	2	1
Total	719	511	23?

NR - Number of remains
MNE - Minimum number of elements
MNIc - Minimum number of individuals by combination

fragments smaller than 2 cm in length (the analysis of bone splinters was conducted during excavations by V. McKinley).

The faunal remains, in general, are relatively poorly preserved; the cheek teeth (molars and premolars) of *Equus hydruntinus* are mostly ruptured. The surfaces of the bones are altered and the upper layer is often missing; some are corroded, others present light traces of partial dissolution. Weathering action, along with that of climate, significantly affected the preservation of the bones. The assemblage remained in the open air for a relatively long time, undergoing climatic alteration (desquamation, exfoliation, splintering of fragmented bone, rupture of cheek teeth, alteration or even destruction of very fragile bones, such as those of juveniles, for example). Carnivores have left only one indication of their presence: a proximal extremity of a proximal phalanx of *Equus hydruntinus* (in square O5) bears a perforation from the bite of a small canid or mustelid. The role of carnivores in the origin and history of the assemblage, therefore, is only anecdotal.

Analysis of *Equus hydruntinus* Remains

Cranial Skeleton

Petrous bones are the best represented of the cranial elements (50% of cranial bones, Table 3-3). Other elements, which are very fragile, are very badly preserved, including hemi-maxillas (30% of cranial bones, Table 3-3). On the other hand, hemi-mandibles are relatively frequent (15.9% of total cranial remains, Table 3-3), but only one fragment of a horizontal ramus has 2 teeth in place. The horizontal ramus is best represented among these remains (65.8% of hemi-mandibles, Table 3-3). Teeth, by far, are the best conserved elements (205, including teeth present on maxillas and mandibles, or 80.7% of total cranial skeleton remains, Table 3-3). The permanent lower cheek teeth are the most abundant (42.4%, Table 3-3). The premolars are the least fragmented of the teeth, being the most robust. Incisors/canines, as well as deciduous teeth, are rare, as they are more fragile (9.8% and 1.9% respectively of total cranial bones, Table 3-3).

Given this set of remains, and taking into account age and sex, 15 individuals are estimated to be represented (Table 3-3).

TABLE 3-3

Kabazi II, Level II/7E, Cranial Skeleton Elements of *Equus hydruntinus* (number of teeth in jaw)

	NR	*MNE*	*MAU*	*MNIf*	*MNIc*
Cranial Bones	7	3	3	3	3
Hemi-Maxilla	3 (12)	2	1	2	2
Isolated Permanent Upper Cheek Teeth	66	66	5.5	4	10
Isolated Permanent Incisors/Canines	7	7	0.87*	2	3
Isolated Upper Deciduous Teeth	3	3	0.18*	1	1
Hemi-Mandible	38 (2)	8	4	4	4
Isolated Permanent Lower Cheek Teeth	85	85	7.08	10	14
Isolated Permanent Lower Incisors/Canines	4	4	0.5*	3	3
Isolated Lower Deciduous Teeth	2	2	0.12*	1	1
Unidentifiable Isolated Cheek Teeth	10	10	–	–	–
Unidentifiable Isolated Incisors/Canines	14	7	–	–	–
Total	239 (254)	197 (212)	4.6 (4.7)	10	15

NR - Number of remains
MNE - Minimum number of elements
MAU - Minimum animal units
MNIf - Minimum number of individuals by frequency
MNIc - Minimum number of individuals by combination
* estimate uncertain

Post-Cranial Skeleton

The faunal remains from Kabazi II, Level II/7E are fragmented and the bone surfaces tend to be poorly preserved (often missing the upper surface).

Axial Skeleton (vertebrae, ribs, sterna, sacra, innominates)

With the exception of innominate bones, the elements of the axial skeleton are badly preserved: 28.5% of total post-cranial elements or 15.5% of MNE (Minimum Number of Elements) (Table 3-4). Sterna and sacra are absent, as well as the cartilaginous innominate bones. Among the vertebrae, thoracic vertebrae are the most frequent (11 of 29 in MNE). The ribs, which are very fragmented, are principally represented by shaft fragments. Of the innominate bones, the majority are represented by the acetabulum (condyloid cavity).

Upper Foreskeleton

The humerus, followed by the radius, is the most frequent element (Table 3-4). Scapulae are rare (mostly fragments of the glenoid cavity, 4 of 6), as are the degenerate metapodia and the carpals (Table 3-4). Among the carpals (usually complete, 14 of 16), the scaphoid is most abundant; the cuneiform and trapezoid carpals are absent.

Upper Hindskeleton

The tarsals (most often complete), dominated by the talus, tibia, and metatarsal III, are the most well preserved elements (Table 3-4). Femurs and splint bones are rare (Table 3-4). The patella and intermediate cuneiform are absent.

Autopodium Bones (phalanges and sesamoids)

The preservation of the proximal phalanges is relatively good, while that of the other phalanges, and especially the sesamoids, is poor (Table 3-4). The phalanges are usually complete (84.3%).

Based on the post-cephalic skeleton, it is estimated that the minimum number of individuals (by combination) present in Kabazi II, Level II/7E, is fifteen (Table 3-3).

TABLE 3-4
Kabazi II, Level II/7E, Skeletal Elements of *Equus hydruntinus*

	NR	*MNE*	*MAU*	*MNIf*	*MNIc*
Skull Fragments	7	3	3	3	3
Hemi-Maxilla	3	2	1	2	2
Hemi-Mandible	38	8	4	4	4
Isolated Upper Teeth	76	76	3.8	4	10
Isolated Lower Teeth	91	91	4.55	10	14
Isolated Teeth, Unidentifiable	24	17	–	–	–
Cranial Skeleton Sub-Total	*239*	*197*	*4.6*	*10*	*15*
Vertebra	104	29*	0.93	1	2
Rib	6	4*	0.11	1	1
Innominate	22	10	5	5	6
Axial Skeleton Sub-Total	*126*	*43**	*0.6*	*5*	*6*
Scapula	6	4	2	2	2
Humerus	23	12	6	6	8
Radius	16	8	4	4	6
Ulna	7	5	2.5	4	4
Carpals	16	16	1.14	5	5
Metacarpal III	6	6	3	4	4
Metacarpal II and IV	9	9	2.25	3	3
Upper Foreskeleton Sub-Total	*83*	*60*	*2.14*	*6*	*9*
Femur	4	3	1.5	2	2
Tibia	23	16	8	8	9
Tarsals	53	51	4.25	12	13
Metatarsal III	30	16	8	9	9
Metatarsal II and IV	6	6	1.5	2	2
Upper Hindskeleton Sub-Total	*116*	*92*	*3.83*	*12*	*14*
Phalanges, Proximal	32	31	7.75	8	9
Phalanges, Medial	20	17	4.25	5	5
Phalanges, Distal	18	16	4	4	5
Sesamoid	2	2	0.16	1	2
Autopodium Sub-Total	*72*	*66*	*2.75*	*8*	*9*
Metapodials, Unidentifiable	35	15	–	–	–
Long bones, Unidentifiable	10	–	–	–	–
Post-Cranium Sub-Total	442	276*	1.87	12	14
Total	681	473*	2.48	12	18

* estimate uncertain

Preservation of Major Skeletal Units and Long Bones

As shown in Figure 3-2, the unit corresponding to the cephalic skeleton is the best represented, followed by the upper hindskeleton. The tibia and metatarsal III are the best preserved long bones, followed by the humerus (fig. 3-3). Analysis of the preservation of the different parts of long bones (in MNE) shows the absence of proximal extremities of the humerus and tibia, and of the distal extremities of the ulna and femur (fig. 3-4).

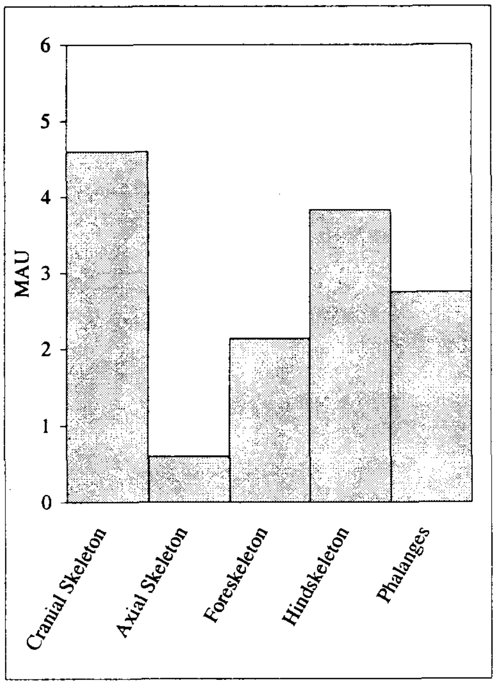


Fig. 3-2—Kabazi II, Level II/7E, preservation of major anatomical units (in MAU) of *Equus hydruntinus*.

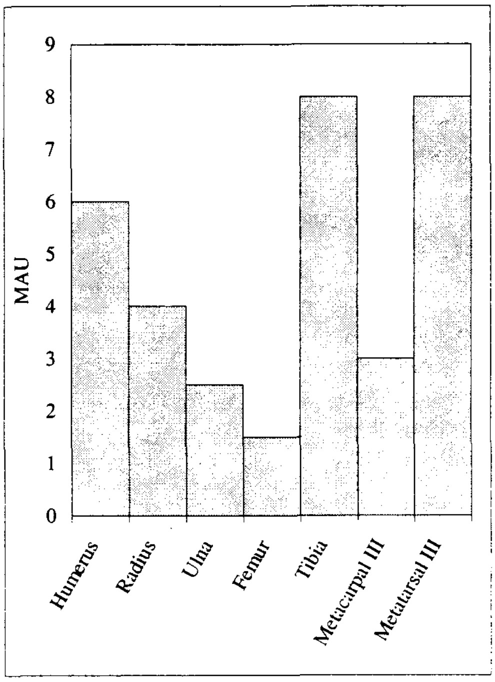


Fig. 3-3—Kabazi II, Level II/7E, preservation of long bones (in MAU) of *Equus hydruntinus*.

Analysis of Long Bone Fragmentation

Only one metacarpal III is complete, all other long bones are fragmented. The morphology of the fracture plane and observed marks (point of impact, internal and external splintering) indicate fracture by percussion on green bone. In most cases, the percussion is on the proximal or distal diaphysis, more rarely on the medial diaphysis, leading to the weakening of these parts (figs. 3-4 and 3-5) and the total or partial preservation of one or two sides, very rarely three.

Analysis of Butchery Marks

No butchery marks were observed on the faunal material in Level II/7E.

Mortality Profile and Composition of the Slaughtered Population

Based on the analysis of dental wear and the epiphyseal fusion of bones, the presence of at least eighteen small equids is estimated: four juveniles younger than 3 years and fourteen adults. One of the juveniles is younger than 12-15 months (and was killed in the spring), two are less than 2 years, and one is about 3 years old. Among the adults, two are about 5 years, two are 4-5 years, three are 5-10 years, four are 10-15 years, and three are older than 15 years. The mortality profile (fig. 3-6) corresponds to a mortality curve of "catastrophic" type, similar to the family group model of M. Levine (1983). One canine and a few bones of large dimensions indicate the presence of at least one adult male.

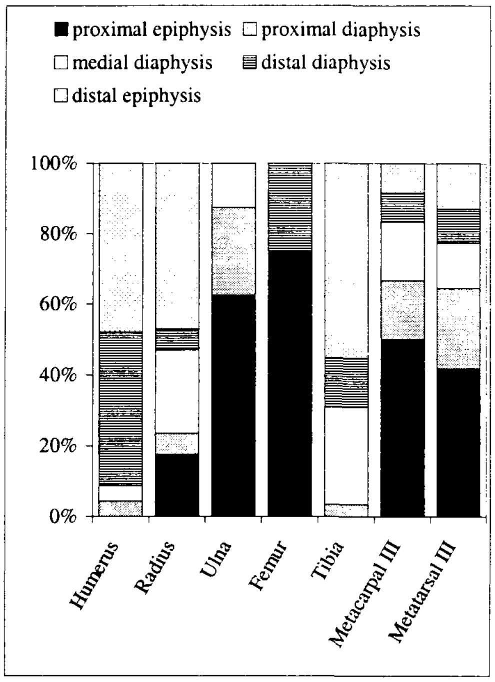


Fig. 3-4—Kabazi II, Level II/7E, preservation of different parts of long bones of *Equus hydruntinus*.

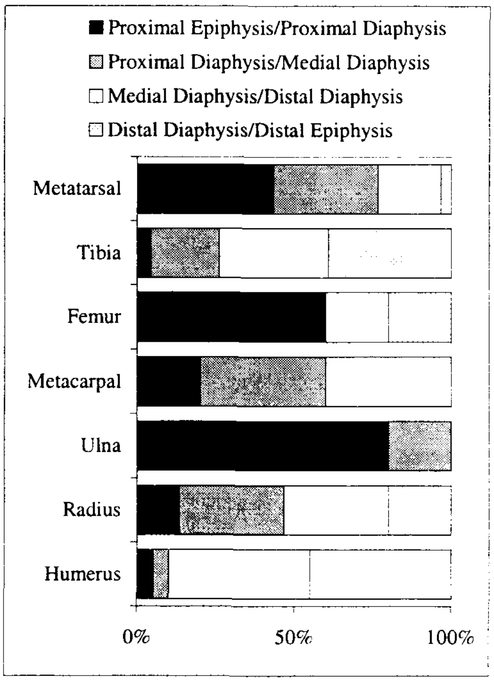


Fig. 3-5—Kabazi II, Level II/7E, point of fracture of long bones of *Equus hydruntinus*.

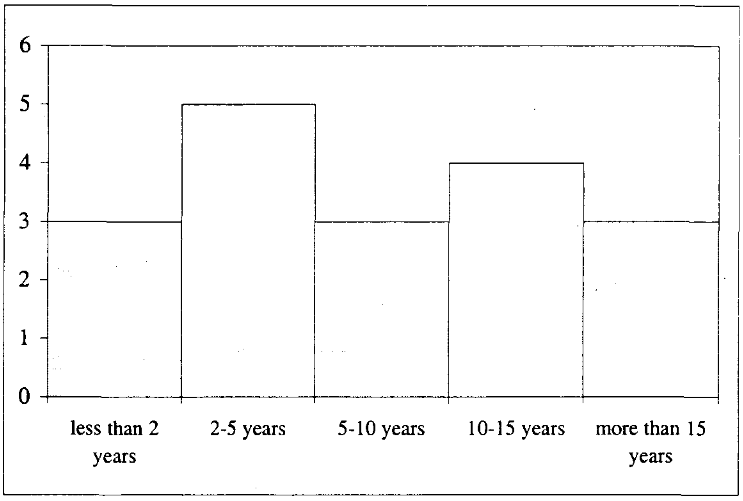


Fig. 3-6—Kabazi II, Level II/7E, mortality profile of *Equus hydruntinus*.

Spatial Analysis of Identifiable Bones

The spatial analysis of the remains of *Equus hydruntinus* (fig. 3-7) indicates a high density in the following squares, in descending order: O4 (120), O5 (88), П5 (68), O6 (43), H5 (42), H4 (34), H6 (32), and M5 (29). Bones of the cranial skeleton are most abundant in O4, O5, П5; those of the axial skeleton in O4; those of the upper foreskeleton in O5, O4, and O6; those of the upper hindskeleton in O4, O5, and M5, and those of the autopodium in O4, O5, П5, and H6. The remains of the juvenile younger than 12-15 months were discovered in M4 and M5, those of the 3 year old juvenile in O5, O6, П5, and H6, and those of the two juveniles younger than 2 years in squares O6, O4, and П5. The unidentifiable bone splinters greater than 2 cm in length are abundant in squares П5 (581), O5 (439), O4 (432), H6 (249), O6 (234), and H5 (181). Splinters shorter than 2 cm are, by weight, most frequent in П5, O5, O4, M4, and O6. With the exception of square M4, they follow the same distribution as the longer bone splinters. Taking into account the ensemble of faunal remains, the squares with the greatest density (fig. 3-8), in descending order, are: П4 (649), O4 (552), O5 (527), H6 (281), O6 (277), H5 (223), M4 (171), M5 (161), and O7 (134).

The analysis of anatomical elements suggests that the dismemberment and disarticulation of these animals took place principally in squares O5 and O6 (especially the forelimb), O4 and П5 (especially the axial skeleton, hind limb, and autopodium), and in square H5. In squares O5, O6, and O4, there are numerous bones rich in meat and marrow; defleshing and marrow extraction were probably carried out here. The "waste" of these activities is found especially in squares M5, H6, and H4. Three squares—M4, Л4, and O7—may be considered toss zones ("garbage dump").

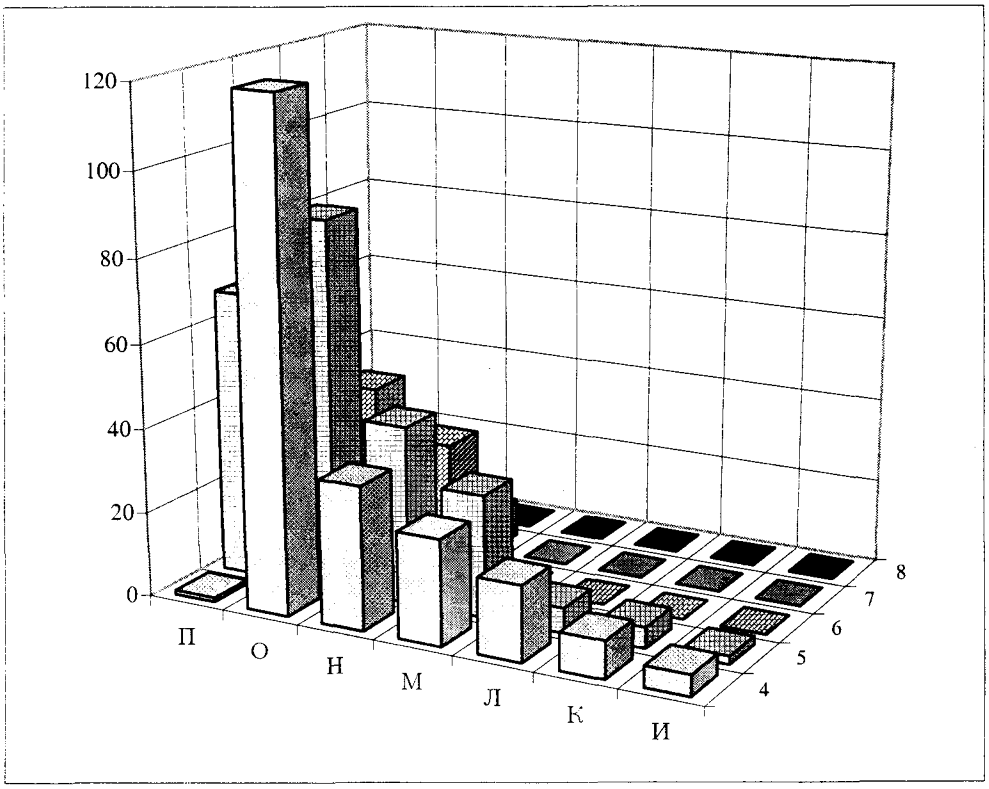


Fig. 3-7—Kabazi II, Level II/7E, spatial distribution of identifiable remains of *Equus hydruntinus*.

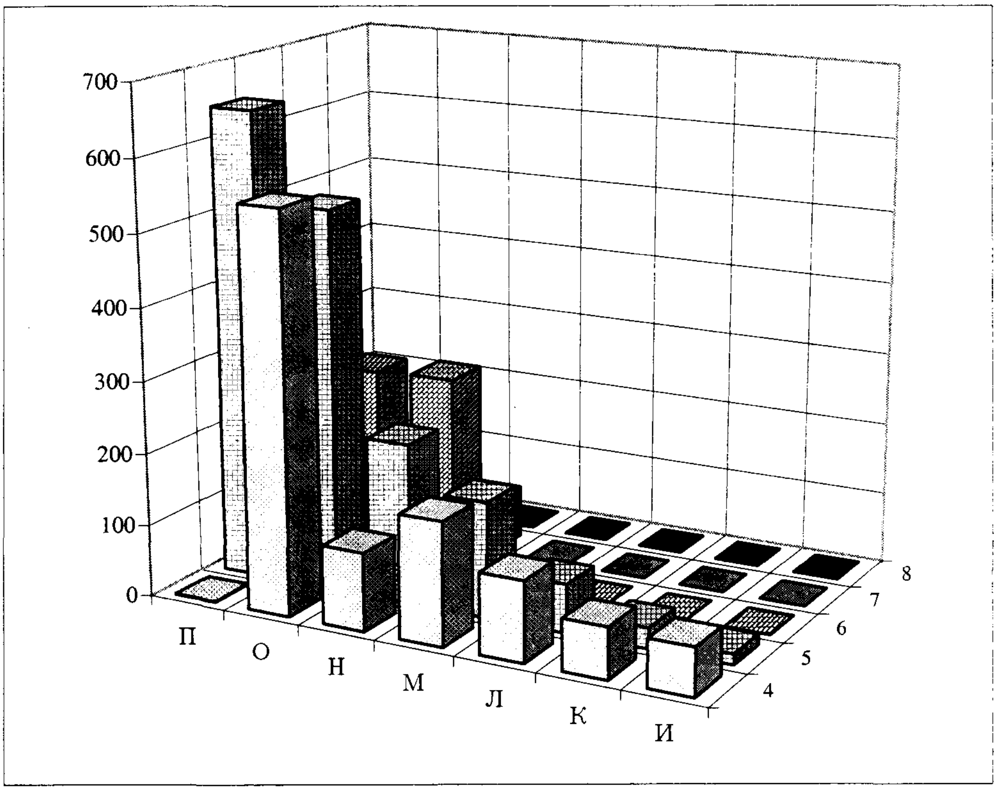


Fig. 3-8—Kabazi II, Level II/7E, spatial distribution of entire faunal assemblage.

Analysis of Remains of Other Species

Only two bones suggest the presence of cave lion near the site: a right metacarpal IV without the distal extremity (in square O5) and a right metacarpal V with exostoses (in square П5), probably due to the advanced age of the animal to which it belongs. These two bones appear to belong to the same animal.

A proximal part of a metapodial III of a Bos/bison was found in square O5.

Thirty-two bones of Saiga antelope were identified, representing at least 3 adult individuals. A number of skeletal elements are absent: the femur, patella, malleolus, the tarsals, carpals (with the exception of the naviculo-cuboid carpal), sesamoids, and the second and third phalanges. The significant deficit of bones (even teeth are extremely rare) is possibly due to climatico-edaphic and/or biological agents. The material probably remained a long time in the open air and the most fragile bones could have been destroyed or consumed by carnivores. The relatively good representation of long bones, especially the upper part of the forelimb (scapula, humerus, radius-ulna) and the age of individuals (only adults) could indicate that they were hunted by the prehistoric inhabitants. The animals were dismembered on site (possibly in squares H5 and O5). The dispersal of the remains of Saiga antelope is wide, and corresponds to that of *Equus hydruntinus*.

LEVEL II/8C FAUNA

The faunal material recovered from Level II/8C consists of 891 pieces, of which 74.3% are unidentifiable. The identifiable remains (25.2% of the total number of remains) belong mostly to *Equus hydruntinus* (97.3%; Table 3-5). The only other species present in this level is Saiga antelope (2.6%; Table 3-5). The six pieces of this small Bovid are a mandible

TABLE 3-5
Kabazi II, Level II/8C, Number of Species Present

	NR	*MNE*	*MNIc*
Equus hydruntinus	219	163	7
Saiga tatarica	6	5	1 v. old male
Total	225	168	8

fragment (in square П5), a very worn distal lobe of a right molar (in К4), a trochlea of the distal end of a right humerus (in O4), a distal end of a metapodial (O4), a tibia diaphysis fragment (M5), and a shaft fragment of a right calcaneum (К4). All of these belong to a very old adult. The total weight of the bone splinters is 2.175 Kg, of which 0.205 Kg, or 9.42%, are splinters shorter than 2 cm.

With the exception of those in square H5, the surfaces of the bones are in good condition. Nineteen *Equus hydruntinus* cheek teeth (17 in square H5) are ruptured (25% of the cheek teeth). Five long bones (2 in square O5, 2 in Ж5, 1 in П5) are significantly altered and a medial phalanx (in Ж5) has light marks from partial dissolution. The climate, therefore, is primarily responsible for the alteration of faunal material (desiccation?). The second phalanx was exposed to the air for a relatively long time. There is no evidence for carnivores in the faunal material; they play no role in the origin and history of the Level II/8C assemblage.

Analysis of *Equus hydruntinus* Remains

Cranial Skeleton

Petrous bone and the occipital condyles are the best represented of the cranial elements (61.5% of the cranial bones). Other elements, which are very fragile, are not at all well preserved, including the hemi-maxillas and hemi-mandibles (1.9% each of cranial bones). Teeth are by far the best preserved cranial element (86, or 83.5% of all cranial bones). The permanent cheek teeth, especially the upper premolars, are the most abundant. Incisors/canines and deciduous teeth are rare, representing 9.7% and 3.9% respectively of all cranial bones (Table 3-6).

Taking age into account, the cranial elements probably represent at least seven individuals (Table 3-6).

TABLE 3-6
Kabazi II, Level II/8C, Cranial Skeleton Elements of *Equus hydruntinus*

	NR	*MNE*	*MAU*	*MNIf*	*MNIc*
Cranial Bones	13	2	1	2	2
Hemi-Maxilla	2	1	0.5	1	1
Permanent Upper Cheek Teeth	44	44	3.6	4	4
Permanent Incisors/Canines	4	4	0.5	1	2
Hemi-Mandible	2	1	0.5	1	1
Permanent Lower Cheek Teeth	26	26	2.16	3	7
Permanent Lower Incisors/Canines	3	3	0.3	1	1
Deciduous Lower Teeth	4	4	0.66	2	2
Unidentifiable Cheek Teeth	2	2	–	–	–
Unidentifiable Incisors/Canines	3	3	–	–	–
Total	103	90	2.09	4	7

Post-Cranial Skeleton

Axial Skeleton (vertebrae, ribs, sterna, sacra, innominates)

Axial skeleton elements are poorly preserved (16.3% of the post-cranial skeleton and 8.3% in MNE, Table 3-7). The sterna, cartilaginous innominates, and sacra are absent. The vertebrae, with the exception of two atlas fragments, are unidentifiable due to their fragmentary state. Ribs, which are also fragmentary and represented only by shaft fragments, are very rare (4.3% of the post-cranial skeleton and 2.7% in MNE, Table 3-7).

TABLE 3-7
Kabazi II, Level II/8C, Skeletal Elements of *Equus hydruntinus*

	NR	*MNE*	*MAU*	*MNIf*	*MNIc*
Skull fragments	13	2	1	2	2
Hemi-Maxilla	2	1	0.5	1	1
Hemi-Mandible	2	1	0.5	1	1
Upper Teeth	48	48	2.4	4	5
Lower Teeth	33	33	1.65	3	7
Unidentifiable Teeth	5	5	–	–	–
Cranial Skeleton Sub-Total	*103*	*90*	*2.09*	*4*	*7*
Vertebra	11	3*	0.09	1	1
Rib	5	2	0.05	1	1
Innominate	3	1	0.5	1	1
Axial Skeleton Sub-Total	*19*	*6**	*0.08*	*1*	*1*
Scapula	7	3	1.5	2	2
Humerus	–	–	–	–	–
Radius	7	4	2	3	3
Ulna	4	3	1.5	2	2
Carpals	7	7	0.5	2	2
Metacarpal III	7	2	1	1	1
Metacarpal II and IV	4	4	1	2	2
Upper Foreskeleton Sub-Total	*36*	*23*	*0.82*	*3*	*3*
Femur	–	–	–	–	–
Tibia	13	6	3	3	3
Tarsus	12	10	0.8	3	3
Metatarsus III	2	2	1	1	1
Metatarsus II and IV	4	4	1	2	2
Upper Hindskeleton Sub-Total	*31*	*22*	*0.91*	*3*	*3*
Phalanges, Proximal	9	9	2.25	3	3
Phalanges, Medial	6	6	1.5	2	2
Phalanges, Distal	6	6	1.5	2	2
Sesamoid	1	1	0.08	1	1
Autopodium Sub-Total	*22*	*22*	*0.91*	*3*	*3*
Metapodials, Unidentifiable	5	–	–	–	–
Carpals or Tarsals	1	–	–	–	–
Long Bones, Unidentifiable	1	–	–	–	–
Vertebral or Cranial Fragments	1	–	–	–	–
Post-Cranium Sub-Total	116	73*	0.49	3	4
Total	219	163	0.85	4	7

Upper Foreskeleton

The radius and the scapula (mostly represented by the glenoid cavity) are the most common elements of the upper foreskeleton (Table 3-7). There are no humeri (Table 3-7). Among the carpals, which are often complete (4 of 7), the pyramidal and pisiform are absent.

Upper Hindskeleton

Tibias are the best represented of the upper hindskeleton elements; femurs and patellae are absent (Table 3-7). The tarsals are relatively well preserved and often whole (7 of 12); the talus and navicular bones dominate; the calcaneum and the small cuneiform are absent (Table 3-7).

Autopodium (phalanges and sesamoids)

Phalanges, especially the proximal phalanges, are well preserved (Table 3-7) and they are usually complete (90.5%).

Based on the post-cephalic skeleton, it is estimated that at least four individuals (by combination) are present in Level II/8C.

Preservation of Major Skeletal Units and Long Bones

As shown in Figure 3-9, the MAU indices are weak, with the exception of the cephalic skeleton. Tibias, followed by radii, are the best preserved of the long bones (fig. 3-10). The study of the preservation of the different portions of long bones (in MNE) shows that the extremities are not well preserved, with the exception of the extremities of metacarpals and the distal ends of tibias (fig. 3-11).

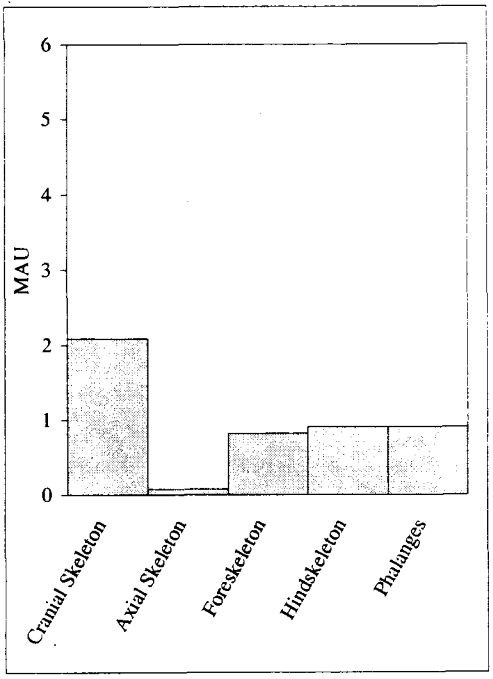


Fig. 3-9—Kabazi II, Level II/8C, preservation of major anatomical units (in MAU) of *Equus hydruntinus*.

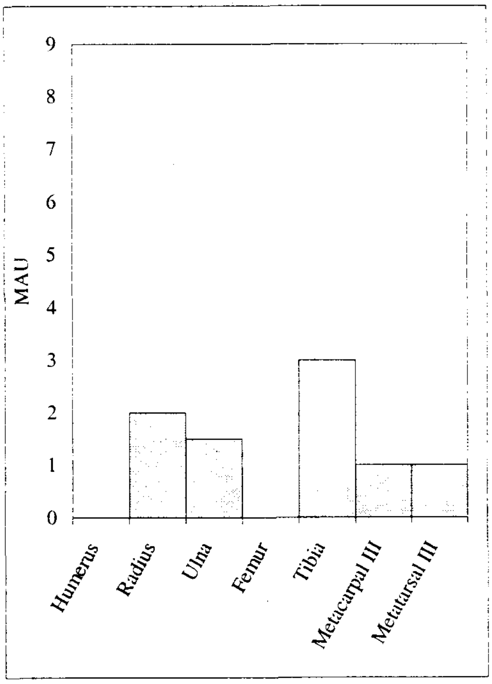


Fig. 3-10—Kabazi II, Level II/8C, preservation of long bones (in MAU) of *Equus hydruntinus*.

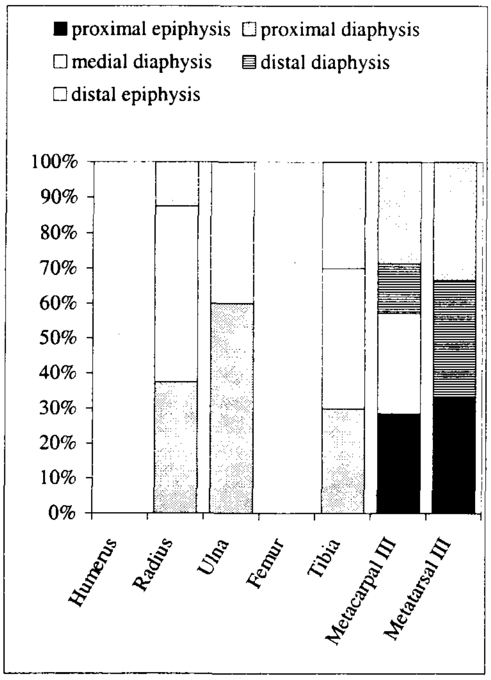


Fig. 3-11—Kabazi II, Level II/8C, preservation of different parts of long bones of *Equus hydruntinus*.

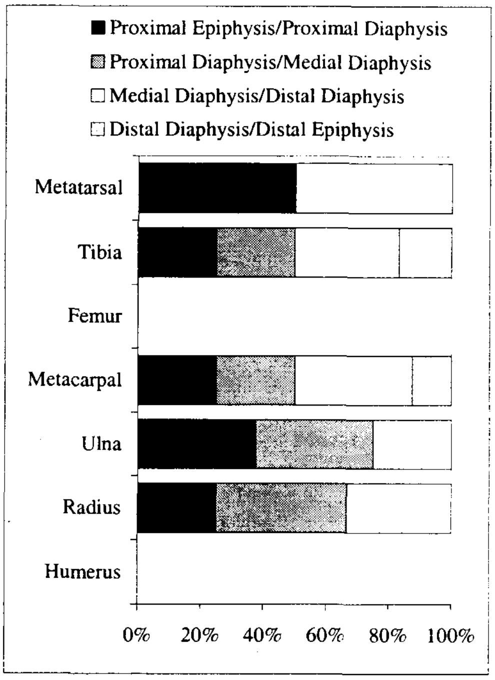


Fig. 3-12—Kabazi II, Level II/8C, point of fracture of long bones of *Equus hydruntinus*.

Analysis of Long Bone Fragmentation

None of the long bones are complete. The morphology of the fracture planes indicates anthropic fracture followed by post-depositional breakage. In most cases, percussion occurred on the distal diaphyses of bones, resulting in the weakening of these parts (figs. 3-11 and 3-12). Only one or two faces of the long bones are preserved. According to the index of fragmentation, NR/MNE, the metacarpal III and the tibia are the most fragmented of the long bones.

Analysis of Butchery Marks

No marks that could be attributed to butchery were observed on the faunal material. Only the presence of five burned splinters indicates a clear anthropic alteration.

Mortality Profile and Composition of the Slaughtered Population

Based on the analysis of dental wear and the epiphyseal fusion of bones, it is estimated that at least seven small equids—two juveniles less than 3 years old and five adults—are present in Level II/8C. One of these juveniles was between 4-9 months and died in autumn/winter. Among the adults, one is between 3-5 years, two between 5-10 years, one between 10-15 years, and one is older than 15 years. The mortality curve (fig. 3-13) corresponds to the slaughtering of a small group of females and young, close to the family group model of M. Levine (1983). None of the assemblage indicates the presence of a male *Equus hydruntinus*.

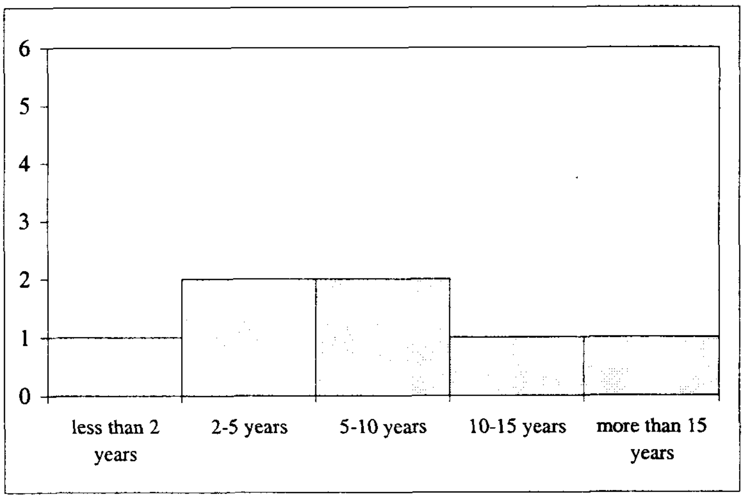


Fig. 3-13—Kabazi II, Level II/8C, mortality profile of *Equus hydruntinus*.

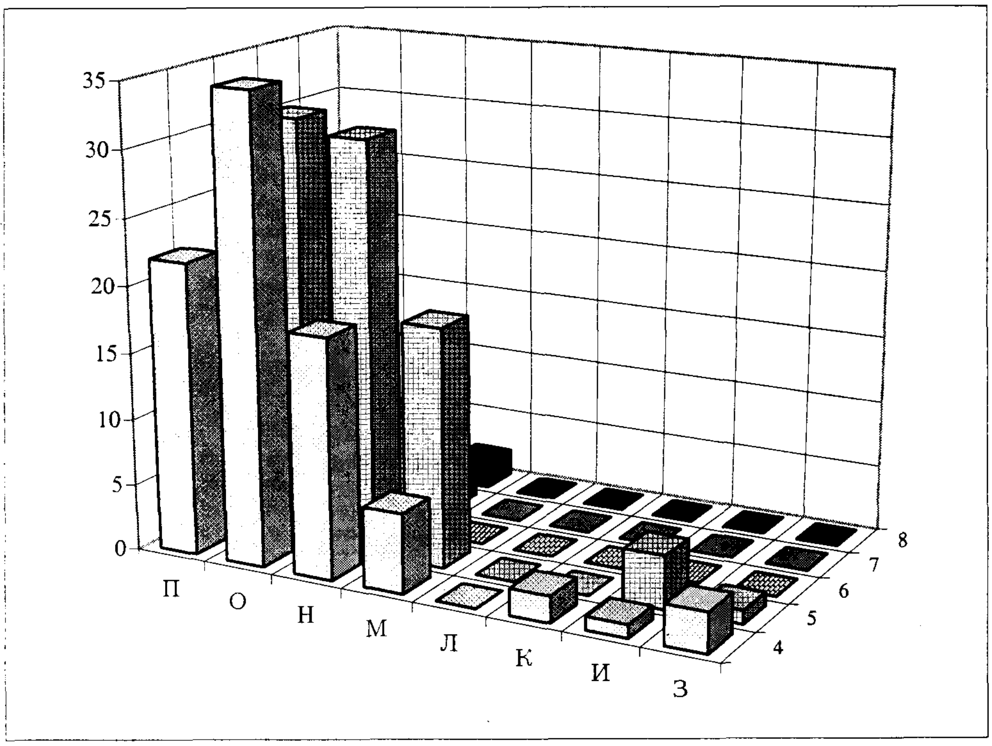


Fig. 3-14—Kabazi II, Level II/8C, spatial distribution of identifiable remains of *Equus hydruntinus*.

Spatial Analysis of Identifiable Bones

The spatial analysis of the faunal material of *Equus hydruntinus* shows a significant density in the following squares, in descending order: O4 (35), O5 (32), and H5 (31) (fig. 3-14). Cranial bones are most abundant in H5, O4, П4, and M5. Those of the axial skeleton are dispersed. The bones of the upper foreskeleton are most abundant in squares П4, H4, П5, and O5, those of the upper hindskeleton and autopodium in squares O4 and O5. Bones rich in meat are also most abundant in these two squares, as well as in squares П4 and П5. The remains of the juveniles were found in H8, M5, П5, and, especially, in O4 (5 of 8 bones).

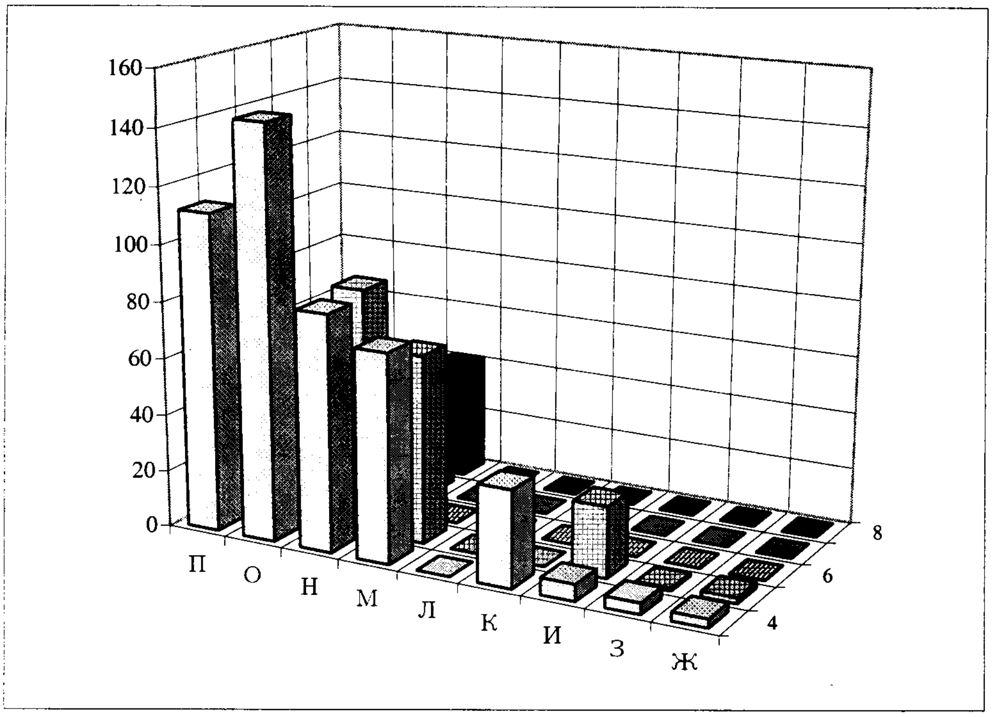


Fig. 3-15—Kabazi II, Level II/8C, spatial distribution of entire faunal assemblage.

Unidentifiable bone splinters longer than 2 cm are abundant in O4 (112), П4 (90), M4 (66), H5 (55), and П5 (50). Splinters shorter than 2 cm in length are, by weight, most frequent in squares H4, П5, and M4. They follow a spatial distribution similar to the longer splinters. For the entire faunal assemblage, the squares with the highest density of bones are, in descending order: O4 (145), П4 (112), H5 (86), H4 (83), M4 (73), П5 (67), and M5 (66) (fig. 3-15).

Spatial analysis of anatomical elements suggests that the complete treatment of the animals took place principally around squares O4 and O5. The five burned bones were found outside this zone, towards the back of the excavated area in Ж4 (3), З4, and Ж5. It should be noted that there is a large rock slab at the intersection of squares O7 and O6.

LEVEL IIA/1 FAUNA

The faunal material in Level IIA/1 comprises 757 pieces, of which 72.7% are unidentifiable. The identifiable bones (27.3% of the total) are mainly (99.5% of identifiable remains) *Equus hydruntinus* (Table 3-8). Only one other species was identified, saiga antelope (a fragment of the horizontal ramus in square O5). The total weight of the bone splinters is 1.385 Kg, of which 0.185 Kg, or 13.35%, are splinters shorter than 2 cm in length.

The surfaces of the bones are in good condition, but there is significant fragmentation. The cheek teeth of *Equus hydruntinus* are mostly fragmentary and the bones in small pieces. Two bones are corroded and three others show traces of partial dissolution. It is mainly climatic factors (along with weathering) which have altered a significant portion of the material, and the assemblage appears to have remained in the open air for a relatively long time. A metacarpal IV of *Equus hydruntinus* was gnawed on by a small rodent (in square O4). There is no indication that carnivores played any role in the origin and history of the faunal assemblage.

TABLE 3-8
Kabazi II, Level IIA/1, Number of Species Present

	NR	*MNE*	*MNIc*
Equus hydruntinus	206	146	8
Saiga tatarica	1	1	1 Adult
Total	207	147	9

Analysis of *Equus hydruntinus* Remains

Cranial Skeleton

Petrous bones are the best represented element of the cranial skeleton (21.4% of cranial bones in MNE, Table 3-9). The other cranial bones, which are very fragile, are very poorly preserved; there are no hemi-maxillas, and the hemi-mandibles are very rare (4% of all cranial bones, Table 3-9). For these remains, only fragments of the horizontal ramus and ascending ramus are present. The teeth are by far the best preserved (81 or 81.8% of the total cranial skeleton, Table 3-9). Permanent cheek teeth, especially the upper premolars and the lower molars, are most frequent (Table 3-9). Incisors/canines are rare (14.8% of all teeth) and there are no deciduous teeth (Table 3-9).

The assemblage of cranial elements indicates the presence of at least eight individuals (by combination) (Table 3-9).

TABLE 3-9
Kabazi II, Level IIA/1, Cranial Skeleton Elements of *Equus hydruntinus*

	NR	*MNE*	*MAU*	*MNIf*	*MNIc*
Cranial Bones	14	1	1	1	1
Hemi-Maxilla	–	–	–	–	–
Permanent Upper Cheek Teeth	35	35	2.9	4	6
Permanent Incisors/Canines	3	3	0.3	2	2
Hemi-Mandible	4	1	0.5	1	1
Permanent Lower Cheek Teeth	26	26	2.1	4	6
Permanent Lower Incisors/Canines	7	7	0.8	3	3
Unidentifiable Cheek Teeth	8	8	–	–	–
Unidentifiable Incisors/Canines	2	2	–	–	–
Total	99	83	1.9	4	8

Post-Cranial Skeleton

Axial Skeleton (vertebrae, ribs, sterna, sacra, innominates)

Elements of the axial skeleton, especially the ribs (there is only one), are rare (24.3% of total post-cranial bones and 11.1% in MNE, Table 3-10). Sterna, cartilaginous innominates, and sacra are absent. The vertebrae, which are very fragmentary, are unidentifiable.

Upper Foreskeleton

The radius is the most frequent long bone present of the upper foreskeleton (Table 3-10). The carpals are represented by the scaphoid, unciform, and semi-lunar bones (4 complete of

TABLE 3-10
Kabazi II, Level IIA/1, Skeletal Elements of *Equus hydruntinus*

	NR	*MNE*	*MAU*	*MNIf*	*MNIc*
Skull Fragments	14	1	1	1	1
Hemi-Maxilla	–	–	–	–	–
Hemi-Mandible	4	1	0.5	1	1
Upper Teeth	38	38	1.9	4	6
Isolated Lower Teeth	33	33	1.65	4	6
Isolated Unidentifiable Teeth	10	10	–	–	–
Cranial Skeleton Sub-Total	*99*	*83*	*1.9*	*4*	*8*
Vertebra	21	4*	0.12	1	1
Rib	1	1	0.02	1	1
Innominate	4	2	1	1	1
Axial Skeleton Sub-Total	*26*	*7**	*0.09*	*1*	*1*
Scapula	3	2	1	1	1
Humerus	1	1	0.5	1	1
Radius	6	4	2	2	2
Ulna	3	2	1	2	2
Carpals	5	5	0.35	2	2
Metacarpal III	1	1	0.5	1	1
Metacarpal II and IV	13	13	3.25	4	4
Upper Foreskeleton Sub-Total	*32*	*28*	*1*	*4*	*4*
Femur	1	1	0.5	1	1
Tibia	3	1	0.5	1	1
Tarsals	10	10	0.83	3	4
Metatarsal III	2	2	1	1	1
Metatarsal II and IV	4	3	0.75	2	2
Upper Hindskeleton Sub-Total	*20*	*17*	*0.7*	*3*	*4*
Phalanges, Proximal	1	1	0.25	1	1
Phalanges, Medial	6	6	1.5	2	2
Phalanges, Distal	2	2	0.5	1	1
Sesamoid	2	2	0.16	2	2
Autopodium Sub-Total	*11*	*11*	*0.45*	*2*	*3*
Metapodials, Unidentifiable	3	–	–	–	–
Unidentifiable Vestigial Metapodials	8	–	–	–	–
Long Bones, Unidentifiable	7	–	–	–	–
Post-Cranium Sub-Total	107	63*	0.42	4	5
Total	206	146*	0.76	4	8

* estimate uncertain

5); the pyramidal, pisiform, capitate, and the trapezoid are absent. There is only one principal metacarpal, while vestigial metacarpals are abundant.

Upper Hindskeleton

Bones of the upper hindskeleton are rare. Only tarsals (9 complete of 10) are relatively abundant (Table 3-10). Among these, the navicular dominates; the talus and small cuneiform are absent. There are no patellae.

Autopodium (phalanges and sesamoids)

Phalanges are relatively poorly represented; the intermediate phalanges are the most numerous (Table 3-10).

The analysis of the post-cephalic skeleton indicates that at least five individuals (by combination) are present in Level IIA/1.

Preservation of Major Skeletal Units and Long Bones

On the whole, preservation is poor and the MAU are low. As seen in Figure 3-16, the unit corresponding to the cranial skeleton is the best represented, followed by that of the upper foreskeleton. The radius is the most frequent type of long bone (fig. 3-17). The study of the different parts of the long bones (in MNE) also indicates the poor preservation of long bone extremities. These are absent for the humerus and femur; there are no proximal extremities of tibia, as well as no distal extremities of radii, ulnas, metacarpal III, or metatarsal III (fig. 3-18).

Analysis of Long Bone Fragmentation

All of the long bones are fragmented. The morphology of the fracture planes indicates anthropic breakage followed by secondary post-depositional breakage. In most cases, fracture is on the proximal or distal diaphyses of the bones (figs. 3-18 and 3-19). One or two faces of the long bones (that is, ¼ to ½ of the circumference) are preserved. According to the index of fragmentation, NR/MNE, the tibia and the metatarsal III are the most broken.

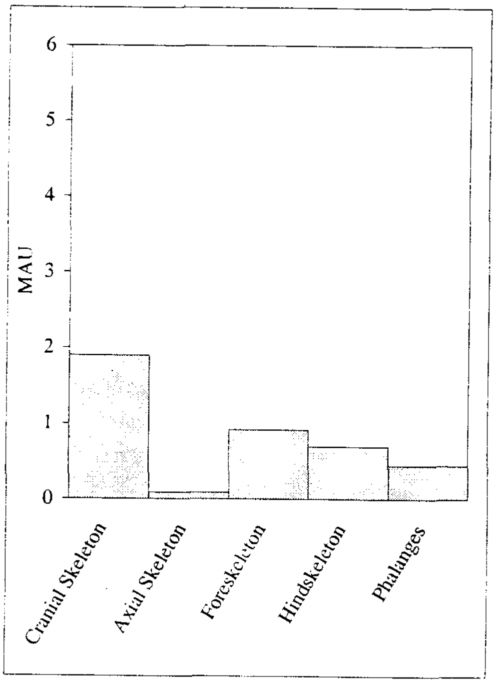


Fig. 3-16—Kabazi II, Level IIA/1, preservation of major anatomical units (in MAU) of *Equus hydruntinus*.

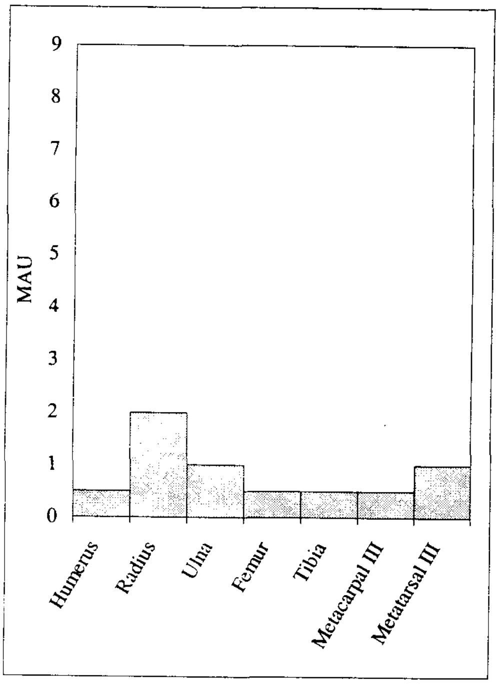


Fig. 3-17—Kabazi II, Level IIA/1, preservation of long bones (in MAU) of *Equus hydruntinus*.

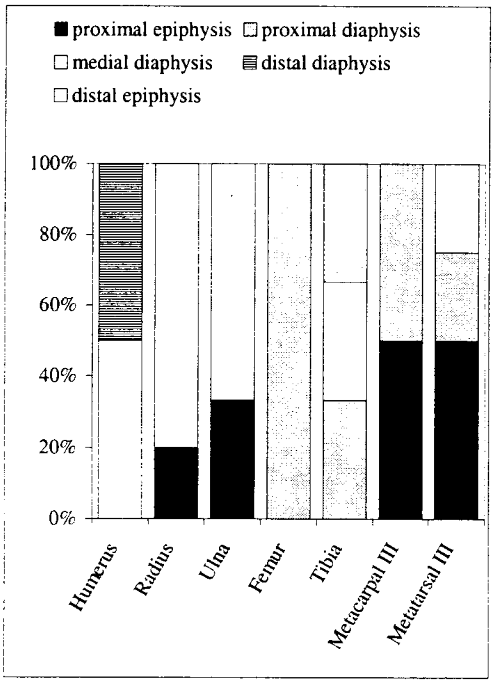


Fig. 3-18—Kabazi II, Level IIA/1, preservation of different parts of long bones of *Equus hydruntinus*.

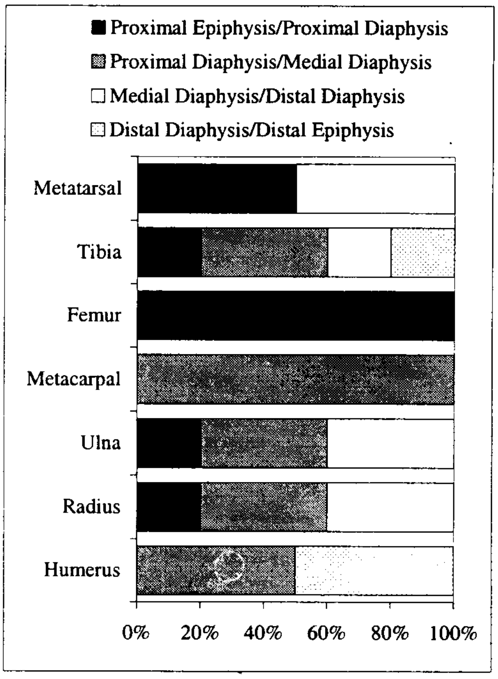


Fig. 3-19—Kabazi II, Level IIA/1, point of fracture of long bones of *Equus hydruntinus*.

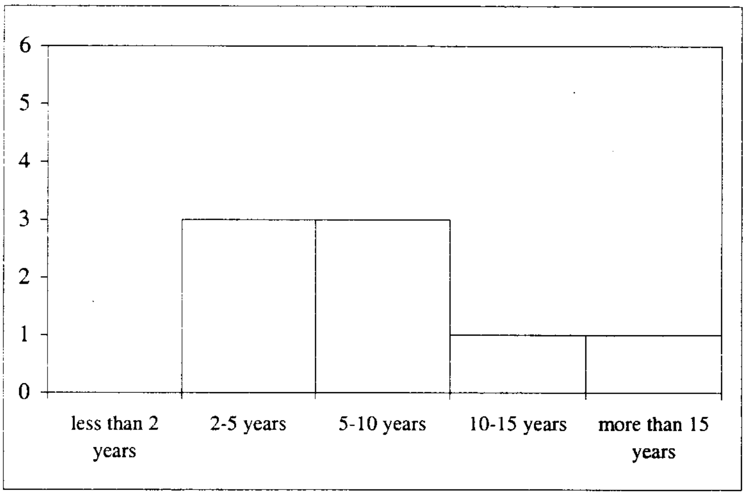


Fig. 3-20—Kabazi II, Level IIA/1, mortality profile of *Equus hydruntinus*.

Analysis of Butchery Marks

No cut marks resulting from butchery were observed in the assemblage from Level IIA/1. The only clear indication of anthropic intervention is the presence of nine burnt bone splinters, including a diaphyseal fragment of an *Equus hydruntinus* femur.

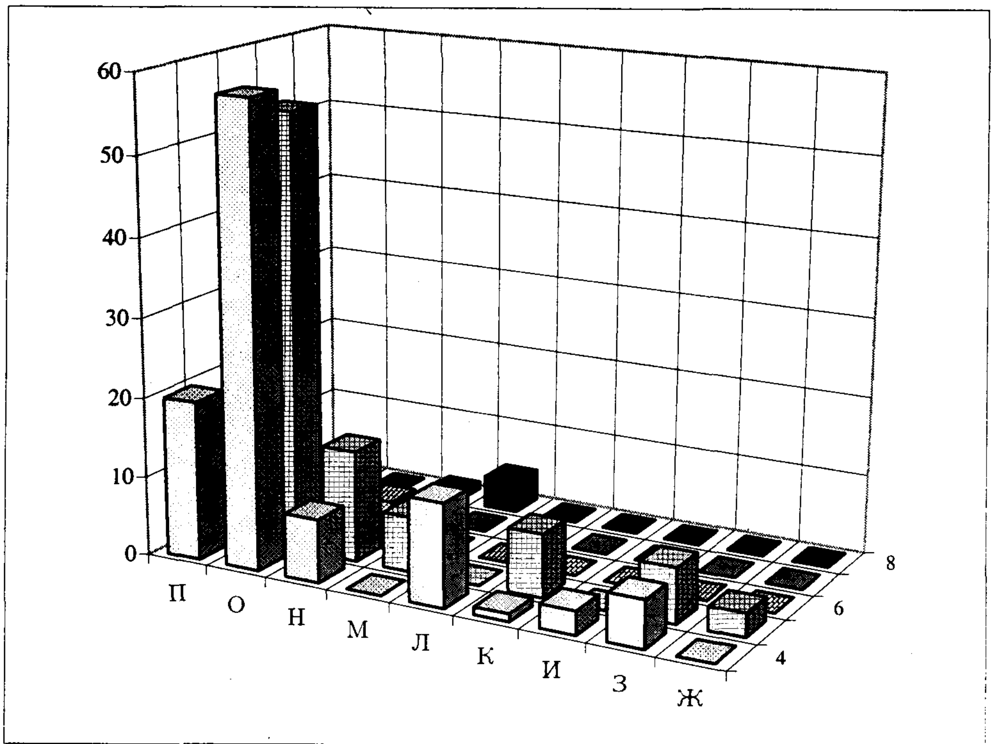


Fig. 3-21—Kabazi II, Level IIA/1, spatial distribution of identifiable remains of *Equus hydruntinus*.

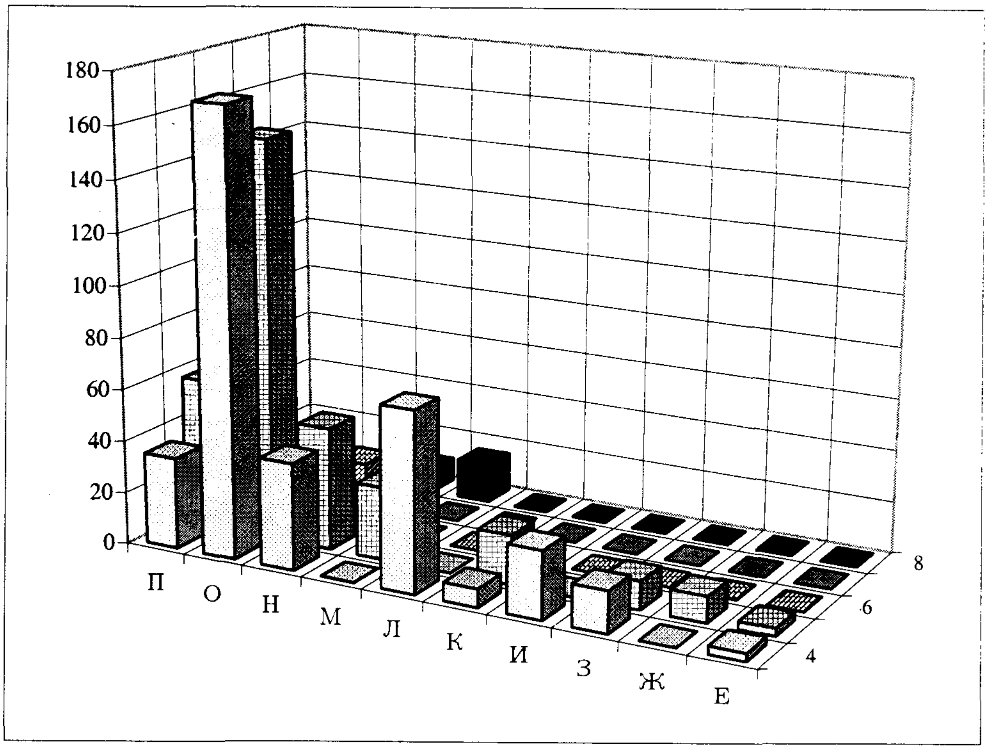


Fig. 3-22—Kabazi II, Level IIA/1, spatial distribution of entire faunal assemblage.

Mortality Profile and Composition of the Slaughtered Population

According to the analysis of dental wear and the epiphyseal fusion of bones, at least eight individuals are estimated to be present: a juvenile younger than 3 years and seven adults. The juvenile was around two and a half years old. Among the adults, two were 3-5 years old, three were 5-10 years, one 10-15 years, and one older than 15 years. The mortality profile (fig. 3-20) corresponds to a catastrophic type curve, similar to the stalking model or bachelor group model of M. Levine (1983). A few bones that are large indicate the presence of at least one adult male.

Spatial Analysis of Identifiable Bones

Spatial analysis of the *Equus hydruntinus* remains (fig. 3-21) shows the highest density in squares O4 (58, or 28.1%) and O5 (56, or 27.1%). Cranial skeleton elements are most abundant in these two squares, and those of the axial skeleton are found in two zones: И4, Л4, К5 and O4, O5, H5, П4, П5. Long bone fragments are dispersed. Bones of the end of the hoof (from the carpal/tarsal to the phalanges) are grouped in squares O4, O5, П4, and П5. The juvenile remains were found in squares O4 and M5. The burnt bone splinters are outside the denser zones, toward the back (3 in E4, 3 in E5, and 2 in Ж5), although there is one burnt fragment of a femur diaphysis in square O4. Unidentifiable bone splinters longer than 2 cm are most abundant in squares O4 (113), O5 (97), and Л4 (56). Those splinters shorter than 2 cm are by weight most abundant in these squares. They therefore follow the spatial distribution of the longer splinters and that of the identifiable bones. For the entire assemblage, the densest squares are, in descending order: O4 (171), O5 (154), Л4 (69), and П5 (58) (fig. 3-22).

According to the spatial analysis of anatomical elements, dismemberment was principally carried out in two areas, one around square И4 and the other around square O4. Disarticulation took place principally in O4 and O5. The extremities of the hooves were apparently left in this disarticulation zone, while the long bones, which are richer in meat and marrow, were taken elsewhere on the site, or, for the most part, outside of the site. It should be noted that there is a large rock slab at the intersection of squares O7 and O6.

LEVEL IIA/2 FAUNA

Faunal remains in Level IIA/2 comprise 3355 pieces, of which 57.8% are unidentifiable. The identifiable bones (42.2% of the total remains) belong for the most part to *Equus hydruntinus* (98.8% of identifiable remains; Table 3-11). The other species are saiga antelope (0.21%), Bos (Bison? 0.35%), *Cervus elaphus* (0.14%), and horse (0.07%) (Table 3-11). The total weight of bone splinters is 11.41 Kg, of which 2.6 Kg (or 22.77%) are splinters shorter than 2 cm.

The bones are by and large poorly preserved, especially in certain squares (for example, squares H7, O6, and M5). *Equus hydruntinus* cheek teeth are fragmented for the most part, and the bone surfaces are altered and often missing the upper layer. Some bones are corroded, others display light marks of partial dissolution and of manganese dioxide. With the exception of one tooth (in square O8), there are no plant rootlet vermiculations on the bones. This suggests that during the deposition of Level IIA/2, there was relatively little vegetation at the site and the environment was arid steppe. It is therefore weathering, along with the climate, which has significantly altered the faunal remains in this level. The assemblage remained in the open air for a relatively long time and underwent alteration from climate and weather. There is evidence of carnivores on seven *Equus hydruntinus* bones.

TABLE 3-11
Kabazi II, Level IIA/2, Number of Species Present

	NR	*MNE*	*MNIc*
Equus hydruntinus	1399	670	16
Saiga tatarica	3	3	1 male adult
Bos/Bison	5	3	1 adult
Cervus elaphus	2	2	1 adult
Equus (caballus) sp.	1	1	1 adult
Unidentifiable Species	6	1	1 adult
Total	1416	680	21

TABLE 3-12
Kabazi II, Level IIA/2, Cranial Skeleton Elements of *Equus hydruntinus*

	NR	*MNE*	*MAU*	*MNIf*	*MNIc*
Cranial Bones	59	4	4	3	3
Hemi-Maxilla	9	6	3	3	3
Permanent Upper Cheek Teeth	98	98	8.16	9	13
Permanent Incisors/Canines	16	16	2	3	3
Isolated Upper Deciduous Teeth	0	0	0	0	0
Hemi-Mandible	30	12	6	7	7
Permanent Lower Cheek Teeth	63	63	5.33	8	10
Permanent Lower Incisors/Canines	23	23	2.87	4	4
Isolated Lower Deciduous Teeth	1	1	–	1	1
Unidentifiable Isolated Cheek Teeth	14	10	–	–	–
Unidentifiable Isolated Incisors/Canines	7	7	–	–	–
Hemi-Mandible/Maxilla	1	–	–	–	–
Total	321*	240*	5.58	9	14

* Estimate uncertain

These are tooth bites or gnawing of small canids or mustelids (2 in square O8, 1 in M5, 1 in H7, and 1 in H5). Carnivores, therefore, played only a small role (0.2% of the total remains) in the origin and history of this assemblage.

Analysis of *Equus hydruntinus* Remains

Cranial Skeleton

Two more or less complete skulls of *Equus hydruntinus* were found in Level IIA/2. The first, in square P4, had the entire maxilla with six left and three right cheek teeth and the six incisors/canines. The other, in square П4, had the whole maxilla with four left and five right cheek teeth and four incisors. These skulls were probably from females. Petrous bones and occipital condyles are the best represented of cranial elements (75% of cranial bones in MNE; Table 3-12). The other, more fragile, cranial bones are very poorly represented, even hemi-maxillas (2.5% of all cranial bones). Hemi-mandibles are slightly better represented (5% of

TABLE 3-13
Kabazi II, Level IIA/2, Skeletal Elements of *Equus hydruntinus*

	NR	*MNE*	*MAU*	*MNIf*	*MNIc*
Skull fragments	59	4	4	3	3
Hemi-Maxilla	9	6	3	3	3
Hemi-Mandible	30	12	6	7	7
Hemi-Maxilla/Mandible	1	–	–	–	–
Upper Teeth	114	114	8.4	9	13
Isolated Lower Teeth	87	87	6.2	8	10
Cranial Skeleton Sub-Total	21	17	–	–	–
Cranial Sub-Total	*321*	*240*	*5.58*	*9*	*14*
Vertebra	383	117*	3.77	8	8
Rib	116	15*	0.41	1	1
Innominate	64	28	14	14	14
Axial Skeleton Sub-Total	*563*	*160**	*2.25*	*14*	*14*
Scapula	17	12	6	6	6
Humerus	29	10	5	5	6
Radius	30	11	5.5	6	6
Ulna	10	8	4	6	6
Carpal	22	22	1.57	5	6
Metacarpal III	25	6	3	5	5
Metacarpal II and IV	21	19	4.75	5	5
Upper Foreskeleton Sub-Total	*154*	*88*	*3.14*	*6*	*8*
Femur	13	6	3	3	3
Tibia	21	6	3	3	4
Patella	1	1	0.5	1	1
Tarsals	45	44	3.66	7	7
Metatarsal III	34	10	5	5	5
Metatarsal II and IV	10	10	2.5	5	5
Upper Hindskeleton Sub-Total	*124*	*77*	*3.2*	*7*	*9*
Phalanges, Proximal	50	50	12.5	13	13
Phalanges, Medial	33	33	8.25	9	9
Phalanges, Distal	20	20	5	5	5
Phalanges, Proximal or Medial	1	1	–	–	–
Sesamoid	1	1	0.08	1	1
Autopodium Sub-Total	*105*	*105*	*4.37*	*13*	*13*
Metapodials, Unidentifiable	16	–	–	–	–
Carpals or Tarsals	29	–	–	–	–
Long Bones, Unidentifiable	87	–	–	–	–
Post-Cranium Sub-Total	1078	430*	2.92	14	16
Total	1399	670*	3.52	14	16

* estimate uncertain

all cranial bones). Among these remains, three had teeth in place, fragments of horizontal ramuses and ascending ramuses are the most numerous. The teeth are by far the best preserved (218, including those in place on maxilla and mandibles, or 90.8% of the total cranial bones). Permanent cheek teeth, especially the upper molars are most abundant. Incisors/canines are rare and milk teeth almost absent, 19.1% and 0.4% respectively of all cranial bones (Table 3-12).

Taking into account age and sex, the cranial elements indicate the presence of at least fourteen individuals (Table 3-12).

Post-Cranial Skeleton

Axial Skeleton (vertebrae, ribs, sterna, sacra, innominates)

The bones of the axial skeleton, especially the innominates, are relatively well preserved (52.2% of total post-cranial bones and 37.2% in MNE, Table 3-13). Notably, the innominates have a very high MAU (Table 3-13) and usually only the acetabulum was preserved. The sterna, cartilaginous innominates, and sacra are absent. Among the vertebrae, the thoracic vertebrae are most numerous (51 of 117, in MNE, Table 3-13). The ribs, fragmented and principally represented by the shaft fragments, are much rarer (10.7% of post-cranial identified and 3.4% in MNE, Table 3-13).

Upper Foreskeleton

Scapulae (especially the glenoid cavity), radii, and humeri are the most frequents elements of the upper foreskeleton (Table 3-13). Among the carpals, which are rather rare but often complete (18 of 22), the scaphoid and the capitatum are most abundant; there are no pyramidal carpals.

Upper Hindskeleton

The metatarsal III is the most abundant element of the upper hindskeleton, and the patella the least abundant element (Table 3-13). Among the tarsals, which are relatively well preserved and most often complete (39 of 45), the talus and the calcaneum dominate. Tibias, femurs, and vestigial metatarsals are rare (Table 3-13).

Autopodium (phalanges and sesamoids)

The preservation of proximal phalanges is very good (88% are complete), that of the other phalanges and especially the sesamoids is worse (Table 3-13). Phalanges, except distal phalanges, are complete for the most part (77.8%).

It should be noted that in Level IIA/2 there is a significant number of bone fragments—especially long bone diaphyses—that are unidentifiable, both anatomically and to species.

The study of the post-cephalic skeleton indicates that the minimal number of individuals present in Level IIA/2 is sixteen (by combination).

Preservation of Major Skeletal Units and Long Bones

As seen in Figure 3-23, the unit corresponding to the cephalic skeleton is the best represented among major skeletal units, followed by the autopodium. The radius, followed by the humerus and metatarsal III, is the best preserved long bone (fig. 3-24). Analysis of the differential preservation of parts of long bones (in MNE) shows the very good preservation of distal extremities, with the exception of those of the femur and ulna, and the rarity of proximal extremities of the humerus and tibia (fig. 3-25).

Analysis of Long Bone Fragmentation

Only an ulna, four metacarpals III, and three metatarsals III are complete, all other long bones are broken. The morphology of the fracture planes and the observed marks (point of impact, internal and external splintering) indicate breakage by percussion on green bone. In most cases, percussion took place on the proximal or distal diaphyses, and very rarely on the medial diaphysis, thereby leading to the weakening of these parts of the long bones (figs. 3-25 and 3-26). Two bones, a humerus and a tibia, are present in the form of small pieces of diaphyseal cylinders; aside from these, one or two faces are preserved, and very rarely three. According to the index of fragmentation, NR/MNE, the metacarpal III, the tibia, and the metatarsal III are the bones most often fragmentary.

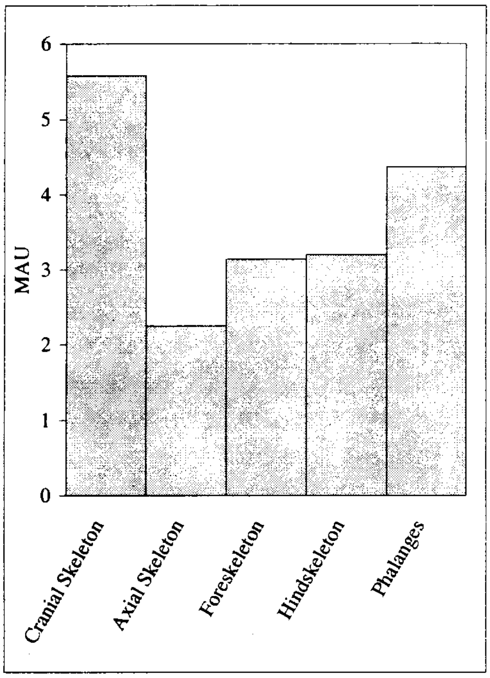


Fig. 3-23—Kabazi II, Level IIA/2, preservation of major anatomical units (in MAU) of *Equus hydruntinus*.

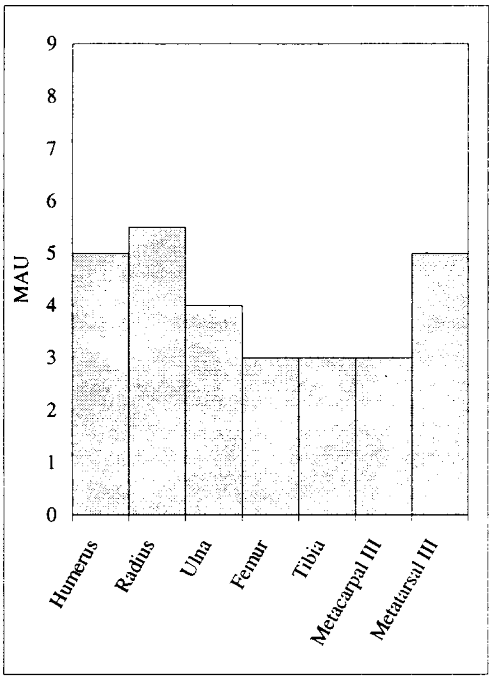


Fig. 3-24—Kabazi II, Level IIA/2, preservation of long bones (in MAU) of *Equus hydruntinus*.

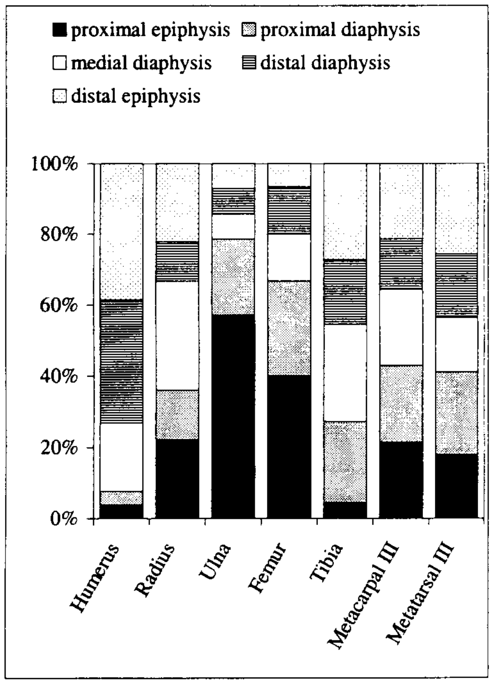


Fig. 3-25—Kabazi II, Level IIA/2, preservation of different parts of long bones of *Equus hydruntinus*.

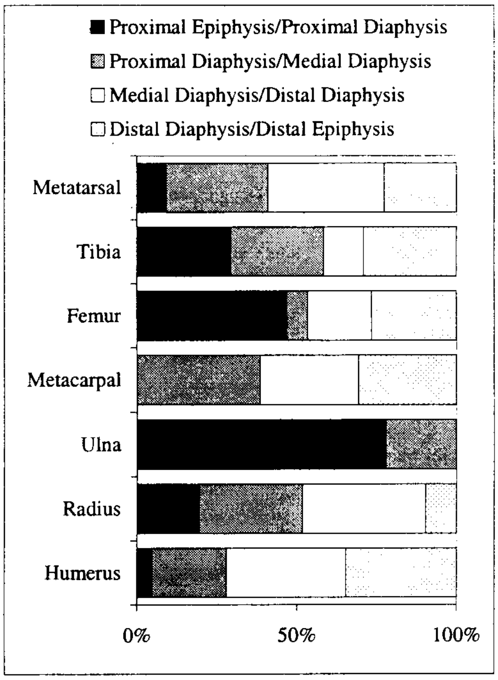


Fig. 3-26—Kabazi II, Level IIA/2, point of fracture of long bones of *Equus hydruntinus*.

Analysis of Butchery Marks

Cut marks are difficult to observe due to the alteration of the superficial layer of the bones; only three bones of *Equus hydruntinus* have such marks. In square M5, a left calcaneum with a short, deep cut mark, indicates a tibia-tarsal disarticulation. In squares H7 and O5, two proximal extremities of a metacarpal II (a left and a right) have, on one, two short and deep cut marks, and on the other, a cut mark from the disarticulation of the radius-ulna/ metacarpals.

Mortality Profile and Composition of the Slaughtered Population

According to the analysis of dental wear and epiphyseal fusion of bones, the presence of at least sixteen individuals is estimated: three juveniles less than 3 years old and thirteen adults. One of the juveniles is younger than 13-15 months, another is around 13-15 months old, and the third is between 2-½ and 3 years. Among the adults, two are between 3 and 5 years old, three 5-10 years, four 10-15 years, and four are older than 15 years. The mortality profile (fig. 3-27) corresponds to a "catastrophic" type mortality curve, similar to the family group model of M. Levine (1983). A canine and a few large bones suggest the presence of at least one adult male older than 15 years in age, and the two nearly complete skulls represent two females, one of which was 10-15 years old, the other 15-20 years.

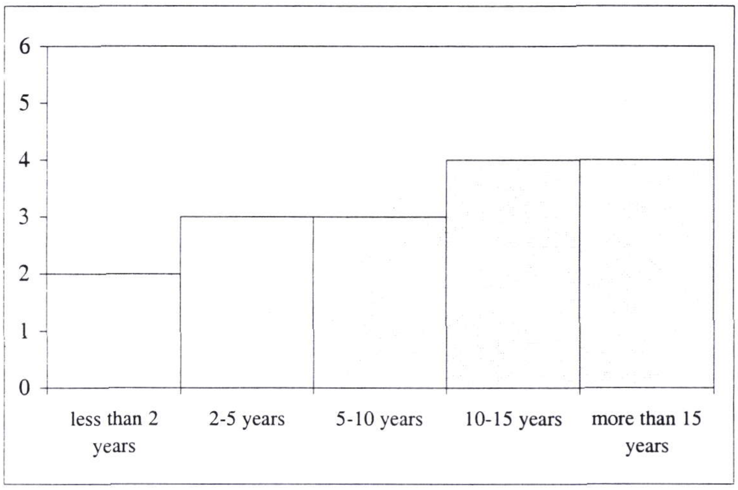


Fig. 3-27—Kabazi II, Level IIA/2, mortality profile of *Equus hydruntinus*.

Spatial Analysis of Identifiable Bones

The analysis of the spatial distribution of the *Equus hydruntinus* assemblage (fig. 3-28) shows the highest densities in the following squares, in descending order: H5 (139), M5 (138), H6 (105), O4 (72), H4(70), O8 (66), O5 (56), and H7 (54). The bones of the cranial skeleton are most abundant in squares К4, H4, O4, and M5 (plus the presence of the two complete skulls in squares P4 and П4); bones of the axial skeleton are most abundant in M4, those of the upper foreskeleton in П4, П5, H5, and O4; those of the upper hindskeleton in O4, H5, and H6; and those of the autopodium in O7, O8, H7, П5, and O5. The remains of the three juveniles aged less than 3 years were discovered in squares M5, M4, H6, O4, and O7. Unidentifiable bone splinters longer than 2 cm are abundant in squares H4 (471), H5

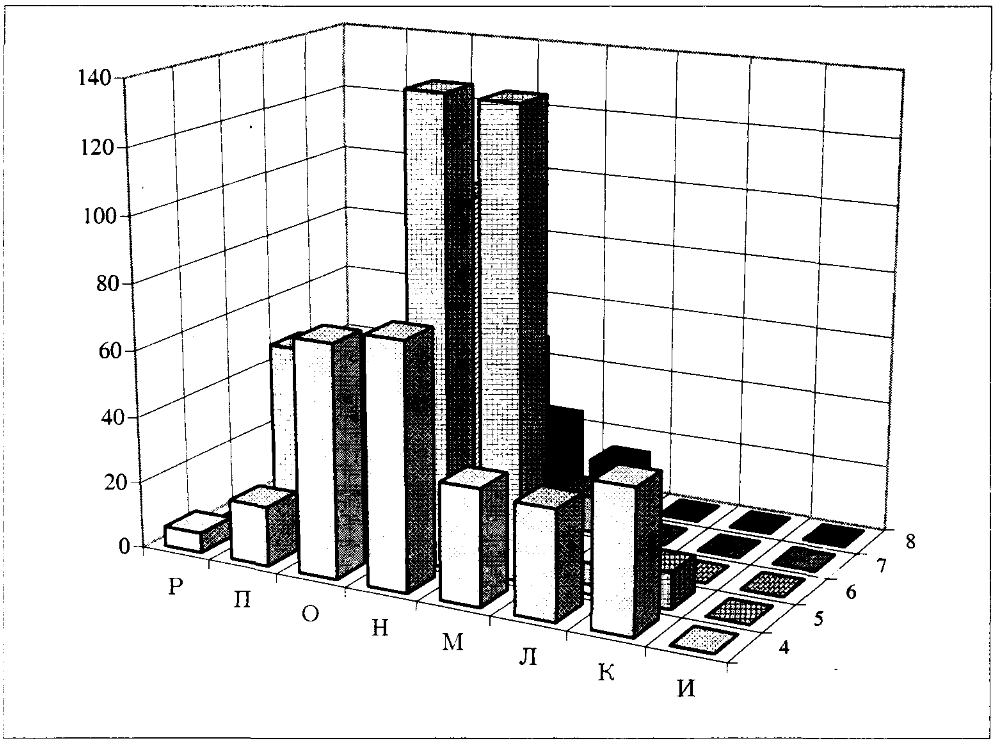


Fig. 3-28—Kabazi II, Level IIA/2, spatial distribution of identifiable remains of *Equus hydruntinus*.

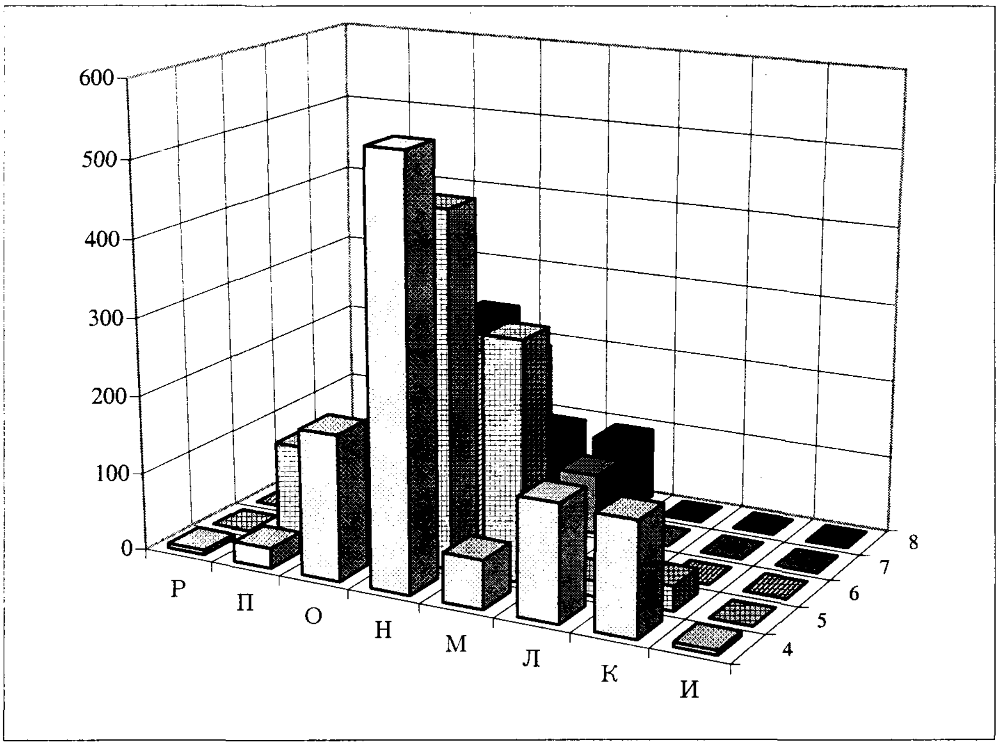


Fig. 3-29—Kabazi II, Level IIA/2, spatial distribution of entire faunal assemblage.

(314), H7 (219), O8 (171), and H6 (149). Bone splinters shorter than 2 cm are, by weight, most frequent in H4, M5, H5, O8, H7, and H6. With the exception of M5, they follow the spatial distribution of the longer splinters. For the entire faunal assemblage, squares with the largest densities are, by decreasing order: H4 (545), H5 (455), H6 (254), O8 (237), and H7 (219) (fig. 3-29).

According to the analysis of the distribution of anatomical elements, there are at least nine crania of adults (reconstruction, cranial bones, atlas, and axis) in squares P4, П4, O4, H4, К4, Л4, H5, and two skulls in square M5. The distribution of innominates and scapulas is similar to the distribution of the skulls (with the exception of squares П5 and H7), especially in O4 and H5, as is the distribution of vertebrae and ribs. These observations suggest that that the slaughtering and dismembering took place in the same area, and principally in row 4. Disarticulation of limbs likewise took place in this zone. On the other hand, rows 6 (except square H6), 7, and 8 would correspond to toss zones (numerous unidentifiable bone splinters and abundance of carpal bones, tarsals, and phalanges). It should be noted that there is a large rock slab at the intersection of the squares O7 and O6.

Analysis of Remains of Other Species

Two remains of deer indicate their presence near the site: a proximal diaphysis fragment of a small right tibia in square O5 and a proximal part of a metacarpal III in square H5.

Five remains of Bos were discovered: a fragment of a thoracic vertebra and a right radius missing its distal portion in square П5, and three diaphysis fragments of the same left humerus, two of these in square O5 and one in П4.

Three Saiga antelope bones were identified, belonging to at least one adult male. These include, in square O4, a distal extremity of a right humerus and a complete proximal phalanx, and in square M8, a fragment of a tibia-fibula condyle.

In square H5, a distal part of a left tibia was found and is attributed to a horse.

In square П4, six shaft fragments of one rib belong to a small, unidentifiable animal.

COMPARATIVE ANALYSIS OF LEVELS II/7E, II/8C, IIA/1, AND IIA/2

Level II/7E is the most rich in total number of remains, in number of individuals, and in unidentifiable bone splinters (especially those longer than 2 cm). On the other hand, Level IIA/2 has the largest number of total identifiable bones and the most bone splinters less than 2 cm in length (fig. 3-30).

Equus hydruntinus and Saiga antelope are omnipresent, with the latter slightly more abundant in Level II/7E (fig. 3-31). In Levels II/8C and IIA/1, only these two species were identified. The faunal range of Level IIA/2 appears a little more diverse (fig. 3-31). During the formation of the four levels, the climate remained nearly the same, except with a slight increase in aridity in Levels II/8C and IIA/1 (this is further supported by the taphonomic analysis). This increase could correspond either to an occupation of the site during a different time of year (winter, in this case, in a strongly continental regime where the climate is cold and dry) or to a regional climatic alteration. Based on the composition of the slaughtered populations, the first hypothesis seems more likely. The ecological niches of the species that are present at the site during this time suggest a cold climate, but not rigorously so (no permafrost) and dry (without substantial snowfalls). The countryside was very open and should correspond to a grass steppe. The small equids, Saiga antelope, and bison grazed on the top of Kabazi cuesta and the deer on the hills below.

The condition of the bone surfaces suggests that the two non-biological taphonomic agents that played a role in the history of the faunal assemblages are weathering and climate

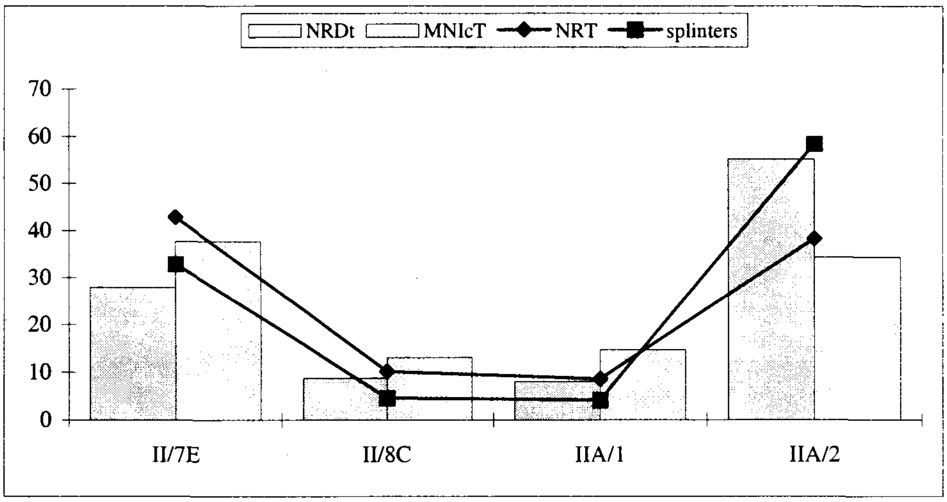


Fig. 3-30—Kabazi II, relative quantification of faunal material, by level.

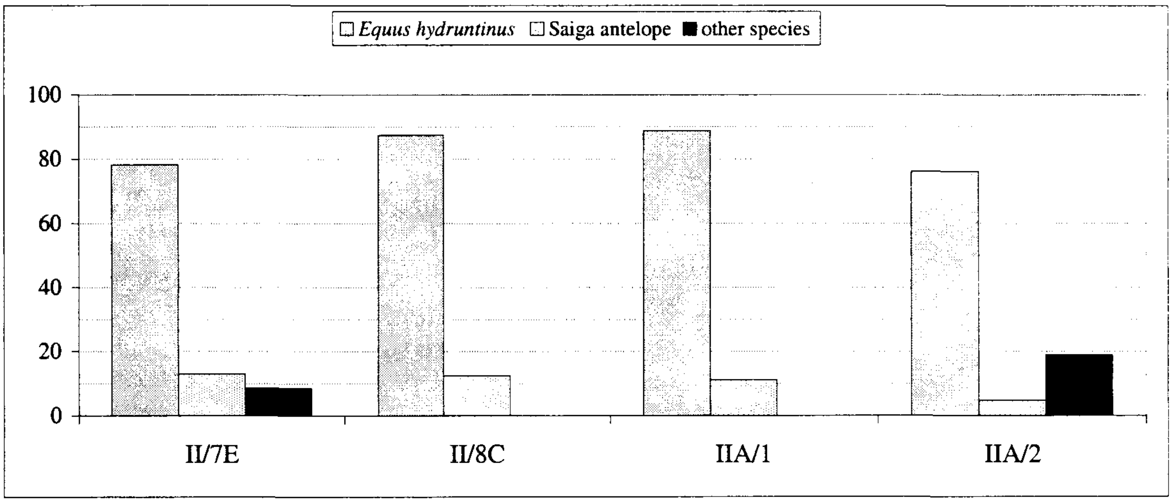


Fig. 3-31—Kabazi II, relative percentages of species present.

(desiccation). While usually associated with each other, in Levels II/7E and IIA/2 it is the former that is more important, whereas in Levels II/8C and IIA/1, climate is more important. We have used numerous criteria to evaluate the degree of preservation of the bones (Table 3-14); the preservation appears better in Levels II/7E and IIA/2, slightly worse in Level II/8C, and especially worse in Level IIA/1. The degree of fragmentation of the material could also be evaluated with the aid of several indices, such as the ratio of the number of identifiable to unidentifiable specimens (%NRDt/NRI) and the ratio of the minimum number of elements to the total number of remains (%NMEt/NRt). In addition, one can compare the proportion of bone splinters shorter than 2 cm to those longer than 2 cm. From Table 3-15, it is evident that the bones have a higher degree of fragmentation in Levels II/7E and IIA/2. In these two levels, the observation of fracture planes and marks indicates breakage by percussion on green bone. A post-depositional secondary fragmentation further altered the material already fractured by humans in Levels II/8C and IIA/1. In all these levels, there are very few complete long bones (1 in Level II/7E and 8 in Level IIA/2) or intact diaphysis cylinders (3 in Level IIA/2). The faunal remains in all the levels carry very few extrinsic marks. In Level II/

TABLE 3-14
Kabazi II, Taphonomic Criteria for Degree of Preservation

	II/7E	*II/8C*	*IIA/1*	*IIA/2*
NR/MNIc	37.8	31.3	25.75	87.43
% unidentifiable cheek teeth/ % identifiable	6.2	2.7	11.6	8
% intact deciduous teeth	10.4	11.1	–	2.77
% dental remains	28.04	39.26	39.32	15.86
% ribs and vertebrae	15.27	7.3	10.67	35.66
% long bone extremities	53	17.24	14.28	24.38

TABLE 3-15
Kabazi II, Taphonomic Indices of Fragmentation

	II/7E	*II/8C*	*IIA/1*	*IIA/2*
% identifiable remains/ % unidentifiable remains	23.72	33.78	37.63	73.02
% NMEt/NRt	69.45	74.43	71.01	48.02
% weight of bone splinters < 2cm	13.7	9.4	13.3	22.7

7E, only one bone has evidence for gnawing by a small canid or mustelid (0.01% NR); in Level II/8C, there are five burned bones (2.2%); in Level IIA/1, one bone was gnawed by a small rodent (0.48%) and nine bone splinters were burned (4.3%); and in Level IIA/2, seven bones were chewed by carnivores (canids or hyaenas) and three bones have marks from disarticulation (0.21%). The relatively bad preservation of the bone surfaces, which are often missing the upper layer, makes the identification of butchery marks very difficult. Carnivores only played an anecdotal role in the origin and history of these faunal assemblages. The site is situated on the upper part of the slope, so the natural deaths of herds recurring exactly in the same place and not topographically caused cannot be envisioned. Only the prehistoric human inhabitants are responsible for these accumulations.

The analysis of the preservation of the major anatomical units of *Equus hydruntinus* (figs. 3-2, 3-9, 3-16, and 3-23) indicates that the cephalic unit is always the best represented and the axial skeleton the least well represented. The MAU indices are weak, particularly in Level II/8C and especially in Level IIA/1; they are slightly higher in Level II/7E and even more so in Level IIA/2. These low ratios might correspond to strategies referred to as reverse (Binford 1978; Lyman 1994). They are characteristic of butchery sites. The modified general utility indices (MGUI) as a function of the percentage of minimum animal units (MAU) (fig. 3-32) indicate that the four levels can be grouped into pairs: Levels II/8C and IIA/1 (group A) and Levels II/7E and IIA/2 (group B). The curves of group A (fig. 3-32) emphasize the rarity of all anatomical elements, especially the most nutritious. This might suggest a strategy of reverse mass (reverse bulk strategy). Those of group B, on the other hand, show a relative abundance of elements with an average nutritive value (fig. 3-32). This might correspond to a reverse gourmet strategy, especially in Level IIA/2. Figures 3-33 and 3-34 confirm these results; there is a strong deficit in most of the bones rich in meat (notably femurs and humeri). Some of these bones were therefore taken out of the site at the same time as the meat. There was apparently less of a selective choice in group A, where the quantity appears to have been more important than the quality. On the other hand, the indices of bones rich in marrow as a function of the MAU (figs. 3-35 and 3-36) indicate a greater abundance of marrow in group A

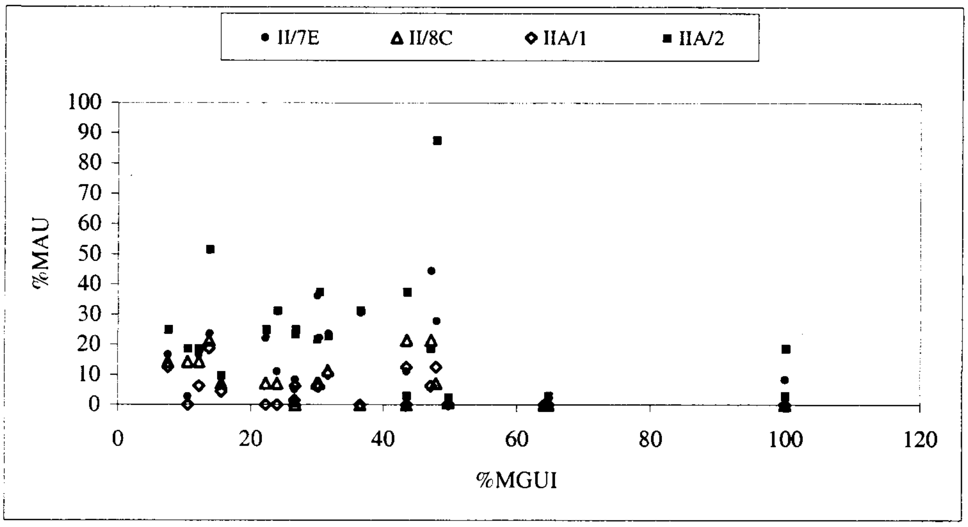


Fig. 3-32—Kabazi II, relationship between the MGUI and MAU of *Equus hydruntinus*.

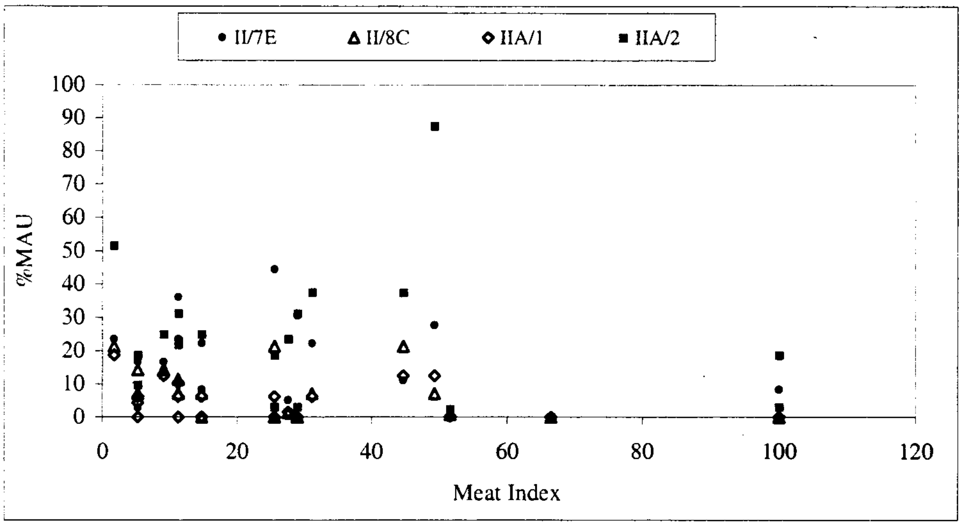


Fig. 3-33—Kabazi II, relationship between the Meat Index and MAU of *Equus hydruntinus*.

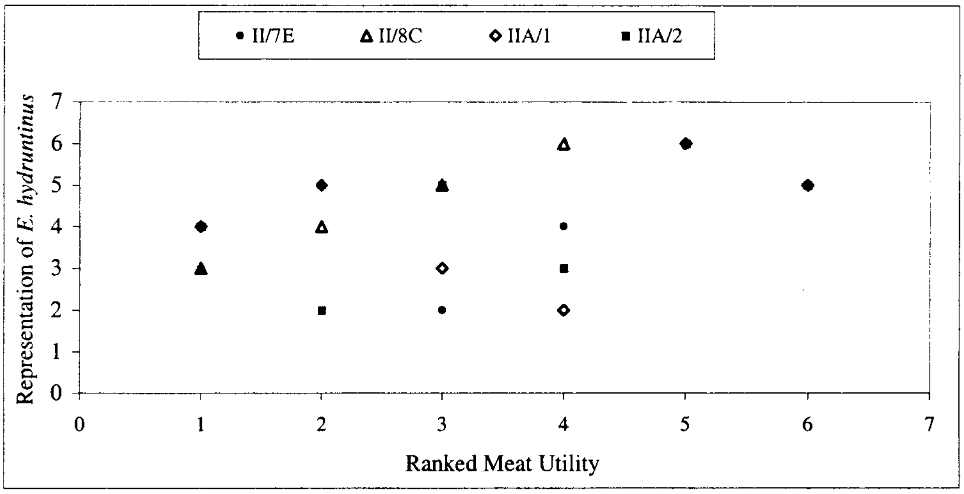


Fig. 3-34—Kabazi II, relationship between the Ranked Meat Utility and representation of remains of *Equus hydruntinus*.

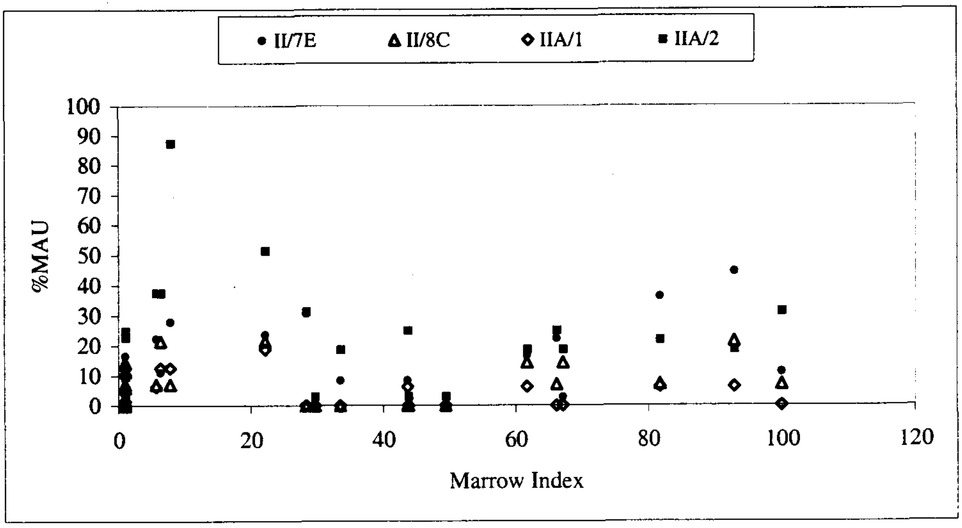


Fig. 3-35—Kabazi II, relationship between the Marrow Index and MAU of remains of *Equus hydruntinus*.

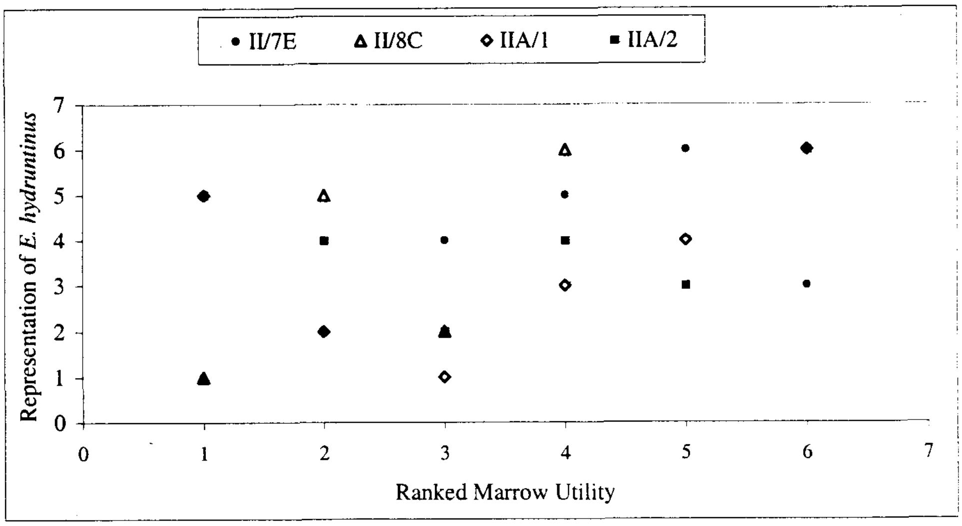


Fig. 3-36—Kabazi II, relationship between the Ranked Marrow Utility and the representation of remains of *Equus hydruntinus*.

than in group B. These bones were broken on-site to extract marrow; whether the marrow was then immediately consumed or taken out of the site is unknown.

In addition, by the number of slaughtered individuals, the four levels also fall into the same distinct two groups. The analysis of mortality curves of the small equids (figs. 3-6, 3-13, 3-20, 3-27, and 3-37) indicates the killing of small family groups (family group model) in Levels II/7E and IIA/2, the killing of a group of females with young in Level II/8C, and probably of a group of males (bachelor group model) in Level IIA/1. For Level IIA/1, one could also propose the hypothesis that there was selective hunting for "heavy" animals aged between 2 and 10 years. The presence of a few milk teeth and the structure of the populations indicate that the animals were killed in the springtime for the equids in Levels II/7E and IIA/2, the beginning of winter for those of Level II/8C, and for Level IIA/1, in the winter or summer, although given the data presented above, it was most likely the beginning of the winter. During this season, it is more difficult to procure game (the horses live in small

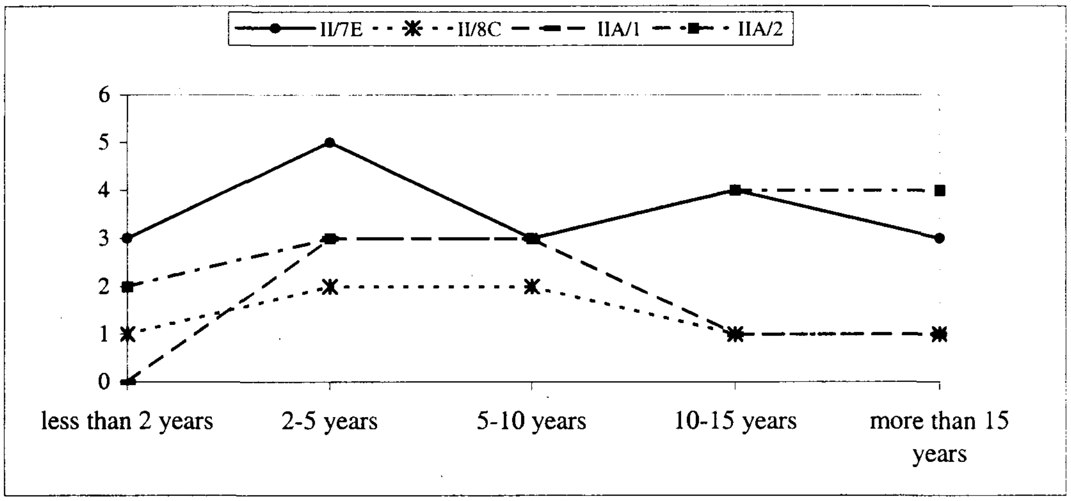


Fig. 3-37—Kabazi II, mortality profiles of *Equus hydruntinus*.

isolated groups, which, especially for the bachelor male group, can move across great distances) and the animals are therefore exploited to the maximum extent, which appears to be the case for Levels II/8C and IIA/1. According to all of these data, we can propose the hypothesis that within each level there was a single kill and butchery episode.

A few observations can be made on the basis of the spatial distribution of the faunal material. The highest density is found in Level IIA/2 (about 83 in comparison to the total number of excavated squares) and in Level II/7E (163 in comparison to the number of squares in which at least one bone was found), followed by Levels II/8C and IIA/1. The post-mortem dispersal of bones is relatively significant; with the exception of the bones of extremities of the hooves, no articulations were observed. This further confirms the assumption of anthropic intervention on the faunal assemblage. In all four levels, a concentration of faunal material is observed towards the front of the excavated area and on the right side (as one faces the cliff). The heaviest density of bones is present in Levels IIA/1, followed by II/7E, II/8C, and IIA/2. For all four levels, the bones are found primarily in nine squares: rows 4 and 5 of П to H, in O, and H6, Л4 (figs. 3-8, 3-15, 3-22, and 3-29). The highest concentration of unidentifiable bone splinters is found in Level IIA/2, followed by II/7E and IIA/1, then in II/8C. The areas of concentration of bone splinters in Levels II/7E and IIA/1 are very similar and differ slightly from the other two (in II/8C more towards the back and in Level IIA/2 more towards the left, row 8). For the bones of *Equus hydruntinus*, their concentration is highest in IIA/1, followed by II/7E and II/8C, then IIA/2. They are found principally in squares O4 and O5 in Levels II/7E, II/8C, and IIA/1, and more towards the back in H5 and M5 in Level IIA/2 (figs. 3-7, 3-14, 3-21, and 3-28). In examining the spatial distribution of different major anatomical units of *Equus hydruntinus*, one notes a higher concentration of: the cranial elements in Level IIA/1 (this level and Level II/7E also have a similar distribution); axial skeleton elements in II/7E and IIA/2; upper foreskeleton elements in level II/7E, row O (Levels II/8C and IIA/2 also have a similar distribution of this unit); upper hindskeleton elements in II/8C (and the distribution is similar to that of Level II/7E); and finally, the autopodium elements in Level II/8C (and this distribution is similar to that of Levels II/7E and IIA/1). In sum, the dismemberment of these equids, with the exception of Level IIA/1, took place in the same zone (O4-5). The disarticulation, defleshing, and breakage of bones for marrow extraction were also carried out in this zone (around O4-5, especially in row 4 in Level IIA/2). On the other hand, the toss zones and garbage dumps differ by level. The presence of burnt bone in

Level II/8C and IIA/1 indicates the existence of a hearth; based on the distribution of these elements, it might have been situated towards the back of the excavated area, outside the main area of butchering activity. The distribution of the remains of species other than *Equus hydruntinus* varies. The remains of Bos/Bison and Saiga antelope have an identical spatial distribution to that of *Equus hydruntinus*, while that of deer and horse differs in comparison to the zones of highest density.

CONCLUSIONS

For Levels II/7E, II/8C, IIA/1, and IIA/2, the inhabitants of Kabazi II occupied the site during a somewhat cold and dry period. The environment was very open grass steppe. The human inhabitants are responsible for the accumulation of faunal material in all four of the studied levels. The site corresponds to a slaughter and butchery site, which is further confirmed by the relative paucity of lithic material (Chabai 1996) and the absence of habitation structures. The inhabitants practiced the specialized hunting of *Equus hydruntinus*. On Kabazi Mountain, probably in a single episode for each level, they killed a small family group (in springtime) in Levels II/7E and IIA/2. In Level II/8C, they killed a smaller group composed of females and young. In Level IIA/1, a small group of bachelors, or male adults aged between 2 and 10 years, was killed during the winter. In Levels II/8C and IIA/1, the treatment of the carcasses was complete; pieces of meat still containing bone (e.g. humeri and femurs) were taken out of the site (reverse mass strategy). On the other hand, in Levels II/7E and IIA/2, the treatment was more selective, with quality having more importance than quantity (reverse gourmet strategy). Perhaps in these levels, the strategy was to recover meat specifically to take out of the camp (to their habitation site?). One could also advance the hypothesis that, contrary to the two other levels, the conditions during Levels II/7E and IIA/1 were more favorable (a period of abundance). This may be related to the season of the slaughter; during the winter, game is more rare, more dispersed across the territory, and the animals more thin. This would correspond more to a period of shortage. Except in Level IIA/1, the treatment of animals took place in the same zone, towards the front and right of the excavated area. The rarity (or even absence in some levels) of carnivore remains and their traces, implies that either they were rare in the immediate vicinity of the site, or that the defleshing by the humans was very significant (which would confirm the above assumptions about the function of the site). The site of Kabazi II provides an extremely interesting perspective on the subsistence behavior of Neandertals during the Last Interglacial.

Chapter 4

SMALL MAMMAL FAUNA FROM KABAZI II, KABAZI V, AND STAROSELE: PALEOENVIRONMENTS AND EVOLUTION

ANASTASIA K. MARKOVA

INTRODUCTION

Excavations of Starosele, Kabazi II, and Kabazi V included the recovery of small mammal remains. The principal tasks of the paleontological investigation of small mammal remains were: to establish the species composition of rodents, insectivores, and lagomorphs present during the Paleolithic occupation of these sites; to reveal changes in species composition; to elucidate the characteristics of the paleoenvironments surrounding the sites as related to climatic fluctuations; and to establish the principal morphological features of small mammal remains and their difference from modern and more ancient remnants.

Dr. Constantine Mikhailesku and Gavril Gylku (Institute of Geography, Moldova) carried out the bulk of the selection of fossil remains of small mammals. Samples of small mammal remains were also selected by the archeologists studying these sites: Dr. Victor Chabai (Kabazi II), Dr. Alexander Yevtushenko (Kabazi V), Dr. Anthony Marks and Dr. Yuri Demidenko (Starosele).

PRINCIPAL METHODS OF SAMPLING

During excavation of the sites, normal methods for the selection of mammal bones were used. At the first stage of work, test samples from most archeological levels were screened through 5 mm screens, followed by screening through 1-1.5 mm screens. In the event that small mammal bones were found in these test samples, the sample was increased three-fold. After this procedure, the remaining sediments were washed through 1.5 mm screens. More detailed information about the principal stages of collecting the mammalian remains will be described below and can be found in Chapter 5. In most cultural layers, the density of small mammal remains was rather low.

Kabazi II

During fieldwork between 1994-1996, small mammal remains were sought for in six strata of Kabazi II (Strata 6, 7, 9, 10, 11, 13). This site is situated on third ridge of the Crimean Mountains, on the right bank of the Alma River. This Middle Paleolithic-age multi-layered site is currently being studied by archeologist Dr. Victor Chabai (Chabai 1996, 1998).

At Kabazi II, only a few remains of small mammals were found in a sterile layer in the lower part of Stratum 11, between Units III and IV, and included only one species, northern mole-vole *Ellobius (Ellobius) talpinus* Pallas.

Kabazi V

Kabazi V is situated on the third ridge of the Crimean Mountains, on the right bank of the Alma River, 100 m above the river and 350 m in altitude. The site is a buried rock shelter located beneath the limestone cliff at the top of Kabazi Mountain, on the south-south-west facing slope (Kolosov et al. 1993, Yevtushenko 1998a). Archeologist Dr. Alexander Yevtushenko is currently studying the site and has recognized 8 archeological complexes (A - G) and 9 geological strata with numerous archeological levels containing artifacts of the Middle Paleolithic "Staroselian" industry (Yevtushenko 1998b).

Four complexes—B, C, D, and E—of Kabazi V were sampled. About 140 Kg of sediment were sampled from each complex. An additional 105 Kg of sediment (which was set aside by A. I. Yevtushenko in the beginning of the field season) were washed from these complexes. Small mammalian materials found in previous years of excavation (1990 and 1994) at Kabazi V were also included in the sample. The species composition of small mammals from Kabazi V is shown in Table 4-1.

Starosele

Starosele is situated in Kanly-Dere Gorge, which is a part of the Bakchisarai Valley system, a drainage basin of the Kacha River. The site is located on a narrow platform at the base of a cliff on the right bank of the Kanly-Dere Valley, 11 m above the valley floor (Marks et al. 1998). This site was excavated by A. A. Formozov between 1952-1956 (Formozov 1958) and again between 1993-1995 as part of the Joint Ukrainian-American Middle Paleolithic project (Marks and Chabai 1998).

The recent excavations at Starosele revealed the presence of four archeological levels, separated by extensive rockfall and sterile sediments (see Marks et al. 1998). As the levels differ in thickness and in extent, the sample sizes and their results are quite variable. More than one ton of sediment was washed from Level 1, providing the largest number of small mammal remains. In Level 2, about 50 Kg of sediment were screened and washed, producing rodent remains only. In Level 3, 1.5 tons of sediments were screened, of which 230 Kg were further washed, and which produced small mammals and snails. Over one ton of material from cultural Level 4, consisting of a reddish-brown loam (pedosediment), was screened, and 140 Kg further washed. This level produced poorly preserved rodent remains. Sediments from sterile layers were also processed; in the layer between archeological Levels 3 and 4, 0.5 tons of sediment were screened, and 105 Kg further washed, which produced rodent remains. Table 4-2 presents the species composition and number of small mammal remains from the site.

ECOLOGY OF SMALL MAMMALS

Small mammals are good indicators of landscape types, as most small mammals are closely connected with specific environmental conditions. The *Rodentia* and *Lagomorpha* are herbivorous and thus, are trophically closely associated with certain vegetation types. Fluctuations in temperature and precipitation indirectly influence changes in zoogeographical provinces, chiefly through changes in the food base. Some small mammals are ecologically specialized and occur only in certain habitats. This group includes most tundra species and many forest animals. Steppe and desert mammals are adapted to defined biotic conditions, primary vegetation, and substrate types. At the same time, a certain number of eurytopic species of small mammals exist which are distributed from tundra zones to semi-desert. These are species often connected with intrazonal areas near water basins.

TABLE 4-1
Kabazi V, Species Composition of Small Mammals

		Complex B			Complex C		Complex D			Complex E
		II/3	II/3-4	II/4	II/4a	II/7	III/1	III/1a	III/2	III/3
Insectivora:										
Talpa sp.	Eurasian mole	1	–	–	–	–	–	–	–	–
Sorex araneus Linnaeus	Eurasian common shrew	1	–	–	–	–	–	–	–	–
Rodentia:										
Spermophillus pygmaeus Pallas	little suslik	2	1	–	13	–	4	6	7	–
Allactaga major Kerr	great jerboa	1	–	–	–	–	–	–	–	–
Apodemus (Sylvaemus) flavicollis Melchior	yellow-necked mouse		2	1	–	–	–	–	–	–
Cricetulus migratorius Pallas	grey hamster	2	–	–	–	–	–	–	–	–
Ellobius (Ellobius) talpinus Pallas	northern mole-vole	–	–	–	1	–	–	–	–	–
Lagurus lagurus Pallas	steppe lemming	1	1	–	2	–	–	20	–	–
Eolagurus luteus Eversmann	yellow steppe lemming	–	–	–	3	–	2	–	1	2
Arvicola ex gr. terrestris Linnaeus	water vole	1	–	–	1	–	–	–	–	–
Microtus (Microtus) arvalis obscurus Eversmann	common vole	65	56	2	25	–	5	–	6	–
Microtus (Pallasiinus) oeconomus Pallas	root vole	–	3	–	–	–	–	–	–	–
Microtus (Stenocranius) gregalis Pallas	narrow-skull vole	–	–	–	–	–	2	–	–	–
Microtus sp.	vole	–	–	–	–	–	–	–	2	–

TABLE 4-2
Starosele, Species Composition of Small Mammals

		Level 1	*Level 2*	*Level 3*	*Sterile*[1]	*Level 4*
Insectivora:						
Talpa sp.	Eurasian mole	1	–	–	–	–
Rodentia:						
Spermophillus pygmaeus Pallas	little suslik	2	–	–	–	–
Sicista subtilis Pallas	steppe sicista	2	–	–	–	–
Allactaga major Kerr	great jerboa	1	–	–	–	–
Apodemus (Sylvaemus) flavicollis Melchior	yellow-necked mouse	4	–	–	–	–
Cricetulus migratorius Pallas	grey hamster	5	5	–	1	–
Ellobius (Ellobius) talpinus Pallas	northern mole-vole	30	–	5	7	–
Lagurus lagurus Pallas	steppe lemming	–	4	2	–	–
Arvicola ex gr. terrestris Linnaeus	water vole	26	1	8	3	–
Microtus (Microtus) arvalis obscurus Eversmann	common vole	170	14	26	24	24
Microtus sp.	vole	–	–	1	3	–

[1] archeologically sterile horizon between Levels 3 and 4.

The modern species diversity in Eastern Europe changes significantly from the north to the south: 25 species now live in the tundra zone, 47 in the taiga, 60 in mixed forests, 59 in broad-leaved forests, 53 in steppes, and 35 in semi-deserts and deserts (Tishkov 1993). These changes are closely connected with values of the hydrothermic gradient. During the time of last glaciation, the values of species richness on the Russian Plain were noticeably lower (Markova et al. 1996). Only in mountain systems (Carpathians, Caucasus, and partly in the Crimean Mountains) were the number of mammal species rather high during this time. Numerous *Mammalia* species founded refugia in a variety of local biotopes in the mountain systems.

Small mammals also evolved very intensively during the Pleistocene and these changes are reflected in their morphology. Even during the Late Pleistocene, numerous pronounced evolutionary stages in several lineages of *Rodentia* (especially in *Arvicolinae*) have been recognized. These morphological changes help to establish the age of localities and fossiliferous layers.

Studies of Paleolithic sites containing small mammals indicate that the accumulation of these remains is due to the activities of predators—both birds and mammals (Gromov 1961; Andrews 1990; Smirnov et al. 1990). Generally, these accumulations at such localities correspond closely to the time when ancient people lived at a site, as the intervals of bone accumulation were relatively short. This has been confirmed by AMS (Accelerator Mass Spectrometer) dating of small bone samples (for example, separate rodent teeth) from cultural layers of archeological sites in North America (Graham and Grimm 1990). These data, therefore, can carry very important information about the age of cultural layers, as well as the environmental conditions near the sites.

KABAZI V

Thirteen species of *Rodentia* and *Insectivora* were identified in nine levels, corresponding to 4 archeological complexes, at Kabazi V. Only one species, the yellow steppe lemming *Eolagurus luteus*, was present in the lower Level III/3 (Table 4-1). This species is typical of desert, semi-desert, and dry steppic landscapes (fig. 4-1). Presently, *Eolagurus luteus* inhabits the Zaisan Depression in Middle Asia, in N-W China and Interior Mongolia, where it is found on the plain and low mountain desert and semi-desert areas (Gromov and Erbaeva 1995). In the Late Pleistocene, during the Valdai Glaciation, the range of yellow lemming was very wide and covered the vast territories of Northern Eurasia (Markova et al. 1996). It still remained rather widespread during the Holocene, and even in the 19th century existed in the Lower Volga River drainage basin and in Kazakhstan deserts. The remains of the *Eolagurus* genus were found in different localities of the southern and central Russian Plain from the Lower Pleistocene through Late Pleistocene, during both interglacials and glacials, in steppe mammal communities of different types. Gromov (1961) described this species from several Paleolithic and Mesolithic sites of the Crimean Mountains. The presence of this species in the lower layer of Kabazi V indicates an open semi-desert or dry steppic environment near the site.

Kabazi V, Level III/2 is characterized by three species of *Rodentia* (Table 4-1): little suslik *Spermophillus pygmaeus*, yellow steppe lemming *Eolagurus luteus,* and common vole *Microtus arvalis obscurus*. *Eolagurus* and *Spermophillus pygmaeus* prefer open landscapes, and now inhabit the south-east Russian Plain and northern regions from the Caspian Sea and Kazakhstan. They prefer semi-desert and southern steppic landscapes, and live on plains as well as in low mountains. *Microtus arvalis obscurus* presently inhabits meadow-steppe biotopes, and is currently distributed throughout the Crimean and Caucasus Mountains, the Volga-River basin, and the Urals (fig. 4-2) (Malygin 1983; Zagaradniuk 1991). The presence

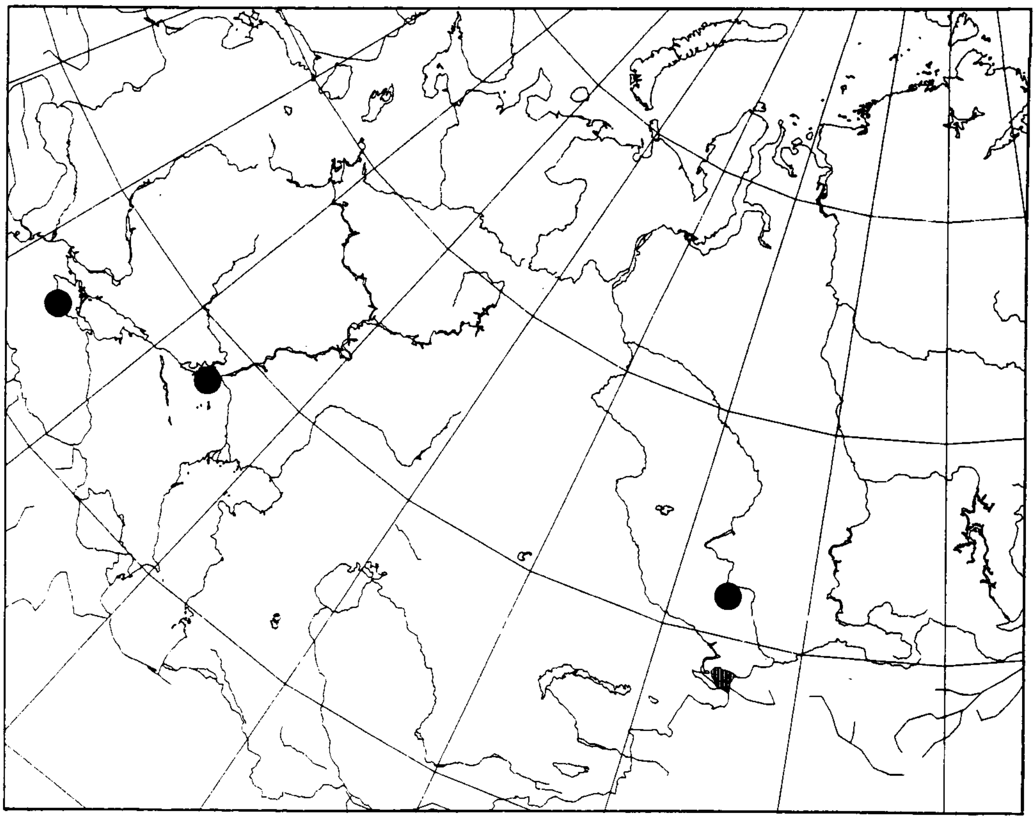


Fig. 4-1—Early Valdai localities (black circles) and modern range (crosshatched areas) of *Eolagurus luteus*.

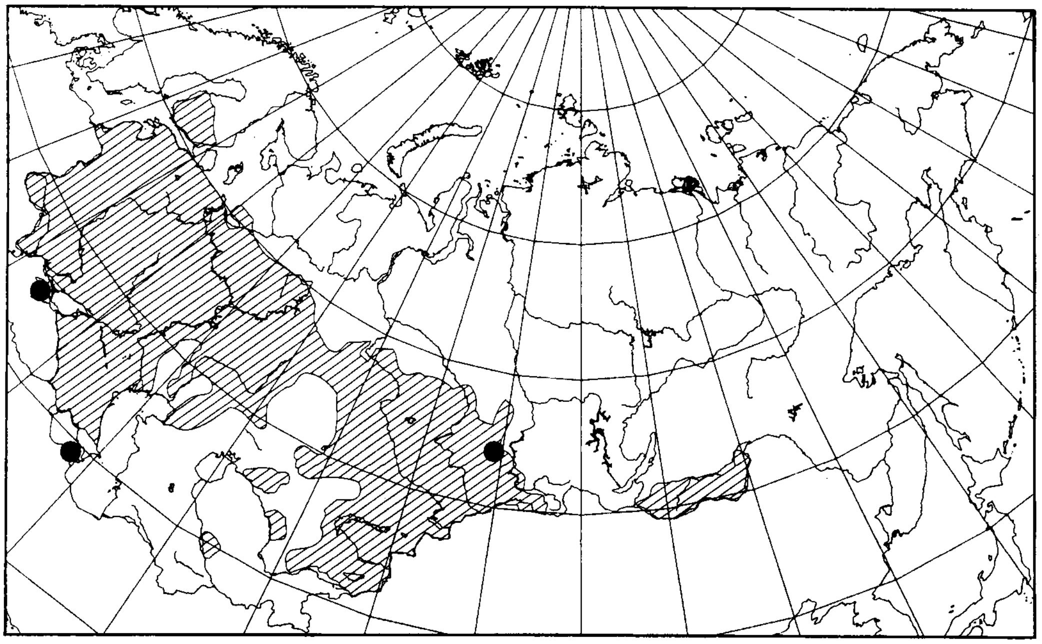


Fig. 4-2—Early Valdai localities (black circles) and modern range (crosshatched areas) of voles of *Microtus arvalis* group.

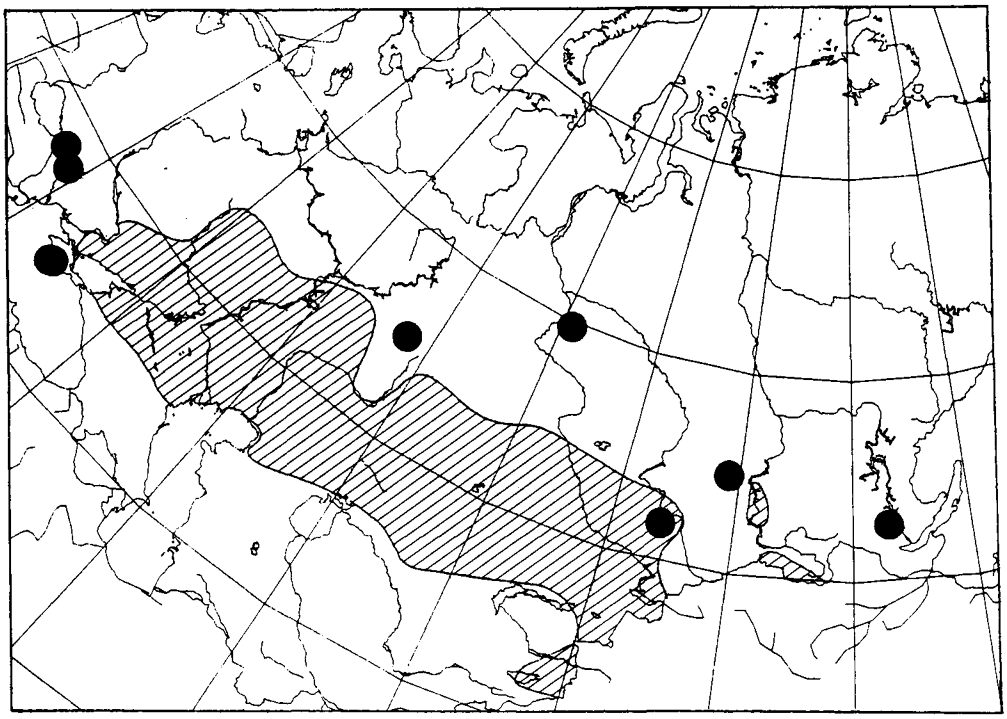


Fig. 4-3—Early Valdai localities (black circles) and modern range (crosshatched areas) of *Lagurus lagurus*.

of these three species definitely points to the presence of open environments near the site during the formation of Level III/2.

During the formation of the upper Level III/1a and Level III/1, the same type of landscapes continued to exist. In Level III/1a, the remains of two typical steppe species were distinguished: little suslik and steppe lemming *Lagurus lagurus*. The latter species (and its ancestral forms) was very characteristic of open landscapes of different types, periglacial as well as warm steppes of interglacials (Markova 1982a; Recovets 1994). During the Valdai Glacial (Early Valdai and Late Valdai), steppe lemmings were widely distributed in the Northern Hemisphere (fig. 4-3). In Level III/1, the remains of little suslik, yellow steppe lemming, common vole, and narrow-skulled vole *Microtus (Stenocranius) gregalis* were found (Table 4-1). *M. gregalis* now lives in different types of open landscapes (tundra and steppe). Narrow-skulled voles are indifferent to low temperatures. During the Valdai Glacial, their range was very wide, and *M. gregalis* was one of the characteristic members of the mammoth faunal complex (Markova 1982b; Baryshnikov and Markova 1994). At the present time, its range is in tundra and steppe zones.

During the time of following unit's (Level II/4a) deposition, the environmental conditions became more moderate. The presence of substantial *Microtus arvalis obscurus* remains and the bones of water vole *Arvicola terrestris* demonstrate changing environmental conditions. The remains of a single northern mole-vole *Ellobius talpinus* in Level II/4a is interesting; this mammal prefers open steppe and forest steppe landscapes (figs. 4-4, 4-5). In Level II/3, the tooth of great jerboa *Allactaga major* was found. This animal is typical of steppe, forest-steppe, and semi-deserts; it is distributed on the southern Russian Plain, in Crimea, and in western Siberia (figs. 4-6, 4-7a). In the same level, remains of grey hamster *Cricetulus migratorius* were also identified (fig. 4-7a-c). This species now inhabits open landscapes of different types; its modern range includes the central and southern Russian Plain, Crimea, and Middle Asia.

As a whole, moderate conditions were maintained during the deposition of Levels II/4, II/

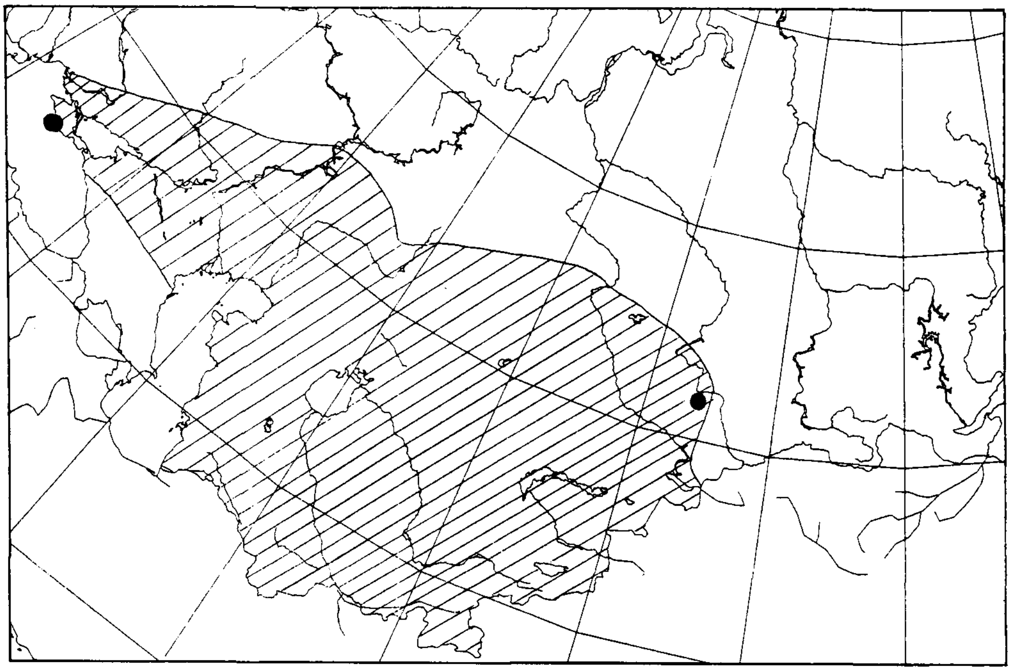


Fig. 4-4—Early Valdai localities (black circles) and modern range (crosshatched areas) of *Ellobius talpinus*.

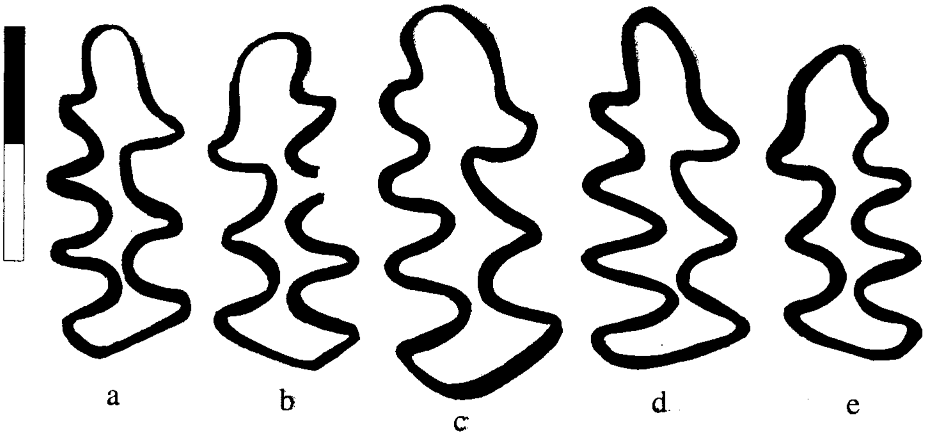


Fig. 4-5—Occlusal surface of M_1 of *Ellobius talpinus* from Starosele: *a-d*–Level 1; *e*–Level 3.

3-4, and possibly, Level II/3. This is indicated by the presence of forest species such as yellow-necked mouse *Apodemus flavicollis*, Eurasian mole *Talpa* sp., and a substantial quantity of *Microtus arvalis obscurus*. *Apodemus flavicollis* is a typical dweller of broad-leaved forests, distributed on plains as well as in mountains (figs. 4-8, 4-9). Its preferred foods are the nuts of beeches, acorns of oaks, hazels-nuts, and the seeds of lime-trees and maples. The near-absence of *Eolagurus luteus* remains and low numbers of *Lagurus lagurus* and *Spermophillus* bones confirm this conclusion of a moderation of climate at this time. However, the presence of such typical steppe species as the great jerboa, little suslik, grey hamster, and steppe lemming is prolonged, and make up a significant portion of the species composition even at this time.

In sum, during Levels III/3-III/1, practically only steppe species of small mammals existed

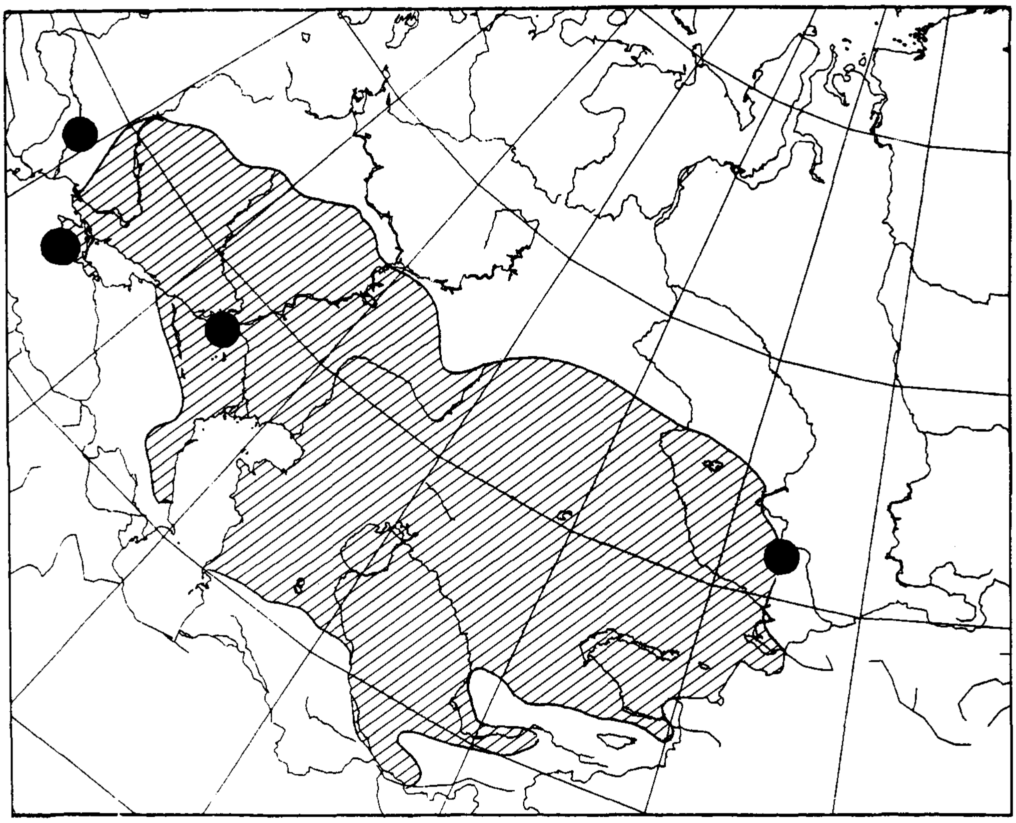


Fig. 4-6—Early Valdai localities (black circles) and modern range (crosshatched areas) of *Allactaga major.*

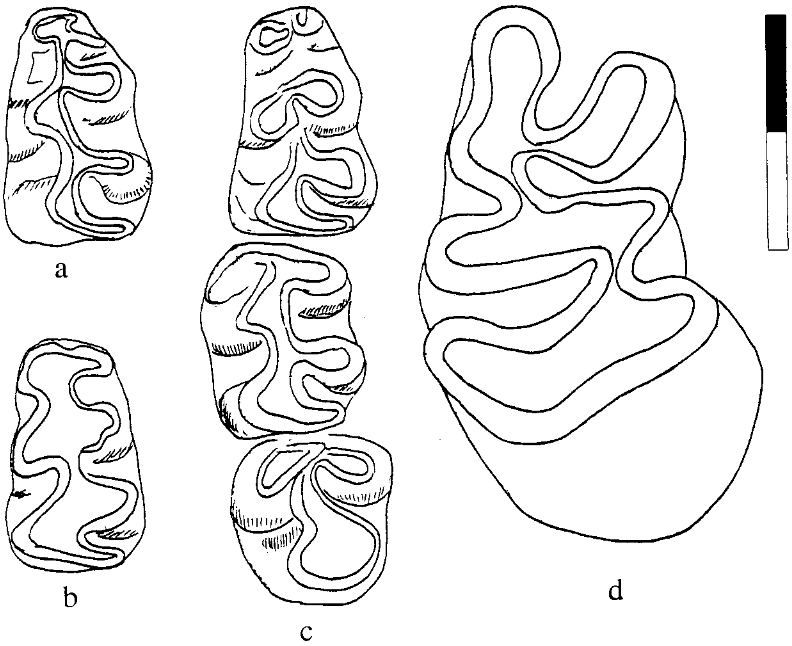


Fig. 4-7—Occlusal surface of teeth of *Cricetulus migratorius* and *Allactaga major* from Starosele: *a-b*–M^1; *c*–M_1-M_3 of *C. migratorius*; *d*–M_1 of *A. major.*

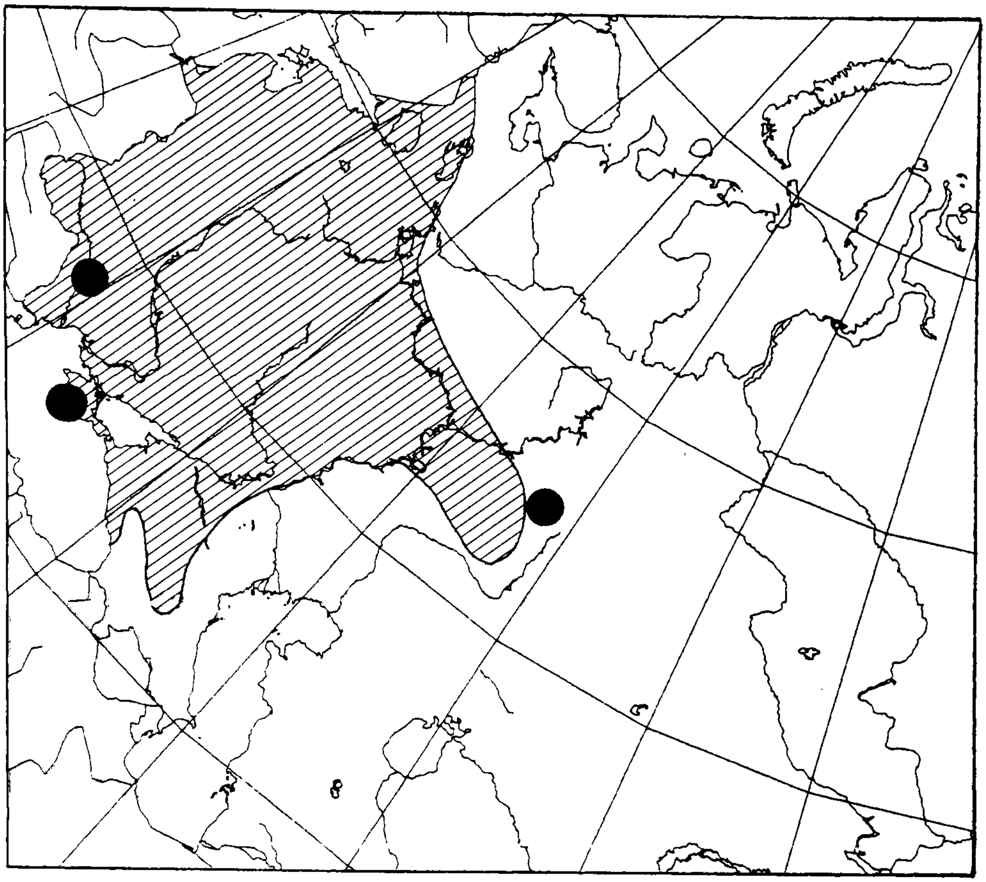


Fig. 4-8—Early Valdai localities (black circles) and modern range (crosshatched areas) of *Apodemus flavicollis*.

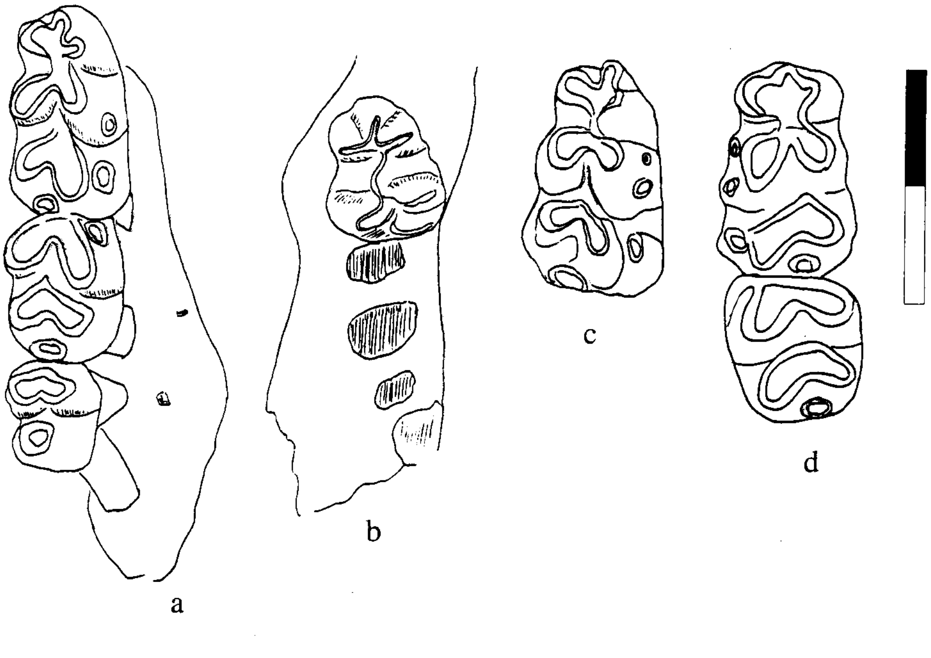


Fig. 4-9—Occlusal surface of teeth of *Apodemus flavicollis* and *Sicista subtilis* from Starosele: *a*–M_1-M_3 of *A. flavicollis*, Level 2; *b*–M_1 of *Sicista subtilis*, Level 2; *c*–M_1; *d*–M_1-M_2 of *A. flavicollis*, Level 1.

near Kabazi V, and it is possible to reconstruct the steppe landscapes surrounding the site. The environment noticeably changed—becoming more moderate—during the deposition of Levels II/4a-II/3. In this time, according to the small mammal data, a mosaic of forest and steppe biotopes existed near the site, in spite of the location of this site on the sunny slope of Kabazi Mountain and 100 m above the Alma River.

STAROSELE

The remains of small mammals were found in 5 layers (in all 4 archeological levels and 1 sterile layer) of Starosele.

The bones of only one species, *Microtus arvalis obscurus,* were present in the lowermost level, Level 4 (Table 4-2). As discussed above, this species presently prefers meadow-steppe conditions.

Four species were found in the culturally sterile layer between Levels 4 and 3. Two of these are typical steppe animals: grey hamster *Cricetulus migratorius* and northern mole-vole *Ellobius talpinus.* The presence of water vole *Arvicola terrestris* points to the nearness of a water basin. This species has intrazonal range and inhabits periaquatic biotopes of wide areas of Eastern Europe, from steppe to forest-tundra zones. The location of the site on the right bank of Kanly-Dere Valley, only 11 m above the bottom of the canyon, is reflected in the species composition of the small mammals. The ecological characteristics of other species from Level 3 definitely indicate the wide distribution of steppe environments near the site.

It is possible that in Level 2, deposition occurred under somewhat more moderate climatic conditions. The remains of northern mole-vole were not found in this level. Two of the species present in Level 2 prefer open landscapes: grey hamster *Cricetulus migratorius* and steppe lemming *Lagurus lagurus. Microtus arvalis obscurus* inhabits meadow and steppe biotopes, *Arvicola terrestris* inhabits hydromorphic biotopes. The number of small mammal remains in this level is rather low, and this reconstruction, therefore, is rather tentative.

A richer small mammalian fauna was found in Level 1. Here, eight species were distinguished. The faunal list includes two forest species: yellow-necked mouse *Apodemus flavicollis* and Eurasian mole *Talpa sp.* Other species besides *Arvicola terrestris* and *Microtus arvalis obscurus* prefer open habitats. They include the little suslik, steppe sicista, grey hamster, and northern mole-vole. It is significant that there are no remains of steppe lemming found here, which were present in Levels 2 and 3. Forested, as well as open steppe-like biotopes, were distributed near Starosele during the formation of Level 1. The ranges of bush and forest vegetation are possibly connected with the better watered depression of the valley. Steppe animals were distributed on higher and drier slopes. These environmental changes are probably connected with climatic warming (possibly with the Bryansk Interstadial).

CONCLUSIONS

During the present day in the mountainous part of Crimea, 14 species of rodents (including *Rattus* and *Ondatra* which appear only in Holocene and historical times) and 6 species of insectivores exist (Flint et al. 1970; Panteleev et al. 1990; Gromov and Erbaeva 1995). The remains of ten species of *Rodentia* and two species of *Insectivora* were identified from Kabazi V and Starosele. Kabazi II, unfortunately, produced small mammal remains only in one archeologically sterile horizon. No lagomorphs were found in the sites (one species is present today). Several of the *Rodentia* species have now disappeared from the Crimean Mountains, including *Eolagurus luteus* and *Microtus gregalis.* These species were very well adapted to various periglacial open landscapes widely distributed during the Valdai glaciation in the Northern Hemisphere.

Modern species currently inhabiting the Crimean Mountains, such as *Sciurus vulgaris* and *Mus musculus*, were not found in the cultural layers at Kabazi V or Starosele. Their absence may be connected with the generally infrequent recovery of the remains of fossil small mammals, as well as with changing mammal ranges during the Late Pleistocene and Holocene due to climatic fluctuations. *Sciurus vulgaris* is a typical forest mammal. In sub-arctic and forest zones, *Mus musculus* prefers to inhabit human buildings. It is also abundant in steppe and semi-desert "wild" biotopes.

Most of the species present in the cultural layers of Kabazi V and Starosele prefer to inhabit open landscapes. However, definite differences are noticeable between the small mammal fauna of Kabazi V and Starosele, as well as the fauna of different layers of each site. As a whole, the local small mammal fauna from all the levels of Starosele reflect the proximity of a wet biotope connected with the valley depression. The position of Kabazi V at a significant height above the river basin and on the sunny slope of Kabazi Mountain is expressed by another species composition lacking periaquatic species.

Definite changes in species composition of different levels of every site can also be seen. This allows elucidation of the main environmental fluctuations most likely caused by climatic changes.

The changes in natural conditions expressed in the moderation of steppe environments are

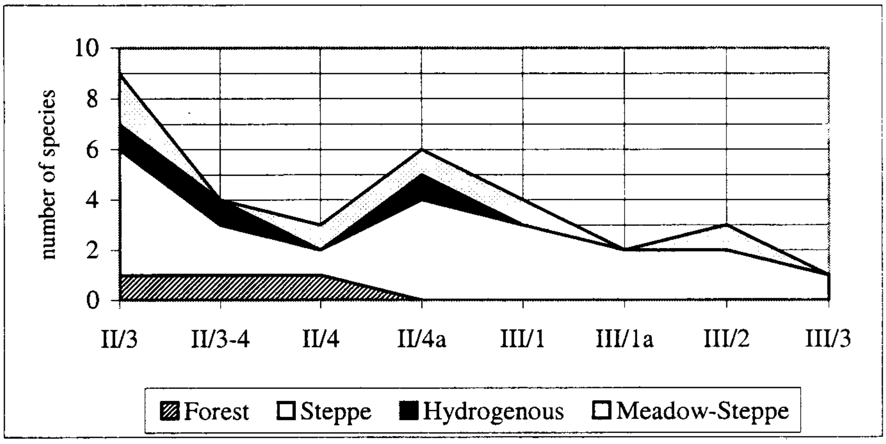


Fig. 4-10—Kabazi V, ecological groups of small mammals.

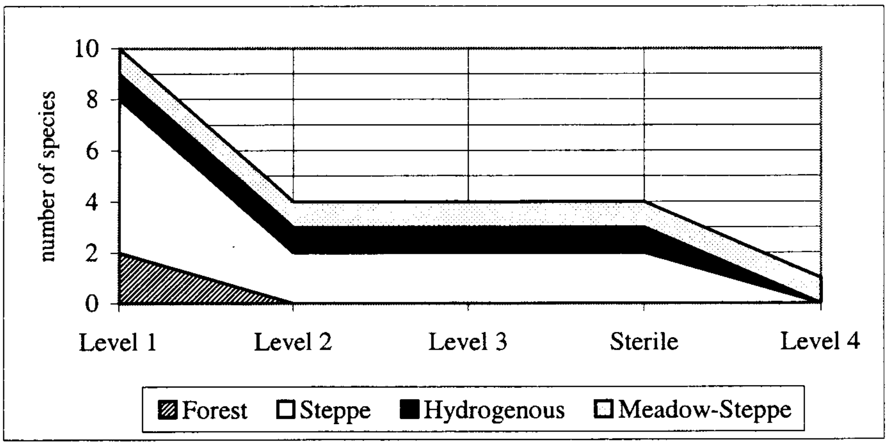


Fig. 4-11—Starosele, ecological groups of small mammals.

seen in the time after the formation of Kabazi V, Levels III/3-III/I and the deposition of Levels II/4a-II/3, when forest-steppe landscapes were distributed around the site (fig. 4-10). These environmental changes probably were connected with the interglacial warming of Middle Valdai time, possibly with the Grazhdansky Interstadial of the Russian Plain, dated to 40-50,000 BP (Faustova and Velichko 1992). Serebryanny (1978), however, identified this warming period as an interglacial.

Analysis of small mammal fauna from Starosele shows that the noticeable changes in species composition correspond to Levels 2 and 1. Earlier (during the formation of Levels 3 and 4), the principal types of biotopes near the site were open steppe-like landscapes. Later, when Levels 2 and 1 were deposited, more temperate conditions prevailed. The presence of small forest mammals signals this change (fig. 4-11). This moderation of the climate possibly can be correlated with the beginning of Bryansk Interstadial warming (Velichko 1973; Serebryanny 1978).

SYSTEMATIC DESCRIPTION

Rodentia - rodents
Cricetidae Fischer, 1817
Arvicolinae Gray, 1821

Microtus (Microtus) arvalis obscurus (Eversmann, 1941) – common vole

Material

Kabazi V—58 M_1,14 M_2, 4 M_3, 26 M^1, 19 M^2, 8 M^3.
Starosele—61 M_1, 9 M_2, 6 M_3, 38 M^1,16 M^2, 8 M^3.

Description

The teeth are relatively large in size, without roots, with cement. The enamel is differentiated in a "microtus" way.

M_1 has 7 well-distinguished dentine fields. The angles in the base of the anteroconid complex are usually separated (fig. 4-12c, d, f, h, j-k, o-r), sometimes broadly confluent (fig. 4-12a, b, e, g, n). M_1 has an "arvalis" morphotype with anterior cap that varies from a simple "arvalis" form (fig. 4-12a-c, f) to a "mushroom" form (fig. 4-12d, e, k). The neck of the anterior cap is usually narrow. The teeth are rather big (Table 4-3).

M^3 has separate dentine surfaces on the occlusal surface. The form of the posterior loop varies from a trefoil to "mushroom" form (fig. 4-13). The measurements of the upper third molars are presented in Table 4-4.

Comparison

The *Microtus* teeth from Kabazi V and Starosele were compared to five modern species: (1) *Microtus* from Crimea national park (Crimean Mountains); (2) *Microtus arvalis arvalis* from the Tver' district; (3) *Microtus rossiaemeridionalis* from the Tver' district; (4) *Microtus agrestis*; and (5) *Microtus socialis* from the southern Russian Plain.

The sizes of *Microtus* teeth from Kabazi V and Starosele are most similar to modern Crimean *Microtus*. They differ from *M. rossiaemeridionalis* by their larger size (Tables 4-3,

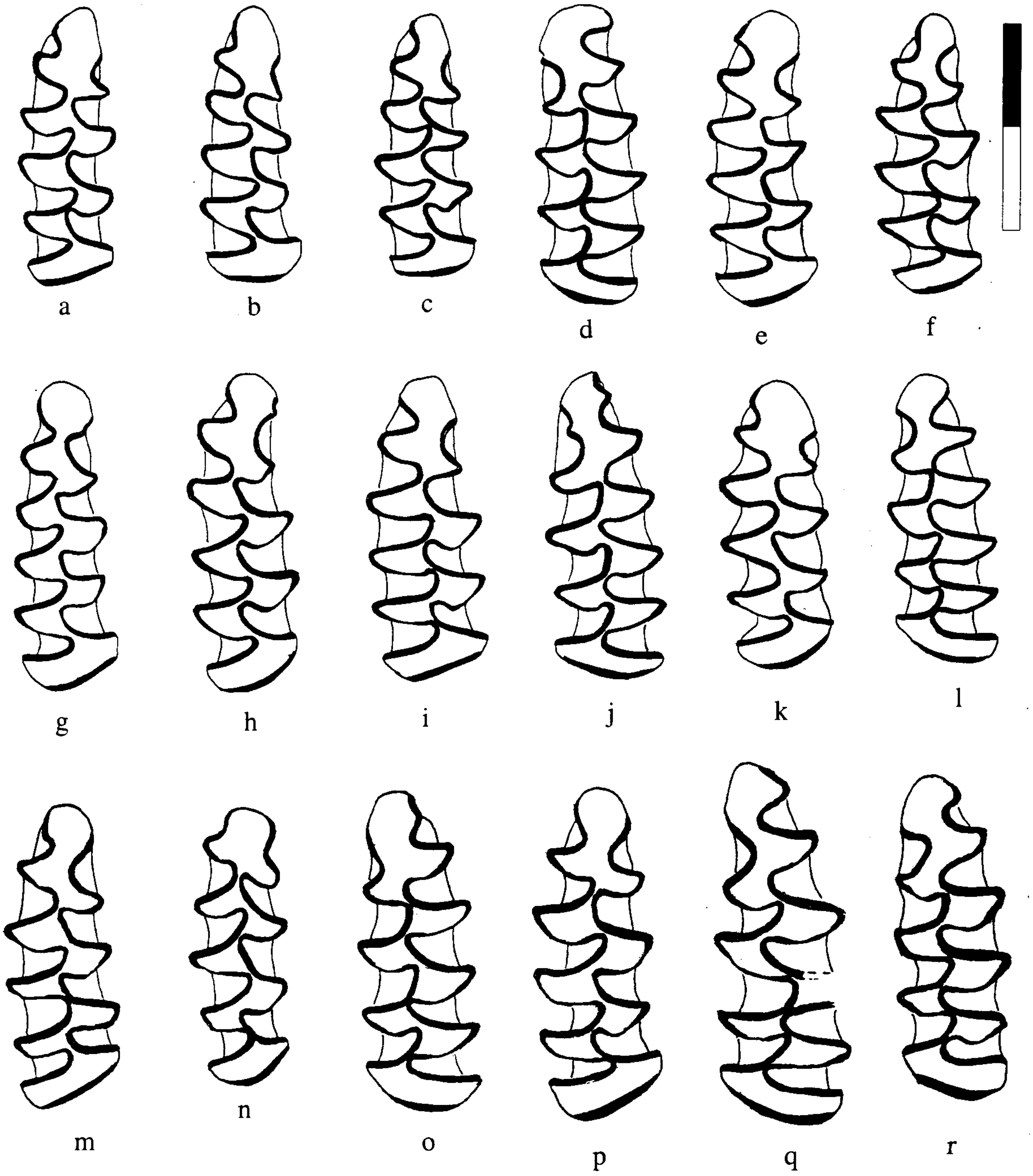


Fig. 4-12—Occlusal surface of M_1 *Microtus arvalis obscurus*: *a-l*–Starosele, Level 1; *m-r*–Kabazi V, Level II/3.

4-4) and the more asymmetrical anteroconid complex (most of the M_1 of *M. rossiaemeridionalis* has the anteroconid complex with trefoil anterior cap). In addition, the M^1 and M^2 of *M. rossiaemeridionalis* are always without additional angles in the posterior part of the teeth. Crimean voles sometimes have the tendency of complication of the posterior part of these teeth.

The teeth of Crimean voles are distinguished from the teeth of modern *Microtus socialis* (collections of the Zoological Museum of Moscow University) by: (1) larger sizes; and (2) by the absence of the additional angle on the posterior part of M^2, which is always present on the *Microtus socialis* second upper molar.

The Crimean remains are distinguished from the teeth of *Microtus agrestis* (collections of

TABLE 4-3

Measurements of M_1 of Recent *Microtus* from the Russian Plain and Crimea, and *Microtus arvalis obscurus* from Kabazi V and Starosele (in mm)

			Length						Width			
	N	$\bar{X}$	Min	Max	S.E.	S.D.	N	$\bar{X}$	Min	Max	S.E.	S.D.
Microtus arvalis obscurus (Kabazi V, Level II/3-4, Sq.10A)	10	2.85	2.50	3.05	0.057	0.171	10	1.03	1.00	1.10	0.010	0.035
Microtus arvalis obscurus (Kabazi V, Level II/3, Sq. 12B)	17	2.87	2.50	3.30	0.480	0.205	17	1.04	0.95	1.10	0.010	0.044
Microtus arvalis obscurus (Starosele, level1)	30	2.86	2.50	3.25	0.041	0.227	30	1.07	0.90	1.20	0.014	0.077
Microtus arvalis obscurus (Crimean Mts., modern)	15	2.61	2.45	2.80	0.029	0.113	15	0.99	0.90	1.00	0.007	0.028
Microtus arvalis arvalis (Tver' district, modern)	12	2.52	2.45	2.60	0.013	0.044	12	0.93	0.80	1.00	0.015	0.065
Microtus rossiaemeridionalis (Ndth' district, modern)	35	2.51	2.25	2.80	0.018	0.105	35	0.92	0.85	1.00	0.007	0.044
Microtus agrestis (Carpathian Mts.)	5	2.69	2.50	2.80	0.053	0.019	5	1.04	1.00	1.05	0.010	0.022
Microtus socialis (Southern Russian Plain)	15	2.54	2.30	2.75	0.028	0.105	15	0.93	0.85	1.00	0.013	0.050

TABLE 4-4

Measurements of M^3 of Recent *Microtus* from the Russian Plain and Crimea, and *Microtus arvalis obscurus* from Kabazi V and Starosele (in mm)

			Length						Width			
	N	$\bar{X}$	Min	Max	S.E.	S.D.	N	$\bar{X}$	Min	Max	S.E.	S.D.
Microtus arvalis obscurus (Starosele, Level 1)	5	2.14	2.10	2.30	0.055	0.111	5	0.98	0.95	1.00	0.012	0.027
Microtus arvalis obscurus (Crimean Mts., modern)	15	1.79	1 60	2.10	0.034	0.130	15	0.89	0.80	0.95	0.011	0.042
Microtus arvalis arvalis (Tver' district, modern)	12	1.64	1.55	1.80	0.024	0.085	12	0.82	0.70	0.90	0.017	0.058
Microtus rossiaemeridionalis (Tver' district, modern)	35	1.69	1.45	1.95	0.190	0.112	33	0.87	0.70	0.95	0.009	0.055
Microtus agrestis (Carpathian Mts.)	5	1.87	1.60	2.00	0.077	0.177	5	0.94	0.90	1.00	0.024	0.055
Microtus socialis (Southern Russian Plain)	14	1.71	1.60	1.85	0.021	0.079	14	0.85	0.75	0.90	0.013	0.048

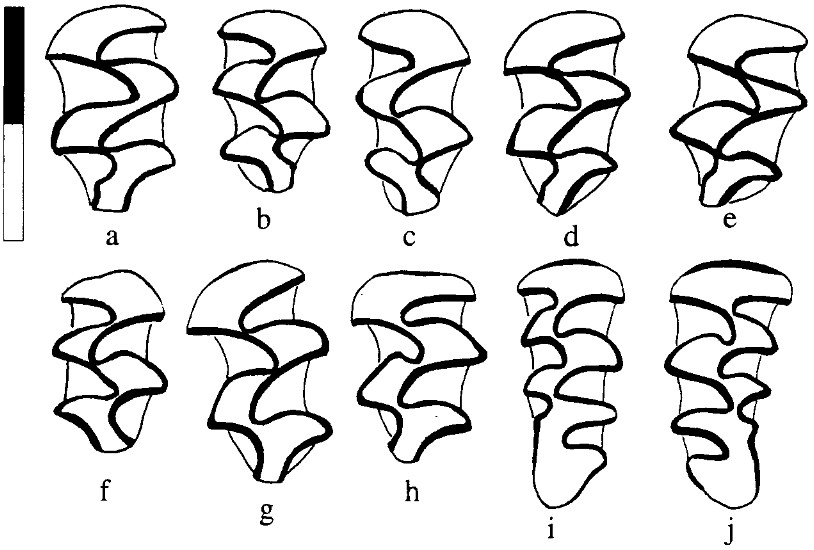


Fig. 4-13—Occlusal surface of M^2 and M^3 *Microtus arvalis obscurus*: *a-f*–M^2, Kabazi V, Level II/3; *g-h*–M^2; *i-j*–M^3, Starosele, Level 1.

the Zoological Museum of Moscow University) by the absence of an additional prism on second upper molars. The sizes of teeth of *Microtus agrestis* and Crimean *Microtus* are close (Tables 4-3, 4-4). The anteroconid complex of M_1 of *M. agrestis* has a more complicated form, with additional internal angles on the anterior cap and a well-pronounced asymmetrical structure of the tooth.

Comparison with the teeth of modern *Microtus arvalis arvalis* (karyotyped) from the Tver' district shows that the latter have a more simple structure of the first lower and upper third teeth, and tooth size is also smaller than Crimean voles (Tables 4-3, 4-4).

According to recent data, the polytypic species *Microtus arvalis* (common vole) includes not less than 45 subspecies and not less than 5 species distinguished by karyotype (Malygin 1983; Gromov and Erbaeva 1995; Pavlinov et al. 1995). Genetic analysis has allowed the revision of Eurasian forms of *Microtus arvalis* (with 2n=46; NF=56) (Malygin 1983; Zagaradniuk 1991), distinguishing several species: *M. kirgisorum* (2n=54; NF=80); *M. rossiaemeridionalis* (2n=54; NF=56); *M. transcaspicus* (2n=52; NF=54); and *M. kermalinsis*. The rank of the Crimean subspecies *Microtus arvalis obscurus* (2n=46; NF=72), which also now inhabits the Caucasus, the Ural Mountains, and Siberia, is debated. Dr. Zagaradniuk (1991) attributed this form to a separate species; but according to Malygin (1983) and Pavlinov et al. (1995), this form is a subspecies of *Microtus arvalis*, since it easily mates with *M. arvalis arvalis* and produces fecund progeny.

From the present study, it is possible to distinguish significant morphological differences between Crimean *Microtus* and the subspecies of *Microtus arvalis*, as well as between *Microtus agrestis* and *M. socialis*. This indicates the significant antiquity of the Crimean form (*M. a. obscurus*) which was common during the first part of the Late Pleistocene.

Lagurus lagurus (Pallas, 1773) – steppe lemming

Material

Kabazi V—1 M_3, 1 M^2 (Level II/4a); 1 M_2 (Level II/3-4); 1 M_2 (Level II/3); 6 M_1, 5 M_2, 2 M_3, 4 M^1, 2 M^2, 1 M^3 (Level III/1A).

Starosele—2 M_1, 2 M_2 (Level 2); 2 M_3 (Level 3).

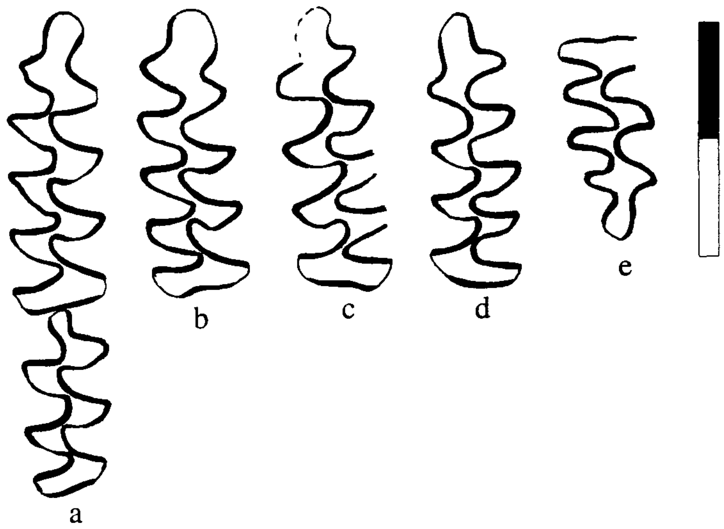


Fig. 4-14—Occlusal surface of *Lagurus lagurus* teeth: *a*–M_1 and M_2, Starosele, Level 2; *b-d*–M_1; *e*–M^3, Kabazi V, Level III/1a.

Description

Uncemented, unrooted vole with well-differentiated enamel.

The first lower molar M_1 has 7 separated dentine fields on the occlusal surface. The anterior cap usually has a trefoil form (fig. 4-14a-d). The "walls" of the anterior loop are parallel (fig. 4-14d) or closed at the base (fig. 4-14a-c).

The third upper molar of *Lagurus* has 5 dentine fields. The posterior angle has a trefoil configuration (fig. 4-14e).

The teeth are larger than modern *Lagurus lagurus* from different parts of the Russian Plain and Kazakhstan. The Crimean fossil teeth are also bigger than the teeth of *Lagurus ex gr. lagurus* from several Late Pleistocene and Middle Pleistocene localities of the Russian Plain (Table 4-5). This appears to be specific to the Crimean Mountains population; the significantly larger tooth size of *Lagurus* from Late Pleistocene-age Crimean sites in comparison to modern *Lagurus* was noted by I. M. Gromov (1961).

Comparison

The morphology and the sizes of the M_1 and M^3 identify the remnants of steppe lemmings from Kabazi V and Starosele as *Lagurus lagurus*. The ancestral form of *Lagurus lagurus* - *L. transiens* has an anteroconid complex of M_1 and posterior part of M^3 with weakly separated dentine fields. The anteroconid complex of *L. transiens* never has the walls closed at the base of the anterior cap and usually has the walls broaden in this direction. The morphological

TABLE 4-5
Measurements of M_1 of Steppe Lemming *Lagurus lagurus* from Kabazi V and Starosele, and some Modern and Pleistocene *Lagurus lagurus* (in mm)

Age	*Site*	*Location*	*Length* *N*	*Length* *X̄*	*Length* *Min*	*Length* *Max*	*Width* *N*	*Width* *X̄*	*Width* *Min*	*Width* *Max*
Late Pleistocene	Kabazi V/95	Crimean Mts.	6	2.73	2.60	2.80	6	0.90	0.85	0.95
Late Pleistocene	Starosele/94	Crimean Mts.	1	2.55	—	—	1	0.85	—	—
Late Pleistocene (Briansk Interstadial)	Arapovichi[1]	Upper Dnieper basin	18	2.41	2.20	2.65	18	0.86	0.75	1.15
Late Pleistocene (Mikulino Interglacial)	Malyutino[1]	Seim River basin	16	2.43	2.40	2.75	16	0.87	0.70	0.95
Late Middle Pleistocene (Kamenka Interglacial)	Priluki[1]	Sula River basin	15	2.52	2.40	2.75	15	0.86	0.75	1.00
Late Middle Pleistocene (Likhvin Interglacial)	Gun'ki II[1]	Psel River basin	48	2.35	2.10	2.65	50	0.84	0.65	1.05
Modern	Moscow Zool. Museum	Riasan' and Voronezh districts	47	2.27	2.20	2.60	51	0.80	0.75	0.90
Modern	Moscow Zool. Museum	Southern Ukraine	20	2.32	2.15	2.55	20	0.80	1.00	0.90
Modern	Moscow Zool. Museum	Astrakhan steppe, W. Kazakhstan	20	2.48	2.00	2.75	20	0.87	0.80	0.95
Modern	Moscow Zool. Museum	Kazakhstan	30	2.38	2.20	2.63	35	0.80	0.65	1.00

[1] collections of A.K. Markova (Inst. of Geography RAS)

TABLE 4-6
Measurements of M_1 of Yellow Steppe Lemming *Eolagurus luteus* (in mm)

Age	*Site*	*N*	*L*	*W*	*A*	*B*	*C*	*A/L x 100*	*B/L x 100*	*C/L x 100*
Late Pleistocene	Kabazi V/95, III/3	1	3.15	1.10	1.75	0.050	0.060	55.00	1.60	1.90
Late Pleistocene	Kabazi V/95, III/4a, 8D	1	3.30	1.40	1.75	0.060	0.070	53.00	1.82	2.12
Late Pleistocene	Starosele/95, Lev. 1	1	3.25	1.35	1.70	0.050	0.060	52.00	1.54	1.85
Late Pleistocene (Mikulino Interglacial)	Shkurlat[1]	8	3.05	1.12	1.61	0.050	0.050	55.00	1.67	1.70
Late Middle Pleistocene (Likhvin Inter.)	Gun'ki II[1]	17	2.93	1.08	1.54	0.083	0.094	52.27	2.90	3.20
Late Middle Pleistocene (Likhvin Inter.)	Chigirin[1]	11	2.97	1.07	1.55	0.078	0.099	52.36	2.66	3.50
Early Middle Pleistocene	Tikhonovka[1]	12	2.92	1.08	1.48	0.080	0.160	50.50	3.07	5.09
Early Pleistocene	Karai-Dubina[1]	30	2.77	1.01	1.39	0.070	0.190	50.20	2.90	7.03

[1] collections of A.K. Markova (Inst. of Geography RAS)

(*L*)-Length; (*W*)-Width; (*A*)-Length of anteroconid; (*B*)-Width of "neck" of anterior loop; (*C*)-Width of confluence of angles in the base of anteroconid.

changes of the *Prolagurus-Lagurus* phyletic lineage are now well described (Markova 1975 1982).

There are currently four subspecies of *Lagurus lagurus* known: *L. l. agressus,* distributed in the central and southern Russian Plain; *L. l. lagurus*, in Ukraine, North Caucasus, Volga-Ural semideserts, and in Kazakhstan; *L. l. altorum,* in Middle Asia and China; and *L. l. abacanicus,* in the Abacan River drainage basin (Gromov and Erbaeva 1995).

The absence of *L. transiens* morphotypes among *Lagurus* teeth confirms the Late Pleistocene age of fauna from Kabazi V and Starosele. The morphological features of the Crimean *Lagurus* teeth are very similar to the typical modern *Lagurus lagurus* and Late Pleistocene steppe lemming teeth.

Eolagurus luteus (Eversmann, 1842) – yellow steppe lemming

Material

Kabazi V—1 M_1, 1 M^1, 1 M^2 (Level II/4a); 1 lower mandible (Level III); 1 M_1, 1 M_3 (Level III/1); 1 M_1 (Level III/2); 1 M_1, 1 M_2 (Level III/3).

Starosele—there are no remains of *Eolagurus* at this site.

Description

Uncemented, unrooted vole, with well-differentiated enamel and with rather large sizes.

The first lower molar has 7 dentine fields and an asymmetrical anterior angle. The dentine fields in some cases are rather broadly confluent (fig. 4-15a), and in others are separated (fig. 4-15c-d). The sizes of M_1 are presented in Table 4-6.

Comparison

The remains of this species are significantly larger than the remains of steppe lemming *Lagurus.*

Previous analysis of the M_1 of yellow steppe lemmings from different Pleistocene localities in Eastern Europe revealed several significant characteristics that are most important in distinguishing the evolutionary level: the length of tooth, the ratio A/L, and the values of the width of the interfluence between the angles in the base of the anteroconid (Agadjanian and Markova 1984). From these features, it is possible to correlate the *Eolagurus* species with the stratigraphic scheme. As is readily visible by the measurements presented in Table 4-6, the Crimean yellow steppe lemmings belong to the most progressive group of Pleistocene *Eolagurus* and are well distinguished from earlier yellow steppe lemmings of Middle and Early Pleistocene localities of the Russian Plain.

Given the morphological structure and sizes of teeth, the remains of *Eolagurus* from Kabazi V can be described as *E. luteus.*

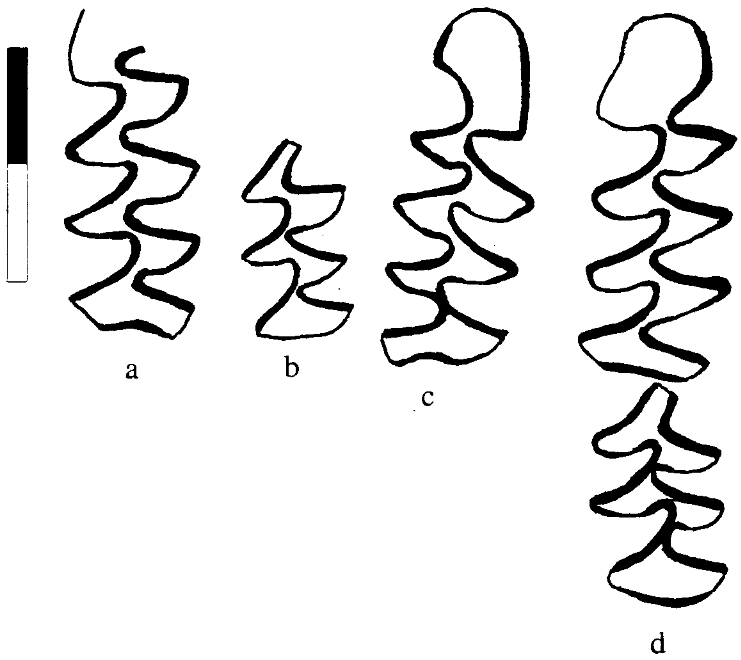


Fig. 4-15—Occlusal surface of teeth of *Eolagurus luteus*: *a*–M_1; *b*–M_2, Kabazi V, Level III/1; *c*–M_1, Kabazi V, Level III/2; *d*–M_1 and M_2, Kabazi V, Layer III/3.

Arvicola terrestris Linnaeus (1758) – water vole

Material

Kabazi V—1 M^1 (Level II/4a); 1 M^1 (Level II/3).

Starosele—3 M^1, 5M^2, 1 M^3, 5 M_1, 5 M_2, 2 M_3 (Level 1); 1 M_1 (Level 2); 2 M_1, 2 M^2, 1 M_3, 2 fragments of mandibles (Level 3); 1 M_1, 1 M_2, 1 M^1 from the sterile horizon between Levels 3 and 4.

Description

Arvicola has an unrooted, cemented vole with a large size and massive structure of teeth. The enamel is differentiated by "microtus" type.

There are 5 dentine fields on the M_1 occlusal surface (fig. 4-16a-c). The anteroconid complex has a rather simple trefoil structure without additional angles.

The third upper molar has 4 dentine fields on the occlusal surface and a simple asymmetrical posterior angle (fig. 4-16d). The sizes of M_1 and enamel coefficient K (value of the ratio between the enamel thickness on the anterior part of all angles of the tooth and the posterior part of the angles) are presented in Table 4-7.

Comparison

Arvicola tooth remains from Starosele can be compared with the teeth of Late Pleistocene *Arvicola* by their dimensions (Table 4-8). The length and width of the M_1 of *Arvicola terrestris* from Starosele is significantly bigger than the M_1 of the Middle Pleistocene water

TABLE 4-7
Measurements of M_1 of *Arvicola terrestris* from Starosele (in mm)

	Length					*Width*					*Anteroconid Length*					*K*				
	N	$\bar{X}$	*Min*	*Max*	*S.D.*	*N*	$\bar{X}$	*Min*	*Max*	*S.D.*	*N*	$\bar{X}$	*Min*	*Max*	*S.D.*	*N*	$\bar{X}$	*Min*	*Max*	*S.D.*
Level 1	3	4.10	4.00	4.30	0.17	3	1.70	1.60	1.80	0.10	3	1.87	1.80	2.00	0.11	3	1.39	1.33	1.50	0.12
Level 3	1	4.25	—	—	—	1	1.70	—	—	—	1	2.10	—	—	—	1	1.25	—	—	—

TABLE 4-8
Measurements of M_1 of *Arvicola* from Starosele and Pleistocene Localities of the Russian Plain (in mm)

			Length				*Width*				*K*			
			N	$\bar{X}$	*Min*	*Max*	*N*	$\bar{X}$	*Min*	*Max*	*N*	$\bar{X}$	*Min*	*Max*
Late Pleistocene	Late Valdai	Troitsa II[1]	3	3.91	3.67	4.10	3	3.91	3.70	4.10	3	1.25	1.20	1.40
		Starosele, Level 1	3	4.10	4.00	4.30	3	1.70	1.60	1.80	3	1.39	1.33	1.50
		Starosele Level 3 & 3a	1	4.25	—	—	1	1.70	—	—	1	1.25	—	—
	Mikulino Interglacial	Shkurlat	3	3.72	3.50	4.00	3	1.65	1.50	1.80	3	1.94	1.67	2.50
		Malyutino	4	3.94	3.75	4.20	4	1.59	1.50	1.65	4	1.63	1.00	2.33
		Chernianka	4	4.00	3.80	4.20	4	1.55	1.50	1.60	4	1.00	0.90	1.11
		Novonekrasovka (up. layer)	18	3.84	3.50	4.10	18	1.66	1.50	1.75	18	1.15	0.67	1.66
		Novonekrasovka (lower layer)	14	3.78	3.60	4.00	14	1.66	1.50	1.75	14	1.08	0.91	1.67
Middle Pleistocene	Dnieper Glaciation	Igorevka	3	3.41	3.30	3.65	5	1.42	1.40	1.45	5	0.79	0.73	0.90
	Likhvin Interglacial	Gun'ki I	23	3.43	3.15	3.70	35	1.45	1.50	1.55	35	0.80	0.33	1.00
		Gun'ki II	12	3.38	3.20	3.45	9	1.49	1.30	1.65	12	0.47	0.33	0.83
		Chigirin	48	3.49	3.20	3.90	62	1.47	1.30	1.65	62	0.94	0.60	1.25
		Verkhnya Emancha	33	3.38	3.00	3.75	48	1.35	1.25	1.60	8	0.96	0.75	1.00

[1] Dated to 32,500±700; 26,860±300; 27,700±350 BP

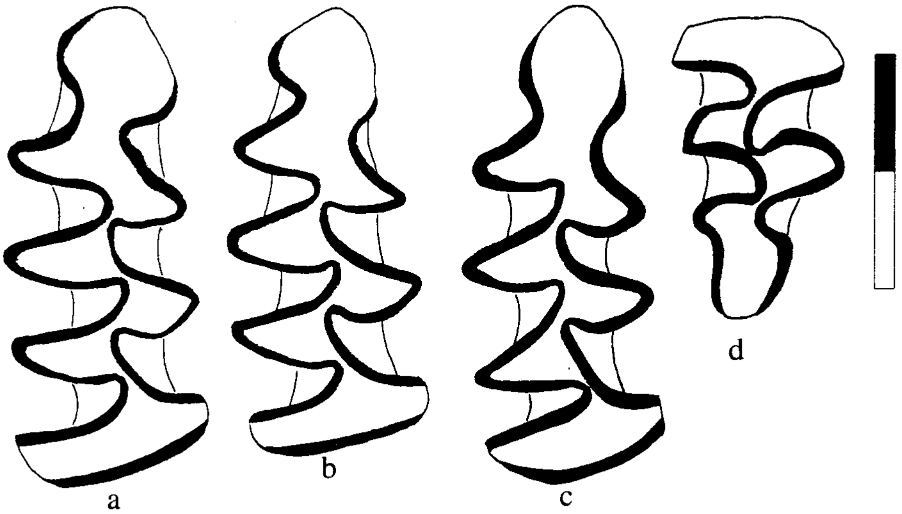


Fig. 4-16—Occlusal surface of teeth of *Arvicola terrestris* from Starosele: *a-b*–M_1. Level 1; *c*–M_1, Level 3; *d*–M^3, Level 1.

vole. It is also bigger than first lower molars of Mikulino *Arvicola* from various localities of the Russian Plain (Table 4-8).

One of the most important characteristics to identify the evolutionary level of water voles is the value of the ratio between the enamel thickness on the anterior part of all angles of the tooth and the posterior part of the angles, which is described by coefficient (K). This ratio can be measured different ways (Markova 1981, 1982a; Heinrich 1987, 1990). Here, we used this coefficient in the same way as we used it in our earlier publications (Markova 1981, 1986, 1990). The comparative information of fossil *Arvicola* was also taken from these publications.

As is seen in Table 4-8, the coefficient K of the Starosele water vole is close to the parameters of Mikulino and Late Valdai water voles. The coefficient K easily distinguishes these fossils from the Middle Pleistocene water vole *Arvicola chosaricus* and the more ancient *Arvicola cantiana*. The latter species is characterized by a K less than 1. In addition, practically all Middle Pleistocene water voles are characterized by an M_1 length of less than 4.0 mm. The M_1 length of different modern *Arvicola* of the Russian Plain is larger than 4.0 mm (Markova 1982a). The fossil remains of water voles from Crimean sites can therefore be definitely described as *Arvicola terrestris*.

APPENDIX: PROVENIENCE AND SAMPLE SIZES OF SMALL MAMMAL REMAINS

Kabazi II

Kabazi II/95, Sterile layer between Units III and IV, Sq. 39; depth -6.95-7.30 m

Ellobius (Ellobius) talpinus Pallas	1 M^1, M^2, 2 incisors

Kabazi V

Kabazi V/90, Level II/3; КПЭ-Я

Microtus sp.	mandible without teeth

Kabazi V/90, Level II/4/5

Microtus (Microtus) arvalis obscurus Pallas	1 M_1, 1 mandible
Apodemus sp.	1 M_3

Kabazi V/95, Level II/4A, Sq. 8D

Spermophillus sp.	P_4, 1 M_1, 3 M1, 4 M2, 1 M3, 2 remnants of upper mandible
Ellobius (Ellobius) talpinus Pallas	1 M_3
Eolagurus luteus Eversmann	1 M_1, 1 M1, 1 M2
Lagurus lagurus Pallas	1 M_3, 1 M2
Microtus (Microtus) arvalis obscurus Pallas	3 M_1, 1 M_2, 1 M_3, 3 M1, 2 M2

Kabazi V/94, Level II/4A

Arvicola terrestris Linnaeus	1 M1
Microtus (Microtus) arvalis obscurus Pallas	4 M_1, 3M_2, 6 lower mandibles; 1 upper mandible

Kabazi V/95, Level II, Horizon 3+4, Sq.10A

Spermophillus sp.	1 M3
Apodemus (Sylvaemus) ex gr. flavicollis Melch	1 M_1, 1 lower mandible without teeth
Lagurus lagurus Pallas	1 M_2
Microtus (Microtus) arvalis obscurus Pallas	18 M_1, 5M_2, 1 M_3, 11 M1, 7 M2, 7 M3, 7 remnants of lower mandibles
Microtus (Pallasiinus) cf. oeconomus Pallas.	1 M_1, 2 M1

Kabazi V/95, Level II, Horizon 3, Sq.12B

Talpa sp.	1 M_2
Sorex araneus Linnaeus	1 lower mandible with M_2
Spermophillus sp.	1 M_2, 1 M_3
Allactaga major Kerr	1 M_1
Cricetulus migratorius Pallas	1 M_1, 1 M_2
Arvicola ex gr. terrestris Linnaeus	1 M1,
Lagurus lagurus Pallas	1 M_2
Microtus (Microtus) arvalis obscurus Pallas	19 M_1, 3 M_2, 2 M_3, 9 M1, 6 M2, 1 M3, 5 remnants of lower mandibles, 20 incisors

Kabazi V/90, Level III; D-9; sample 6

Eolagurus luteus Eversmann	1 lower mandible without teeth, 1 incisor
Microtus sp.	1 lower mandible without teeth

Kabazi V/94, Level III/2

Spermophillus pygmaeus Pallas	1 mandible, 1 P3, 1 M2
Microtus sp.	1 M_2, 1 incisor

Kabazi V/94, Level III/1A

Spermophillus pygmaeus Pallas	1 lower mandible with P4 - M3, 1 lower mandible with

	P_4 - M_3, 1 upper mandible with P_4, & 1 M1
Lagurus lagurus Pallas	6 M_1, 5 M_2, 2 M_3, 4 M1, 2 M2 ,1 M3
Kabazi V/94, Level III/1	
Spermophillus pygmaeus Pallas	2 P4, 1 M2
Microtus (Microtus) arvalis obscurus Pallas	1 M_1, 1 M_2
Microtus (Stenocranius) gregalis Pallas	2M_1
Kabazi V/94, Level III/2	
Spermophillus sp.	1P4, 1 M2
Microtus sp.	1 M_1, 1 incisor
Kabazi V/95, Level III/I; Sq 8D	
Spermophillus pygmaeus Pallas	1 M_1
Eolagurus luteus Eversmann	1 M_1, 1 M_3
Microtus (Microtus) arvalis obscurus Pallas	1 M_1, 1 M1, 1 M2
Kabazi V/95, L III/2; Sq 9A-B	
Spermophillus pygmaeus Pallas	1 M1, 1 M2, 1 M, lower mandible with M_2
Eolagurus luteus Eversmann	1 M_1
Microtus (Microtus) arvalis obscurus Pallas	3 M_1, 3 incisors
Kabazi V/95, Level III/3	
Eolagurus luteus Eversmann	1 M_1, 1 M_1

Starosele

Starosele/94, Level 1, Sq. H24; U24; G23	
Allactaga major Pallas	1 M_1
Cricetulus migratorius Pallas	Mandible with M_1 - M_3
Arvicola terrestris Linnaeus	2 M1, 2 M2, 2 M_2, 1 M_3
Microtus (Microtus) arvalis obscurus Pallas	11 M_1, 5 M1, 2 M2
Starosele/94, Level 1, horizon 1	
Ellobius (Ellobius) talpinus Pallas	2 M_1, 2M1, 3 M2, 4 incisors
Arvicola terrestris Linnaeus	1 M_1, 1 M2, 1 M2, 5 incisors
Microtus (Microtus) arvalis obscurus Pallas	5 M_1, 1 M2, 2 lower mandibles, 12 incisors
Starosele/95, Level 1	
Talpa sp.	1 lower mandible with M_1 - M_3
Spermophillus pygmaeus Pallas	1P 3, 1 M2
Allactaga major Kerr	2 M1, 1 M3
Sicista subtilis Pallas	2 M_1
Ellobius (Ellobius) talpinus Pallas	3 M_1, 2 M_2, 1 M_3, 3M1, 5 M2, 5 incisors
Apodemus (Sylvaemus) ex gr. flavicollis Melch	2 M_1, 1 M_2,1 M_3, 1 lower mandible without teeth
Arvicola terrestris Linnaeus	4 M_1, 2M_2, 1 M_3, 1 M1, 2 M2, 1 M3
Microtus (Microtus) arvalis obscurus Pallas	34 M_1, 3 M_2, 2 M_3, 26 M1, 7 M2, 5 M3, 9 lower mandibles, 3 upper mandibles, 50 incisors

(16 M1 from this layer have large size - more than 3.00 mm)

Starosele/94, Level 2, Sq. E22, G22	
Apodemus (Sylvaemus) ex gr. flavicollis Melch	1 M_1, 1 M_1 +1 M_2
Cricetulus migratorius Pallas	2 M1, 1 M2
Lagurus lagurus Pallas	2 M_1 + 2 M_2
Arvicola ex gr. terrestris Linnaeus	1 M_1
Microtus (Microtus) arvalis obscurus Pallas	1 M_1, 1 M_2, 2 M1, 1 M2, 1 M3
Starosele/94, Level 2, Sq. E22	
Apodemus (Sylvaemus) ex gr. flavicollis Melch	1 M_1 -1 M_3 in lower mandible, 1 incisor
Microtus (Microtus) arvalis obscurus Pallas	1 M_1, 1 M_1, 2 incisors

Starosele/95, Level 2

Microtus (Microtus) arvalis obscurus Pallas	3M_1, 1 M2
Apodemus sp.	1 lower mandible

Starosele/95, Pondsilt between Level 3 and Level 3a, Sq. G22;

Microtus (Microtus) arvalis obscurus Pallas	2 M_1, 1 M_1, 2M1

Starosele/94, Level 3+3a, E19, Depth -431

Arvicola terrestris Linnaeus	1 M_1, 1 M_3, 2 fragments of mandibles, 1 incisor

Starosele/94, Level 3, G19, Depth -443

Ellobius (Ellobius) talpinus Pallas	1 M_1, 1 M_2, 2 incisors
Microtus sp.	1 M1

Starosele/95, Level 3a, F22, Depth -1,67-1,72

Lagurus lagurus Pallas	1 M_3
Microtus (Microtus) arvalis obscurus Pallas	1 M_1, 1 M_2, 1 M1

Starosele/95, Level 3, Depth 1,65-1,73m

Ellobius (Ellobius) talpinus Pallas	1 remnant of tooth
Lagurus lagurus Pallas.	1 M_3
Arvicola ex gr terrestris Linnaeus	1 M1, 2 M2
Microtus (Microtus) arvalis obscurus Pallas	3 M_1, 1 M_1,1 M1, 1 incisor, 1 M2, 1 M3, 10 incisors

Starosele/94, sterile horizon between Levels 3 and 4

Ellobius (Ellobius) talpinus Pallas	2 M_1, 2 M1, 3 M2
Apodemus sp.	Lower mandible without teeth
Arvicola terrestris Linnaeus	1 M_1, 1 M_1, 1 M1
Microtus (Microtus) arvalis obscurus Pallas	2 M_1, 2 M_1 + 2M_1, 1 M2, 3 lower mandibles, 14 incisors
Microtus sp. (large form)	1 M_1

Starosele/95, sterile horizon between Levels 3 and 4, Depth -1,73- -2,10 m

Microtus sp.	1 M1, 1 M2

Starosele/95, Level 4

Microtus (Microtus) arvalis obscurus Pallas	1 M_1, 1 M_2, 4 M1, 1 M2, 1 M3, 16 incisors

Chapter 5

MALACOLOGY AND PALEOENVIRONMENTS OF WESTERN CRIMEA

CONSTANTINE MIKHAILESKU

INTRODUCTION

Malacological studies were carried out on the western Crimean sites of Kabazi II, Kabazi V, and Starosele. The field investigations, which included sample selections and collection of the fossil remains of small mammals and snails, were conducted in July 1994, July-August 1995, and June 1996. The results of those investigations are used to reconstruct local paleoenvironments in the immediate vicinities of the site. In addition, modern snail species of western Crimea, until now poorly investigated, are compared to the fossil snail fauna to identify evolutionary changes in their morphometric and ecological parameters.

METHODOLOGY

Traditional methods of sample selection were used on sediments from archeological horizons and culturally sterile horizons. The sample selection began with the preliminary screening of sediments through 1.5 mm mesh to identify productive horizons (containing cockleshells of snails or remains of small mammals). At this stage, about 45-64 Kg of sediment were screened from every archeological level and sterile horizon of each site. Once productive horizons were identified, sediments were first screened through 5 mm screens. The selected fraction was then screened through 1.5 mm screens; and the resulting fraction (between 1.5 and 5 mm in size) was washed using the same screens of 1.5 mm. Occasionally, if shells smaller than 1.5 mm were found, a 1 mm screen was also used. This was the case for certain horizons at Starosele and Kabazi V containing very fine sediments. After the resulting sediments were washed and dried, microfaunal and malacological remains were selected.

Because snail shells are very fragile, most were selected directly from the screen during the dry or wet screening. A significant portion of small mammal remains was selected later from the washed and dried concentrate. Only mandibles or other fragile fragments, including large teeth, were selected during the wet screening.

After more than 25 exploratory screenings, the most productive horizons were chosen at Kabazi II (5 horizons), Kabazi V (3), and Starosele (5). From each productive horizon, more than one ton of sediment was screened, followed by wet screening of 110-210 Kg of the dry-screened fraction. Unfortunately, during the summer in Crimea, water is not very accessible, and the dry-screened fractions had to be transported long distances for the final wet screening, then removed to the field camp for drying and sorting.

A large portion of the malacological and microfauna collections was selected earlier (1986-1994) by the archeologists: Dr. Victor Chabai (Kabazi II), Dr. Alexander Yevtushenko (Kabazi V), Dr. Anthony Marks and Dr. Yuri Demidenko (Starosele). During the fieldwork, the author was greatly aided by an assistant, postgraduate Gavril Gylku and also by these archeologists of the Crimean group, to whom we express our sincere appreciation.

The second stage of the research included the laboratory analysis of the selected samples and their identification. At this stage, the major problem was to find and obtain type collections and malacological literature concerning the region. Unfortunately, the modern snail fauna of Crimea is very poorly investigated, and a portion of the fieldwork had to be devoted to developing a type collection of modern Crimean malacological fauna. This focused primarily on the areas surrounding the sites, but also on slopes and water basins of the third range of the Crimean Mountains, as well as the high elevations of the yaila plateau in the coastal Crimean Mountain range. The identification of these collections of modern fauna helped to define the morphometric and ecological parameters of modern and fossil Crimean snail species (Tables 5-1, 5-2).

Further hindering the identification of Crimean snail species is the fact that the last major description of modern species was undertaken in 1918-1925 by Professor I. I. Pusanov. Because he was isolated from the European zoological literature by the Civil War, the local nomenclature of species deviated from that of neighboring regions. Over time, the same species was often identified and described by different authors, usually using different names. This has resulted in a large number of synonymies, and their resolution is hampered by the variations in shell morphometric parameters given by individual authors.

To solve this problem in our investigations, determinants that are more recent were used, where the majority of old Crimean species names (which were described by I. I. Pusanov) are considered synonyms (Table 5-1). It should also be noted that for some modern natio and subspecies of *Helicella*, *Chondrus*, and *Zebrina*, definitive identification is possible only by comparing their anatomical structure. Unfortunately, such an approach is impossible in the identification of fossil remains (because in this case we have only the shells, not the entire organism) and so identification is occasionally limited to species. Often in this study, only the species name is given, and only in rare cases (for example, occasionally for *Chondrus bidens*) are the subspecies or natio forms identified.

Identification of the Crimean collections, both modern and fossil, used the following identification guides and mollusca descriptions: V. Lozek 1964; I. M. Likharev and E. S. Rammelmeier 1952; N. N. Akramovski 1976; J. J. Puissegur 1976; Ya. I. Starobogatov and L. A. Kutikov 1977; A. A. Shileico 1978; A. V. Grossu 1955, 1981, 1983, among others. Because there are also some variations in diagnostic traits used in this work, the descriptive monograph on Eastern European snails, *Continental Mollusks of the USSR* by I. M. Likharev and E. S. Rammelmeier (1952) should be consulted, as they describe most of the known modern Crimean snail species.

ECOLOGY OF SNAILS

Before presenting the Crimean malacological results, the main ecological factors that have an influence on modern snail fauna distribution should be mentioned. The most important environmental factor for snail fauna is climate, usually expressed by two main components: atmospheric precipitation and temperature.

The influence of temperature is very significant for the distribution of snails. There is an important decrease in the number of snail species as one moves from areas with a warm and humid climate to areas with a cold and arid climate. For example, according to I. M. Likharev and E. S. Rammelmeier (1952: 30), on the Russian Plain, the total number of snail species distributed according to ecological zones is: (1) in tundra and tundra-forest zones—19 species; (2) forest zone—80 species; and (3) steppe zone—71 species.

Temperature usually determines not only the distribution, but also the individual morphometric parameters of the snails. The cockleshells of species from the southern zones are usually larger than their northern analogs. The latter are usually smaller and have obviously thinner and finer shells.

For the majority of snail species, humidity is also significant. By this criterion, all snails may be conventionally divided into three main groups:

(1) hydrophiles—includes species which live in very humid conditions, usually near water basins; *Succinea, Oxiloma, Cochlicopa, Vertigo, Vallonia, Caecilioides, Zonitoides, Zenobiella,* etc.;

(2) mesophiles—prefer the relatively humid conditions of forests, flood plain grasses, shrubs, and bushes: *Acanthinula, Vitrea, Clausilia, Helix, Oxychilus, Carichium, Columella, Retinella (Perpolita)*, some species of *Theba*, like *Theba carthusiana*, etc.;

(3) xerophiles—prefer steppe landscapes and open south-facing slopes with sunny exposures: *Zebrina, Chondrus, Helicella, Chondrula, Pupilla*, some species of *Theba*, like *Theba fruticola*, etc.

Crimean snails of the first two groups, hydrophiles and mesophiles, characteristically have thick and shiny shells, usually of very large dimensions (especially *Helix, Theba,* and *Oxychilus*). The xerophile species characteristically have small and thin shells, usually not shiny, but with well-developed pigmentation, and occasionally with evident micro sculpture.

More detailed ecological classification of modern European snails was undertaken by the French investigator Jean-Jacques Puissegur (1976: 16). He distributed all species of snails into the following ten groups:

Group 1	F1 - Forestry, conventional, without precision.
	F2 - Forestry, humid and warm
Group 2	f(m) - Semi-forestry (mesophilic)
	f(s) - Semi-forestry (steppic)
	f(h) - Semi-forestry (hydrophilic)
Group 3	FH - Forestry, very hydrophilic
Group 4	S -Steppic
	Sr - Steppic on rocks
	S(f) - Steppic (forestry)
Group 5	D - Terrain découvert (open rocks)
	D(r) - Terrain découvert (with rocks)
Group 6	X - Xerothermic
Group 7	M - Mesophilic
	Mfr - Mesophilic, with forests, bushes, and rocks
	M(h) - Mesophilic (hydrophilic)
Group 8	H - Hydrophilic (near the water)
Group 9	P - Paludal
Group 10	A1 - all freshwater mollusks of different types of basins (stagnates, torrents, etc.).

Unfortunately, not all of these groups and subgroups are represented in our collections, which include only a very small area and the relatively short time interval of the Upper Pleistocene. The investigated Crimean species may be attributed to seven groups (see Table 5-3).

The distribution presented in Table 5-3 was in turn used to compose diagrams showing the ecological niches of snails in modern samples and archeological levels at Kabazi II, Kabazi V, and Starosele (figs. 5-1–5-4). The diagrams display the major changes of the ecological composition of snails on the individual and species levels. In the cases where the total number of shells in the sample was less than 30 or 40, such types of diagrams are not representative, and they were therefore not drawn up for the small samples from Kabazi V and also for some very poor samples from the sondage at Kabazi II.

TABLE 5-1
Modern Snails of Western Crimea, Nomenclature, and Size Data (mm)

Name of species, author, and year of first description	Synonymies and year of description	Shell Parameters			Aperature Parameters	
		Height	Width	Whorls	Height	Width
Helix (Helicogena) lucorum taurica (Kryn.), 1833	*Helix radiossa* Rossmassler, 1838	40-47	41-49	4.5-5	30-35.5	27.5-30
H. (H.) vulgaris Rossm., 1839		27-36	30-38	4	23-25	19-22
Theba carthusiana Mull., 1774	*Helix carthusiana* Draparnaud, 1801	7.5-10	10-16	5.5-6	6-7	7-9
Theba fruticola (Kryn.), 1833		12-15	16-20	6.5-7	7-8	8-11
Helicella (Helicopsis) dejecta Cr. et J., 1832	*Helicella arenosa* Krynickii, 1836	6-11	9-18	5-6	6-7	8-10
	Helicella substriata Clessin, 1881					
H. (H.) gireorum Lindh., 1926		7-8	11.5-13	5	6-7	8-9
H. (H.) retowski Clessin., 1883		5-7	8-10	5-5.5	4-5	6-7
H. (H.) filimargo (Kryn.), 1833		7.5-11	12-17	5-6	6-7	7-9
H. (Xeropicta) Krynickii (Kryn.), 1883	*Xeropicta (Heliomanes) Orianda* Pusanov, 1926	6.5-9	12-15	5-5.5	6-7	8-10
Oxychilus (Schistophallus) deilus (Bourg.), 1857	*Hyalinia Krynickii* Clessin, 1883	7-7.5	13-17	6-6.5	5-7	8-9
Oxychilus (Oxychilus) diaphanellus (Kryn.), 1833	*Hyalinia taurica* Clessin, 1881	3.5-4	7-8.5	6-7	3-3.5	4-5
	Hyalinia zonulata Westerlund, 1886					
	Hyalinia (Polita) Pusanov, 1925					
Vitrea subeffusa var. depressa (Bttg.), 1879	*Hyalinia Kamia* Pusanov, 1925	1.6	3.5	4		
V. iphigeniae Lindh., 1926		2.25	4.5	4		
V. pygmaea Bttg., 1880	*Vitrea (Crystallus) etrusca* Lindholm, 1926	0.7-1	1.5-2	3.5-4		
V. diaphana (Stud.), 1820	*Helix hyalina* Ehrmann, 1933	2	4	5-6		
Zebrina (Buliminus) cylindricus Mke., 1828	*Chondrus lineatus* Krynickii, 1833	23-30	7.5-10	9-10	7-8.5	6-7
	Buliminus (Zebrina) cylindricus Pusanov, 1925					
Z. (B.) subulata (Rssm.), 1837	*Buliminus (Brephulus)* Kobelt, 1902	10-14	2.5-3	10-11	6-7.5	5-6
Chondrus (Buliminus) bidens (Kryn.), 1833	*Buliminus (Brephulus) bidens* Pusanov, 1925	12-20	5-6	8-10	5	3
Ch. (B.) bidens attenuatus (Kryn.), 1833	*Buliminus (B.) bidens attenuatus* Pusanov, 1925	10-14	4-4.5	7-11	3-4	2-2.5
Chondrula tridens Mull., 1774	*Chondrus galiciensis* Clessin, 1879	10-12	4-5	6-8	3.5	2.5-3
Ch. tetrodon (Mort.), 1854	*Buliminus (Chondrula) Kollyi* Retowski, 1889	11-16	4-6	7.5-9	3.2	2.3-2.8
	Clausilia (Clausiliastra) laminata Pusanov, 1925					
Clausilia (Cochlodina) laminata (Moel.), 1774	*Cochlodina laminata* (Mout.), Lich.& Ramm., 1952	15-17	3.9-4.1	10-12	3.5-4	2.5-3
Clausilia (Mentissa) gracilicosta (Rossm.), 1836	*Lacinaria (M.) gracilicosta* (Rssm.), Lich.& Ramm., 1952	18-19	4-4.5	11-13	3.5-4	2.3-2.8
	Clausilia (Mentissa) canalifera Zgl., Pusanov, 1925					
Cl. (Mentissa) canalifera (Rossm.), 1836	*Lacinaria (M.) canalifera* (Rssm.), Lich.& Ramm., 1952	16-20	3.5-4	11-13	3.5-4	2.5-3
Pupilla muscorum (L.), 1758	*Pupa marginata* Draparnoud, 1801	3-3.5	1.75	6-6.5	1-1.2	1-1.3
P. triplicata (Stud.), 1820	*Pupilla signata var. parvula* Moussom, 1876	2.3-2.75	1.3-1.5	5-6	0.9	0.8
Vallonia pulchella Mull., 1774	*Vallonia costellata* (Al. Br.) Sanberger, 1875	1.3	2.5	3-3.5		
Succinea (Oxiloma) elegans Risso., 1826		16.2	8-9	2.5-3		
Retinella (Perpolita) radiatula Alder., 1830	*Hyalinia radiatula* Taylor, 1908	2-2.2	3.5-4.5	3.5-4		
Caecilioides acicula (Mull.), 1774	*Caecilianella (Aciculina) praeclara* Westerlund, 1898	4.5-5.5	1.3-1.4	5.5-6		
Ca. raddei Bttg., 1879	*Cochlicopa (Hohenwartiana)* Pilsbury, 1909	4.8-5	1.5	5.5	2.1	2.3
Carichium minimum Mull., 1774		1.5-2.1	0.8-1	4.5		
Collumella columella (Mart.), 1830	*Pupa gredleri* Clessin, 1872	2.8-3.5	1.35-1.48	7-7.5	0.85	0.75
C. edentula (Drap.), 1805		2.25-2.6	1.3-1.4	6-6.5	0.8	0.7
Acanthinula (A.) aculeata (Mull.), 1774		1.8-2.1	2-2.3	4		
Cochlicopa lubrica Mull., 1774	*Buliminus subcylindricus* Ehrmann, 1933	5.5-6	2.5-2.7	5.5-6	2.5	1.75
Pisidium casertannum Poli., 1881	*Pisidium ovutum* Clessin, 1884	6	5			
Limnaea (Gulnaria) pygmaea Pusanov, 1925		6.5	4.5	3	4.3	3

TABLE 5-2

Modern Snail Species of Western Crimea and their Preferred Habitats

Name of species, author, year of first description	*Specific landscapes and preferred biotopes*	*Region*
Helix (Helicogena) lucorum taurica (Kryn.), 1833	humid broad-leaved forests, shrubs, and bushes	Crimean Mountains
H. (H.) vulgaris Rossm., 1839	dry landscapes with grass, trees, shrubs, and bushes	Crimean steppe and mountainous northern coast of Black Sea
Theba carthusiana Mull., 1774	slope shrubs and mesophytic grasses of the flood plain	Crimea and N-W coast of Black Sea
Theba fruticola (Kryn.), 1833	shrubs and dry steppes of sunny slopes	Crimea and N-W coast of Black Sea
Helicella (Helicopsis) dejecta Cr. et J., 1832	xerophytic steppes	Crimea and N-W coast of Black Sea
H. (H.) gireorum Lindh., 1926	xerophytic steppes	Crimean steppes of the Bakchisarai zone
H. (H.) retowski Clessin., 1883	xerophytic steppes	Crimean Mountains
H. (H.) filimargo (Kryn.), 1833	xerophytic steppes	Crimean and northern coast of Black Sea
H. (Xeropicta) Krynickii (Kryn.), 1883	xerophytic steppes	Crimean and northern coast of Black Sea
Oxychilus (Schistophallus) deilus (Bourg.), 1857	humid broad-leaved forests, shrubs, and bushes	Crimean Mountains
Oxychilus (Oxychilus) diaphanellus (Kryn.), 1833	humid broad-leaved forests, shrubs, and bushes	Crimean Mountains
Vitrea subeffusa var. depressa (Bttg.), 1879	broad-leaved forests, shrubs, and bushes	Crimean Mountains
V. iphigeniae Lindh., 1926	broad-leaved forests, shrubs, and bushes	Crimean Mountains
V. pygmaea Bttg., 1880	broad-leaved forests, shrubs, and bushes	Crimean Mountains, Caucasus, Iran
V. diaphana (Stud.), 1820	broad-leaved forests, shrubs, and bushes	Crimean and Carpathian Mountains
Zebrina (Buliminus) cylindricus Mkc., 1828	steppe regions	Crimea, Moldova, Romania, etc.
Z. (B.) subulata (Rssm.), 1837	slope grasses and small bushes	Crimean Mountains
Chondrus (Buliminus) bidens (Kryn.), 1833	xerophytic steppes	Crimean steppes and slopes
Ch. (B.) bidens attenuatus (Kryn.), 1833	xerophytic steppes	boreal zone of Europe
Chondrula tridens Mull., 1774	slope grasses and bushes	Crimean and Carpathian Mountains
Ch. tetrodon (Mort.), 1854	slope grasses and bushes	Crimean and Carpathian Mountains
Clausilia (Cochlodina) laminata (Moel.), 1774	broad-leaved and coniferous forests, shrubs, and bushes	Crimean Mountains
Clausilia (Mentissa) gracilicosta (Rossm.), 1836	calcareous rocky slopes, coniferous forests and bushes (esp. Juniperus)	Crimean Mountains
Cl. (Mentissa) canalifera (Rossm.), 1836	broad-leaved and coniferous forests, small trees, shrubs and bushes	Crimean Mountains
Pupilla muscorum (L.), 1758	mesophytic grasses, bushes, and calcareous rocky slopes	boreal zone of Europe
P. triplicata (Stud.), 1820	steppe grasses, bushes, and calcareous rocky slopes	boreal zone of Europe
Vallonia pulchella Mull., 1774	very humid places, near water, mountain and forest zones	boreal zone of Europe
Succinea (Oxiloma) elegans Risso., 1826	very humid places, around water basins, on water grasses	boreal zone of Europe
Retinella (Perpolita) radiatula Alder., 1830	forest bedding and mesophytic grasses of flood plains	boreal zone of Europe
Caecilioides acicula (Mull.), 1774	underground (10-40 cm depth), carbonate and humid soils of forests	Crimean, Caucasian, Carpathian Mountains
Ca. raddei Bttg., 1879	in cowes, *in the* 780 *rock* crack, and in the soil of forests or bushes	Crimean, Caucasus, Iran, and Middle Asia
Carichium minimum Mull., 1774	very humid places near water in forests	Eurosibiric forests
Collumella columella (Mart.), 1830	humid forests, bushes, and mesophytic grasses	forest zone of Europe
C. edentula (Drap.), 1805	forests, bushes, and mesophytic grasses	boreal zone of Europe
Acanthinula (A.) aculeata (Mull.), 1774	forest bedding and bushes	boreal zone of Europe
Cochlicopa lubrica Mull., 1774	humid places near water	boreal zone of Europe
Pisidium casertannum Poli., 1881	fresh water basins	South Ukraine
Limnaea (Gulnaria) pygmaea Pusanov, 1925	fresh water basins	Crimean zone

Other important factors affecting snail distribution are the topographic relief and type of soils. The most favorable conditions for snails are on calcareous soils. Calcareous soils are usually porous in structure, and contain enough useful elements for cockleshell construction, as well as for the nutrition of the snails themselves.

Vegetation also significantly affects the distribution of most snails. The majority of snails are phytophagous. All phytophagous snails may be divided into two main groups based on which types of plants they prefer: (1) species which live on mushrooms and the rotting remains of plants: Pupilidae, Valloniidae, Clausiliidae, *Euconulus, Carichium*, etc. and (2) species which live on not only mushrooms, but also the green parts of plants: Helicidae, Eulotidae, Succineidae, Enidae (Chondrulinae), etc.

Usually, snails are not very mobile, so their distribution is closely tied to their surrounding climatic and ecological conditions, making the use of malacological data of prime importance in the reconstruction of the paleoenvironments of Paleolithic sites and general climatic changes during the Quaternary.

KABAZI II

From Kabazi II, six samples were selected from Unit II, six samples from Unit III, and one sample from Unit IV (Table 5-4). In addition, 21 samples from the sondage (excavated in 1986) and materials which were selected earlier by the archaeologists were processed (Table 5-5). Because the number of remains overall in the sediment was not very high and each sample contained only a small number of shells, samples from different field seasons and different depths were combined into four comparable complexes which correspond to the major archeological units of Kabazi II (Figs. 5-1, 5-2, Table 5-4). (The description of archeological units, and their subdivision into levels, can be found in Chabai 1998b, c, d.)

At the time of the deposition of the upper part of Unit III, steppe fauna predominated (samples IIIa-IIId). The presence of *Helix (Helicogena) lucorum taurica* (Kryn.) and *H. (H.) vulgaris* Rossm. in the sample IIIe may serve as a good indicator of relatively more humid and warm conditions. Also, the presence of two shells of *Vitrea subeffusa* (Bttg.), which are usually characteristic of humid stands of forest or bushes near the water, should be noted.

Relatively more humid conditions than those of the present day during the deposition of Unit III suggest that there were areas surrounding the site with a high level of ground water or, perhaps, temporary springs. If the geological structure of the area and the mineral composition of slope rocks are taken into consideration, such assumptions look probable. Calcareous rocks surround Kabazi II, but some horizons have a finer lithological composition and a higher level of cementation. Usually, such types of calcareous rock absorb a large quantity of water during rains (or during the winter) and become good sources of fresh water springs for a long time.

The snail fauna of Unit II predominates in steppe xerophiles, such as *Helicella (Helicopsis) dejecta* Cr. et Jan., *H. (H.) Retowski Clessin, H. (Xeropicta) krynickii* (Kryn.), and *Chondrus (Buliminus) bidens* (Kryn.). These indicate that during the deposition of Unit II, steppe landscapes and arid climate conditions existed near the site. The small dimensions of *Helicella* and the predominance of small and very thin shells of *Chondrus (Buliminus) bidens natio attenuatus* Kryn., suggest that the climate was more arid and probably more cold than present-day conditions. Only the presence of *Vitrea pygmaea* Bttg., *Chondrula tridens* Müll., and *Helix (Helicogena) vulgaris* Rossm. indicates that some bushes or small trees were near site (fig. 5-1).

TABLE 5-3
Ecological Groups of Western Crimean Snails

■ **I. Fresh water fauna**
Limnaea pygmaea
Pisidium casertanum

▧ **II. Hydrophile fauna**
Cochilicopa lubrica
Columella edentula
Succinea elegans
Carichium minimum
Vallonia pulchella

░ **III. Fauna of forest areas (humid)**
Acanthinula aculeata
Vitrea diaphana
Vitrea iphigeniae
Columella columella
Retinella radiatula

▓ **IV. Fauna of semi-forest areas (mesophiles)**
Clausilia gracilicosta
Clausilia canalifera
Clausilia laminata
Oxychilus diaphanelus
Oxychilus deilus
Vitrea pygmaea
Vitrea subeffusa

□ **V. Fauna of mesophytic steppes with small trees, bushes, & shrubs**
Helix lucorum taurica
Helix vulgaris
Theba carthusiana
Zebrina cylindricus
Chondrula tridens
Chondrula tetrodon

▨ **VI. Fauna of xerophytic steppes (xerothermic)**
Helicella dejecta
Helicella gireorum
Helicella Retowski
Helicella filimargo
Helicella (Xeropicta) Krynikii
Zebrina subulata
Chondrus bidens
Theba fruticola

▦ **VII. Rocky and soil fauna**
Caecilioides acicula
Caecilioides raddei
Pupilla muscorum
Pupilla triplicata

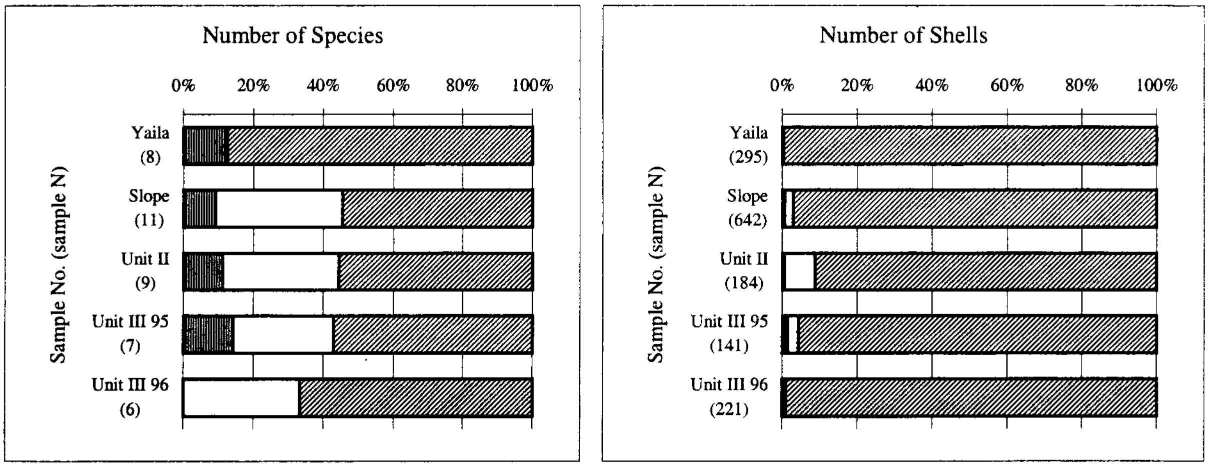


Fig. 5-1—Kabazi II, 1994-1996, cumulative number of species and number of shells by unit (see key, Table. 5-3).

TABLE 5-4
Kabazi II, Fossil and Modern Snails

Excavations	*1994*	*1995*														*1996*			*Modern*	
Archeological Unit and Sample No.	*II*	*IIa*	*IIb*	*IIc*	*IId*	*IIIa*	*IIIb*	*IIIc*	*IIId*	*IIIe*	*IIIf*	*IV*	*M-5 II/11*	*M6 II/ 10-583*		*III/2*	*II/10*	*III/1*	*Yaila Plateau*	*Near Site*
Helix (Helicogena) lucorum taurica (Kryn.)	–	–	–	–	–	–	–	–	–	3	–	–	–	–		–	–	–	–	-
H. (H.) vulgaris Rossm.	–	–	2	–	–	–	–	–	–	1	–	–	–	–		–	–	–	–	-
Theba fruticola (Kryn.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	11	[illegible]
Helicella (Helicopsis) dejecta Cr. et J.	35	5	5	9	6	–	24	14	3	5	6	–	–	–		153	–	4	6	22
H. (H.) gireorum Lindh.	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–	[illegible]
H. (H.) retowski Clessin.	1	1	2	1	1	–	2	–	–	4	–	–	–	–		3	–	1	24	1
H. (Xeropicta) Krynickii (Kryn.)	5	9	14	20	–	1	36	34	–	–	–	–	–	–		32	–	–	2	10
Oxychilus (Schistophallus) deilus (B.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–	[illegible]
O. (O.) diaphanelus (Kryn.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	1	-
Vitrea subeffusa (Bttg.)	–	–	–	–	–	–	2	–	–	–	–	–	–	–		–	–	–	–	-
V. pygmaea Bttg.	1	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–	-
Zebrina (Buliminus) cylindricus Mke.	–	–	1	–	1	–	–	–	–	–	–	–	–	1		–	4	1	–	1
Chondrus (Buliminus) bidens (Kryn.)	6	2	1	–	1	–	1	1	1	3	–	1	2	–		24	–	2	243	27
Ch. (B.) bidens natio pygmaea (Kryn.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	6	[illegible]
Ch. (B.) bidens attenuatus Kryn.	–	13	13	14	2	–	–	–	–	–	–	–	–	–		–	–	–	2	-
Chondrula tridens Müll.	3	–	3	–	–	–	–	–	–	–	–	–	–	–		1	–	–	–	1
Ch. tetrodon (Mort.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–	1
Total	51	30	41	44	11	1	65	49	4	16	6	1	2	1		213	4	8	295	64

TABLE 5-5
Kabazi II, Fossil Snails from 1986 Sondage

Depth (cm)	*289-303*	*303-315*	*745-760*	*779-780*	*795*	*820*	*830-831*	*840*	*854*	*860*	*880*	*890*	*902-906*	*915*	*920*	*925*	*933-940*	*950-956*	*965-973*	*980*
Sample No.	*609*	*610*	*611*	*612*	*613*	*614*	*615*	*616*	*617*	*618*	*619*	*620*	*621*	*622*	*623*	*624*	*625*	*626*	*627*	*628*
Helix (Helicogena) lucorum taurica (Kryn.)	9	–	1	2	2	2	8	2	4	4	10	5	11	6	5	1	16	4	2	–
H. (H.) vulgaris Rossm.	3	–	–	–	1	–	1	–	3	–	4	–	2	3	1	–	7	1	2	–
Theba fruticola (Kryn.)	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–	1	–	–
Helicelia (Helicopsis) dejecta Cr. et J.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	–
Vitrea pygmaea Bftg.	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–
Zebrina (Buliminus) cylindricus Mke.	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Chondrus (Buliminus) bidens (Kryn.)	1	4	1	–	1	–	–	–	–	–	3	2	26	15	23	24	84	83	92	5
Ch. (B.) bidens natio pygmaea (Kryn.)	48	2	–	–	–	–	–	–	–	–	–	1	–	1	1	2	12	8	11	–
Clausilia (M.) gracilicosta Rossm.	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–
Cl. (M.) canalifera Rossm.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–
Total	63	6	2	2	4	2	9	2	7	4	21	8	39	25	30	27	120	98	108	5

KABAZI II, 1986 SONDAGE

Malacological data from the 1986 Sondage indicate that during the Upper Pleistocene, the climatic conditions and the vegetation around the site were exposed to significant changes. Kabazi II during this time was situated in steppe with small trees and bushes. The bush stands underwent important modifications, given the oscillation in the number and in the morphometric parameters of mesophile species such as *Helix (Helicogena) lucorum taurica, H. (H.) vulgaris, Theba fruticola, Clausilia (Mentissa) canalifera, Cl. (M.) gracilicosta, Vitrea pygmaea*, etc. (Table 5-5 and fig. 5-2).

Relatively more favorable climatic conditions correspond to the samples 609 (depth=289-303 cm below datum), 615-619 (depth 830-880 cm), 620 (depth 890 cm), 621, 622 (depth 902-915 cm), and 625 (depth 933-940 cm), when the bush-small tree stand was evidently larger. The significant predominance of the xerophiles *Chondrus (Buliminus) bidens, Ch. (B.) bidens natio pygmaea*, and *Helicella (Helicopsis) dejecta* in samples 610 (depth 303-315 cm), 611-614 (depth 745-820 cm), 623-624 (depth 920-925 cm), 626-629 (depth 950-990 cm), indicates that, during the sedimentation of these horizons, a steppic landscape predominated (fig. 5-2).

It should be noted that a number of the samples from the sondage are very homogenous and not representative enough. This is probably due to an incomplete selection in this area (carried out by the archeologists), and they therefore do not reflect the true composition of the malacological fauna, nor do they permit the full reconstruction of paleoenvironmental conditions. In the cases where the archeologists collected the samples, usually only the large-size representatives of snails were selected. These tend to be mesophile warmth-loving species, whose shells are always bigger than xerophile cold-loving snail species.

KABAZI V

Unfortunately, the samples from Kabazi V are too small and not very representative (Table 5-6). This fact confirms that Kabazi V is a buried rockshelter; further supported by the presence in Unit III of one small shell of *Caecilioides raddei* (Bttg.), which usually prefers cracks of calcareous rocks in the humid walls of caves and rockshelters. During the deposition of Units II and III, a steppe-forest landscape surrounded the site. Steppic conditions are indicated by the presence of xerophile *Helicella (Helicopsis) dejecta, H. (Xeropicta) krynickii*, and *Chondrus (Buliminus) bidens*. The presence of mesophile species such as *Vitrea subeffusa, Clausilia (Mentissa) gracilicosta*, and *Caecilioides raddei* indicates the existence of small trees and bushes near the site. The presence *Vitrea subeffusa* and *Caecilioides raddei* may also serve as a good indicator of ground water or springs in the vicinity of the site. This may be due, in part, to the hygroscopic nature of calcareous rock, which absorbs and preserves rain or snow water for long time.

A comparison of the species composition of modern fauna around Kabazi V with the fossil fauna from Unit II indicates that the fossil fauna is more mesophilic. None of the above-mentioned mesophile species of Unit II are found in the modern day fauna on the sunny slope around the site (Fig. 5-3). This indicates that, during the deposition of Unit II, the area around Kabazi V experienced conditions that were more humid. The author spent many fruitless hours in the vicinity of Kabazi V looking for the cockleshells of *Clausilia* or other mesophiles. In the modern fauna of these sunny slope landscapes, *Chondrus bidens* (311), *Theba fruticola* (21), and *Helicella (Helicopsis) dejecta* (7) absolutely predominate, and confirm the semiarid climatic conditions of the present-day xerophytic steppe landscape.

TABLE 5-6
Kabazi V, Fossil and Modern Snails

	1994	*1995*			*1996*	*Modern*	
	II	*II*	*III/II*	*III*	*III*	*Near Site*	*Alma Flood Plain*
Helix (Helicogena) lucorum taurica (Kryn.)	–	–	–	–	–	–	21
H. (H.) vulgaris Rossm.	–	–	–	–	–	–	12
Theba carthusiana Müll.	–	–	–	–	–	–	18
Theba fruticola (Kryn.)	–	–	–	–	–	21	6
Helicella (Helicopsis) dejecta Cr. et J.	–	1	–	–	1	7	–
H. (H.) gireorum Lindh.	–	–	–	–	–	–	22
H. (H.) retowski Clessin.	–	–	–	–	–	1	32
H. (Xeropicta) Krynickii (Kryn.)	–	3	3	1	–	1	–
Oxychilus (Schistophallus) deilus (B.)	–	–	–	–	–	–	1
O. (O.) diaphanelus (Kryn.)	–	–	–	–	–	–	3
Vitrea subeffusa (Bttg.)	–	1	–	1	–	–	–
V. pygmaea Bttg.	–	–	–	–	–	–	2
Zebrina (Buliminus) cylindricus Mke.	1	–	–	2	–	–	26
Chondrus (Buliminus) bidens (Kryn.)	–	4	1	3	–	311	16
Ch. (B.) bidens natio pygmaea (Kryn.)	–	–	–	–	–	8	–
Ch. (B.) bidens attenuatus Kryn.	–	–	–	–	–	3	–
Chondrula tridens Müll.	–	–	–	–	–	1	–
Ch. tetrodon (Mort.)	–	–	–	–	–	–	3
Clausilia (M.) gracilicosta Rossm.	–	3	–	–	–	–	–
Cl. (Mentissa) canalifera Rossm.	–	–	–	–	–	–	2
Caecilidoides raddei Bttg.	–	–	–	–	1	–	–
Limnaea (Gulnaria) pygmaea Pusanov	–	–	–	–	–	–	2
Total	1	12	4	7	2	353	166

STAROSELE

A total of 20 samples were collected from Starosele, including from Level 1 (2 samples), Level 2 (1), Level 3 (6), Level 4 (9), one sample from the sterile horizon between Level 2 and 3, and one sample from the pond silt between Levels 3 and 4. Two samples of modern fauna were also collected: one from the Kanly-Dere Valley, where the site is located, and one from the neighboring plateau. In general, the preservation of fossil snail shells at Starosele is much better than at Kabazi II. The majority of samples are also more diverse and numerous in comparison to Kabazi II and Kabazi V (Tables 5-4–5-7).

In Level 4, xerophile steppe elements predominate; *Helicella dejecta* Cr. et Jan., *H. (Xeropicta) krynickii* (Kryn.), *Chondrula bidens* (Kryn.) comprise 57.8% of the total number of individuals (Fig. 5-4). Nevertheless, this predominance may be only happenstance, because for such a large sample (467 shells) the proportions of mesophile (33%) and hydrophile forms (6%) are also very high. This species composition indicates a more humid climate than exists at the present day. The presence of shells of *Columella edentula* (Drap.) (3), *Retinella (Perpolita) radiatula* Alder. (3), *Vallonia pulchella* Müll. (12), *Caecilioides acicula* (Müll.) (1), and *Acanthinula aculeata* (Müll.) (1) indicates that conditions were also relatively colder than today. Taking into consideration that 50% of species (9 of 18) represent mesophilic and hydrophilic inhabitants of forests and semi-forest areas, the steppic landscape was evidently more limited in the immediate area as compared to today.

It is very interesting to mention here two mussels of *Pisidium casertanum* Poli., a freshwater mollusk which prefers small torrents clean and rich in oxygen. Their presence indicates that during the time of Level 4, there was a permanent torrent of spring water near the site. This conclusion is further confirmed by the presence of *Caecilioides acicula* (Müll.), *Acanthinula aculeata* (Müll.), and *Columella edentula* (Drap.), which prefer to live in humid places near water.

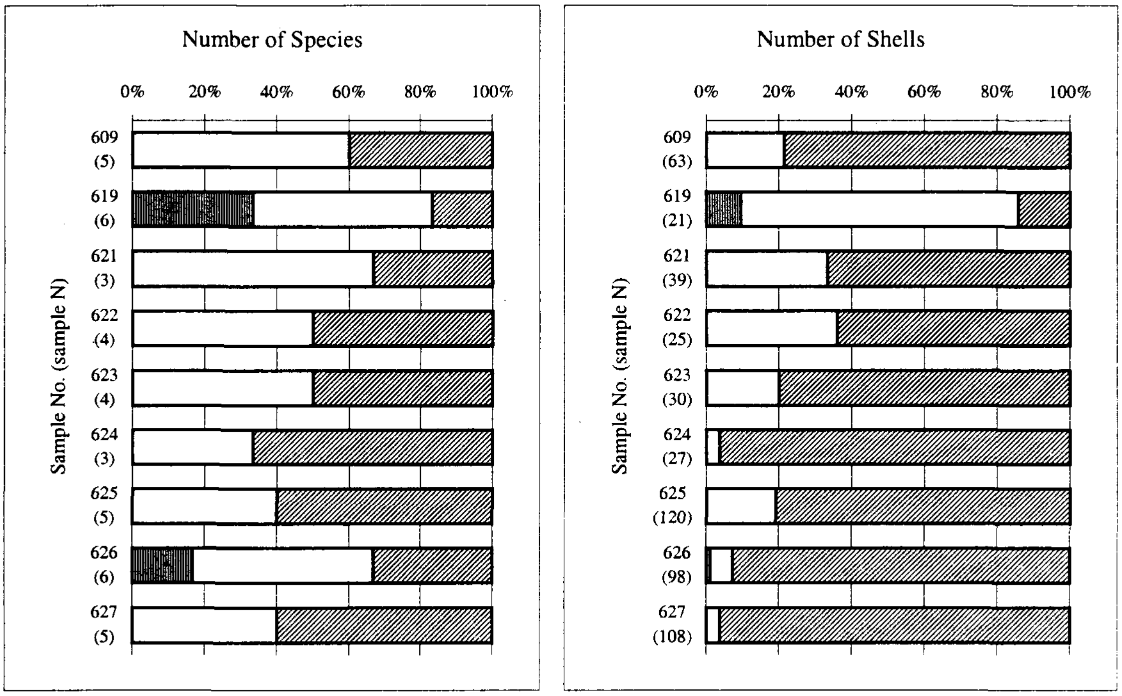


Fig. 5-2—Kabazi II, 1986 sondage, cumulative number of species and number of shells by depth (see key, Table 5-3).

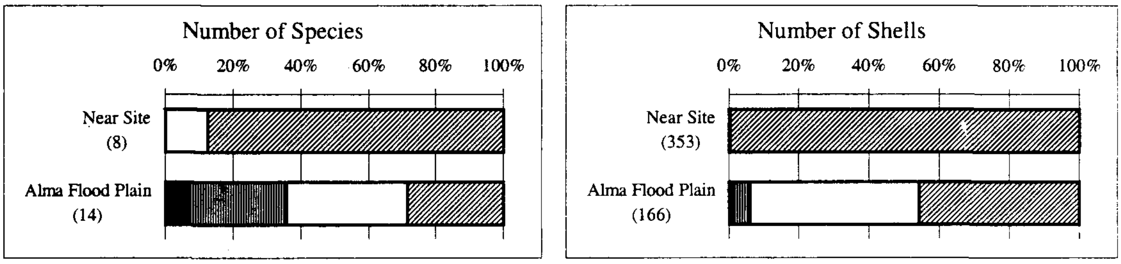


Fig. 5-3—Kabazi V, modern samples of snails (see key, Table 5-3).

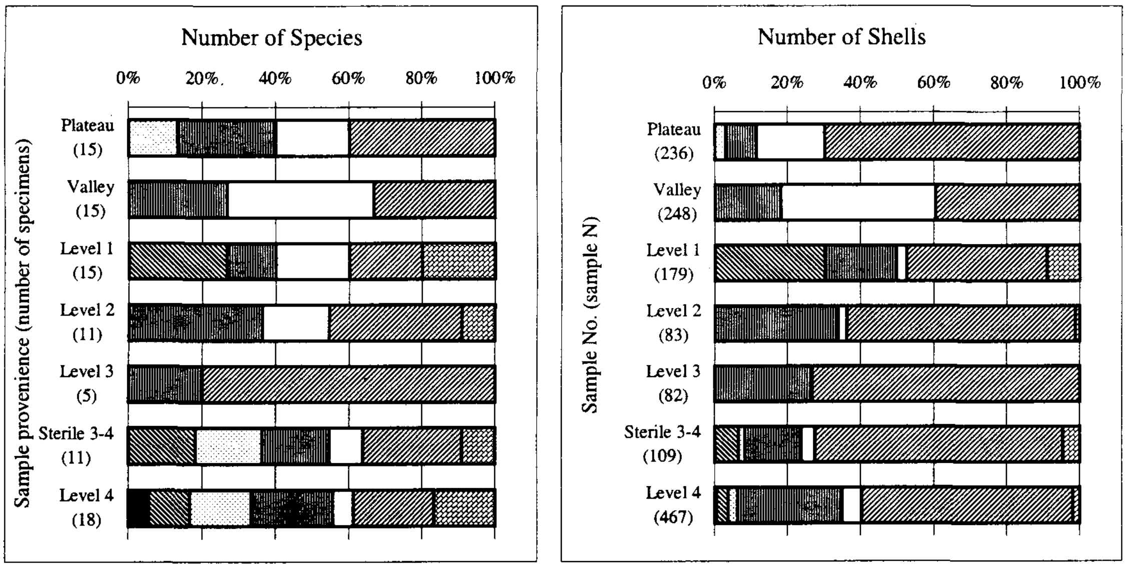


Fig. 5-4—Starosele, cumulative number of species and number of shells of modern and fossil snails (see

TABLE 5-7

Starosele, Fossil and Modern Snails

				1994						1995												Modern	
				H24	G20	G21	G21	H23	K22			G19	F22	F22									
	Height	Diameter	Whorls	1	3a	3b	4a	4b	4c	1	2	3a	3b	3c	3-4a	3-4b	3-4c	4a	4b	4c	4d	Plateau	Valley
Helix (Helicogena) lucorum taurica (Kryn.)	40-47	41-49	4.5-5	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	38
H. (H.) vulgaris Rossm.	27-30	29-38	4	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	32
Theba carthusiana Müll.	6-10	10-12	5-6	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	11
Theba fruticola (Kryn.)	10-15	15-20	6-7	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	29	27
Helicella (Helicopsis) dejecta Cr. et J.	6-11	9-18	5-6	2	5	3	–	–	3	25	6	–	1	3	8	2	3	12	9	16	3	48	14
H. (H.) gireorum Lindh.	7-8	11-13	5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5	7
H. (H.) retowski Clessin.	5-6	8-10	5-5.5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	7
H. (Xeropicta) Krynickii (Kryn.)	7.5-11	12-17	5-6	1	–	4	–	–	–	33	30	–	4	8	3	–	4	20	30	32	10	12	–
Oxychilus (Schistophallus) deilus (B.)	7-7.5	13-17	6-6.5	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	16
Vitrea subeffusa (Bttg.)	1	3.5	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	2	3	7	12
V. iphigeniae Lindh.	2	25	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	2	3	1	4	–
V. pygmaea Bttg.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	5	–	1	1	–	–
V. diaphana (Stud.)	2	4	5-6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–
Zebrina (Buliminus) cylindricus Mke.	24-37	7-9	9-10	–	–	–	–	–	–	–	–	–	–	–	–	4	–	22	3	–	–	5	18
Z. (13.) subulata (Rossm.)	10-14	2.5-3	10-11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	10	–
Chondrus (Buliminus) bidens (Kryn.)	12-20	5-6	8-10	–	11	4	4	3	2	8	15	3	9	4	8	25	21	16	51	53	4	61	43
Ch. (B.) bidens natio pygmaea (Kryn.)	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–
Chondrula tridens Müll.	10-12	4-5	6-7	1	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	23	4
Ch. tetrodon (Mort.)	11-16	4-6	7-9	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	16	2
Clausilia laminata (Moel.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	–
Clausilia (Mentissa) gracilicosta (Rossm.)	18-19	4-4.5	11	–	12	6	1	–	–	3	8	1	3	–	10	2	3	14	12	23	30	7	13
Cl. (Mentissa) canalifera (Rossm.)	16-20	3.5-4	13	7	–	–	–	–	–	25	16	–	–	–	–	–	–	–	–	–	–	2	4
Cl. sp. indent	–	–	–	–	–	–	–	–	1	–	2	–	–	–	–	–	–	18	20	–	–	–	–
Pupilla muscorum (L.)	3-3.5	1.75	6.5	–	–	–	–	–	–	4	–	–	–	–	–	–	–	1	2	1	–	–	–
P. triplicata (Stud.)	2.4-2.8	1-1.6	5-6	–	–	–	–	–	–	–	–	–	–	–	5	–	–	–	–	4	–	–	–
Vallonia pulchella Müll.	1.2-1.3	2.4-2.5	3-3.5	–	–	–	–	–	–	45	–	–	–	–	6	–	–	–	–	12	–	–	–
Succinea (Oxiloma) elegans Risso.	12-24	6-10	2.5-3	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–
Retinella (Perpolita) radiatula Alder.	2	3.5-4	3.5-3.7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	–	–
Caecilioides acicula (Mull.)	4.5-5.5	1.3-1.4	5.5-6	–	–	–	–	–	–	2	1	–	–	–	–	–	–	–	–	1	–	–	–
Ca. raddei Bttg.	–	–	–	–	–	–	–	–	–	10	–	–	–	–	–	–	–	–	–	–	–	–	–
Carichium minimum Müll.	–	–	–	–	–	–	–	–	–	5	–	–	–	–	–	–	–	–	–	–	–	–	–
Collumella columella (Mart.)	2.8-3.5	1-1.5	7-7.5	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–
C. edentula (Drap.)	2.3-2.8	1-1.4	6-6.5	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	1	1	–	–	–
Acanthinula (A.) aculeata (Mull.)	1.8-2	2-2.3	4	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1	–	–
Cochlicopa lubrica Müll.	5.7-7	2.4-2.8	5.5-6	–	–	–	–	–	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–
Pisidium casertannum Poli.	2.9-3.4	2-2.5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	–	–	–
Total				11	28	17	5	3	6	168	83	4	18	15	42	36	31	112	135	153	53	236	248

The shell samples from the sterile horizon (pond silt) between cultural Levels 3 and 4 are smaller than Level 4, totaling only 109 shells of 11 species. In these samples, the number of xerophile steppic elements increase (68.1%), as do species which live in the cracks of rocks or in calcareous soils (4.5%) (Fig. 5-4).

All samples from cultural Level 3 of Starosele are fairly homogenous. Here, there are only two ecological groups of snails: xerophile steppe fauna—73% of the total number of individuals (82), and mesophile semi-forest fauna—27 %. Such a composition of snails may indicate that the climate was becoming increasingly arid beginning from cultural Level 4 and culminating in Level 3.

Probably, the level of ground water during this time had decreased, because in all samples from Level 3, mesophile species which live near the water are absent. This fact adds weight to an interpretation of changing climate in the direction of increasing aridity, but it could also merely reflect the downcutting of the canyon bottom and the resultant elevational drop of surface water.

In the malacological fauna of Level 2, steppic xerophiles predominate, such as *Helicella (Xeropicta) krynickii* (Kryn.) (30), *H. (Helicopsis) dejecta* Cr. et Jan. (6), and *Chondrus (Buliminus) bidens* (Kryn.) (15). But in comparison with Level 3, there is an increase in the total number of mesophile species and individuals *Clausilia (Mentissa) gracilicosta* Rossm. (18), *Oxychilus (Schistophalus) deilus* (B.) (2), *Helix (Helicogena) lucorum taurica* (Kryn.) (1), and *Theba fruticola* (Kryn.) (1). This relatively large diversity of mesophiles may indicate changing climatic conditions towards higher humidity. During the sedimentation of Level 2, steppe landscapes predominated, but were more limited than during the time of Level 3. The forest and bush areas were larger than in the time of Level 3, but evidently, more limited compared with the time of Level 1. The process of increasing humidity from Level 3 to Level 1 is easily observed in the comparative diagram of the site (fig. 5-4).

In Level 1, there are a large number of forest mesophiles: *Clausilia (Mentissa) canalifera* Rossm. (25), *Cl. (M.) gracilicosta* Rossm. (3), *Vallonia pulchella* Müll. (45), *Caecilioides raddei* Bttg. (10), *C. acicula* (Müll.) (2), *Carichium minimum* Müll. (5), and *Cochlicopa lubrica* Müll. (3). These species may serve as reliable indicators for the continued increase in humidity, and that the annual amount of precipitation reached its culmination—these fauna indicate more humid conditions than previously seen at the site, as well as more humid conditions than the present day. Probably, this horizon corresponds to one of the Late Würm interstadials, when the climate of this region was more humid, but relatively colder, than today.

CORRELATIONS AND CONCLUSIONS

The essential peculiarity of Crimean snails is their very high level of endemism (more than 30% of species), which has provoked huge problems in correlating them with neighboring continental regions of the north coast of the Black Sea. Prof. I. I. Pusanov (1926) described 108 species of modern snails on the Crimean Peninsula. Not long afterwards, I. M. Likharev and E. S. Rammelmeier (1952) described 110 species, but 20 of these are freshwater mollusks.

Because our collections of modern and fossil snails represent only a small sector of the second Crimean Mountain range, they include only about 40 species of snails, which comprise a little more than one-third of all modern Crimean species. The importance of these collections lies in the fact that it is the first and only sample of fossil snails from Crimea. Taking into account the relatively large diversity of the represented species, and the large number of individuals from each species (some samples include more than 200-300 cockleshells), the investigated samples, examined in parallel with palynological and mammalian faunal data, may serve as a good basis for the paleoenvironmental reconstructions of the main stages of the evolution of Stone Age hominids and regional climatic oscillations during the Upper Pleistocene.

The results of Quaternary malacological investigations from throughout Europe demonstrated that during last million years, the evolution of snails took place predominantly on the morphs, natio, and subspecies levels. Analyses of Crimean fossil snails confirm this conclusion. The main changes in Crimean snails during the Upper Pleistocene predominantly reflect changes in paleoenvironment (especially changes in climatic conditions) and less the evolutionary transformation of fossil species.

The comparison of the morphometric parameters of fossil and modern snails suggests that none of the species in Crimea evolved into new species during the Upper Pleistocene. Chondrulinae (especially the genus *Chondrus (Buliminus)*), did undergo more evolutionary change, given the number of subspecies distinguished, but such a conclusion needs to be supported by more extensive collections. The changes in *Chondrus bidens*, as seen in the author's studies, may be due at least in part, to this group's very high morphometric parameter variation as a result of differences in relief (slope exposure), soils, and vegetation.

The method of sampling used at all sites was aimed at selecting as many fossil cockleshells as possible from different horizons and from different granulometric fractions of sediments. Because the calcareous soils and the dry, warm climate of Crimea ensure excellent preservation of cockleshells, it is assumed that the selected samples accurately reflect the species composition of Paleolithic-age Crimean snails. The changes in composition of species, and the number of individuals of each species, therefore reflect the major climatic oscillations during the Upper Pleistocene and Holocene of this zone.

Characteristic of the Crimean Upper Pleistocene are the frequent changes of relatively warm and humid associations of snail fauna and relatively cold and arid associations of species. These oscillations may be readily observed in the changing species composition and changing number of individuals in each species in the samples from the 1986 Sondage at Kabazi II (Table 5-5, fig. 5-2).

During the early Upper Pleistocene (Mikulino, or Pryluky, Interglacial), the Crimean snail population consisted of warmth-loving species, including *Helix (Helicogena) lucorum taurica* (Kryn.), *H. (H.) vulgaris* Rossm., *Helicella (Helicopsis) dejecta* Cr. et J., *H. (Xeropicta) krynickii* (Kryn.), *Zebrina (Buliminus) cylindricus* Mke., *Chondrus (Buliminus) bidens* (Kryn.), *Clausilia (Mentissa) gracilicosta* (Rossm.), and *Pupilla muscorum* (L.).

The main environmental changes in the vicinities of Kabazi II, Kabazi V, and Starosele become more evident through the comparison of the species composition at each site (Figs. 5-1–5-4). Such changes may be very well observed at Starosele. For example, the very extensive sample (467 shells) from Level 4 and the underlying sediments indicates that the climate was more humid than it is at the present time. This species composition, when compared to fossil snail fauna from Moldova and southern Ukraine, suggest that Level 4 corresponds to the end of the Mikulino (Pryluky) Interglacial. This conclusion is further supported by the lithological character and composition of the sediments, which are composed of red pedosediments. Fossil soils of this nature are specific to the Mikulino Interglacial. The pedosediment of Level 4 is an erosional product that was transported by water torrents from the plateau above the site. Given the fact that loess or other sediments younger than Mikulino age were not observed either in the Level 4 deposit or below it, very little time must have passed between the formation of the red pedosediment on the plateau and its subsequent deposition below as Level 4. That Level 4 was formed not parallel with the Mikulino soil, but sometime afterwards, is indicated by the appearance of comparatively cold elements for the Crimean zone (*Vitrea pygmaea, Columella edentula, Retinella radiatula, Vallonia pulchella, Acanthinula aculeata*) along with the relatively warm and humid fauna.

During the Early Valdai glaciation (Early Würm), some short phases of warming such as Amersfoort, Brörup, and Odderade, occurred on the north coast of the Black Sea. In the snail fauna of the neighboring zones (from southern Ukraine and Moldova), the number of cryophilic species during these phases became more limited. In Crimea, these warm horizons may correspond the sample numbers 621, 625, and 626 from the Kabazi II sondage, where mesophile snail fauna increase in number. This correlation is only preliminary, however, as these samples are very small and homogenous.

A warmer complex of snail fauna corresponds to the Middle Valdai interstadial, which may be correlated to the fresh water mollusks in the alluvium of the first terraces of the Eastern European Don, Dniepr, Dniester, and Danube rivers. Characteristic of the Middle Valdai thermocomplex are *Lithoglyphus naticoides* C. Pf., *Valvata piscinalis* Müll., *Chondrula tridens* Müll., *Chondrula tetrodon* (Mort.), *Helicella (Helicopsis) dejecta* Cr. et Jan., *Helicella (Xeropicta) Krynickii* (Kryn.), *Chondrus (Buliminus) bidens* (Kryn.), *Zebrina (Buliminus) cylindricus* Mke., *Clausilia (Mentissa) laminata* (Moell.), and *Clausilia gracilicosta* (Rossm.). This thermocomplex may be comparable with the humid fauna from Starosele Level 2, and possibly with the snail fauna from the samples 615-619 from the Kabazi II sondage.

While the snail fauna from Starosele Level 2 is similar to the Middle Valdai thermocomplex, it should be noted that Level 2 contains some cold elements which are also characteristic of the relatively warm interstadials of the Upper Valdai in Crimea. During the second part of the Valdai, the snail fauna of the north coast of the Black Sea are characterized by a cold complex (cryocomplex) which includes *Vallonia pulchella* (Müll.), *Caecilioides acicula* (Müll.), *Ca. raddei* Bttg., *Carichium minimum* Müll., *Succinea elegans* Risso, and *Pupilla muscorum* (L.). During this time, the cooling process appears to have been more intense than in Early Valdai time, on the basis of the reduced number of thermophiles. Unfortunately, the limited collection of fossil faunas from the Crimean Peninsula precludes assigning a typical fauna associated with this cryocomplex.

Another relatively warm and humid complex of snail fauna was found in Starosele Level 1. This complex may correspond to one of the warm Late Valdai interstadials. This correlation is only preliminary, however, due to our limited fossil malacological collection, and until the Crimean climatic oscillations are better understood in relation to global climatic change.

In spite of its geographical situation, the climatic oscillations on the Crimean Peninsula probably possess regional peculiarities and differ from those experienced on the Eastern European Plain. For example, on the north coast of the Black Sea, warming trends are usually accompanied by increasing humidity, and cooling trends are usually accompanied by increasing aridity. On the Crimean Peninsula, in spite of its southern geographical situation and the significant influence of the Black Sea, changes in humidity may be more important than changes in temperature. In Crimea, warm faunal complexes are not always mesophilic (humid), so it is very difficult to correlate Crimean snails faunas with their analogs in the continental zone. Yet, the results of the malacological analyses of Kabazi II, Kabazi V, and Starosele generally confirm paleontological data known from the littoral zone of the Black Sea, including the data of marine and brackish water mollusks.

Chapter 6

LATE PLEISTOCENE VEGETATIONAL HISTORY OF KABAZI II

NATALIA GERASIMENKO

INTRODUCTION

Multiple changes of ecotones in the vicinity of Kabazi II have been revealed through palynological analysis of the site's sediments. During human occupations of the site, more than 11 meters of deposits accumulated behind a huge rock slab that fell to rest on a bench on the Kabazi Mountain slope (Chabai 1998a). The geomorphological-geological setting of the site, as well as the detailed sedimentologic characteristics of the Kabazi II sequence, have already been described (Chabai 1998a). The archeological sequence has been elaborated in detail in numerous publications (e.g., Kolosov et al. 1993; Chabai 1996, 1998).

The first palynological investigations of Upper Pleistocene deposits of the Crimean Mountains were conducted for the Mousterian site Zaskalnaya V, located in eastern Crimea (Gubonina 1985). Zaskalnaya V sediments have been correlated to the first half of the Valdai (Würm) Glacial—from the Krutitsa Interstadial (Brörup) to the beginning of Bryansk Interstadial (Hengelo-Denekamp) (Velichko 1988). Three stages of vegetational development have been established. The first one, corresponding to the Krutitsa Interstadial, was characterized by forest-steppe ecotones, including hornbeam forests. The second stage was marked by a predominance of xeric steppes during the Valdai stadial, while the third stage (the Bryansk Interstadial) was characterized by rather humid climatic conditions with the expansion of more mesophilic grasses and birch-alder forests.

Kabazi II is located in western Crimea, an area characterized by considerably higher humidity than eastern Crimea. The present annual precipitation around the site is between 500-550 mm, while in the Zaskalnaya V locality, it is between 400-450 mm. This results in distinctly different modern vegetational covers in western and in eastern Crimea.

Kabazi II is located within a belt of low mountain forest-steppe, characterized by an alternation of meadow steppes and moderately high forests. The area belongs to the Euxinian forest province, Crimean Mountain subprovince, forest-steppe region of forests (of *Quercus pubescens Willd.),* and meadow steppes (Barbarych 1977). The distribution of woodlands and grasslands depends partially on topography. The site is situated in the upper part of a scarp slope of a mountain cuesta (300 m above sea level). A plateau-like flat northern slope of the Kabazi cuesta is occupied by steppes: Gramineae-*Herbetum mixtum* associations, which are accomplished by a sparse growth of xeric *Herbetum mixtum.* A combination of typical steppe, meadow-steppe, and xeric grasses is a characteristic feature.

Arboreous vegetation is spread at the foot of the scarp slope: oak *(Quercus pubescens Willd., Quercus petraea Liebl.*, and *Quercus robur L.*, the first predominates); hornbeam *(Carpinus orientalis Mill.),* maple *(Acer campestre L.),* ash-tree *(Franxinus excelsior L.),* and elm *(Ulmus foliacea Gilib.).* All grow as low trees and are almost mixed with shrubs. Shrubs are very abundant and diverse: hazelnut (Corylus *avellana L.),* spindle tree *(Euonumus europaea L.),* Cornelian cherry (Cornus mas *L.),* bloody dogwood (Cornus *sanguinea L.),* buckthorn *(Rhamnus cathartica L.),* Christ's thorn *(Paliurus spina-Christi Mill.),* hawthorn *(Crataegus pentagyna* Jacg.), blackthorn *(Prunus spinosa L.),* rose *(Rosa corymbifera L.),* pear *(Pyrus elaeagrifolia Pall.)*, smoke tree *(Cotinus coggygria Scop.)*, and juniper *(Juniperus Sabina L.)*. Shrubs also occupy the lower part of the slope, which is dissected by ravines. The middle part of the slope is vegetated by recently planted pine trees.

The significant human impact on the vegetational cover of the area is evident. Historical documents and maps record that the western foothills of the Crimean Mountains were covered with dense forests. The occasional gigantic broad-leaved tree, as well as shade-loving plants in the grass-covered foothills, attest to the tall tree growth and dense canopies of the past. Nevertheless, the chernozem-type soils of the gently sloping plain of Kabazi cuesta indicate that the mountain plateau has never been entirely forested.

The scarp slope of the cuesta on which Kabazi II is located faces the lower part of the northern slope of the Main Range of Crimean Mountains. Its vegetation could also impact the formation of pollen spectra in the site's sediments. The lower part of the slope of the Main Range (up to 650 m in height) is occupied by a belt of oak forests (Kochkin 1967). *Quercus pubescens Willd.* and *Quercus petraea Liebl.* predominate and form the first level of forests, while hornbeam forms the second level with the above-mentioned shrubs as undergrowth. Patches of pine and juniper trees occur here and there. Above 600 m, oak woodlands are replaced by hornbeam and beech forests. Lime-tree, ash-tree, maple *(Acer campestre L.)*, and pine occur as admixtures, while higher in the mountains, unadulterated pine forests grow. It should be noted that the Chatyrdag Yaila mountain massif, which is just above the Kabazi locality, is distinguished by limited pine forests.

Surface samples of the Chatyrdag Yaila soils show a lower value of pine pollen (10-45% in 4 samples and 40-70% in 2 samples) than the surface samples of the other mountain massifs of the Main Ridge (40-80%) (Artiushenko and Mishnev 1978). The surface samples have been taken from the soils of mountain meadow-steppes which are surrounded by the forest types discussed above, and are characterized by 33-78% of arboreal pollen (AP) and by 22-60% of non-arboreal pollen (NAP), depending on the distance to the forest boundary. Beech dominates among broad-leaved taxa pollen (3-7%), due to its prevalence in the forest composition. Hornbeam, oak, elm, maple, and lime-tree also occur, while alder, juniper, and other shrubs represent the rest of the AP. *Herbetum mixtum* prevails in NAP. The following dominate in the NAP: Fabaceae (5-16%), Polygonaceae (1-17%), Asteraceae (1-6%), Rosaceae (1-5%), Caryophyllaceae (2-5%), Lamiaceae (2-3%), and Brassicaceae (2-4%). The values of Gramineae are 2-4%, and Chenopodiaceae 2-6%, although all samples have been taken under *Herbetum mixtum*-Gramineae associations and no Chenopodiaceae have been fixed in the modern grass cover. Polypodiaceae spores sharply prevail over Bryales.

Surface samples taken by author in the *Herbetum mixtum*-Gramineae steppe in the vicinity of Saki Lake (about 50 km north-west of Kabazi II) are quite different in their NAP composition; they include the xerophytes Chenopodiaceae and *Artemisia* (27-64%), Gramineae (4-20%), *Herbetum mixtum* (28-49%), and Cyperaceae (1-3%). Bryales sharply prevail over Polypodiaceae. Annual precipitation is above 900 mm on the Chatyrdag Yaila and less than 400 mm in the Saki Lake vicinity.

Surface samples of forest soils have been taken in beech forests (1150 m a.s.l.) and in oak-hornbeam forests (600 m a.s.l.), and both are characterized by 80% AP (Artiushenko and Mishnev 1978). In the former, beech shares the second place in abundance with pine (26-27%), while alder dominates (40%), although it is related to water outlets only. There are 1-2% of oak, elm, and juniper pollen grains. In oak-hornbeam forests, pine pollen dominates (50%), while oak and hornbeam share the second place (16-17%). Lime, elm, ash-tree, maple, hazelnut, and Cornus are represented by 2-5% of pollen grains.

METHODOLOGY

Forty-eight 100-gram samples have been processed following the methodology of Saint Petersburg University. This involves treatment with 10% HCI, 10% KOH, cold treatment of HF, disintegration in a solution of sodium pyrophosphate (Na4 P2 O7), and flotation in heavy liquid (KdJ2 + KJ2) of specific gravity 2.2. The pollen grains were mostly well preserved and their frequency varied from 11 to 52 grains per slide. Six of the 48 processed samples contained only a few microfossils and could not be used for plotting a pollen diagram. Apart from certain irregularities in pollen frequency distribution, the general tendency is a frequency decrease upwards through the Kabazi II section. The deposits were more rich in pollen at the depth of 11.0-7.0 m below datum (Strata 14, 13, and a lower part of Stratum 11). Between 6.9-3.6 m (Strata 11-9, lower part of Stratum 7) there was a moderate pollen frequency, while the interval between 3.5-1.5 m (Strata 7-4) showed a low concentration of microfossils (with the exception of the uppermost level). This demonstrates a direct correlation between pollen frequency and the content of clay particles in the sediments; as shown by grain size analysis, Stratum 13 to the lower part of Stratum 11 are most rich in clay, while the upper part of Stratum 7 through Stratum 4 have the lowermost content (Chabai 1998a: 176).

Special studies of pollen spectra of surface samples in modern vegetational zones and subzones have been carried out in order to correctly interpret pollen spectra in Quaternary deposits (Grichuk and Zaklinskaya 1948; Grichuk 1950; Berezina and Tyuremnov 1969; Bolikhovskaya 1976; Dinesman 1977). Correction factors between vegetation and the resulting palynospectra for different vegetational zones of Ukraine have been elaborated (Arap 1972, 1976; Bezus'ko et al. 1992). These studies provide a methodological and comparative basis for the reconstruction of paleovegetational history with pollen data.

The peculiarities of pollen spectra formation in mountainous regions have also been studied (Klopotovskaya 1973, 1976). It has been demonstrated that in mountains, the pollen of most plants is insignificantly distributed aerially; only pine and alder pollen can be aerially transported long distances in these areas. Hornbeam, beech, and oak, as plants of insignificant pollen productivity, can be represented by only a small portion of pollen in comparison with pine. This is true even when pine is absent in the studied area, but present within the orographical region. The most local spectra have been shown to be formed under forest vegetation in soil, proluvial, and hillwash deposits.

In the accompanying spore-pollen diagram, the total sum of microfossils includes pollen of arboreous plants, herbs, and spores (fig. 6-1). The percentages of different spore taxa have been calculated in relation to the total sum, while the percentages of different arboreous (and herbaceous) taxa are related to the sum of trees and herbs, assumed equal to 100%

POLLEN ZONATION

Fourteen pollen zones have been recognized in the deposits of Kabazi II based on the 48 samples taken from Strata 4-14 (figs. 6-1, 6-2; Table 6-1).

Pollen zone I, observed at the depth 11.0-10.7 m below datum, is characterized by forest-steppe pollen spectra (46-49% AP, 38-42% NAP) and by a high proportion of broad-leaved taxa pollen (32-56%). The latter is mainly represented by *Quercus* and *Carpinus* (fig. 6-1). The percentage of *Quercus* pollen in this zone (21-22%) is the highest for the section. *Ulmus* and *Tilia* pollen occur, as well as that of *Corylus, Euonymus,* Caprifoliaceae, and arboreous Rosaceae (2-5% each). The percentage of pine in the AP is less than average for the section. There is an insignificant peak of alder for the section (up to 13%). The characteristic feature of NAP is a very low value of xerophytes (*Artemisia* and Chenopodiaceae): 0-8% total, and

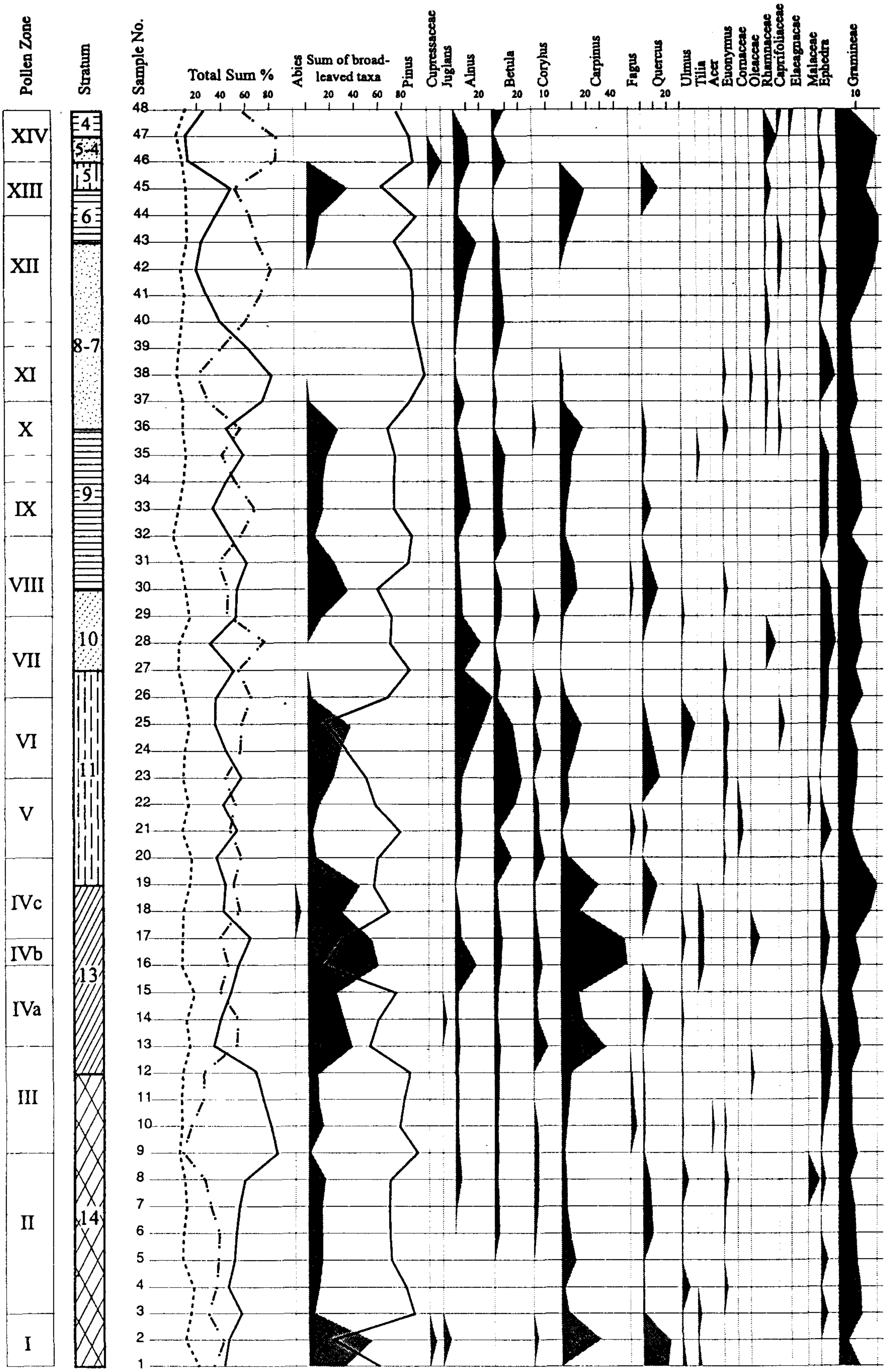
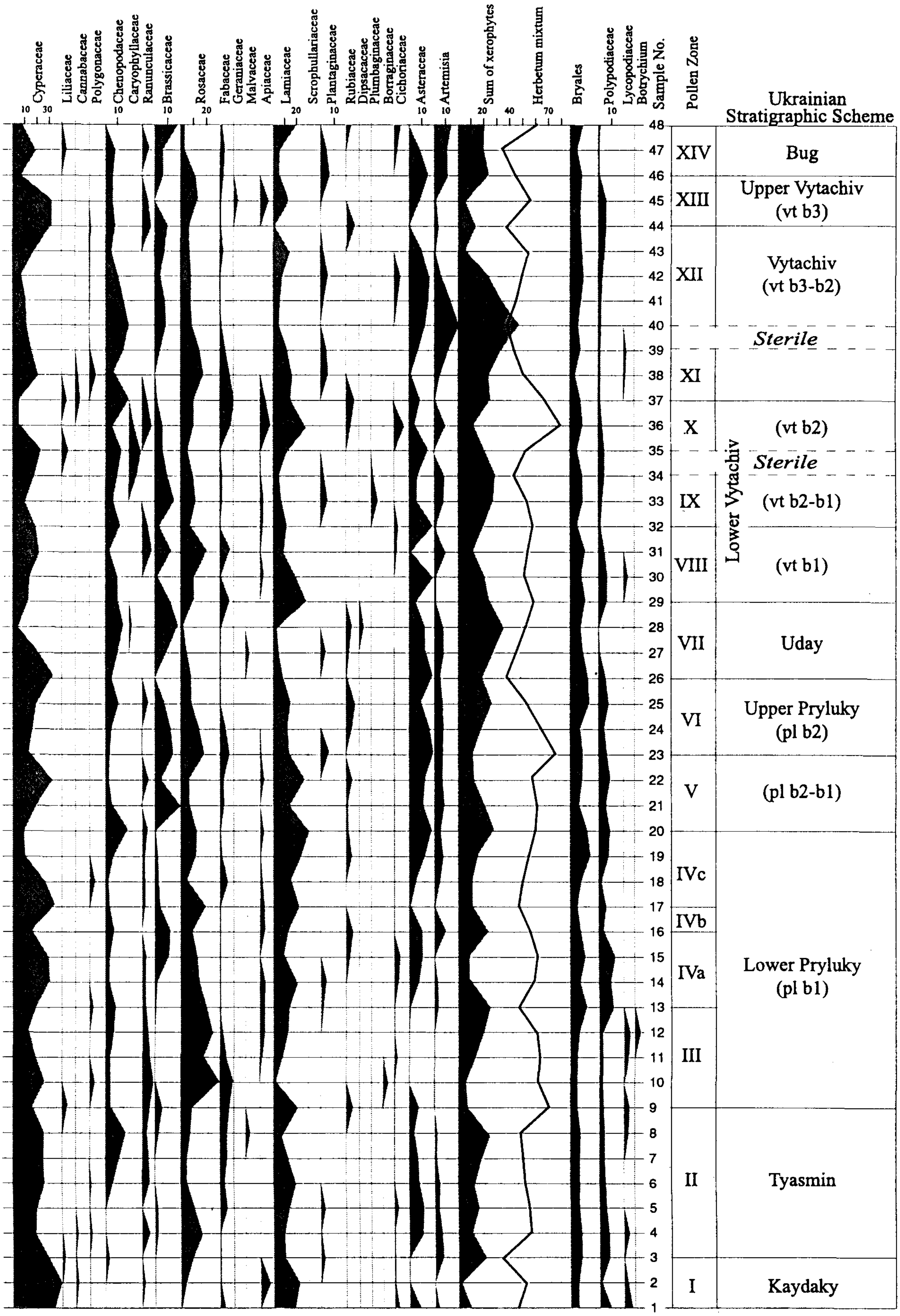
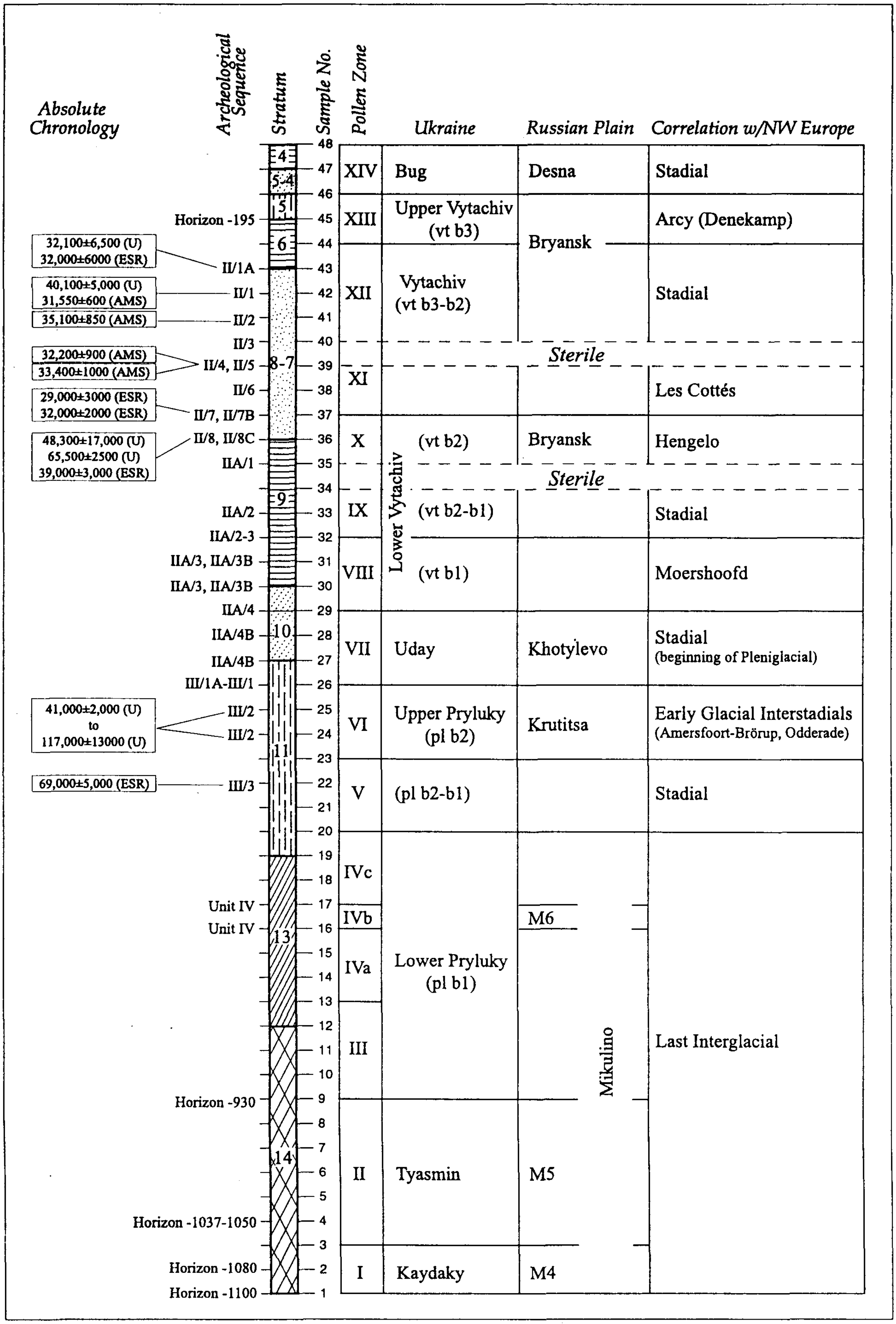


Fig. 6-1—Kabazi II, pollen diagram.


Cyperaceae
10
30
Liliaceae
Cannabaceae
Polygonaceae
Chenopodiaceae
10
Caryophyllaceae
Ranunculaceae
Brassicaceae
10
Rosaceae
20
Fabaceae
Geraniaceae
Malvaceae
Apiaceae
Lamiaceae
20
Scrophullariaceae
Plantaginaceae
10
Rubiaceae
Dipsacaceae
Plumbaginaceae
Borraginaceae
Cichoriaceae
Asteraceae
10
Artemisia
10
Sum of xerophytes
20
40
Herbetum mixtum
70
Bryales
Polypodiaceae
10
Lycopodiaceae
Botrychium
Sample No.
Pollen Zone
Ukrainian Stratigraphic Scheme
48
47
46
45
44
43
42
41
40
39
38
37
36
35
34
33
32
31
30
29
28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
XIV
Bug
XIII
Upper Vytachiv
(vt b3)
XII
Vytachiv
(vt b3-b2)
Sterile
XI
X
(vt b2)
Sterile
IX
(vt b2-b1)
VIII
(vt b1)
Lower Vytachiv
VII
Uday
VI
Upper Pryluky
(pl b2)
V
(pl b2-b1)
IVc
IVb
IVa
Lower Pryluky
(pl b1)
III
II
Tyasmin
I
Kaydaky



Pollen Zone	Ukraine		Russian Plain	Correlation w/NW Europe
XIV	Bug		Desna	Stadial
XIII	Upper Vytachiv (vt b3)		Bryansk	Arcy (Denekamp)
XII	Vytachiv (vt b3-b2)			Stadial
	Sterile			
XI				Les Cottés
X	Lower Vytachiv	(vt b2)	Bryansk	Hengelo
	Sterile			
IX		(vt b2-b1)		Stadial
VIII		(vt b1)		Moershoofd
VII	Uday		Khotylevo	Stadial (beginning of Pleniglacial)
VI	Upper Pryluky (pl b2)		Krutitsa	Early Glacial Interstadials (Amersfoort-Brörup, Odderade)
V	(pl b2-b1)			Stadial
IVc	Lower Pryluky (pl b1)		Mikulino	Last Interglacial
IVb			M6	
IVa				
III				
II	Tyasmin		M5	
I	Kaydaky		M4	

an extremely high value of Cyperaceae: 37-50%. The percentage of Polypodiaceae and Lycopodiaceae spores (5-14%) is high for the section. *Herbetum mixtum* pollen (45-48%) comprises 8 families, but Lamiaceae predominates by far.

Pollen zone II (10.6-9.5 m) is conspicuous for a decrease in broad-leaved taxa pollen (13-18%) and a predominance of pine (68-86%). Broad-leaved trees are mainly represented by *Carpinus* and *Quercus,* but at some levels, *Ulmus* is just as abundant. In the lowermost level, single pollen grains of *Juglans* and *Tilia* occur. *Corylus*, *Euonymus*, and *Cornus* are consistently present in small numbers, and arboreous Rosaceae becomes noticeable in the upper levels. Single pollen grains of birch appear throughout the pollen zone.

The pollen spectra of zone II are still of forest-steppe type (47-59% AP, 29-40% NAP). The percentage of *Herbetum mixtum* is the same as in pollen zone I, but Cyperaceae decreases at the expense of an increase of xerophytes (12-23%), especially Chenopodiaceae (up to 19%). *Ephedra* is constantly present (up to 8%). The *Herbetum mixtum* composition becomes more diverse, predominating in Lamiaceae, Rosaceae, and Asteraceae. Polypodiaceae prevails over Bryales, and single Lycopodiaceae spores occur.

Pollen zone III (9.4-8.7 m) is characterized by pollen spectra of forest type (66-82% AP, 11-26% NAP) and by a low proportion of broad-leaved taxa pollen (7-16%). *Pinus* pollen predominates sharply (75-83%). Broad-leaved trees are represented by *Carpinus, Fagus,* and *Quercus,* single pollen grains of *Ulmus* and *Acer* also occur. *Betula, Alnus,* and *Corylus* pollen grains are consistently present in small numbers, while *Euonymus*, Cornaceae, Oleaceae, and arboreous Rosaceae occur sporadically. The NAP is characterized by a higher value of *Herbetum mixtum* (60-69%), dominated by Rosaceae, Lamiaceae, Ranunculaceae, and Fabaceae. Cichoriaceae and Borraginaceae are present consistently, while Asteraceae and *Artemisia* disappear. The proportion of Gramineae and Cyperaceae is within their average ranges, but the proportion of xerophytes is small (7-18%), although *Ephedra* pollen peak (up to 9%). This is the last pollen zone with a diverse spore composition, including Bryales, Polypodiaceae, Lycopodiaceae, and *Botrychium.*

Pollen zones I-III are in geological Stratum 14, represented by light grey loam with abundant *Helix* mollusca. The division of the geological strata used here follows Kolosov et al. (1993) and Chabai (1998a).

Pollen zone IV (8.6-7.4 m) is complex in structure and is divided into three subzones. The main features of zone IV are a predominance of forest-steppe pollen spectra and high values of broad-leaved taxa pollen, especially of *Carpinus.* Subzone IVa (8.6-8.1 m) is characterized by an approximately equal proportion of AP (35-45%) and NAP (38-50%). Broad-leaved tree pollen accounts for 23-37%. *Carpinus* (16-37%) sharply predominates over *Quercus, Corylus* becomes more abundant that in zones I-III, and few pollen grains of *Juglans* and *Ulmus* appear. *Alnus* and *Betula* pollen are consistently present in low percentages. The NAP

Key for figure 6-1, Table 6-1:

⬚ soil sediments ☰ loesses ⬚ humic soil horizons ◫ Bt soil horizons ▨ dark loams ⊠ light loams

——— arboreous pollen ------- non-aboreous pollen -·-·- spores

AMS dates: Hedges et al. 1996; U-series dates: McKinney 1998, Rink et al. 1998; ESR dates (all LU): Rink et al. 1998

Facing page: Table 6-1—Kabazi II, correlation of pollen zones, absolute dates, archeological and geological sequences, and European glacial stages.

components and their proportions are typical for the section: a low value of Gramineae, an insignificant proportion of xerophytes, and considerable Cyperaceae and *Herbetum mixtum.* The latter is more diverse in composition and represented invariably by Lamiaceae, Rosaceae, and Brassicaceae (which dominate), Asteraceae, Ranunculaceae, Apiaceae, and Plantaginaceae. Spores are rather abundant (12-17%), but include Bryales and Polypodiaceae only.

Pollen subzone IVb (8.0-7.8 m) is conspicuous for having the highest content of broad-leaved taxa pollen (50-56%), represented almost entirely by *Carpinus* (42-50%). *Tilia* pollen grains (5-6%) also occur. Shrubs include *Corylus* (7-8%), Cornaceae, and Oleaceae. A peak of *Alnus (Alnus glutinosa Gaertn.)* pollen (7-19%) is observed, while the percentage of *Pinus* (13-28%) is the lowest in the section. AP values of subzone IVb (50-57%) are highest within zone IV and make the spectra similar to a forest type. NAP and spore composition do not differ from that of subzone IVa.

Pollen subzone IVc (7.7-7.4 m) is characterized by the same proportion of broad-leaved taxa pollen (23-43%) as subzone IVa. *Carpinus* still predominates (18-29%). The AP composition of the lower part of subzone IVc is similar to that of IVb *(Tilia, Alnus, Coryus)*, except *Pinus* pollen increases (62%). In the upper part of subzone IVc, *Quercus* pollen (14%) becomes noticeable again, *Betula* somewhat increases, and few pollen grains of *Abies* appear—the only occurrence in the section. A particular feature of the NAP is a peak of Gramineae pollen (16-20%) at the expense of a drop in Cyperaceae. Within *Herbetum mixtum,* an increase of Fabaceae pollen at the expense of Brassicaceae is also observed. The other NAP characteristics are the same as in the entire zone IV. Bryales spores prevail somewhat over Polypodiaceae.

The subzones of pollen zone IV distinctly show a climatic optimum (subzone IVb) with its initial and final substages. Zone IV corresponds to the main part of Stratum 13, which consists of a greenish-grey loam.

Pollen zone V (7.3-6.8 m) shows a sharp reduction of broad-leaved taxa pollen (5-10%) and a considerable increase of *Betula* pollen (up to 18-20%). Broad-leaved trees are represented mainly by *Carpinus*, although *Fagus* and *Quercus* also occur. Shrub pollen grains are not abundant but they are diverse: *Corylus* (dominating at 3-9%), *Euonymus*, Cornaceae, Oleaceae, and arboreous Rosaceae. Pollen spectra are still of forest-steppe type (33-49% AP, 41-53% NAP). The NAP composition is similar to that of zone IV, but a drop of Gramineae (3-8%) takes place again, at the expense of Cyperaceae, but also owing in part to an increase of the xerophytes Chenopodiaceae and *Ephedra.* Brassicaceae becomes consistently noticeable beginning from zone V. Zone V is within the uppermost part of Stratum 13 and the lower part of Stratum 11.

Pollen zone VI (6.7-6.2 m) comprises pollen spectra of a forest-steppe type (32-52% AP, 40-54% NAP) with a considerable percentage of broad-leaved taxa pollen (23-33%). The latter, however, is lower than that of pollen zones I and IV. *Carpinus* and *Quercus* share a dominance within the group of broad-leaved trees. *Ulmus, Corylus, Euonymus,* and Caprifoliaceae also occur. The characteristic feature of zone VI is a high proportion of *Betula* (*Betula pendula Ehrh.*): 17-23%, which is the maximum for the section. Pollen of the other small-leaved taxa *Alnus (Alnus glutinosa Gaertn.)* become abundant (25%) in the uppermost level. Concomitantly, the proportion of *Pinus* pollen is low (17-46%). A high ratio of *Herbetum mixtum* is typical for NAP (50-71%), while Cyperaceae values become lower beginning from zone VI (13-21%). *Herbetum mixtum* is dominated by Rosaceae, Lamiaceae, Asteraceae, and Brassicaceae. Xerophyte pollen, consisting mainly of Chenopodiaceae, is not abundant (8-23%). Spores include Bryales and Polypodiaceae in equal proportions.

Pollen zone VI corresponds to the main part of Stratum 11, described as a dark-brown loam with limestone clasts. Its upper part, exposed by the excavation, represents a soil humic

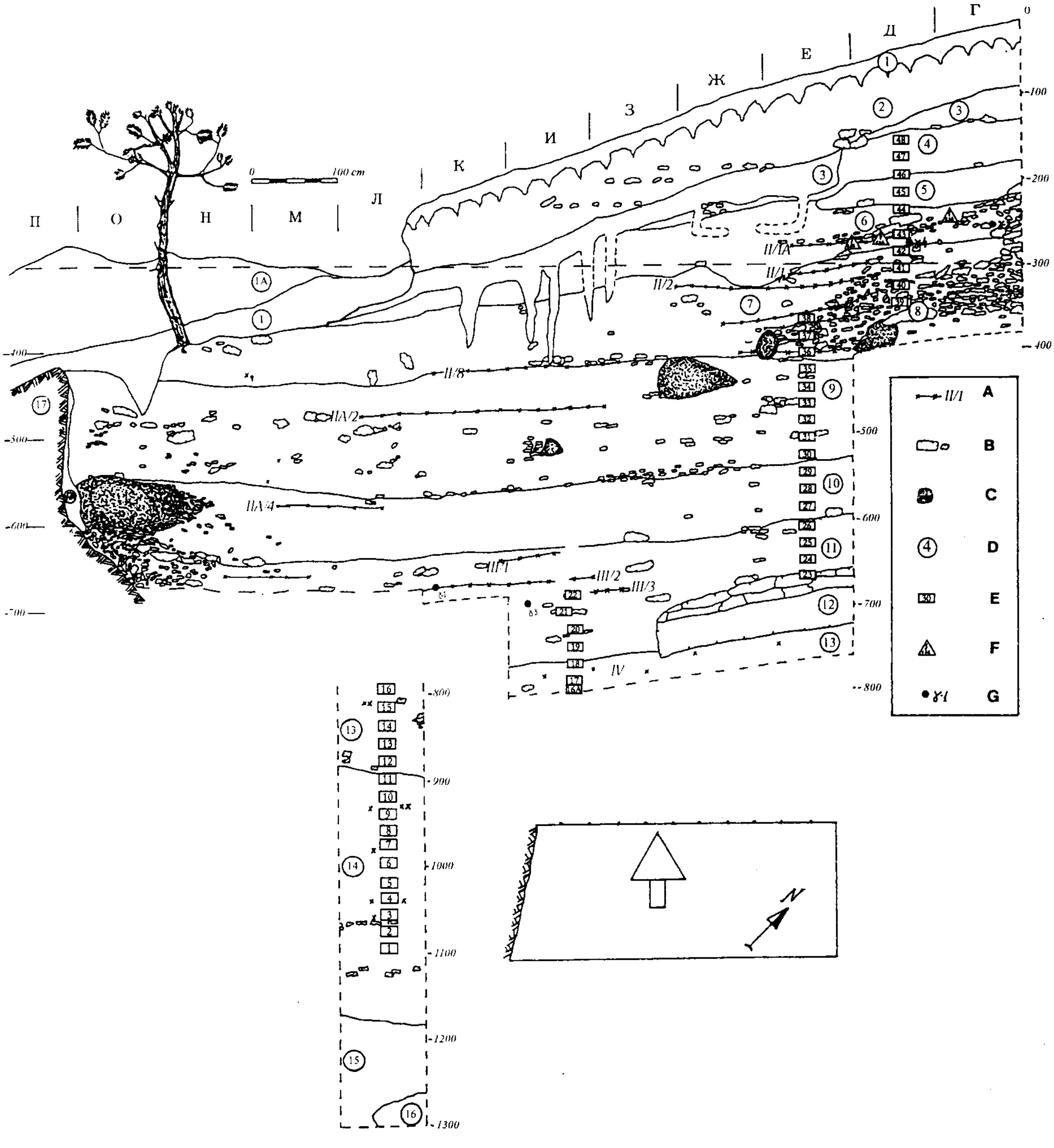


Fig. 6-2—Kabazi II, section along the line of squares "9": *A*–archeological levels; *B*–limestone blocks; *C*–large animal tunnels; *D*–numbers of strata; *E*–numbers of pollen samples; *F*–ESR samples; *G*–ESR dosimeters.

horizon, supposedly of a turf-carbonate soil. Pedogenic features have been also described by Ferring (in Chabai 1998a) for the lower part of Stratum 11—presence of pedogenic clay and carbonate leaching from the middle of Stratum 11. Nevertheless, there is a decrease in pollen frequencies beginning from this zone.

Pollen zone VII (6.1-5.6 m) is the first zone with a distinct predominance of NAP over AP, although the spectra are still of a forest-steppe type (28-47% AP and 49-68% NAP). A prominent feature of zone VII is also a sharp drop in broad-leaved taxa pollen, up to their complete disappearance in the middle part of the interval. A few pollen grains of *Carpinus* occur in the lower part, while single grains of *Quercus* and Rhamnaceae pollen occur in the upper part of the zone. AP is dominated by *Pinus* (61-79%) and *Alnus* (9-28%). This is the highest percentage of *Alnus* recorded in the section. *Betula* is present in a smaller number (up to 9%).

The changes in NAP composition through the zone show a trend towards decreasing Cyperaceae and increasing xerophytes and *Herbetum mixtum*. All xerophytes become more abundant (up to 33% total) and include Chenopodiaceae, *Artemisia*, and *Ephedra*. The percentages of *Artemisia* and *Ephedra* are highest for the section. In addition, pollen of such xeric taxa as Plumbaginaceae and Dipsacaceae appear. The increase in *Herbetum mixtum* is due to an increase in Brassicaceae (up to 20%). With the exception of the lowermost level, spore values are very low (4%), due to the disappearance of Polypodiaceae.

Pollen zone VII is within the uppermost level of Stratum 11 and the main part of Stratum 10. The latter is represented by a yellowish-grey loam with small limestone clasts. Its lower part, exposed in the excavation, is of pale-yellow color.

Pollen zone VIII (5.5-5.0 m) was recognizable by a new increase in broad-leaved taxa pollen (13-30%), which is not less than that of pollen zone VI. *Carpinus* predominates, although *Quercus* is noticeable, and single grains of *Ulmus* and *Fagus* also occur. The distinction from zone VI is that the AP value (48-58%) is higher than the NAP (34-42%), and pollen grains of small-leaved taxa (*Alnus* and *Betula)* are not prominent, though constantly present (4-10% each). A few *Corylus* and *Euonymus* grains appear at some levels. The NAP composition is close to that of zone VII. Nevertheless, a drop in xerophytes pollen (12-20%) is observed, while there is a slight increase in both Cyperaceae and Gramineae. Chenopodiaceae and Artemisia decrease, while *Ephedra* is still high. The dominant components of *Herbetum mixtum* become more diverse, now including Ranunculaceae and Fabaceae, as well as Lamiaceae, Rosaceae, Brassicaceae, and Asteraceae. Polypodiaceae spores appear again in equal numbers with Bryales, and single Lycopodiaceae spores occur.

Pollen zone IX (4.9-4.6 m) consists of forest-steppe spectra with a predominance of NAP (54-63%) over AP (31-44%), and with low values of broad-leaved tree pollen (5-13%). Very few taxa contribute to AP composition: *Alnus* and *Betula* (up to 13% each) and *Carpinus* and *Quercus* (up to 60% each). The remainder belongs to *Pinus* pollen. No specific features appear in NAP, except for some increase in xerophytes (namely *Artemisia* and Plumbaginaceae) at the expense of an Asteraceae drop within *Herbetum mixtum*. Low values of spores, represented mainly by Bryales, are also typical (2-6%).

Zone IX is separated from the following pollen zone X by a palynologically sterile level (4.5-4.4 m).

Pollen zone X (4.3-4.0 m) differs from the previous zone not only by a higher proportion of AP (41-55%) and broad-leaved tree pollen (17-25%), but also by a more diverse AP composition. After *Pinus*, *Carpinus* pollen is next in abundance (10-17%). *Alnus, Betula,* and *Quercus* are constantly present in a middling number, but *Fagus*, *Tilia, Euonymus, Corylus,* Rhamnaceae, and Caprifoliaceae also appear. The *Herbetum mixtum* maximum for the section (79%) occurs within zone X. Besides the commonly occurring Lamiaceae, Rosaceae, Asteraceae, and Brassicaceae, Caryophyllaceae, Ranunculaceae, Fabaceae, Apiaceae and Cichoriaceae also contribute significantly to its number. This abundance exists partly at the expense of a decrease in xerophytes, but is mainly due to a sharp drop in Cyperaceae, which generally looses its high values beginning from this zone. Polypodiaceae becomes noticeable again in the spore composition.

Pollen zones VIII-X are within Stratum 9. This stratum is described as a yellow loam with limestone clasts. A brown color of some levels has also been observed, and suggests that Stratum 9 is composed of pedosediments of a brown rendzina soil type.

Pollen zone XI (3.9-3.6m) has a forest type of pollen spectra (67-77% AP, 19-26% NAP). At the same time, the proportion of broad-leaved tree pollen is very low (2-4%). The *Pinus* value is maximal for the section (76-89%). *Carpinus, Betula,* and *Juniperus* are 24% each, while the other taxa *(Alnus, Tilia, Euonymus,* Oleaceae, Caprifoliaceae, and arboreous Rosaceae) are represented by single pollen grains. *Herbetum mixtum* is very abundant at the lower level, owing to a low value of Cyperaceae, but at the upper level, all components of NAP are within their average range for the section. Despite the forest type spectra, xerophytes are noticeable (24-25%), and *Ephedra* attains its last peak (12%). It is also the last zone in which Lycopodiaceae spores are observed.

Zone XI corresponds to the lowermost part of Stratum 7, represented by yellow loam with a great number of limestone clasts. Zone XI is separated from the following pollen zone by a palynologically sterile level (3.5-3.4 m).

Pollen zone XII (3.3-2.6 m) is notable for the appearance of a steppe type of spectra (19% AP, 75% NAP), for maxima of both xerophytes (44%) and Gramineae (18%) pollen, and for the absence of broad-leaved taxa. The lower pollen spectrum is of a forest-steppe type (36% AP, 57% NAP). *Pinus* consistently predominates in AP (78-80%). *Alnus* and *Betula* pollen (5-10% of each) are noticeable, while a few grains of Caprifoliaceae and Rhamnaceae appear. The peak of xerophytes is produced by Chenopodiaceae mainly in the lower part of zone XII, while the Gramineae peak occurs in its upper part. Concomitantly, the Cyperaceae value is low, and *Herbetum mixtum* is not abundant (39-48%). The latter is dominated by Asteraceae and Lamiaceae. Besides Rosaceae and Brassicaceae, Plantaginaceae and Cichoriaceae are also notable. Bryales prevail sharply over Polypodiaceae.

Zone XII corresponds to Stratum 7. Beginning from zone XII, there is a low concentration of observable pollen grains.

Pollen zone XIII (2.4-2.1 m) is characterized by forest-steppe types of pollen spectra, although NAP predominates (23-44% AP, 46-66% NAP). This is the last appearance of broad-leaved taxa pollen (6-33%), represented by *Carpinus* and *Quercus.* The former prevails slightly over the latter. A few pollen grains of *Alnus* and Rhamnaceae also occur, but *Pinus* usually predominates considerably (up to 83%). The characteristic feature of the NAP is a peak both of Cyperaceae (32-33%) and of Gramineae (10-21%). The percentage of xerophytes is very low (5-12%), and *Herbetum mixtum* is not abundant (33-54%), although diverse in composition. Polypodiaceae spores are about equal to Bryales.

Zone XIII corresponds to Stratum 6 and the lower part of Stratum 5. Stratum 6 is described as a yellowish-grey loam, while Stratum 5 is described as a grey loam, both with limestone clasts. From a pedological viewpoint, the strata comprise humus and humus-transitional horizons of a specific turf-carbonate soil, which has been formed under conditions of intensive accumulation of clastic material.

Pollen zone XIV (2.0-1.5 m) contains a steppe type of pollen spectra and the absence of broad-leaved pollen (13-14% AP, 79-82% NAP). This is the maximum of NAP for the section. The uppermost level of the zone is only slightly different (29%AP, 59% NAP, and a single *Fagus* pollen grain). *Pinus* dominates the AP and some *Betula, Alnus,* Cupressaceae, and Rhamnaceae appear. The presence of Elaeagnaceae pollen—the only occurrence in the section—is noticeable. *Herbetum mixtum* dominates the NAP (36-68%), though Gramineae becomes prominent (up to 25%). Xerophytes, represented by Chenopodiaceae and *Artemisia*, are not abundant (14-25%), and Cyperaceae drop in this zone. Asteraceae and Brassicaceae prevail in *Herbetum mixtum* (up to 16-17%), while Lamiaceae becomes dominant at the uppermost level only. Low values of spores, represented by Bryales, also increase at the uppermost level, in which Polypodiaceae and Lycopodiaceae appear.

Zone XIV corresponds to Stratum 4, described as a yellow loam with abundant limestone clasts, and to the uppermost part of Stratum 5. Stratum 4 underlies a carbonate illuvium (Ck horizon) of the modern soil. The latter is represented by well-developed turf-carbonate soil (humus horizons 1 m thick) with visual features of intensive carbonate leaching (deep and expressive sinter-like carbonate accumulations in the subsoil).

MAIN CHARACTERISTICS OF THE POLLEN DIAGRAM

Three main intervals are distinguished by the AP/NAP ratio: pollen zones I-III with a predominance of AP, pollen zones IV-X with approximately equal ratios of AP and NAP, and pollen zones XIII-XIV with a predominance of NAP. Pollen zones X and XII are separated by pollen zone XI, in which AP dominates. Despite this fact, the general trend of decreasing AP can be observed in the diagram (fig. 6-1).

The second feature of the diagram is its division into two parts by the content of broad-leaved taxa pollen. Pollen zones I-VI are characterized by its constant presence (whether in small or large percentages), while pollen zones VII-XIV are notable for an alternation of zones without broad-leaved pollen (VII, XII, and XIV) and zones with it (VIII-XI and XII). Furthermore, the broad-leaved taxa values in the upper part of the diagram are not as rich as those observed in its lower part. Thus, a general trend towards decreasing broad-leaved taxa pollen upwards can be also be seen in the diagram.

Another characteristic of the diagram is a rhythmic alternation of zones which are high in broad-leaved taxa pollen (I, IV, VI, VIII, X, and XIII) and zones which are low or absent in broad-leaved taxa pollen (II-III, V, VII, IX, XI-XII, and XIV). In general, positive correlation exists between zones rich in AP and broad-leaved taxa pollen, on one hand, and zones rich in NAP and poor in broad-leaved taxa pollen, on the other hand. But these correlations do not hold true for all pollen zones; although the most rich in AP, pollen zones III and XI are notable for low values of broad-leaved taxa pollen, while pollen zones I and VI, with high values of broad-leaved taxa, are not richer in AP than the adjacent pollen zones.

The diagram can also be divided into two parts by values of small-leaved tree pollen. *Betula* and *Alnus* pollen form significant curves in the upper part of the diagram only, beginning from the boundary of zones IV and V. *Pinus* pollen is a constant dominant in the diagram, which is fully expected given the high productivity and long-distance dispersal of pine pollen. The lower *Pinus* values correspond to pollen zones I and IV-VI and tend to be inversely correlated with broad-leaved taxa pollen.

Herbetum mixtum and Cyperaceae are constant dominants of NAP in the diagram, while xerophyte pollen is not very abundant, forming a significant maximum in zone XII only. As Kabazi II faces the lower part of the northern slope of the Main Range of the Crimean Mountains, the predominance of mesophyte pollen is not surprising. *Herbetum mixtum* and Gramineae compose the present-day grass cover of the area under investigation. Judging from the incomplete representation of the Gramineae family in the modern surface samples (Arap 1972, 1976; Bolikhovskaya 1976), it is possible there was a higher proportion of Gramineae in the past vegetational cover than is observed in the fossil pollen spectra. Cyperaceae could be very abundant throughout the deposits because of the shade conditions produced by the collapsed rock slab. Their values are more than 20% in zones I-IV, about 20% in zones V-X, and less than 20% in zones XI-XIV. In fact, Cyperaceae pollen is directly correlated with AP in the diagram, and shows the same trend of decreasing upwards. In contrast, Gramineae is more abundant only in zones XII-XIV. *Herbetum mixtum* is inversely correlated with xerophyte pollen, but not in all zones. Polypodiaceae spores show the same trends as broad-leaved taxa pollen. They are constantly present and more abundant in pollen zones I-VI, while they disappear at many levels in pollen zones VII-XIV. In the upper part of the diagram, their high values coincide with pollen zones VIII, X, and XIII, which are more rich in broad-leaved taxa pollen. So, a general trend to a decrease of Polypodiaceae upward is also a characteristic feature of the diagram.

VEGETATIONAL AND CLIMATIC DYNAMICS

Pollen Zone I: Environment

Pollen zone I indicates a spread of hornbeam-oak forests in the vicinity of Kabazi II, while the immediate locality was possibly surrounded by grass coenoses of *Herbetum mixtum* and Cyperaceae (fig. 6-1). The latter might be drawn towards the shady growth conditions behind the rock slab. The absence of pedogenic features in the studied deposits gives evidence that a deep cleft behind the slab was not completely vegetated. Such shade-loving mesophytes as sedges, ferns, and club-mosses could grow nearby. The prevalence of Lamiaceae in *Herbetum mixtum* is evidently related to the limestone substrata, since a number of representatives of the family are regarded as petrophytes, e.g., *Thymus L.* and *Teucrium L.* Typical xerophytes such as Chenopodiaceae, *Artemisia,* and *Ephedra* were practically absent.

In the forests, there was an admixture of elm and lime-tree, while diverse shrubs (hazelnut, spindle tree, Caprifoliaceae, and arboreous Rosaceae) formed the undergrowth. The appearance of walnut pollen just above zone I suggests its growth during the formation of sediments of pollen zone I, too, as it is doubtful that this warmth-loving tree would suddenly appear when other broad-leaved taxa in zone II decrease. The number of walnut trees in the forests was obviously not significant enough to result in their consistent appearance in the pollen spectra. Alder *(Alnus glutinosa Gaertn.),* which produces long-distance transport pollen, was abundant in the Alma River valley. The amount of pine was very low, even in the forests of the higher mountain belts, as it is at the present day.

The reconstructed vegetational cover indicates a warm climate during this interval, which might be compared with modern conditions. The presence of walnut is a specific feature that can be explained, on one hand, by even warmer climatic conditions than today, but on the other hand, by the more relict character of the flora.

The archeological horizons -1100 and -1080 are within pollen zone I. (Description and position of archeological horizons, levels, and units of the Kabazi II sequence can be found in Chabai 1998a.)

Pollen Zone II: Environment

Pollen zone II shows a reduction of broad-leaved and alder valley forests. Does the observed increase of *Pinus* pollen indicate an expansion of pine forests in the studied area? It has been shown that the proportion of *Pinus* pollen in pine forests is not less than 90%, while the AP is also not less than 90% (Klopotovskaya 1976). The AP/NAP ratio of zone III is the same as in pollen zone I. It is more probable that the recession of broad-leaved forests from the site increased the possibility for an intensive influx of omnipresent *Pinus* pollen into the more open landscapes. The floral composition of broad-leaved forests did not change significantly and shrubs became even more diverse including Cornaceae, Oleaceae, and abundant Rosaceae.

The recession of broad-leaved trees was accompanied by some changes in grass cover: a drop of sedges (though still dominant) and an insignificant increase in the xerophytes wormwood, ephedra, and Chenopodiaceae. The more diverse composition of *Herbetum mixtum* (Ranunculaceae, Rosaceae, Fabaceae, and Asteraceae became abundant) can be explained by their expansion to more suitable soils left by an arboreous vegetation. Ferns and club-mosses confirm that the herbaceous vegetation generally preserved its mesophytic character, despite a spread of xerophytes.

The noticeable feature of pollen zone II is the presence of *Betula* pollen, which is also a long-distance transport pollen. Birch is not at all typical for the modern vegetation of Crimea. Small birch groves occur in the uppermost mountain forest belt only, and are regarded as relicts of the glacial epoch (Maleev 1948). *Betula* pollen has not been found in modern pollen spectra, even in the highest Crimean Mountain meadow-steppes (yailas), although it is present in the lowermost layers of their soils (Artiushenko and Mishnev 1978). These layers have been correlated to the Early Holocene, characterized by a considerably cooler climate than the present day (Artiushenko and Mishnev 1978).

This suggests that in the higher mountain forest belt of Crimea, the spread of birch and pine was more extensive during the interval corresponding to pollen zone II than it is at present, indicating a cooler climate during that time. Thus, the recession of broad-leaved forests, as well as some xerophytization of herbaceous coenoses, might have been caused by the climate becoming cooler and slightly drier. Nevertheless, the changes were not drastic and no taxa disappear from the floral composition.

The archeological horizons -1037-1050 and -980 correspond to pollen zone II.

Pollen Zone III: Environment

Pollen zone III is very similar in composition to the spectra of mountain pine forests as described by Klopotovskaya (1976). This suggests that mountain pine forests occurred near Kabazi II, probably covering at least a considerable part of the northern slope of the Main Ridge opposite the site. The appearance and noticeable value of *Fagus* pollen are important, since at the present, beech grows in the upper mountain belt, as well as pine. The spectra of pollen zone III are similar to the surface samples taken at the upper boundary of a beech forest which contain 80% AP, composed of 67% *Pinus*, 3% *Fagus,* 1% each of *Carpinus, Ulmus, Alnus,* and *Corylus*, with *Juniperus* making up the remainder (Artiushenko and Mishnev 1978). An exclusion of the latter from the pollen sum produces values very similar to those of pollen zone III.

Thus, a lowering of forest belt borders might have taken place during the interval corresponding to pollen zone III and was possibly a result of further climatic cooling. Nevertheless, the cooling was not significant enough to prevent the growth of broad-leaved trees. A lowering of the forest belt could also occur with increasing humidity, and, in fact, there are no indications of aridity in pollen zone III. Mesophytic *Herbetum mixtum* (Ranunculaceae, Rosaceae, Fabaceae, Lamiaceae, and Asteraceae are absent) became more abundant in the grass cover than during previous intervals, while xerophytic coenoses were reduced (wormwood disappeared completely). The presence of *Botrychium*, together with other ferns and club-mosses, also supports the evidence for an increase in humidity.

The archeological horizon -930 is within pollen zone III.

Pollen Zone IV: Environment

Pollen zone IV represents a completely different environment and vegetation, dominated by broad-leaved forests and forest-steppe. The prevalence of hornbeam forests is a characteristic feature of this interval. During the first stage (subzone IVa), hornbeam forests grew in the vicinity of the site, with abundant hazelnut at their borders. The immediate locality was surrounded by grass coenoses of *Herbetum mixtum* and Cyperaceae, the former having a diverse composition. Brassicaceae, Plantaginaceae, and Apiaceae attained their previous composition, and Asteraceae appeared again. This, together with disappearance of club-mosses, shows that conditions became suitable for a wider spectrum of herbs, not just for moisture-loving ones. Nevertheless, typical xerophytes such as wormwood and Chenopodiaceae were not noticeable.

Oak, elm, and warmth-loving walnut grew as admixtures in the forests, while the proportion of birch was miserable, up to its complete disappearance in the spectra. Beech and pine forests, judging from the pollen composition, receded upwards into the mountains again. This suggests a warmer and somewhat drier climate during this interval as compared with the previous one. The subzone IVa indicates interglacial conditions.

The absence of pedogenic features in the sediments represented by pollen zone IV shows that the cleft bottom was still not vegetated during this interval. The high clay content (highest among all strata) and very low frequency of larger eboulis, however, suggest greater slope stability above the site, slower deposition on the site, and warmer/moister conditions than those represented in younger sediments (Chabai 1998a) through the whole interval of zone IV.

The next stage (subzone IVb) was characterized by an even more extensive spread of hornbeam coenoses. Forests, almost completely dominated by hornbeam, approached quite close to the site. Lime-trees occurred in small numbers, while the disappearance of oak was a characteristic feature. Hazelnut, Cornaceae, and Oleaceae grew at the border of the forest, and alder became abundant in the Alma valley again. Peaks in alder correspond to those of hornbeam. The increasing climatic humidity caused the expansion of mesophilic hornbeam on drained slopes, and of hygrophilic alder (*Alnus glutinosa Gaertn.*) on the valley floor. Shade hornbeam forests prevented an influx of pine pollen. The grass cover was the same as that seen in subzone IVa. Subzone IVb corresponds to a climatic optimum of an interglacial, with the most favorable conditions for the growth of mesophilic arboreous vegetation.

Archeological Unit IV was formed during this interval.

During the last substage (subzone IVc), the vegetational cover was rather similar to that of subzone IVa. Some reduction of broad-leaved forests took place at the expense of hornbeam associations, while oak spread more extensively again. Not only lime tree and alder, but also hazelnut and other shrubs became less abundant during the substage, and the proportion of birch increased slightly. Ferns and Cyperaceae decreased in the ground cover, while Gramineae became one of its dominant components. Cyperaceae-*Herbetum mixtum* coenoses have been changed by more xeric *Herbetum mixtum*-Gramineae associations. All of these features indicate some climatic aridization, although the proportion of broad-leaved forest pollen still indicates interglacial conditions. A notable feature is the appearance of fir (*Abies*) pollen just at the moment of a birch increase, at the end of subzone IVc. The spread of dark-coniferous trees is generally regarded as a characteristic feature of the final stage of interglacials. While both birch and fir pollen are dispersed over long distances, the spread of these taxa in the higher mountain belt can also be significant evidence for the final stage of the interglacial.

Pollen Zone V: Environment

Pollen zone V confirms this conclusion. A sharp reduction of broad-leaved trees (both hornbeam and oak) took place, more considerable than that of the time interval corresponding to pollen zones II-III. The broad-leaved trees were possibly characterized by sparse growth, while shrubs (hazelnut, spindle tree, arboreous Rosaceae, Cornaceae, and Oleaceae) spread among and around them. A replacement of arboreous formations by shrub-arboreous formations might have taken place on the southern slope of Kabazi Mountain.

The northern slope of the Main Ridge opposite Kabazi II might have been characterized by rather different vegetation. There is a high percentage of *Betula* pollen (*Betula pendula Ehrh.*) beginning from zone V, and *Fagus* pollen appears again. The presence of both taxa, which today grow in the higher forest belt, suggests a lowering of mountain forest belt borders during pollen zone V. In addition, the proportion of beech was lower and birch was much higher than at the present, which may indicate considerably cooler climatic conditions. The percentage of *Betula* pollen might indicate its growth not far from the site.

Changes in the grass coenoses surrounding the site were not significant. The less mesophytic herbs Brassicaceae and Asteraceae became more noticeable components of *Herbetum mixtum* beginning with zone V. Xerophytes, such as Chenopodiaceae and *Ephedra*, extended their spread slightly at the beginning of interval corresponding to zone V. Later on, however, Cyperaceae became dominant again, demonstrating an increase in humidity. Overall, grass cover was mesophytic. This suggests that the reduction of broad-leaved trees was caused not so much by aridization, as by a considerable climatic cooling.

Neither fir (*Abies*) nor walnut (*Juglans*) appeared after the beginning of the interval corresponding to pollen zone V. This may indicate the end of a major interglacial stage in vegetational development. The predominance of such a boreal element as *Betula*, as well as a depletion of broad-leaved taxa, provide evidence that this interval corresponds to the beginning of the Early Glacial.

After the deposition of 4 meters of sediment, a spot behind the rock slab became suitable for vegetation growth. This can be concluded from the pedogenic features of the lower part of Stratum 11 (Chabai 1998a) which correspond to pollen zone V. Weathering of the slab's surface appears to have occurred under moist and temperate conditions, leading to dissolution rather than spalling. This further supports our conclusion of rather humid climatic conditions in pollen zone V.

Archeological Level III/3 of Unit III corresponds to the upper part of this zone.

Pollen Zone VI: Environment

Pollen zone VI represents a rather specific pattern of forest-steppe vegetation. Broad-leaved and birch formations shared a dominance on the slope of Kabazi Mountain, while the site itself was surrounded by herbaceous coenoses. Broad-leaved forests consisted of hornbeam, oak, and elm, with hazelnut, spindle tree, and Caprifoliaceae at the borders. These forests expanded considerably as compared with the previous interval, but did not reach the prevalence they possessed during both optima of the foregoing interglacial (pollen zones I and IV). Birch, which spread extensively during the previous climatic cooling, competed with them. The existence of favorable growth conditions for birch indicates a temperate climate, less warm than the present-day one.

An extensive spread of alder (*Alnus glutinosa Gaertn.*) characterizes the upper part of zone VI. Since nothing indicating increasing climatic humidity is observed, it might be caused by a deterioration of drainage conditions in the Alma River valley, probably related to channel dynamics, such as abundant silt accretion.

The grass cover was dominated by *Herbetum mixtum*. At the beginning of the stage, it was composed mostly of meadow coenoses. Peaks of arboreous vegetation, of birch, and of mesophytic herbs are directly correlated and indicate more humid and less warm conditions at the beginning of the stage. Later on, the proportion of grass coenoses increased, parallel with a spread of xerophytes (Chenopodiaceae and *Ephedra*).

This corresponds well to the observed pedogenic features in Stratum 11—carbonate leaching in the middle of the stratum and humus accumulation in its upper part (Chabai 1998a). The characteristics of the vegetation and environment suggest this interval experienced interstadial conditions. The archeological Level III/2 of Unit III was formed during this interstadial of the Early Glacial.

Pollen Zone VII: Environment

Pollen zone VII indicates an expansion of grass vegetation and a drastic depletion of broad-leaved flora. The percentage of the latter in the vegetational cover was so insignificant that its pollen is not present (or present in single grains only) in the spectra. The area of birch growth was also reduced. With extensive open grass landscapes, pollen of long distance transport (pine and alder) became dominant. A peak of alder (*Alnus glutinosa Gaertn.*) pollen shows that this hygrophyte continued to grow in abundance in the Alma River valley, so drainage conditions did not improve.

The herbaceous coenoses were dominated by *Herbetum mixtum* and sedges at the beginning of the interval, but later on, the extent and diversity of xerophytes increased. The commonly occurring Chenopodiaceae and *Artemisia* were accompanied by especially abundant *Ephedra* and by Plumbaginaceae and Dipsacaceae. The less mesophytic Brassicaceae and Asteraceae prevailed in *Herbetum mixtum*. The proportion of spore plants decreased, while moisture-loving ferns disappeared completely. In general, the grass cover preserved its mesophytic character, but features of xerophytization became more prominent than foregoing stages.

This type of vegetation can be correlated to stadial conditions of a glacial period. The changes in vegetation indicate more significant climatic deterioration than those recorded in pollen zones II-III and V. Only a few broad-leaved trees survived in refugia, which might include the ravines dissecting the southern slope. Hazelnut, spindle tree, and abundant Rhamnaceae also grew in refugia.

Climatic deterioration during pollen zone VII is confirmed by the soil/lithological features of the Kabazi II sequence. Beginning just at the upper part of Stratum 11, patterns of rapid eboulis deposition are demonstrated, contrasting with the fine sediments and weathering of the lower strata (Chabai 1998a). Humic soil formation still occurred at the beginning of the interval of pollen zone VII, but later on, it declined and was replaced by light non-soil loam accumulation. These facts prove that the climate became more continental.

Archeological Levels III/I and III/1a of Unit III were formed during the interval of pollen zone VII.

Pollen Zone VIII: Environment

Pollen zone VIII is represented by the alternation of forest and steppe formations. A new expansion of broad-leaved flora is the most noticeable feature of the interval. Hornbeam and oak, together with their concomitants hazelnut and spindle tree, spread from refugia. Their proportion in the vegetational cover was approximately the same as during the interval of pollen zone VI, while birch did not attain its former percentage. No features of xerophytization, which could account for the decrease of alder, were observed. An improvement of the drainage regime in the Alma River valley, erosional incision for example, possibly took place.

Grass coenoses were meadow-steppe type, dominated by *Herbetum mixtum*, sedges, and Gramineae. They differed from those of the previous interval by their more diverse composition of mesophytic herbs and a decline of xerophytes. Concurrently, spore plants increase; ferns and even club-mosses reappeared, together with the expansion of arboreous vegetation.

The vegetation of pollen zone VIII shows an interstadial pattern. In comparison with the previous stadial, areas occupied by arboreous vegetation have been extended at the expense of broad-leaved assemblages. Nevertheless, their expansion did not approach that of the previous interstadial.

The archeological Level IIA/4 of Unit IIA was formed during this interval.

Pollen Zone IX: Environment

Pollen zone IX represents another oscillation in the distribution of forest and steppe formations and of broad-leaved taxa. A direct correlation between broad-leaved taxa and arboreous vegetation proves that forests of the southern slope of Kabazi Mountain consisted mainly of broad-leaved trees. An expansion of forests from refugia might have been caused by climatic amelioration, while a decline of forests might have been caused by more continental climatic conditions. The latter regime is recorded in pollen zone IX. Landscapes were dominated by meadow steppes. Later, xerophytes (wormwood) became somewhat more abundant. Hornbeam and oak receded to refugia, and concomitantly, ferns disappeared from grass coenoses adjacent to the site. The proportions of birch and alder, which are not so dependent on a benign climate, did not change.

The climatic deterioration occurring in pollen zone IX was not so prominent as that recorded in pollen zone VII. Nevertheless, the decline of arboreous and broad-leaved vegetation indicates rather stadial conditions.

The archeological Level IIA/2 of Unit IIA was formed during this interval.

Pollen Zone X: Environment

Pollen zone X represents a vegetation complex very similar to that of the previous interstadial (pollen zone VIII). The ecotones were dominated by meadow steppes and broad-leaved forests that expanded from refugia. Hornbeam prevailed in the composition of the latter, while oak and lime tree occurred as admixtures. Diverse shrubs (hazelnut, spindle tree, Rhamnaceae, and Caprifoliaceae) grew at the border of the forests. Boreal birch also was part of the vegetational cover, as well as alder in the Alma River valley.

Grass cover was mesophytic and, at the end of the interval, it was represented by meadows with a rich and diverse composition of *Herbetum mixtum*. Ferns appeared with the forest expansion, while xerophytes decreased. Some decline of sedges began during this interval and might have been caused by local factors: after the deposition of 7 meters of sediment, growth conditions behind the rock slab decreased in shade and humidity.

The AP/NAP ratios are approximately the same in pollen zones I and IV, which represent interglacial conditions, and in pollen zones VIII and X, which correspond to interstadials. The proportion of pine, however, is higher in the interstadial deposits. This indicates that forests occupied smaller areas during these intervals and the more open landscapes provided optimal conditions for an intensive influx of *Pinus* pollen. In addition, the presence of *Fagus* pollen in spectra of both interstadials might indicate the lowering of the higher forest belt, consisting of beech and pine, on the northern slope of the Main Ridge, opposite the site.

Brown pedosediments within Stratum 9 could correspond to the interstadials represented in pollen zones VIII and X. The lithological study shows rounding of small clasts, which may signify weak, pedogenically-related dissolution of carbonate clasts. The presence of larger angular clasts suggests persistent cold winters that are highly probable for interstadials. Factors inhibiting an intensive pedogenesis might be due not only to a continental climate, but to high sedimentation rates (Chabai 1998a).

Archeological Levels IIA/1, II/8C, II/8 (II/7F8) correspond to this interstadial.

Pollen Zone XI: Environment

Pollen zone XI is distinctive in the presence of the highest percentage of *Pinus* pollen in the sequence. According to Klopotovskaya's methodological studies (1973, 1976), pine forests should have grown very close to the site. The intensive influx of *Pinus* pollen masks other wind-transported pollen—birch and alder—although, possibly, their actual portion in the vegetational cover also decreased. Even the overall pollen frequency became much higher due to the abundance of *Pinus* pollen.

A decline of broad-leaved flora is the other prominent feature of the interval. A few occurrences of hornbeam and lime tree pollen grains prove their growth in refugia only. On the other hand, shrubs (Rhamnaceae, Caprifoliaceae, Oleaceae, arboreous Rosaceae, and spindle tree) became more abundant and probably formed separate stands on the Kabazi slope. Pollen grains of juniper, a concomitant of pine forests, are present. Judging from the poor preservation of *Juniperus* pollen in fossil conditions, it probably had an extensive range in the area. Grass coenoses were mesophytic, dominated by rich and diverse *Herbetum mixtum*. Under conditions of restricted growth of broad-leaved vegetation, ferns and club-mosses were, probably, also connected with pine forests.

Environmental conditions characteristic of a transitional phase between an interstadial and the next stadial, or of an interphasial, seem to be present in pollen zone XI. The climate became more inclement as compared with the previous stage. The intensive spalling of the large boulder (Stratum 8) confirms its weathering under continental climatic conditions.

The archeological Levels II/7 and II/6 of Unit II correspond to the interval recorded in pollen zone XI.

Pollen Zone XII: Environment

Pollen zone XII represents an important stage in the vegetational development of the area, when steppe coenoses became dominant. A distinct trend towards the reduction of forested areas from the beginning to the end of the stage is observed. At the beginning of the interval, pine formations with admixtures of birch and Rhamnaceae still existed, although not in close vicinity to the site. Later on, an extensive deforestation of the whole orographical region took place. Arboreous vegetation, even pine, grew in refugia only. Alder, related to the Alma River valley, increased against the background of a general decrease in AP.

The meadow-steppe and meadow coenoses of the previous intervals have been replaced by typical steppe (*Herbetum mixtum*-Gramineae) assemblages. They were characterized by a higher proportion of xerophytes; the maximal extent of wormwood in the site's vicinity occurred during this interval. The Asteraceae family, which includes a lot of xerophytic plants, dominated in the *Herbetum mixtum*. The climatic aridization, recorded in NAP, could itself cause a decline of arboreous vegetation if it takes place on a plain. In mountains with a diversity of growing conditions, however, deforestation more likely occurs not only with an arid, but a cold, stadial climate.

Stratum 7, corresponding in its upper part to pollen zone XIII, is notable for its low clay content and abundance of clasts produced by an intensive spalling of the large boulder (Stratum 8). These are further evidence of a harsh continental climate.

Archeological Levels II/3 through II/1A of Unit II were deposited during the interval represented by pollen zone XII.

Pollen Zone XIII: Environment

Pollen zone XIII indicates the gradual expansion of arboreous vegetation from refugia. Broad-leaved trees (hornbeam and later oak) expanded their habitats. They almost approached the same proportion in the vegetational cover characteristic of previous interstadials. A poor representation of different taxa of arboreous vegetation is possibly caused by the overall lower pollen frequency in the zone. In grass cover, ferns, and particularly, sedges, became more abundant. Steppe *Herbetum mixtum*-Gramineae assemblages have been replaced by meadow-steppe *Herbetum mixtum*-Cyperaceae coenoses, while xerophytes decreased sharply. This shows a significant mesophytization of the grass cover occurring in parallel with the proliferation of broad-leaved flora. From these features, the interval can be regarded as an interstadial.

The corresponding deposits of Stratum 6 and the lower part of Stratum 5 are characterized by pedogenic features, including humus accumulation. Though the latter is obscured by an intensive silt-clast accretion, its increase in Stratum 5 is observed concurrently with the climatic amelioration recorded in the pollen data. Judging from soil development, the area of the site proper was also covered by herbaceous vegetation.

The archeological Horizon -195 was formed during this interstadial.

Pollen Zone XIV: Environment

Pollen zone XIV demonstrates a resumption of steppe ecotones on the Kabazi slope. *Herbetum mixtum*-Gramineae assemblages dominated. Neither sedges nor xerophytes were abundant. Some shrubs (Juniper and buckthorn) occurred, as well as a few birches, while the proportion of broad-leaved trees was so insignificant that they were not represented in pollen spectra. An expansion of pine (which even included a few beech trees and club-mosses) was recorded at the uppermost level only, in parallel with an increase of mesophytic herbs. The appearance of Elaeagnaceae pollen is interesting. Besides being cold- and drought-resistant, these shrubs are known for being completely heliophytic, perhaps proving the existence of vast open landscapes during the interval. All of these features could evidence a cold and continental climate of stadial pattern that limited the spread of arboreous, and especially broad-leaved, vegetation, although it was not arid enough to allow an advancement of xeric steppes.

Humus accumulation developed initially under the above conditions (Stratum 5), but later, pedogenic processes were depleted by more intensive silt accumulation, producing the light loams of Stratum 4.

Summary of Environmental Changes

The changes in the vegetational cover on the Kabazi slope are characterized by a cyclic pattern, and, at the same time, show a distinct trend towards the reduction of forest formations and the expansion of grass coenoses to the end of the interval under investigation. A trend towards decreasing broad-leaved flora elements, as well as decreasing mesophytic components of grass assemblages, also took place. Meadow-steppe and meadow coenoses (Cyperaceae-*Herbetum mixtum*, Gramineae-*Herbetum mixtum*) have been replaced at the end of the Kabazi II sequence by steppe *Herbetum mixtum*-Gramineae assemblages. The boreal element birch extended its habitats during the second part of the interval under investigation. These features reflect an advance of a more cool and continental climate. It developed, however, in an oscillatory pattern. Stages of forest expansion, including broad-leaved ones, and of more mesophytic herbaceous vegetation alternated with stages of steppe expansion and of delimited forest areas. The latter have been commonly connected with a decline both of broad-leaved flora and mesophytic components of ground cover, including ferns.

The analysis of pollen spectra and the reconstructed vegetation of Kabazi II indicate that the site's deposits were formed during the interglacial (zones I-IV) and glacial stage (zones V-XIV) of the Late Pleistocene. The interglacial stage includes two optima, separated by a cool climatic spell (zones II-III). The glacial stage comprises 5 stadials (zones V, VII, IX, XII, and XIV) and 4 interstadials (zones VI, VIII, X, and XIII).

CORRELATIONS

The Late Pleistocene Mikulino Interglacial is generally considered to represent the Eastern European equivalent of the Eemian Interglacial. Seven classical pollen zones (M1-M7), reflecting vegetational successions on the Russian Plain during the Last Interglacial, have been established (Grichuk 1972b). It was later shown (Yelovicheva 1989; Bolikhovskaya 1992, 1995) that the Mikulino stage is characterized by two climatic optima (M4 and M6) separated by a stage of cooling (M5). According to the Ukrainian stratigraphic scheme of the Pleistocene (Veklitch 1993), the Pryluky warm stage is regarded as equivalent to Mikulino. On the basis of pollen data, however, it has been proposed that the Mikulino Interglacial be correlated with both Pryluky and Kaydaky warm stages, separated by the Tyasmin cold stage (Bolikhovskaya 1995; Gerasimenko 1988, 1997). Only the uppermost steppe soil of the Pryluky soil complex forms a separate unit.

In the forest and forest-steppe belts of the Russian Plain, the lower climatic optimum of Mikulino (M4, xerothermic optimum) was characterized by a spread of oak and elm forests initially (M4a), and by hornbeam and lime tree later (M4b) (Grichuk 1972b). The upper climatic optimum (M6, hygrothermic optimum) is known by a spread of hornbeam forests. These successions are similar to the two interglacial climatic optima (zones I and IV) recorded in the Kabazi II sequence.

Vegetational reconstructions for the Mikulino Interglacial at the site Molodova I (Bolikhovskaya 1982), located at the border of north-eastern Moldova and western Ukraine, provide an even more convincing case for correlation. The xerothermic optimum was represented by oak forests with hornbeam, walnut, elm, and maple. The appearance of walnut at the end of the optimum is remarkable, since it correlates completely with the Kabazi II records. The hygrothermic optimum of Molodova I was characterized by hornbeam forests with oak and walnut—an analogue of the observed vegetation in zone IV (subzones IVa and IVb). An expansion of pine with spruce (*Picea*) and shrub birch has been detected for the interval between two optima in Molodova I, although a few broad-leaved species also occurred. This interval is being confidently correlated with zones II-III of Kabazi II. It is difficult to expect an appearance of such boreal and arcto-boreal floristic elements as spruce and shrub birches in the southern Crimean Mountains, but it is worth emphasizing that arboreous birch, which also represents a boreal flora, appeared just at this interval in the Kabazi II sequence.

Finally, the following stage in Molodova I of pine forests with diverse broad-leaved trees can be correlated with the final stage of the upper optimum (subzone IVc) of Kabazi II. The presence of fir (*Abies*)—a single case in both sequences—is a highlight of the correlation. The last stage recorded in the Molodova I sequence, a spread of wormwood and

Chenopodiaceae, is related, in our opinion, to the Early Glacial. The composition of grass cover in Molodova I was much less mesophytic than in Kabazi II, which is to be expected, given the different orographical locations of both sequences. The striking resemblance of forest vegetational successions forms a reliable basis for the correlation of the two sites.

Thus, just the Mikulino (Eem) Interglacial is recorded in pollen zones I-IV of Kabazi II. In the coeval Pryluky-Kaydaky stages, the plains of Crimea were occupied by steppes, initially of *Herbetum mixtum*-Gramineae composition (xerothermic optimum), and later composed of Gramineae-*Herbetum mixtum* coenoses (hygrothermic optimum) (Sirenko and Turlo 1986).

The upper subunit of the Pryluky stage, represented by a turf-chernozem soil even in the northern regions of Ukraine, is correlated with the Krutitsa Interstadial of the Russian Plain established by Velichko (1975). It has been proposed as equivalent to the Early Glacial interstadials Amersfoort (Grichuk 1972a; Bolikhovskaya 1995) and Brörup-Amersfoort (Velichko 1988). Velichko (1988) correlated the Krutitsa Interstadial to the pedosediment of a humic soil at the Zaskalnaya V site (cultural layer V), while all characteristic pedogenic features of the Upper Pryluky soil are represented in the upper part of Stratum 11 at Kabazi II. Pollen data indicate that forest-steppe landscapes, including hornbeam forests, were typical for both Kabazi II and Zaskalnaya V (Gubonina 1985). In eastern Crimea (where Zaskalnaya V is located), the area occupied by forests was much less extensive, the forest composition less diverse, and steppe coenoses more xeric than in western Crimea (where Kabazi II is located). That corresponds well to the present-day differences in precipitation between eastern and western Crimea. The scanty pollen material of Zaskalnaya V does not enable a more detailed correlation.

At Kabazi II, the most characteristic features of the vegetation corresponding to the Upper Pryluky turf-carbonate soil (recorded in pollen zone VI), is an equal coexistence of birch and broad-leaved trees within the same orographical region, and a decrease of forests to the end of the stage. In the forest and forest-steppe belts of Ukraine, the interstadial correlated to the Krutitsa and Upper Pryluky soils was characterized by the spread just of pine-birch forest-steppe with admixtures of oak, elm, and lime (Grichuk 1972a; Gerasimenko 1998; Bolikhovskaya 1995). In the pollen diagram of Molodova I, the lowermost peak of *Betula* corresponds to the interstadial correlated to Brörup (Bolikhovskaya and Pashkevich 1982). The first half of this interstadial was characterized by forest-steppe landscapes (birch, hornbeam, oak, elm, and lime tree in a forest composition), while later on, the steppe *Herbetum mixtum*-Gramineae coenoses expanded. These features could support the correlation of the stage recorded in Kabazi II, pollen zone VI with the Krutitsa Interval and so with the Brörup-Amersfoort Interstadials.

U-series dates of Level III/2, which corresponds to pollen zone VI, fluctuated in a wide range between 41,100 ± 2,000 and 117,000 ± 13,000 (McKinney 1998: 347; table 14-1). At the same time, McKinney assumed that the average date for Level III/2 might be 60,000 ± 3,000. The results of ESR LU dating were 61,000 ± 1,000 for Level III/2 and 69,000 ± 5,000 for Level III/3 (Rink et al. 1998: 333; table 13-4). Also, it is possible that the Level III/3 could be dated 70,000 ± 5,000 (Rink et al. 1998: 336). Since the latter is generally considered to demonstrate the upper age limit, the corresponding intervals might be regarded as those older than 70,000 BP.

The preceding cool spell (pollen zone V), notable for the first maximum of birch pollen and a decline of broad-leaved flora, should correspond to the first stadial of the Early Glacial. This characteristic is in agreement with the vegetation, revealed in the first Late Pleistocene stadials in the vicinity of Molodova I site, namely, an alternation of light pine-birch forests and steppe ecotones. The vegetational cover of northern Moldova was distinct in the presence of arcto-boreal floristic elements: *Betula* sect. *Fruticosae et Nanae* and *Alnaster*, as well as by more xerophilic (and cryophilic) grass cover. In Crimea, on the other hand, broad-leaved trees still occurred in forest composition and herbaceous assemblages were essentially mesophilic.

Pollen zone VII at Kabazi II was characterized by a more significant depression of thermophytic floristic elements, as well as by a more extensive spread of herbaceous coenoses, including xerophilic elements. Judging from the above correlation, this interval corresponds to the Uday (Khotylovo) cold stage of loess formation, established for the plain territory of Ukraine and Russia (Veklitch 1993; Velichko 1988). The present-day forest belt of Ukraine was covered at that time by *Herbetum mixtum*-Gramineae steppe. Chenopodiaceae-wormwood assemblages and shrub birch formations also proliferated (Grichuk 1972a; Gerasimenko 1988; Bolikhovskaya 1995). The steppes of the Crimean plain were represented by xerophilic coenoses (Sirenko and Turlo 1986). The second pollen complex of Zaskalnaya V (Gubonina 1985) is characterized by an increase of herbs, including *Artemisia* and Chenopodiaceae in particular, and by the presence of few pollen grains of birch, hazelnut, and beech. This complex can likely be correlated with pollen zone VII at Kabazi II.

Pollen zone VII at Kabazi II might be correlated with the interval in Molodova I above the disappearance of dark-conifer taxa, and which is also characterized by a drop in *Betula*. It is described as the Middle Valdai (Würm) stadial, with a predominance of *Herbetum mixtum*-Gramineae steppe. Sedges, wormwood, and Chenopodiaceae were also extensive. Light, sparse forests were formed by pine and arboreous birch, with shrub birch in the undergrowth. It is worthwhile to mention that in pollen zone VII at Kabazi II, alder achieves its maximum proportion during this interval. Thus, the proposed correlation might have a confident basis, and the beginning of the Pleniglacial can be recorded in pollen zone VII.

The interstadials represented in pollen zones VIII and X are separated by a stadial (pollen zone IX) characterized by a less harsh climate than that of the preceding and following stadials. An expansion of herbaceous coenoses took place during the stadial, as well as some increase of xeric herbs and a decline of broad-leaved trees, although the latter still grew in a noticeable number. Both interstadials were characterized by similar vegetational cover, dominated by mesophilic Gramineae-*Herbetum mixtum* meadow steppes and oak-hornbeam forests, with admixtures of elm and lime. Beech was also present within the orographic region of Kabazi II.

According to the Ukrainian stratigraphic scheme of the Pleistocene (Veklitch 1993), the Vytachiv warm stage followed the Uday cold stage. A pedocomplex of brown sods was formed during the stage, including a thin loess layer subdividing separate soils. In the present-day forest and forest-steppe belts of Ukraine, the soils were formed under pine-broad-leaved forests (few beeches were present), while the embedded loess was formed under pine forest-steppes, with a few broad-leaved trees in refugia (Gerasimenko 1988). The growth of hornbeam, oak, and elm as an admixture in pine forests has been also shown (Bolikhovskaya 1995) for the lower part of the Bryansk soil, established by Velichko (1975) above the Khotylevo loess. The same broad-leaved trees grew in valley forests of the southern steppe regions of Ukraine during the Vytachiv stage (Sirenko and Turlo 1986).

Two stages of climatic amelioration have been demonstrated for the Middle Valdai (Würm) sequences of Molodova I (Bolikhovskaya and Pashkevich 1982). They were characterized by forest-steppe landscapes, with oak, elm, hazelnut, and sporadic hornbeam and lime in forest composition. A stage of climatic deterioration, which separated the interstadials, was notable for a decline of arboreous vegetation, disappearance of broad-leaved trees, and occurrence of a few shrub birches. The first warm stage is being correlated by Bolikhovskaya and Pashkevich (1982) with the Moershoofd Interstadial, while the second with the Hengelo Interstadial. This correlation is based on charcoal in the marker sooty layer, represented both in Molodova I and the neighboring Korman IV, which yielded a radiocarbon date of 44,400 ±

2,050 (Ivanova 1977).

Similar vegetational changes during both Middle Valdai (Würm) interstadials have been demonstrated for the sequences of the Kiev, Moldova, and Crimea regions. The first interstadial was characterized by a prevalence of oak and elm, while hornbeam and lime were more abundant (or at least present) in the second interstadial. On the whole, in the three studied regions, the latter was characterized by a more diverse floristic composition of forests, including rich undergrowth. At Molodova V and Korman IV, the coeval paleosols (according to Ivanova 1977, 1987) are characterized by spectra with a considerable predominance of pine pollen. Nevertheless, the upper paleosol shows more diverse AP composition, including a few elm and hazelnut grains (Pashkevich 1977, 1987). This indicates its warmer climate and also supports the reliability of the above correlation.

The soil-lithological correlation of the described deposits is not easy, since they are represented by a well-developed soil complex in one case, and by colluvial or proluvial sediments in other cases. However, pedogenic features (presence of brown pedosediments or ferruginous-gley layers) are attributed to both colluvial and proluvial sediments. In all cases, soils are separated by the light non-soil stratum, with features of climatic cooling detected from pollen analysis.

The U-series dating of the archeological Level II/8 (II/7F8), corresponding to pollen zone X, shows to a range from 48,300 ± 17,000 to 65,500 ± 2,500 kyr (McKinney 1998: 347; table 14-1). By ESR LU, the level has been dated to 39,000 ± 3,000 (Rink et al. 1998: 334). It does not contradict a correlation of the interstadials recorded in pollen zones VIII and X with the Moershoofd and Hengelo intervals respectively. More contradictions appear with the correlation of these intervals with the Vytachiv stage. At the present, there exist two ranges of chronological timing of the Vytachiv interval, both based on TL-dating. One relates it to 90-75 kyr (Veklitch 1993), while the other to 45-35 kyr (Shelkoplyas et al. 1986). It seems the above data corroborate the latter conclusion. However, further investigation is needed to elucidate the chronological age of the Vytachiv stage.

The specific conditions of the interval represented by pollen zone XI are relevant to an interphasial or a transition from an interstadial to stadial. Light pine forests with an undergrowth of diverse shrubs and with a mesophilic surface cover, including ferns and club-mosses, replaced broad-leaved formations. Broad-leaved trees occurred sporadically only, while juniper appeared in a vegetational cover. The peak of arboreous vegetation (at the expense of a pine increase) is shown in the pollen diagram of Molodova I above the Hengelo interval, and the peak of juniper is fixed a bit higher. The upper layers of the soil, correlated with the Hengelo Interstadial at Molodova V, have also been shown by pollen data to have been formed under light pine forests (Pashkevich 1987).

This indicates that the described interval might have not only local significance. The Level II/7B, related to the interval, has been ESR LU dated to 32,000 ± 2000 (Rink et al. 1998:333; table 13-4), while by the U-series method for Level II/7 to 46500 ± 8000 (McKinney 1998). A correlation of the interval with the short Les Cottes stage, established for Western Europe (Raynal et al. 1985), might be suggested, judging from the fact that the next stage, pollen zone XII, has AMS dates 35,100 ± 850 (Level II/2) and 31,550 ± 600 (Level II/1) (Hedges et al. 1996: 190). The archeological Levels II/4 and II/5, which correspond to the pollen hiatus between zones XI and XII, are dates by AMS to 32,200 ± 900 and 33,400 ± 1,000 respectively (Hedges et al. 1996).

The pollen zone XII represents a stadial with the expansion of typical steppe (*Herbetum mixtum*-Gramineae) coenoses and the decline of an arboreous, particularly of broad-leaved, vegetation. The corresponding interval in the Molodova I and Molodova V sequences might be that recorded under the Bryansk (Denekamp) soil and also characterized by a decrease of AP and an absence of broad-leaved trees. The proportion of Chenopodiaceae and *Artemisia*, however, is lower than in Kabazi II. In the forest and forest-steppe belt of Ukraine, the corresponding interval was characterized by pine forest-steppe with *Herbetum mixtum*-Gramineae coenoses (Gerasimenko 1988). The pollen diagrams of radiocarbon-dated sites of Romania show the cold spell with the disappearance of broad-leaved trees and a sharp predominance of herbaceous coenoses as occurring between 29,500 and 35,000 BP (Carciumaru 1988).

The last interstadial of the Kabazi II sequence, corresponding to pollen zone XIII, is younger than 31550 ± 600 (by AMS), 32,000 ± 6000 (by ESR LU) for archeological Level II/1, and 39,800 ± 5,000 by U-series dating for Unit II as a single unit (Hedges et al. 1996, Rink et al 1998, McKinney 1998). A spread of oak-hornbeam forests against the background of forest-steppe landscapes took place during the interstadial. The main part of the coeval Bryansk (Denekamp) soil of Molodova I site (28-29 kyr BP) is characterized by forest-steppe pollen spectra with a predominance of broad-leaved forests during the climatic optimum. Hornbeam dominated in a diverse floristic composition, even including beech (Bolikhovskaya and Pashkevich 1982). At Molodova V and Korman IV (Pashkevich 1977, 1987) and in the forest belt of Ukraine (Gerasimenko 1988), the ecotones of coeval soils were dominated by pine forest-steppes. However, they included lime-tree and oak as admixtures. The remarkable features of all these soils and that of Kabazi II are that the upper layers of the soils are characterized by pollen spectra with a predominance of NAP. In Kabazi II, that pollen spectra are related to the next pollen zone XIV, representing a stadial, while in the Moldovan sites they are regarded as evidence of increased climatic continentality and cooling.

It should be mentioned that the original Bryansk soil, described from the Russian Plain, is considered as polygenetic and is correlated with the Hengelo-Denekamp time span, including the stadials in between (Velichko 1988).

The last stadial at Kabazi II, recorded in pollen zone XIV, was characterized by a sharp predominance of steppe (*Herbetum mixtum*-Gramineae) vegetation and the almost absolute disappearance of broad-leaved trees. Shrubs mainly (juniper, buckthorn, and Elaeagnaceae) represent an arboreous vegetation. During the stadial, following the Bryansk interval at Molodova I, Molodova V, and Korman IV, periglacial forest-steppe ecotones were distributed in northern Moldova (Bolikhovskaya and Pashkevich 1982; Pashkevich 1977, 1987). *Artemisia* dominated in steppe assemblages, while pine and juniper dominated in light forests. The presence of arcto-boreal elements of arboreous and grass vegetation is a notable feature. A similar vegetation type has also been demonstrated for the forest belt of Ukraine (Gerasimenko 1988). In Crimea, the climate on the plain was more harsh than in the foothills.

Thus, all stages of vegetational evolution of the Kabazi II site can be correlated with the vegetational succession of Russian Plain and represent the general climatic stages of the Late Pleistocene.

CONCLUSION

Pollen studies of the sequence at the Mousterian site Kabazi II show a complicated picture of vegetational development during the Late Pleistocene. The pollen analysis, which is corroborated by the results of the absolute chronology and pedological-lithological studies, enables the following conclusions.

The vegetational succession of the Mikulino (Eem, Kaydaky-Early Pryluky) interglacial is recorded in the lower part of the sequence. The early climatic optimum of Mikulino, dominated by hornbeam-oak forests, is separated from the late climatic optimum, represented by hornbeam forests, by a stage of cooling. The latter was characterized by the reduction of broad-leaved flora and the expansion pine and herbaceous coenoses. The Early Glacial interstadial, correlated with Brörup (Late Pryluky, Krutitsa) intervals), was characterized by forest-steppe ecotones: meadow steppes shared dominance with birch and broad-leaved formations.

The vegetation of the first stadial of the Pleniglacial (Uday?, Khotylevo), with a prevalence of grass assemblages and a decline of broad-leaved flora, indicates a more cold and continental climate than that revealed from the vegetation of the Early Glacial stadial. The latter was characterized by forest-steppe ecotones with the reduced, but still noticeable, broad-leaved assemblages.

Two interstadials and the interphasial revealed above in the sequence, are correlated respectively with Moershoofd, Hengelo, and Les Cottés. During the interstadials, meadow-steppe ecotones alternated with broad-leaved formations that spread from refugia. The proportion of the latter in the vegetational cover, however, never reached that of the interglacial. Light pine forests dominated at the interphasial. From the pollen data, the above interstadials might be correlated with the Lower Vytachiv warm substage of forest and forest-steppe belt of Ukraine. Since in the last edition of the Ukrainian Stratigraphical Scheme of Pleistocene (Veklitch 1993), the Vytachiv is correlated to the end of the Early Glacial, the correlation with Vytachiv stage is still under a question. The vegetation of the stadial between the intervals correlated with Moershoofd and Hengelo, was somewhat similar to that of the Early Glacial stadial and indicates a less cold and continental climate than of the first Pleniglacial (Uday?, Khotylevo) stadial. In contrast, the stadial following the "Les Cottes" interphasial was characterized by a considerable predominance of typical steppe ecotones, a drastic decline of broad-leaved flora, and therefore by a harsh climate.

The vegetation of the last interstadial represented in the Kabazi II sequence resembles those of the two foregoing interstadials. Broad-leaved trees spread from refugia, and mesophytization of grass coenoses took place. This stage is correlated by radiocarbon dating with the Denekamp (Bryansk) Interstadial. It is still a question whether it corresponds to the Late Vytachiv substage or to the Dofinivka stage of the Ukrainian Stratigraphical Scheme. However, on the basis of pollen data, it resembles the Late Vytachiv of the forest-forest-steppe belt of Ukraine.

The last stadial represented at Kabazi II was characterized by typical steppe vegetation, with an almost complete decline of broad-leaved trees and the appearance of drought-resistant heliophilic shrubs. Both the evolutionary changes of vegetation and climate and their dynamics during the Late Pleistocene are depicted in the vegetational succession seen at Kabazi II. The most warmth-loving (walnut) and moisture-loving (fir) species disappeared with the end of the Mikulino (Eem) Interglacial, while the boreal element birch became noticeable or even prominent. Cold-resistant juniper, buckthorn, and Elaeagnaceae appeared at the Pleniglacial, particularly at its second half. A trend towards contraction of areas occupied by arboreous vegetation can be observed, in parallel with a replacement of meadow-steppe and meadow grass assemblages by typical steppe ones. A considerable predominance of open steppe ecotones is confirmed by the appearance of typical drought-resistant steppe shrubs which are utterly heliophilic (Elaeagnaceae). This demonstrates the trend of increasing climatic cooling and continentality in the second half of the Pleniglacial. The alternation of stadial and interstadial environments show that the above trend developed in a cyclic pattern. The correlation of the Kabazi II sequence with coeval ones of the Eastern European Plain shows the same mode of vegetation dynamics at the Late Pleistocene. Nevertheless, the pollen data evidence that during all cold spells, the climate of the Crimean foothills was milder than at the plain. No arcto-boreal elements, most typical for stadials at the plain area, have been found in the Kabazi II sequence, and the proportion of broad-leaved trees was consistently higher. This suggests that the southern slope of Kabazi Mountain provided favorable conditions for the formation of broad-leaved flora refugia during Late Pleistocene cold spells. The ecosystem of the whole orographical region comprising Kabazi

II showed more stability in its Late Pleistocene vegetational development than the plain ecosystems. Possibly, it was one of the reasons that the region was densely populated by Paleolithic humans. In order to recognize the environmental conditions of the complete last glacial-interglacial cycle, an important task is to study pollen records both of the uppermost and lowermost segments of the sequence.

Chapter 7

THE ANIMAL ENVIRONMENT OF WESTERN CRIMEA

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INTRODUCTION

This chapter presents a reconstruction of the animal environment of Western Crimea during the late Middle Paleolithic occupation of the region. The faunal material which contributes to this reconstruction includes microfaunal assemblages and malacofaunal assemblages from the sites of Kabazi II, Kabazi V, and Starosele, and the large mammal assemblages from Kabazi V, Starosele, and Levels II/7E, II/8C, IIA/1, and IIA/2 of Kabazi II (see Chapters 1-5).

Correlating the different faunal components enables us to reconstruct the local landscape of each site from both a synchronic and diachronic perspective. The large mammal component helps track changes in the animal communities around the sites, and forms a basis for reconstructing short-term, seasonal changes in the regional movements of prey species. Ultimately, these reconstructions present us with the opportunity to contextualize human settlement of the region.

Starosele lies roughly 20 km to the west of the sites of Kabazi II and Kabazi V, which are in close proximity to one another. All three sites are situated along the broad limestone escarpment that forms the second range of the Crimean Mountains. Each site contains multiple Middle Paleolithic occupation phases (Marks and Chabai 1998). Absolute dating of the sites (Hedges et al. 1996; McKinney 1998; Rink et al. 1998) and palynological analysis (Chapter 6) indicate that the occupations of Kabazi II span from the Last Interglacial to the latter part of oxygen isotope stage 3. Levels II/7, II/8C, IIA/1, and IIA/2 at Kabazi II, which are reported here, date to the Hengelo and Les Cottés Interstadials of oxygen isotope stage 3. The occupations at Starosele occurred during oxygen isotope stages 3 and 4, and are probably partially contemporary with occupation levels at Kabazi V (Chapter 11).

Of the faunal assemblages described in this chapter, the fauna assemblage from Starosele Level 4, which probably dates to the Amersfoort-Brörup Interstadial, is the oldest, followed by Kabazi V Unit III and Starosele Level 3, which appears to date to the first stadial of the Last Pleniglacial. The lower levels of Kabazi V Unit II correspond to the Moershoofd Interstadial, while Kabazi II Level II/A2 dates to the following stadial. Starosele Levels 1 and 2, and Kabazi II Levels IIA/1 and II/8C all seem to date to the Hengelo Interstadial. The faunal assemblage from Kabazi II Level II/7E is the youngest for the occupational levels described in this report; it dates to the Les Cottés Interphasial. In sum, the faunal collections being analyzed in this research span isotope stage 5c to the second half of stage 3 (Chapter 11).

STAROSELE

Starosele is situated in a box canyon, at the foot of a slightly overhanging cliff wall, above the Kanly-Dere gorge (Fig. 7-1). There are four occupation levels at Starosele. The lowermost occupation, Level 4, accumulated in an open, dry steppe context in close proximity to a water source. The microfauna and malacofauna are dominated by xeric and mesic

Fig. 7-1—Kanly-Dere box canyon.

components, indicating that temperatures were more humid, and possibly cooler, than today, yet they also indicate that temperatures were relatively warmer than during the succeeding Level 3. The sterile soils between Levels 4 and 3 contain microfauna and malacofauna that indicate a generally drier environment, which may represent a regional climatic shift, or may be a reflection of the downcutting of the thalweg. Microfauna and malacofauna in Level 3 represent a xeric steppe phase; both open vegetation and a continental climate are indicated, although a mesic component persists. Level 2 shows the beginnings of a moderating climatic trend, which carries through into Level 1.

The composition of the local animal communities must have fluctuated with changes in the microtopography and microclimate of the canyon bottom below Starosele. The lack of faunal diversity in Level 4 (Chapter 1), for example, is probably less an indicator of regional environmental change than a reflection of the fact that the canyon was not deeply incised at this time (Marks et al. 1998) and probably didn't support a well-developed mesophytic microenvironment.

Generally, the local landscape around Starosele during all occupations was dominated by steppe regions with a moderate climate. This is entirely consistent with the large mammal assemblages from the site, all of which are dominated by *Equus hydruntinus*. A developed mesophytic environment and a meadow zone, eventually evolved near the site (presumably in the more humid canyon floor) by the time Levels 2 and 1 were occupied, according to microfaunal and malacological data (Chapters 4 and 5). The large mammal assemblages from these levels include components of animal communities that would have frequented these zones (*Cervus elaphus, Sus sp.*). More humid conditions prevailed in Level 1, according to these data, and the steppe regions may have given way to more mesic, open environments with more extensive bush cover, without affecting the distribution of major prey species.

KABAZI II

Kabazi II is an open-air site, situated mid-slope below the escarpment above the Alma River valley (Fig. 7-2), approximately 20 kilometers to the east of Starosele. The site lies within twenty minutes' walk along the Kabazi escarpment from the site of Kabazi V (see below). Overall, the malacofaunal sample is small and probably not representative of a biocoenosis, although an interpretation of local environmental conditions is nevertheless attempted based on presence/absence data (Chapter 5). Due to poor preservation, microfauna was found only in a sterile layer near the base of the sequence (Chapter 4).

The malacofauna generally indicate persistently dry and open conditions throughout the sequence of occupations. They also indicate the probable presence of localized bush or tree cover near the site during the formation of Unit II (Chapter 5).

Analysis of the large mammal fauna from Levels II/7E, II/8C, IIA/1, and IIA/2 (Chapter 3) indicates the persistent dominance of open, dry grasslands inhabited by *Equus hydruntinus* and *Saiga tatarica*. The faunal spectrum in Level IIA/2 is slightly more diverse than Levels II/7E and II/8C (red deer and bison are present) and indicates the probable presence of a second, more mesic biocoenosis. The large mammals at Kabazi II point to slightly more arid conditions in Levels II/8C and IIA/1 than in either of the other two levels examined here—either a result of a different season of occupation of the site (winter) or of a shift in the regional climatic regime (Chapter 3).

KABAZI V

The site of Kabazi V is situated just below the Kabazi escarpment on a relatively gentle, sunny slope overlooking the Kalinovaya Valley, a shallow tributary of the Alma. The site

Fig. 7-2—Kabazi Mountain.

faces a relatively less elevated plateau on the other side of the Kalinovaya (fig. 7-3). Spring water is available near the site at present, and access onto the plateau above is relatively easy from this location. The earliest occupation phases at Kabazi V accumulated under a rockshelter (archeological Units IV-III). Later occupations (Units II-I) apparently occurred in the open air, on top of the collapsed rockshelter (Yevtushenko 1998a).

Microfauna and malacofauna from occupation levels in Unit III are dominated by a xerophilic steppe or grassland component, with some mesophilic taxa (Chapters 4 and 5). The mesophilic component in Unit III probably reflects the local microclimate near the rock overhang. The large mammal fauna in Unit III is clearly dominated by an arid steppe or grassland component. *Saiga tatarica* dominates throughout; *Equus hydruntinus* is occasionally co-dominant (Chapter 2). Species such as wild pig, present in very small numbers in this unit, indicate that the river bottom was at least sparsely vegetated—but apparently rarely exploited by humans.

Unit II at Kabazi V yielded microfauna and malacofauna indicative of a mosaic environment, and a more moderate climate than during the formation of Unit III. In fact, the microfauna and malacofauna indicate more mesic conditions than those that exist around the site today. The slopes around the site would have been more vegetated, with a variety of open environments (such as meadow or prairie) existing near the site. This is consistent with an interstadial environment. The large mammal fauna of Unit II at Kabazi V continues to show a focus on steppe-dwelling species, but also contains more taxonomic diversity than the lower Unit III, including Bos/bison, as well as more mesophilic species such as red deer (Chapter 2). *Saiga tatarica* is dominant and *Equus hydruntinus* is a close second. Forest components indicate that the valley bottom below the site probably harbored a closed and relatively mesic environment that may have reached onto the slopes below the site.

DISCUSSION

Globally, xerophilic components and cold-adapted fauna are represented early in the regional sequence (at Starosele Level 3). A series of mild climatic cycles then commences, which affect the local landscape and vegetation while appearing to have had a lesser impact on the large mammal fauna. Kabazi V shows a progression from a predominantly arid, open steppe or grassland landscape in Unit III, to more mesophilic fauna and a mosaic of habitats during the occupation of Unit II. A progression to milder, more humid conditions in the final two occupation layers at Starosele is followed by predominantly xeric conditions at Kabazi II, in Levels II/8C and IIA/1.

Generally, in accordance with these climatic phases and the regional topography, two distinct biocoenoses are represented in the large mammal fauna. A cold, dry steppe or grassland community (including *Equus hydruntinus* and *Saiga tatarica*) is dominant in all levels at all three sites throughout the time span under investigation. A more mesic biocoenosis is also represented by red deer, suid, and red fox in many levels (see above). This biocoenosis must have been located in the river valleys and valley slopes below the sites. The quasi-absence of bovids is indicative of the generally arid character of the regional landscape and is in keeping with the observation that Bison in this region retreated to the river valleys of high plateaus during the Upper Pleistocene (Vereshchagin 1967:374).

The Ecology of the Large Mammal Fauna from Western Crimea

Equus hydruntinus (the European wild ass) is found across Europe from the middle Pleistocene to the Holocene. It is distributed as far east as Azerbaijan (Eisenmann and Patou 1980). *Equus hydruntinus* was well adapted (but not limited) to steppe regions and fed on

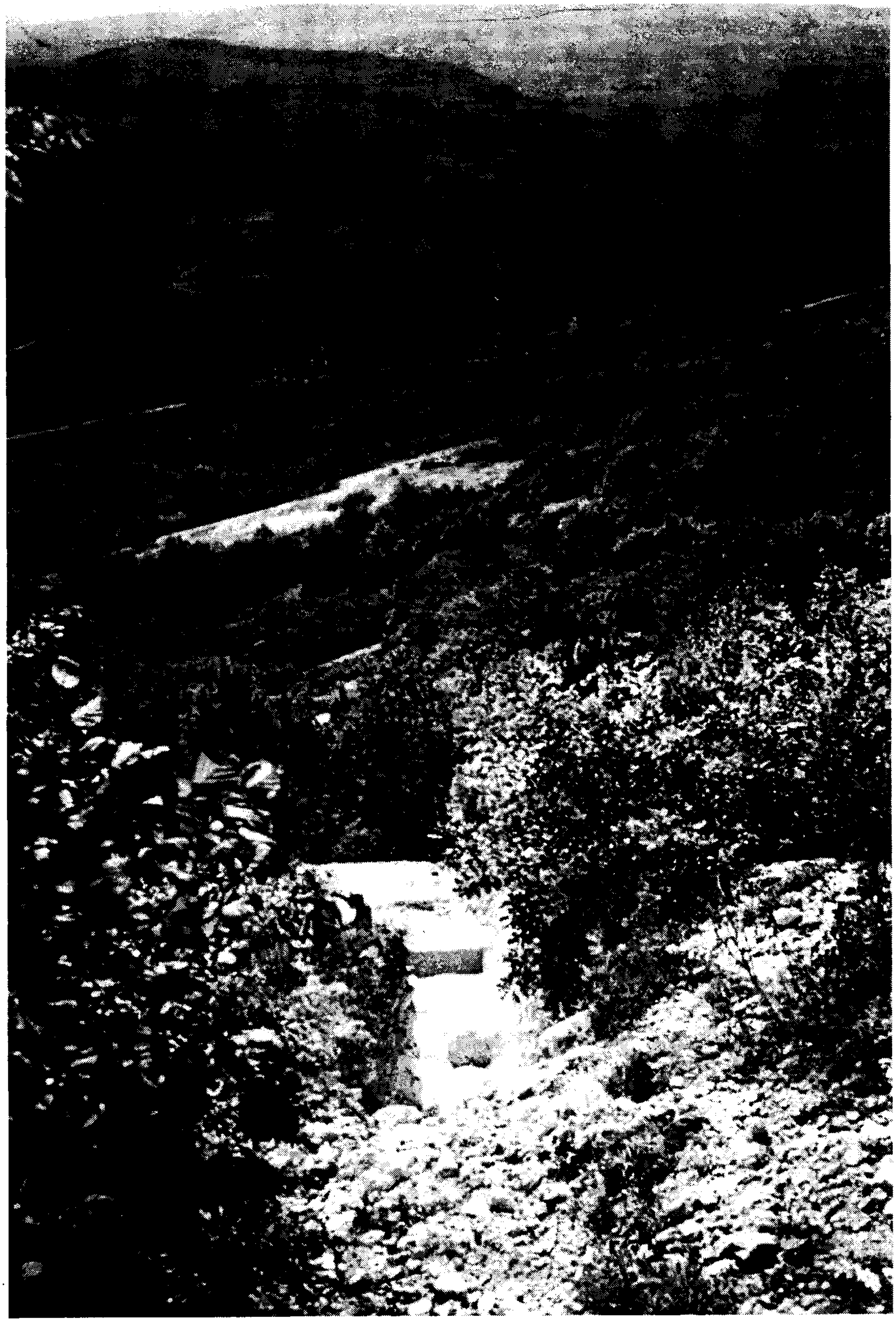

Fig. 7-3—View from Kabazi V over the Kalinovaya Balka.

coarse grasses (Vereshchagin 1967: 326). It is generally associated with wormwood steppes (Vereshchagin 1967: 328). Horses in the wild today often use valley floors and the slopes above valleys as winter habitat when wind-chill is a factor. Horses also frequently descend into river valleys in search of open water (Berger 1986).

Saiga tatarica is distributed today in arid steppes and semi-deserts of southern Russía to Mongolia. During the late Pleistocene, it was more widely distributed, ranging as far east as the Yukon Territories, Canada (Harrington 1981). This small artiodactyl thrives in sparsely vegetated grassland, avoiding broken ground (Bannikov et al. 1961: 56) and regions with heavy snow. A migratory animal, saiga is highly mobile (Bannikov et al. 1961: 79) and is both unpredictable and swift in its movements, changing grazing zones frequently and showing little attachment to particular ranges (Bannikov et al. 1961: 77-78). During extremely cold periods, or under very arid conditions, concentrations of animals occur in river valleys (Bannikov et al. 1961). Saiga typically winter in cereal-wormwood or cereal-Russian thistle zones on sandy soils (Bannikov et al. 1961: 57). Herds of saiga from Crimea are thought to have wintered in Ciscaucasia during the Late Pleistocene (Vereshchagin 1967: 355). It is likely that the foothills of the western Crimean Mountains represented summer grazing grounds for both saiga and horse, from which these animals migrated before the onset of rigorous winter conditions.

Animals from closed, relatively more humid environments are numerically under-represented in the assemblages described here. This may be a reflection of regional abundance, given their probably limited distribution in river valleys and valley slopes. Red deer (*Cervus elaphus*), and even more negligible numbers of wild pig (*Sus sp.*), occur sporadically in all sites.

Wild pigs are averse to strong winter cold, avoid deep snow, and are generally characteristic of interglacial and interstadial forest faunas (Kurtén 1968: 154). Their presence in western Crimea is consistent with the proposed isotope stages 4 and 3 dates, and is probably even indicative of interstadial phases. Wild boar will migrate, and have a vertical distribution, which includes alpine regions of the Caucasus, for example (Vereshchagin 1967: 333). Red deer are common across Europe, especially during the late Pleistocene. They feed on twigs, leaves, herbs, fruit, spruce bark, and lichens (Kurtén 1968: 163) and are generally confined to river valleys and wooded slopes (Vereshchagin 1967: 335).

The presence of chamois, *Rupicapra rupicapra*, in Levels 3 and 1 of Starosele is a reflection of the regional topography. Chamois prefer mountainous terrain and are adapted to cold, Alpine conditions across Europe (Kurtén 1968: 175). In western Caucasia, chamois are common in mid-altitudes and sub-alpine zones ranging from 300-3,000 meters above sea level (Vereshchagin 1967: 357). Chamois feed on clover and herbs, or mosses and lichens. A gregarious animal, chamois migrate to lower valleys in winter, where they form large herds (Kurtén 1968: 176). The individual in Level 3 and the second individual in Level 1 at Starosele indicate that the western Crimean Mountains probably hosted a population of these animals during oxygen isotope stages 3 and 4. The presence of a single reindeer element in Level 3 at Starosele could indicate that a remnant population resisted regional extirpation at the close of isotope stage 4/beginning of stage 3. This species would eventually become regionally extinct later on during stage 3, which explains its absence at Kabazi II and Kabazi V.

The carnivore component in western Crimea contains forms common throughout Eurasia, and belongs to both of the regional biocoenoses. Carnivores identified include the hyena *Crocuta crocuta*, the red fox *Vulpes vulpes*, and the cave lion *Panthera Leo spelea*. The hyena, *Crocuta crocuta*, is a specialized scavenger (Kurtén 1968: 71) adapted to a variety of middle and northern latitudes and is very common in Eurasia from the mid-Pleistocene onwards (Kurtén 1968: 69). They den preferentially in caves or rockshelters, and the limestone outcroppings of western Crimea would have provided them an ideal habitat. The common red fox (*Vulpes vulpes Linne*) appears in Level 3 (MNI=2) and Level 1 (MNI=1) at Starosele. The red fox is fairly common in the late Pleistocene, in cave and open-air sites, and is adapted to a very wide range of conditions, although it does not inhabit the tundra (Kurtén 1968: 115-116). *Panthera Leo spelea*, or cave lion, appears in Level II/7E at Kabazi II (that is, later in the regional chronology). Although rarely found in large numbers, it is a common find in Europe and used to form a continuous population (Kurtén 1968: 87).

Seasonality

The open, upland steppe environment, which dominates the regional landscape of western Crimea on the northern flanks of the second mountain range, must have been seasonally variable. Fetal horse is present in Levels 2 and 3 at Starosele. At Kabazi V, fetal elements were found in some levels of Unit II, and at the top of Unit III. Assuming similar developmental rates between *Equus Hydruntinus* and the similar-sized modern pony, most of the fossil fetal elements are between 80-100 days old (Chapters 1 and 2). The age of the fetal elements at Starosele and Kabazi V, therefore, indicates fall (or possibly late summer) occupations. Fetal elements of a small artiodactyl are also found at Kabazi V. Since faunal assemblages at this site are dominated by *Saiga tatarica*, it is not unreasonable to assume that the fetal artiodactyl is Saiga. The bones are quite small, indicating an early gestation phase. Given modern data for gestation phases of Saiga (Bannikov et al. 1961), Kabazi V was probably also occupied during the fall.

At Starosele, additional seasonal indicators include the fact that Levels 4 and 3 were deposited after severe flash flooding had occurred in Levels 4 and 3 (Marks et al. 1998). Heavy rainfall patterns could be responsible for the flash flooding. Alternatively, sudden thaws bringing meltwater from the Yaila plateau into the drainage systems could have caused localized flooding, that is, during the spring. Occupations therefore would have occurred after spring thawing.

Avifauna also yield seasonal indications: bird taxa recovered at Starosele consist of cliff-nesting species such as alpine swifts, red-billed choughs, and jackdaws, as well as grey partridge (Mlikovski, personal communication 1997). The choughs and swifts are typical elements of southern paleoarctic mountains. The swifts are migratory, and the presence of sub-adults (Mlikovski, personal communication 1997) indicates that western Crimea was a breeding ground for this species, and that Level 2 deposits accumulated during late summer or fall. In contrast, Kabazi II Levels II/8C and IIA/1 may have been occupied during winter (Chapter 3).

CONCLUSION

The occupation levels examined here roughly span from the end of oxygen isotope stage 5 through mid-3. Many faunal indicators point to fall occupations (e.g., at Starosele and Kabazi V). The timing of these occupations is probably linked to the migration patterns of the principal prey species: *Equus hydruntinus* and *Saiga tatarica*. It seems likely, given the behavior of these animals in the wild today (see discussion above), that herds of both equids and saiga would have moved out of the high questas above the sites with the coming of winter, probably to escape the severe wind-chill which must have existed at these altitudes. Their movements would probably have been channeled by the system of river valleys which drains the questas, and along which Kabazi II and V are located. Starosele is located in a box canyon–but one that connects to a major drainage system.

During isotope stages 5 to 3, the local and regional landscapes near the sites must have evolved significantly. The sites all share an important locational feature: they are situated in interzones between valley-bottom and steppe. The valley systems in particular must have evolved as the climate oscillated. The hunting economies of the sites surveyed here remained focussed on steppe-dwelling species such as saiga antelope and horse, however. The large mammal faunas indicate that although the sites were situated in interzonal locations, between the high plateau of the Yaila and river valley systems, their inhabitants preferentially exploited prey from a predominantly open and dry environment during all occupations of the sites.

Chapter 8

STAROSELE STONE TOOL USE-WEAR ANALYSIS

MARVIN KAY

INTRODUCTION

Stone tool use-wear is straightforward and simple. Telltale signs of wear, such as microscopic use scratches, are taken as clues of tool use and of the material against which a tool edge or surface came into contact. This chapter describes the results of a use-wear analysis performed on a sample of tools from the Middle Paleolithic site of Starosele, and addresses these questions: How does tool function compare to form? How were stone tools used, and for what activities? Does the range of activities vary over time? Do conceptual differences exist in how stone tools were made, used, and maintained?

SAMPLES AND SAMPLING

A sample of 102 chipped stone artifacts from the recent excavations at Starosele (Marks et al. 1998) were analyzed. These artifacts were produced on mostly non-local, fine-grained, dark flints from western Crimea. They are ideal for a use-wear study and the photomicrographs of wear traces are truly spectacular in detail and clarity. The sample is an opportunistic one of mostly retouched artifacts, or "tools" (Table 8-1). The nonrandom selection deliberately reflects technological variability across and within the four occupation levels at Starosele, and allows for robust inferences about the artifacts.

The sample comes from four stratified Middle Paleolithic cultural levels (Marks et al. 1998). The uppermost, Level 1, dates by ESR (Rink et al. 1998) and radiocarbon methods (Hedges et al. 1996) to about 41,000 years ago, which correlates with the Hengelo Interstadial. Level 2 falls within the Hengelo or the Moershoofd interstadial. Level 3 occurred during relatively dry stadial conditions of the beginning of the Pleniglacial, which is consistent with its U-Series date of about 67,500 BP. Level 4 falls within the Amersfoort-Brörup or Odderade Interstadial and has a U-series date of >80,000 years old (see Chapter 11, this volume).

Of the artifacts, 34 were excavated in 1995 and 68 in the preceding years. The vast majority of the specimens (from the 1993-94 excavations) were already cleaned of matrix and often labeled before being examined. These specimens were, however, only slightly more likely to have pseudo-wear (13 to 10), whether by metal implements or stone-to-stone contact from field and laboratory settings than the ones that were not cleaned. Pseudo-wear is a serious problem for most archeological collections. Twenty-three of the 102 specimens (22.5%) had pseudo-wear, of which 10 were not retouched (58.82% of 17) and 13 were retouched (15.29% of 85).

MICROWEAR METHODOLOGY

Use-wear analysis is an unequivocal way to evaluate stone tool function and related issues. Microscopic wear traces, scratches for instance, are taken as signs of use and their nature permits inferences about the materials against which the tool edge was in contact. In this context, "contact" or "worked" material refer to both the intended or accidental object of tool use, or that which grips or holds the tool.

The microscopic use-wear analysis used by the author follows the logic and many of the criteria of Semenov's traceological approach, but is neither bound by it, nor by the low-power Keeley method (Semenov 1964, Keeley 1980). A legitimate difference with Semenov's classic study and the author's writings (Kay 1996) is the recognition of additive, soluble, inorganic residues, as expected by Keeley-method analysts. Photomicrographs of additive residues were taken in the 1980s, but they were neither recognized as such, nor their significance appreciated, until the Starosele study began in 1994.

Earlier studies by the author (Kay 1977, 1996, 1997) describe realistic experimental stone tool analogues, appropriate microscopic approaches, and use of ancient stone artifacts. These are, however, an inadequate statement of the use-wear methodology employed for Starosele and Crimea. Starosele has a greater number and complexity of artifacts than any of the author's earlier studies. Its analysis entailed additional experimental controls; a new suite of analytical observations about additive use-wear formation; and wear trace criteria in relation to contact materials, tool use, optional maintenance, and natural wear traces or pseudo-wear. The analysis was staggered over several years.

Confirmation of some of the results of the use-wear study at Starosele was provided by the independent residue analysis undertaken by Bruce L. Hardy (Chapter 9). The 1995 sample destined for specialist analysis was individually packaged in polyethylene plastic bags when excavated, neither cleaned nor further touched, and sent to Hardy. After microscopically examining the adherent matrix and the uncleaned artifact surfaces for organic residues, Hardy forwarded the artifacts to this author, but without providing information of his procedures or results. We later compared our results and realized that we had similarly recorded microscopic evaluations and had complementary findings. Our collaboration results in an especially robust assessment of the use of hand-held and hafted tools, and the recognition of contact materials that would not have been possible otherwise. The results of this collaboration are presented in Chapter 10 of this volume.

Each artifact was assigned an individual specimen number, weighed, measured, and logged into a computerized relational database. After being coated with water-soluble ammonium chloride to enhance flaking and surface details, they were photographed. Ultrasonic cleaning in an ammonium based detergent and water solution then removed the remaining, easily dislodged sediment and any oils that obscured microscopic details. Additional chemical treatment, as recommended by Keeley (1980: 11), was occasionally done after an initial inspection, as needed. The microscopic examination was mostly on the more-or-less flat ventral surface and all edges, but often also included both faces of an artifact. For flakes and other unifacial artifacts, the examination always began with the ventral surface. As this surface represents the side of final detachment from the core, its use-wear reflects that of the tool, whereas the dorsal side, in theory, could reflect activity prior to the flake's detachment.

A differential-interference binocular microscope with polarized light Nomarski optics (see Hoffman and Gross 1970 for a general discussion) was used at magnifications of 100 to 400 diameters. This microscope provides a high resolution, three-dimensional image for microtopography. Most scans for polishes, residues, and striae employed a systematic series of overlapping transects done at 100 diameters. Further evaluations were made at either 200 or 400 diameters, and details photomicrographed, as needed. Microscopic evaluations were also made, as appropriate, at lesser magnifications (10-40X), primarily to observe gross details of edge damage, crushing, and rounding.

The approximate locations of microscopic details and photomicrograph orientation were noted on specimen photographs or schematic illustrations. Photomicrograph illustrations are designed to express the range in wear trace variability, their location, and orientation. For the most part, wear traces are not continuous, and are distributed either along a tool edge or at a high spot on a tool surface.

The overall approach allows for quantitative evaluations of wear traces. The most important, albeit preliminary, are the orientation, number, width, and sequencing of use-wear striae; striae cross-sectional shape; the area or width of a tool edge contact zone (the portion of the edge in direct contact with a worked material); and shape, size, and number of abrasive particles. These data are obtained mostly from observation of photomicrographs.

USE-WEAR FORMATION

Use-wear is a response to micro-chemical and physical environments under which stone tool edges and surfaces contact a worked material. Tool and contact material hardness, moisture, the tool edge's plan and cross-sectional shape, and the direction and amount of applied force are all prime factors that affect tool use. These may result in use-wear. Other, secondary factors are likely to affect tool efficiency and use-wear, too. Among the most important would be abrasive particles; brittleness, malleability, and ductility of either contact material or tool; and dynamic changes in tool edge plan or cross-sectional shape as a tool is used, dulled, and resharpened. Use-wear is likely to be indicative of one or more primary and secondary factors. Abrasive use-wear is a by-product mostly of the manner and amount of applied force and frictional resistance offered by a contact material or introduced abrasives, and the length of time of tool use. For the formation of additive use-wear, or soluble residues, moisture must be added. Undoubtedly, other factors still unknown also must affect formation of soluble residues.

Additive residues also commonly form during stone tool use due to hafting or prehension. These wear traces permanently bond to an artifact surface. Clearly denoting the orientation and direction of their formation are the in-filling of striae, crystallization on the trailing edge of the residue, and, to a lesser degree, desiccation cracking. What goes into solution, or becomes a soluble gel, is probably mostly silica, assuming an X-ray probe of one soluble residue is representative (Kay 1997: 658-660; see also Keeley 1980; Mansur 1982; Vaughan 1985).

Strictly abrasive wear traces tend to smooth and polish, and ultimately lead to a nearly featureless, optically reflective surface. Their range of expression is from a mere scratch, or striation; to heavily striated, well developed polishes; and lastly to other polishes in which the striae are faint and have almost a vestigial appearance. Soluble residues contrast from abrasive polishes, although they invariably are optically reflective. They coat a surface, have a bumpy, textured appearance, and directional flow characteristics. Their deposition is clearly as a liquid, or gel. Exactly how long it takes for the gel to bond and harden onto a tool surface is uncertain. From experiments, hardening must have occurred in minutes, seconds, or even less. It seems likely, too, that hardening is differential and occurs progressively across a still-in-use tool edge.

As determined from experiments, abrasive use-wear also may occur alone, precede the accumulation of soluble residues, continue during the latter's deposition, or be masked by it. Abrasion of a soluble residue relates to the frictional properties of the residue itself, and occurs while it is soluble but viscous. The frictional coefficient of still-soluble residues must be significantly less than either the contact material or a tool surface and edge. When soluble, the residue acts as a lubricant. Yet, as it dries, the residue bonds to the tool surface or edge, and forms thin layers ("microplating"). This residue builds up microscopically, alters the edge, and ultimately reduces tool efficiency because it changes the geometry of the cutting edge.

Contact Materials

Conspicuous microscopic changes to a tool edge and adjacent surfaces occur during use. If only to a degree, these microscopic alterations relate to and are caused by contact materials. This relation is, of course, central to stone tool use-wear studies.

The wear trace criteria used here to differentiate contact materials contrast somewhat from other types of studies for reasons of optics and microscopy. Use-wear evaluations are microscope-dependent. The clearer the image, the more likely one will make meaningful comparisons and set analytical standards. The differential-interference microscope with polarized light Nomarski optics substantially improves the image over that of a reflected light binocular scope, and is similar in its depth-of-field characteristics to a scanning electron microscope at the same magnification range. For all microscopes, depth of field is reduced as magnification increases. For the differential-interference microscope, the resolution increases along with magnification, which is similar to a scanning electron microscope. The Nomarski optics afford an exceptionally detailed, three-dimensional image. It is important to note that the wear traces in question are often significantly smaller than, and may be independent of, edge damage that is either macroscopic or easily observed at magnifications less than 100 diameters. Whether abrasive or additive, these wear traces are readily observed at magnifications at or greater than 100 diameters on stone tool edges and surfaces of all kinds.

Based on experimental evidence, there are wear trace differences due to the relative hardness, malleability of contact materials, and the manner of tool use. These are stronger when moisture is present during tool use and soluble residues form. They also apply when only, or mostly, abrasive wear traces occur.

Everything else being equal, a change in worked material hardness should be inversely proportional to contact with a tool edge. This prediction may be verified by experiments in which the width of a contact zone on a tool edge or surface is compared to worked material hardness and malleability. Generally speaking, as hardness increases, malleability decreases, and the contact zone narrows. So, if one knows or can calculate hardness and malleability of a contact material, one can also predict a tool's contact zone width and other systemic responses to a worked material. This prediction would work best for the theoretical-and-never-realized situation of comparable tool edges used in an identical manner with the same amount of applied force. Yet, it works reasonably well when virtually none of these conditions is met, which is the norm for stone tools. Although the contact zone width can be measured accurately from a photomicrograph, doing so is neither essential in the initial microscopic inspection, nor absolutely needed even later. More important are ordinal scale measures of the contact zone width, along with observations of other contact zone attributes.

We may infer gross differences in contact material from two wear trace criteria: tool edge rounding with a broad contact zone equates well with soft contact materials, while an absence of tool edge rounding over a more restricted contact zone represents harder contact materials. Further distinctions also can be made for either softer or harder contact materials, and these require inspections at magnifications generally greater than 200 diameters. These are based, in their order of importance, on (1) the occurrence, placement and frequency of striae and abrasive particles; (2) micro-edge cross-sectional shapes; (3) invasive wear traces; (4) the manner of deposition of soluble residues; and (5) wear trace sequencing.

Almost exclusively kinematic features include the above first three groups of attributes. *Striae and abrasive particles:* their occurrence is a direct measure of the overall extent of tool contact with a worked material. Their placement and orientation are evidence that a point or tool edge was used and indicate the direction and type of tool stroke. Their frequency (optimally expressed as number per unit area, or density) tends to increase with the relative hardness of the contact material. For example, relatively few striae occur during hide scraping, depending on the presence of abrasive particles, of course. The reverse is true of herbaceous plants, which often are associated with an almost limitless number of striae. Opal phytoliths, or cellular silica bodies, produced by the plant are probably the source of the abrasive materials. Working deciduous hardwoods may result in few striae. More dense contact materials such as bone, antler, or ivory produce heavily striated tool edges and surfaces.

Micro-edge cross-sectional shapes: these respond to and are responsible for certain kinds of tool strokes indicative either directly or indirectly of contact material hardness and malleability. Soft, highly malleable materials such as leather, animal hide, or herbaceous plants produce extensive tool edge rounding. Working deciduous hardwoods may result in little perceptible alteration of a tool edge. More dense contact materials such as bone, antler, or ivory are more likely to damage an acute angle edge, less so on a right or slightly obtuse angle edge.

Invasive wear traces: whenever the contact material envelops and touches the tool edge, or the tool deeply penetrates, the wear traces are invasive and often extend from a tool edge across its surface. Invasive wear traces keyed to tool use are preferentially distributed in a directional way on the leading side (i.e., the side facing the contact material) of higher microtopography, and rarely are continuous. When compared to the first two attribute groups, they provide substantiating evidence about the lateral or areal extent of contact with a worked material and its likely hardness.

Time/duration of tool use, optional maintenance, and recycling are addressed by the final two groups of attributes; these also bear on the kinematic features. *Soluble residue deposition:* first and foremost is the relation to micro-chemical environments affected by the tool and a worked material. The differential build up of soluble residues, their drying and cracking, provide insight into tool edge dulling and needed maintenance. *Wear trace sequencing*: the prime explanatory potential is in establishing a minimum number of observed tool uses, plus the likelihood a tool was maintained further or recycled.

Tool Stroke

Striae, abrasive particles, and soluble residue attributes all provide direct information about tool stroke. The most important soluble residue attribute is crystallization on the trailing edge or side; that is, on the side opposite the point or edge of contact between a tool and a worked material. Crystallization is useful in three general ways: to confirm a single tool stroke direction in which crystallization is only on one side of the contact zone; to identify a bidirectional tool stroke in which crystallization occurs on both sides of the contact zone, or a multidirectional tool stroke in which crystallization occurs on several sides of the contact zone; and, finally, to recognize a rotary tool stroke in which crystallization occurs in a circular pattern about the contact zone and may be seen to radiate from a central point. Abrasive particles are similar in their usefulness, as they tend to stop at the end of a striation, opposite the direction of force and tool motion. Striae provide a clear view of tool stroke orientation and are often complemented by abrasive particles or crystallization. Viewing these lines of evidence, as a whole, the direction, or directions, and orientation of different tool strokes may be defined. Although simplified here, these patterns reflect the observed use-wear evidence.

Although there are a large number of possible specific motions that can be defined through use-wear studies, the following discussion is limited to those actually seen in the Starosele sample.

Cutting

Striae derived from cutting are variable in orientation, and may result from single, bidirectional, and multiple-directional strokes. They also vary with the relative hardness of the contact material. Invasive cutting strokes are more likely with soft (e.g., hide, meat, and herbaceous plants) to medium hard (e.g., deciduous and coniferous wood) contact materials. In cutting, the tool edge acts as a simple wedge to split or cleave through a worked material. If the tool edge is held perpendicular to the surface of a worked material, striae and other wear traces will be at the tool edge itself and both adjacent surfaces. This is most common with biconvex tool edge cross-sections and when the tool edge angle is acute (between 45 and 60 degrees). Tool edges with planoconvex cross-sections where the tool edge angle is greater than 45 but less than 90 degrees almost invariably have evidence of cutting strokes on the flat side. The flat side adjacent to the working edge is the leading surface, the one most in contact with a worked material. For either type of tool edge cross-sectional shape, cutting striae and related wear traces should originate at the edge, and may parallel it, in which case the cutting stroke could be either a single or bidirectional, depending on the placement of abrasive particles and crystallization. The cutting stroke may also be obliquely or transversely oriented to the edge, or a combination of parallel, oblique, and transverse motions. The wear traces, again with priority given to striae, should clearly identify the orientation and direction of the cutting stroke.

Scraping

The predominant orientation of striae and related wear traces due to scraping should be transverse to the tool edge, clearly originate at this edge and should display either a uni- or bidirectional motion. For planoconvex tool edges, the leading surface is the convex one adjacent to the edge. The contact zone usually extends onto the flat side, as well, but is mostly limited to the edge itself. For biconvex tool edges and unretouched near-right-angle and obtuse angle edges, the edge itself is often the prime contact zone, and should display the same wear traces as do planoconvex tool edges.

Planing

Planing is a variation of scraping, with the same general orientation and directionality of wear traces. With a planoconvex cross-section, the leading surface is the ventral surface of the tool edge. The wear traces are invasive. Worked materials which are hard may result in substantial damage to tool edges; soft contact material results in tool edge rounding, which shows mainly on the dorsal surface of the edge itself.

Gouging

Gouging is a variation of scraping peculiar to near-right-angle edges and is usually found on tools with obtusely angled working edges. They will exhibit the same general orientation and directionality of wear traces as those used for scraping. The contact zone is almost invariably limited to the immediate, exceedingly narrow edge, and is usually correlated with hard contact material. The wear traces are not invasive.

Wedging

Wear traces derived from wedging are normally at the edge and invasive on both adjacent faces. Wear traces tend to be localized to the flake arêtes closest to the tool edge. The side opposite the wedge edge often shows hammer pitting. Bifacial flake scars on both the wedge edge and the opposite side are common, use-related, and are largely parallel to the orientation of the microscopic use-wear.

Engraving

Wear traces due to engraving originate at a point and extend back from it along the edge or surface in contact with a worked material. Working within a groove or slot may result in either bidirectional or multidirectional wear traces, as the tool edge is pushed or pulled along the slot. Wear traces generally are limited to the point, adjacent tool edge, or surface and are limited to a narrow contact zone. Invasive wear traces, however, may occur when the slot or groove being made is of sufficient magnitude that contact between it and the tool surfaces occurs. When invasive, the tool motion is often bidirectional, parallels the working edge when the edge is within the groove, or originates at the tip and is perpendicular to the tool's longitudinal axis.

Drilling and Perforating

Although of similar function, a drill and a perforator contrast in tool motion. Rotary motion applied at the tip is typical of a drill. A perforator would be plunged into or through a worked material, creating a conical hole by the wedging action of the tip and the tool shaft. Tool forms should differ, too. The drill form should allow for rotary contact of its tip with a worked material, but ideally, not its shaft. A perforator should have the almost opposite design elements: because its tip initiates an opening that is further wedged by frictional contact with its shaft, the conical shaft should end in a needle-like tip. Because both tools must be extracted from the hole, comparable wear may occur on the shafts of both.

Impact and Penetration

Projectile point use (or simple penetration) result in unidirectional wear traces that originate at the tip, parallel the longitudinal axis of the tool, and are invasive on both faces. The leading surfaces face the tip. It is difficult to distinguish between wear traces resulting from thrown—as opposed to thrusted—actions in killing big game (Kay 1996). A variety of macroscopic damage to the tip, faces, and base of projectile points is also common and impact-related (Witthoft 1968; Ahler 1971; Frison 1977). These consist of simple tip fractures on a needle-like tip, to impact fractures (burin-like facets) on the edges and surfaces, to failure and radical breakage of the tool.

Hafting and Prehension

Hafting allows for an application of greater force directed against a worked material and, thus, has a mechanical advantage over the hand-held employment of a similar tool. It does not necessarily assure the absolute stability of the hafted portion within the haft during tool use, however. Microscopic effects of friction due to haft binding and use-related movement are readily observable (Kay 1996). These afford unambiguous use-wear criteria to differentiate hand-held from hafted tools. Among the more important are the nonrandom placement, orientation, extent, and organization of striae and related wear traces typical of hafted but not of hand-held tool use.

Invasive wear traces due to prehension include abrasive wear traces—principally striae that fan out in a seemingly random fashion from a common surface area—and associated soluble residues that occasionally merge as rounded patches.

Pseudo-Wear

Pseudo-wear of a natural or taphonomic origin includes the effects of wind abrasion, trampling damage, post-excavation transport and stone-to-stone contact, and metal or graphite streaking.

The origin of natural striae should not relate to a tool edge, and should be independent of it, unless edge damage is responsible for the introduction of abrasive particles that are then swept across a surface. Instances where ambiguous wear traces are present are likely to have resulted from wind abrasion, trampling damage, post-excavation transport, and stone-to-stone contact. Wind abrasion results in abundant, highly directional striae and aerosol abrasive particles that parallel one another or form crossbeds. Wind abrasion may be superimposed on and obscure use-wear, or confused with it. Trampling damage, post-excavation transport, and stone-to-stone contact are likely to cause random striae that could be confused with prehension wear traces.

Metal and graphite streaking are common pseudo-wear features, and ones easily identified by their brightness and surface texture. They indicate damage to artifact surfaces and edges produced during or after excavation, or, more broadly, within the historic period. Unless the evidence is equally clear and convincing, striae near to metal or graphite streaks should be discounted, because they may well be caused by the streak but not have the metallic residue.

FUNCTIONAL CLASSIFICATION OF ARTIFACTS

A combination of microscopic and macroscopic information to assign stone artifacts to functional categories was used. Using wear trace evidence, the most basic question is whether the artifact was used. If not, the artifact is classed initially as a non-tool. If intentional and patterned retouch is present, it is further identified as a tool preform; without such retouch, it is classified as debitage. An artifact that displays tool use-wear is classed as a tool; one for which wear traces are inconclusive and/or are pseudo-wear is assigned as unknown.

TABLE 8-1

Starosele, Total Formal Tool Types *(N)* and Use-Wear Samples *(S)* by Level

	Level 1		*Level 2*		*Level 3*		*Level 4*	
Tool Class	*N*	*S*	*N*	*S*	*N*	*S*	*N*	*S*
Scrapers	72	26	15	5	59	14	9	6
Retouched Pieces	35	3	1	–	37	2	3	–
Points	21	13	–	–	5	4	1	1
Pièces Esquillées	2	1	–	–	–	–	–	–
Denticulates/Notches	17	1	4	–	37	7	–	–
Bifacial Tools	13	10	1	1	–	–	–	–
Other	1	–	–	–	2	8	–	–
Total	161	54	21	6	140	35	13	7

For specific tool types, or type subdivisions, additional criteria apply. The leading aspect (surface and/or edge) of the tool during use, the orientation, type, and relative invasiveness of the tool stroke are prime criteria for assigning tool function. Wear trace sequences indicate either repetitive use or tool recycling; wear traces only at a tool edge or on a leading surface indicate optional maintenance and discard. Worked material, when part of tool functional classification, is inferred by the tool contact zone width, edge rounding, or other types of microscopic alteration (edge faceting, damage, etc.), striae, and abrasive particle density. Wear traces for either prehension or hafting further divide tools into two major categories, hand-held or hafted. Macroscopic tool edge cross-sectional shape, curvature, pointedness, symmetry, and overall measures of mass and size are considered.

Starosele Stone Tool Functional Types

Not all morphological tool classes from Starosele were examined, since emphasis was placed on the more heavily retouched tools, scrapers, points, and bifacial foliates (Table 8-1). For those classes, however, a significant sample of each level was studied, ranging from 77%

TABLE 8-2
Starosele, Use-Wear Categories

Function	*Uncertain*	*Unknown*	*Hand-held*	*Hafted*	*Total*
Level 1					
Cut/Scrape	–	–	10	2	12
Wedge	–	–	4	–	4
Burin	–	–	2	6	8
Unifacial Point	3	–	–	8	11
Bifacial Point	1	–	–	8	9
Unifacial Scraper	–	4	–	1	5
Debitage	–	4	–	–	4
Drill	–	–	–	1	1
Level 2					
Unifacial Point	–	–	–	1	1
Bifacial Point	–	–	–	1	1
Cut/Scrape	–	–	2	1	3
Debitage	–	1	–	–	1
Level 3					
Unifacial Point	–	–	–	7	7
Burin	–	–	–	3	3
Cut/Scrape	–	–	10	5	15
Scraper	–	–	–	1	1
Wedge	–	–	4	–	4
Spokeshave	–	–	1	–	1
Debitage	–	4	–	–	4
Level 4					
Unifacial Point	–	–	–	1	1
Burin	–	–	–	2	2
Cut/Scrape	–	–	–	4	4
Total	4	13	33	52	102

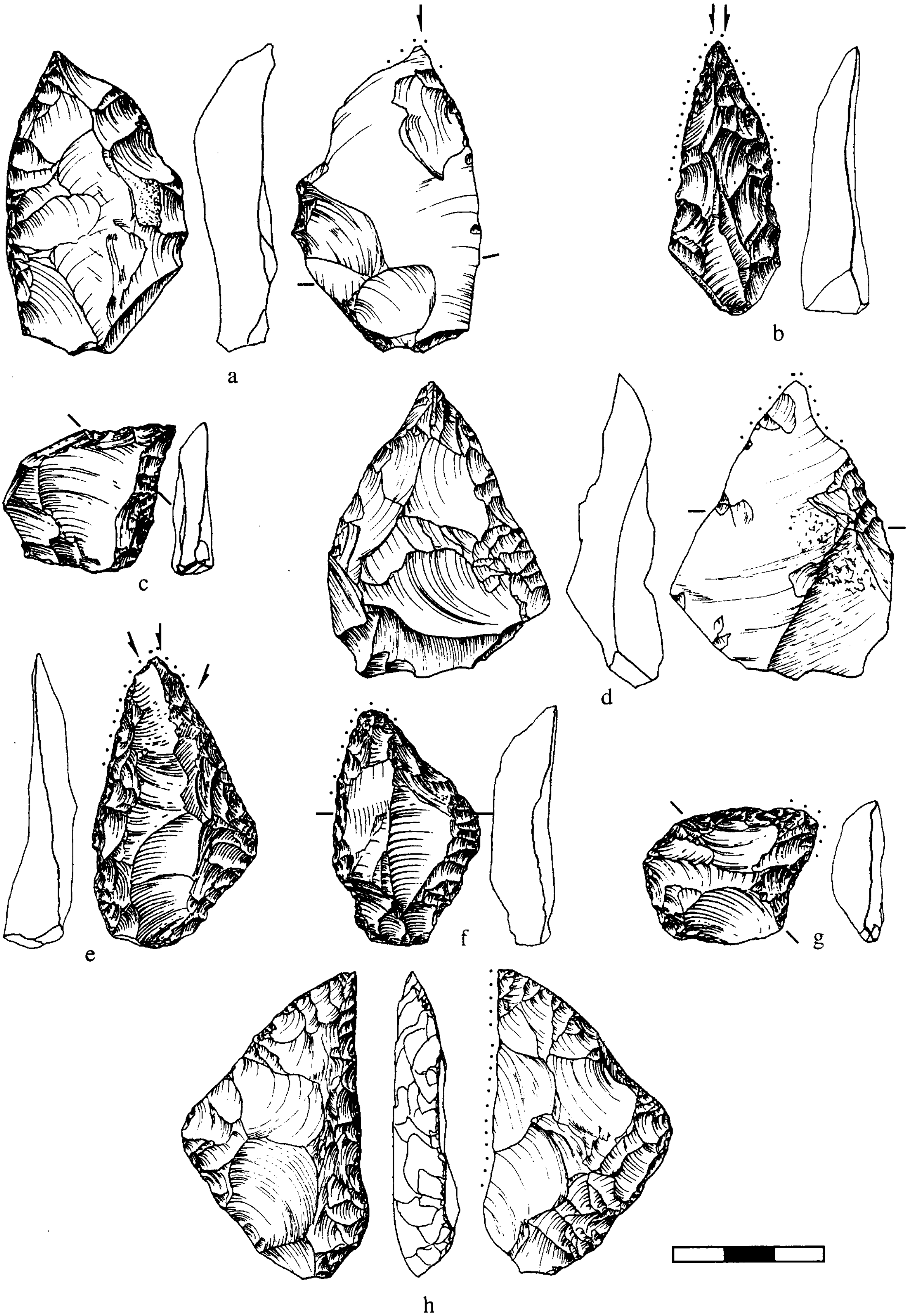

Fig. 8-1—Starosele, functional types, Level 1: *a-f*–unifacial points; *g*–hafted drill; h–bifacial knife. Stippling indicates the tool edge; dashes indicate the extent of the haft element.

of the bifacial tools in Level 1 to 25% of the scrapers in Level 3. As expected, the correlation between morphological types and functional types depends upon the degree to which the morphology determines the way a tool can be used. This rarely is a one to one correlation and, so, it is not surprising that a sample drawn from a morphological class, such as scrapers, will break down into a number of different functional groups.

This study recognizes seven functional groups of tools, based upon the purpose for which they were used. They are defined only briefly below because there is usually a high correlation between a functional type (e.g., knife) and the kind of tool stroke used (e.g., cutting) and these have been described above. The functional types recognized here are drill, spokeshave, wedge, burin, knife, scraper, and point (Table 8-2). Among the latter three cases, individual items functionally may fall into more than one group. For instance, an artifact may be used initially as a knife and then as a scraper, or vice versa. Of these functional groups, five might be thought of as being associated with maintenance classes, while the other two, knives and points, might be more related to extractive activities (Binford and Binford 1966). On the other hand, since numerous items in this study exhibit use for both cutting and scraping, such a clear-cut distinction may not be warranted.

Drill

A drill is used in a rotary motion tool stroke. The one example found was used against a hard contact material. The tool is a Level 1 hafted uniface whose sides converge in a nearly symmetrical way to the rounded but still pointed tip (fig. 8-1g). Only rotary wear traces of crystallization filaments about the heavily microplated and faceted tip can be seen.

Spokeshave

The morphological equivalent of the functional spokeshave type is a notch. Functionally, it is used to scrape or plane; the notch may be deliberately prepared or unprepared. Use-wear shows striae transverse and parallel to the edge, but mainly within the notch. Only a single example was recognized, which is a hand-held, unifacially notched tool from Level 3. In this case, the notch and the edge adjacent to it exhibits minor rounding and abrasive polishing, which suggest a medium hard material, probably wood.

Wedge

The morphological equivalent to the wedge is the pièce esquillée, which is recognized primarily from formal criteria and clear evidence of edge damage. The wedges from Starosele are expedient tools and, aside from the two pièces esquillées recognized from Level 1, all others were formally classed as other types of tools, such as denticulates, notches, and scrapers (fig. 8-2). These wedges were used for splitting relatively hard substances such as wood, bone, or antler. Wedges are distinguished by invasive abrasive polishes and striated soluble residues, as defined above. Among the more important clues for the recognition of wedging, regardless of gross morphology, are bipolar flake scarring of one or both surfaces, hammer-caused pitting, step fracturing, and failure of the edge opposite the wedge edge.

Burin

Burin edges may be produced a number of ways, as in Crabtree's (1977: 48) experiments in which a slightly obtuse extremely tough tool edge was created by radial fracture, by a percussion blow directed perpendicular to the surface, or by burin faceting (see Barton et al.

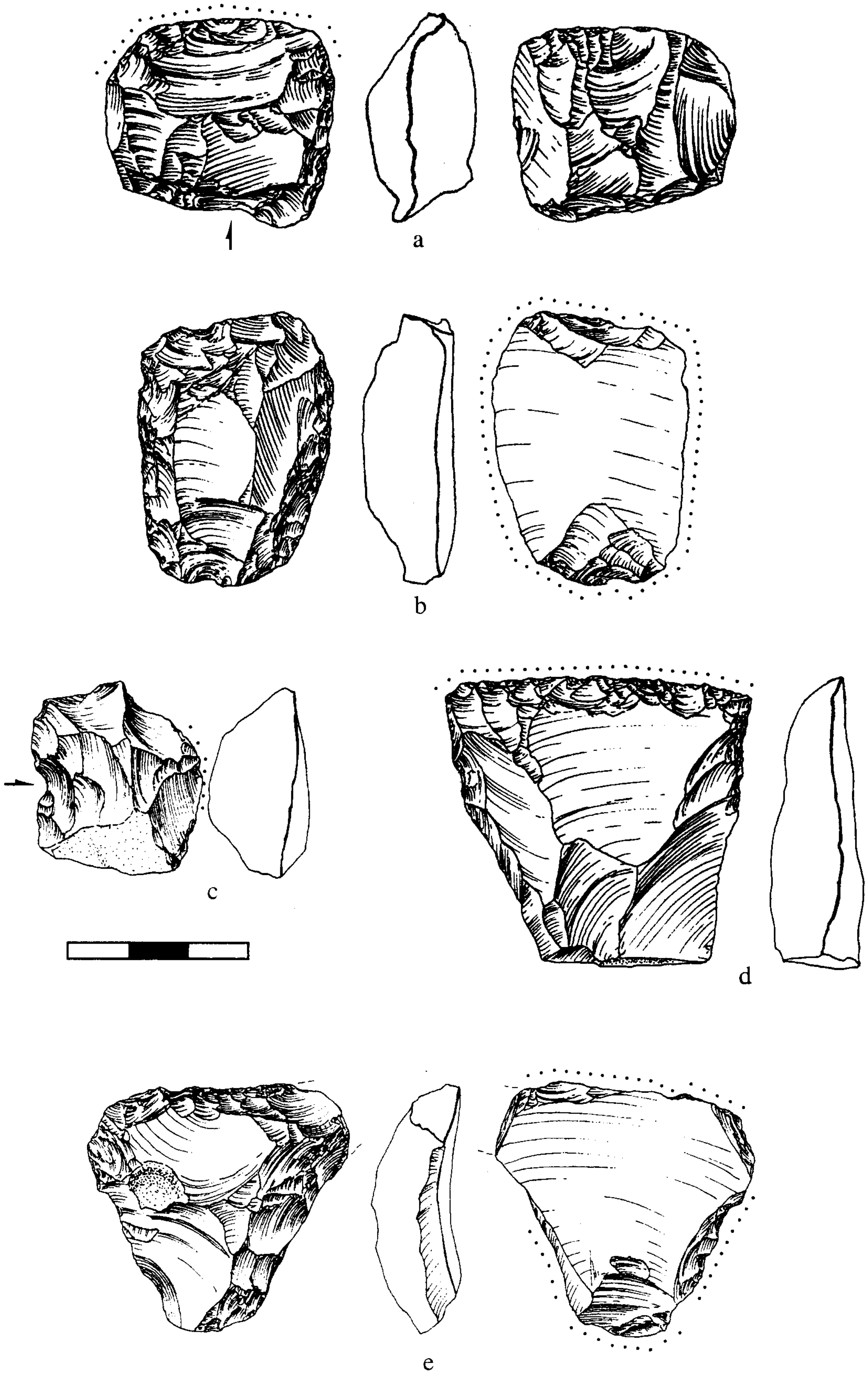

Fig. 8-2—Starosele, functional types, Level 1 *(a-f)* and Level 3 *(c-e)*: wedges. Stippling indicates the tool edge.

1996 for a literature review). The working edge is a near right angle or slightly obtuse angle. These are relatively thick and may be pointed at one end, side, or edge. Functionally, it matters not how these edges are created, only that they exist. From experiments and archeological examples, burins are first and foremost heavy duty fabricating tools used to slot, split, wedge, or engrave medium hard to hard material. The most critical wear traces include a consistently very narrow contact zone, no edge rounding, per se, but often significant edge damage or densely striated edge faceting. All burins at Starosele involved gouging in which the striae are primarily perpendicular to the edge and are consistent with a scraping motion. Although a number of functional burins were recognized, none was morphologically a burin, but ranged (typologically) from broken scrapers and points to denticulates (e.g., figs. 8-4, 8-9). In this sense, they differ from their Upper Paleolithic counterparts, but they are no less burins functionally than are Upper Paleolithic ones.

Knife

In the pure sense, knives are used only for cutting, with the criteria defined above for a cutting motion. On the other hand, many of these pieces show multiple uses, often a combination of cutting and scraping.

Scraper

This functional scraper group, as the group knife above, tends to have examples that have been used in conjunction with cutting, sometimes seemingly as part of the same activity. The use-wear criteria have been described above.

Since these knives and scrapers and their combinations represent a significant sample, it is useful to examine the relationship between these functions and the degree to which they were hafted or hand held. It is noteworthy that those tools used strictly as scrapers were all hafted, while less than half of the pieces used for both scraping and cutting were hafted (Table 8-2).

Point

Points include tools used mostly to penetrate with a straight motion into the contact material. Wear traces are consistent primarily with impact and penetration motions, and these are usually associated with additional wear traces indicating tool hafting. Those tools that display use-wear sequences of impact and penetration followed by cutting were most likely used as points first, either thrust or thrown; those with a reverse use-wear sequence may have been knives first.

Use-Wear Examples

Since space limitations preclude detailed descriptions of each and every artifact studied, a few examples are included here and in Chapter 10 to convey a sense of the study details.

A Level 4 sub-trapezoidal scraper illustrates a variety of ventral surface wear traces. The randomly oriented striae (fig. 8-3a) are experimentally linked to prehension. On the interior (fig. 8-3b) and on the retouched edges (fig. 8-3c, d) there are striated soluble residues perpendicular to the edge (a scraper diagnostic) which carry across the flat ventral surface in a deeply invasive scraping stroke. Cutting followed. Its use-wear striae are parallel to and at the retouched edge (see fig. 8-3c, d and fig. 8-8a) that truncates the scraping striae. Abrasive particles and crystallization filaments have complementary orientations, due to a single direction of the cutting stroke. The cutting edge was drawn back toward the user. Scraping

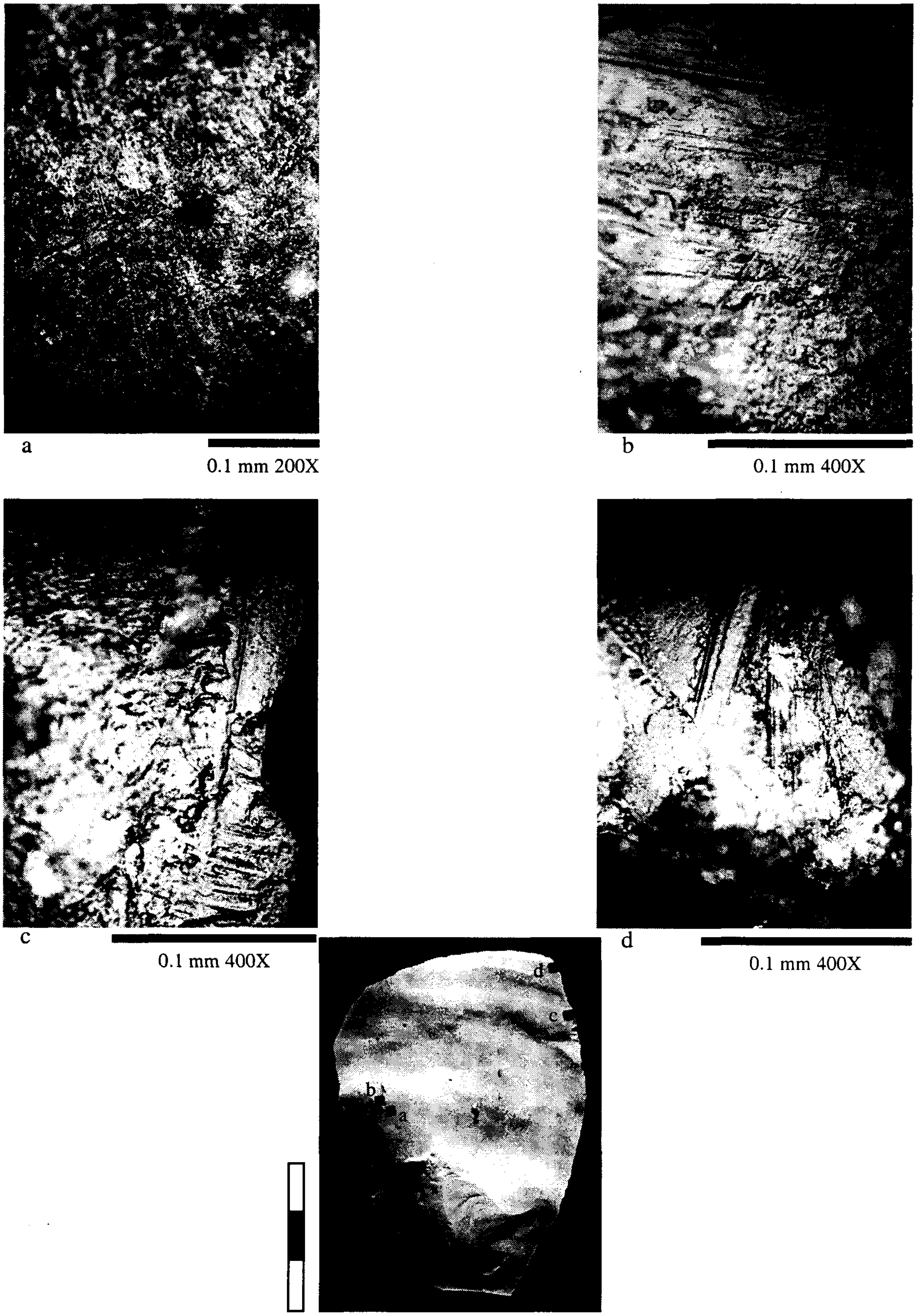

Fig. 8-3—Starosele, functional types, Level 4: oriented photomicrographs of a cut/scrape tool: *a*–random abrasion probably due to prehension; *b-d*–striated soluble residues, crystallization, adhering abrasive particles due to sequential use as a scraper and then as a knife.

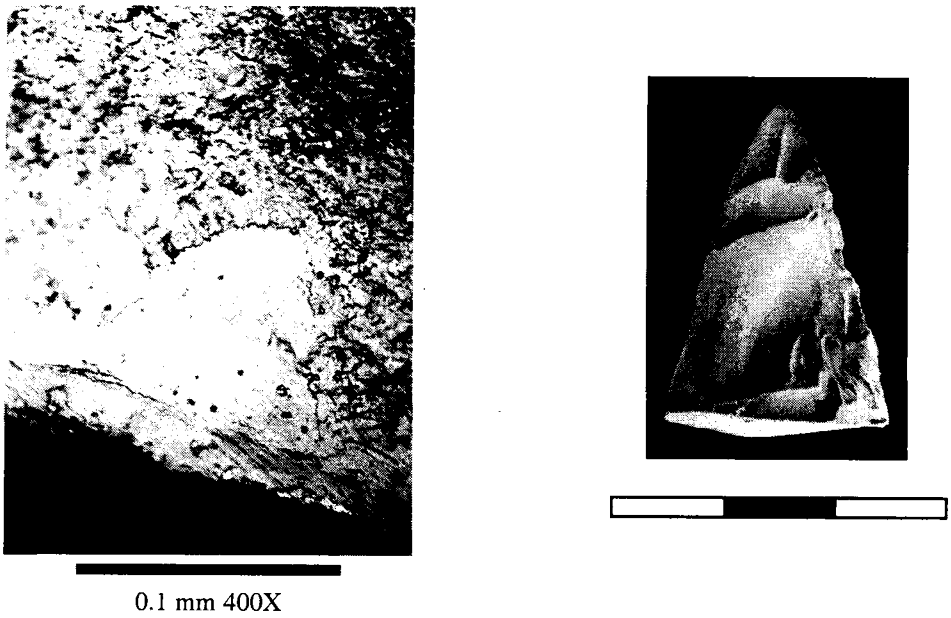

Fig. 8-4—Starosele Level 1: oriented photomicrograph of plano-convex bifacial point tip recycled as a hafted burin.

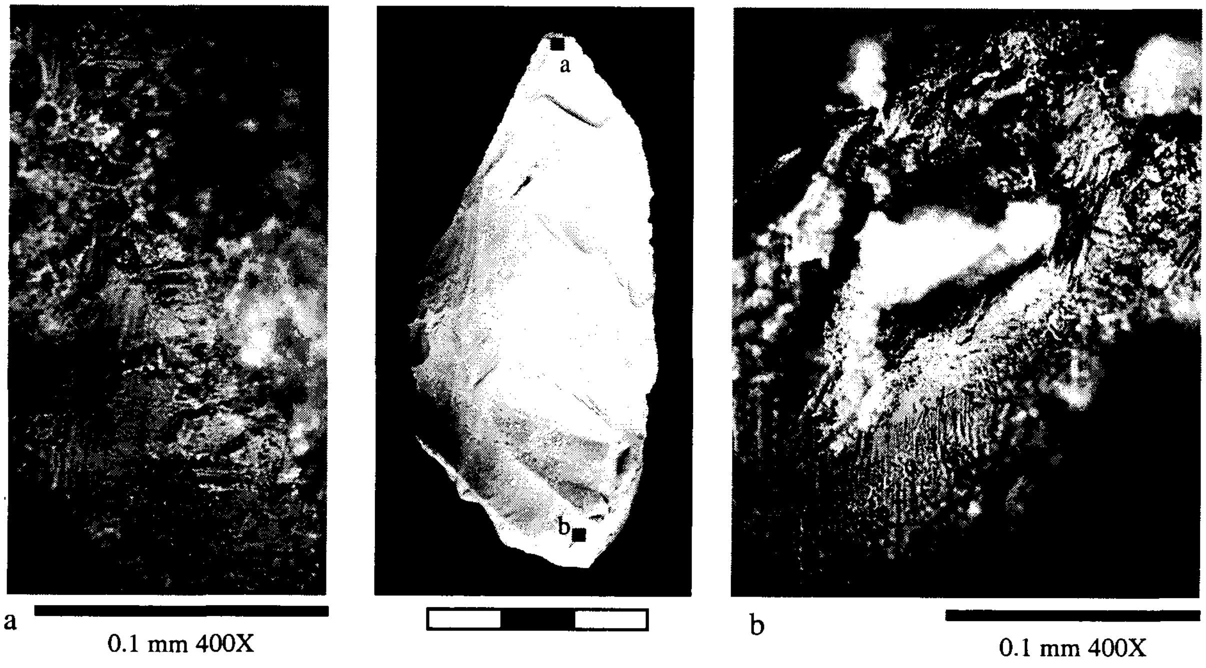

Fig. 8-5—Starosele Level 1: oriented photomicrographs of an asymmetrical plano-convex bifacial point used to cut then pierce game. Note haft wear details in *(b)* and soluble residue use sequence of cutting striae intersected by impact, or penetration, striae.

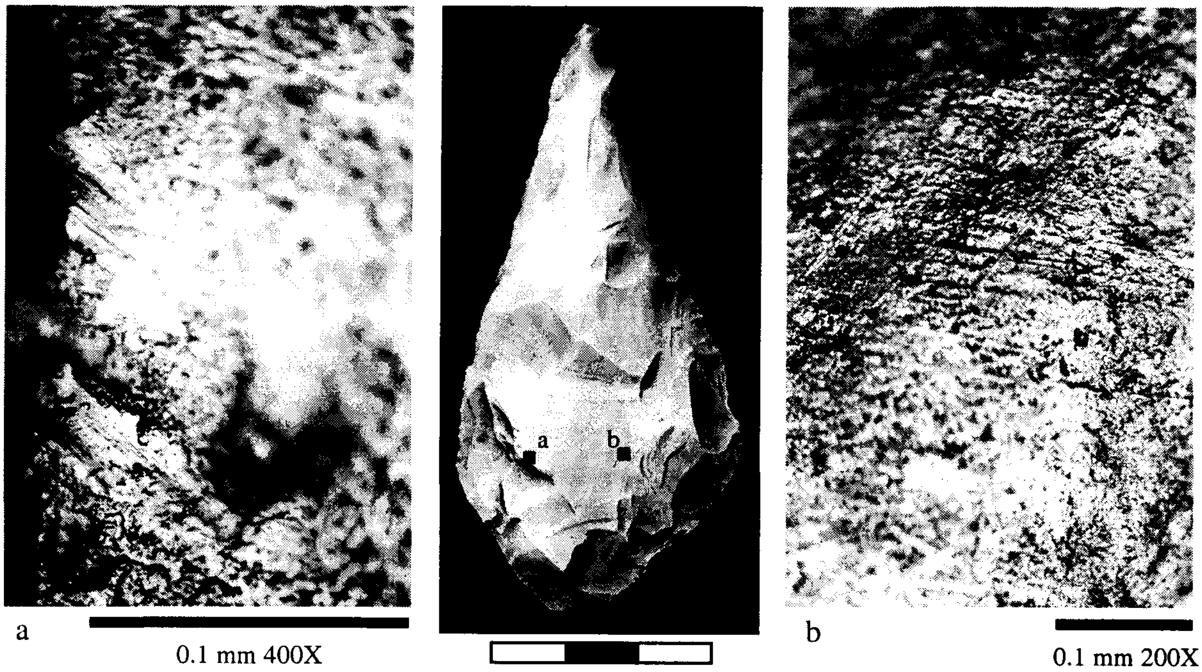

Fig. 8-6—Starosele Level 1: oriented photomicrographs of haft wear details on a symmetrical plano-convex bifacial point.

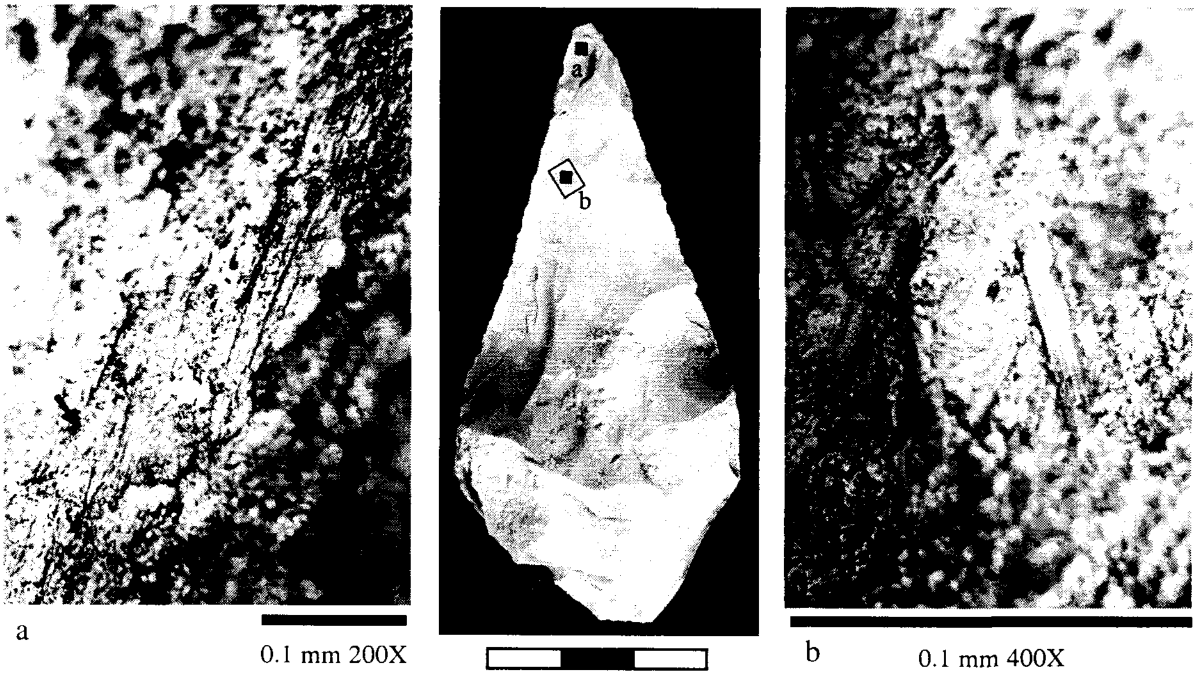

Fig. 8-7—Starosele Level 1: oriented photomicrographs of a symmetrical plano-convex bifacial point (ventral surface of fig. 8-6): *a*–impact striae that originate at the tip, the arrow points to overlying cutting striae; *b*–series of cutting striae nearly identical to those in photomicrograph *(a)*. Note orientation of photomicrograph *(b)* to tool.

and then cutting a medium hard material is likely—perhaps wood, as the striae are generally back from the edge and low in density. Insofar as the wear traces are both at the tool edges and invasive, it is clear the tool was not further maintained, or resharpened.

There is a hafted burin recycled from a broken bifacial planoconvex foliate point tip (fig. 8-4) from Level 1 which is similar to virtually all other functional burins from Starosele in lacking the classic prepared burin facets common to Upper Paleolithic technology. Instead, it has a slightly obtuse extremely tough tool edge created by a bending fracture.

The burin edge is the blunt, thick, transversely broken end opposite the tip, which was stuck into a handle. The use-wear is a textbook example of a densely striated soluble residue and of edge faceting. There is overlapping of the soluble residue indicating two distinct episodes of use, each bordered by its own desiccation crack. The sequence of desiccation cracks is consistent with drying farthest from the tool edge, and then proceeding to the edge during use. Burin use was as a chisel to slot or groove an extremely hard material. The primary direction of movement was at a slightly oblique angle to the tool edge. The burin stroke was bidirectional because the abrasive particles are at opposite ends and across the soluble residue. Final crystallization also occurred at the immediate tool edge, consistent with the placement of the abrasive particles.

A final set of examples is armatures and technologically related knives from Level 1. Level 1 has distinctive planoconvex bifacial foliates and unifacial points of similar cross-sectional shape. These were probably were probably hafted in "V"-shaped split sockets to accommodate similarly shaped, thick butts. The bifacial implements are mostly larger and exhibit a great deal more care in their manufacture than do the unifacial points. Marks and Monigal (1998) regard these bifacial foliates as most likely to have been thrust, due to their larger size and weight. From a wear trace perspective, these could have been attached to a thrusting spear or one that was thrown, or even used as hafted knives, since use-wear of penetration all looks the same, whether from having been thrown or stabbed into a contact material.

TABLE 8-3
Starosele, Formal Tool Types and Prehension

Tool Class	*Sample N*	*Uncertain*	*Unknown*	*Hand-held*	*Hafted*
Scrapers	51	1	10	21	19
Points	18	2	–	3	13
Retouched Pieces	5	–	1	2	2
Pièce Esquillée	1	–	–	1	–
Denticulates/Notches	8	–	–	5	3
Bifacial Tools	11	1	–	1	9
Other	8	–	2	5	1
Total	102	4	13	38	47

Hafting use-wear for this group, as a whole, and for the two illustrated bifacial examples (figs. 8-5–8-7) is consistent in several respects. There is evidence for flat surface-to-surface contact with the handle. Haft binding can be seen by both perpendicular and obliquely oriented striae to the tool's longitudinal axis.

Use-wear on the two bifacial foliates comes from tool use and they exhibit complex use histories. These bifacial foliates may be interpreted as having been used to pierce a carcass

TABLE 8-4
Starosele, Formal Tool Types and Tool Motion

Use-Wear Motion	*Scrapers*	*Points*	*Retouched Pieces*	*Pièces Esquillées*	*Denticulate/ Notch*	*Bifacial*	*Other*	*Total*
Cutting	7	2	2	–	1	3	3	18
Scraping	10	–	–	–	3	–	–	13
Cut/Scrape	6	2	–	–	–	–	2	10
Scrape–>Cut	1	–	–	–	–	–	–	1
Planing	–	–	–	–	–	–	1	1
Gouging	3	1	–	–	–	–	–	4
Wedging	3	–	1	1	3	–	–	8
Engraving	4	3	–	–	1	1	–	9
Rotary	1	–	–	–	–	–	–	1
Impact	5	8	1	–	–	6	–	20
Pseudo Wear only	6	2	1	–	–	–	1	10
Unused	5	–	–	–	–	1	1	7
Total	51	18	5	1	8	11	8	102

and also to butcher it. There is also unambiguous sequencing of use-wear on the pieces. The asymmetric bifacial foliate (fig. 8-5) has a clear sequence of invasive cutting use-wear transverse to the tool edges followed by tip impact-related penetration; the reverse of this sequence is true for the symmetric bifacial point (figs. 8-7 and 8-10b). They also differ from the cut/scrape tool and the chisel burin in that the wear traces are not directly on the tool edges but on the leading surfaces facing the edges and tip. The implication is they both had rejuvenated edges.

TOOL FORM AND FUNCTION

While it long has been recognized that there is no predictably positive correlation between form and function (Bordes 1961), except when necessitated by extremes (e.g., one cannot cut with a rounded edge), most of traditional typological nomenclature has a functional connotation, even if such is explicitly rejected. Thus, the relationship between morphological forms and how they were used is of some interest. For instance, Binford and Binford (1966) assumed such relationships, even adding unretouched blades to Bordes' classes because they seemed to be functionally for cutting. In addition, the distinction between "formal" and "ad hoc" tools has been used to imply differences in "curational" behavior, with the implicit view that the more heavily retouched the tool, the more it was desired and the longer it was used. All of these concerns can be approached from a fresh perspective using use-wear studies.

Form and Hafting

Using the morphological classes described in Marks and Monigal (1998) for Starosele, but combining all four assemblages, it is clear that the most heavily retouched tools—the bifacial foliates—exhibit the highest percentage of hafting: 90%. This is followed by points and then by scrapers. The less heavily retouched tools—denticulates, notches, retouched pieces—show much lower occurrences of hafting, while almost 20% of the scrapers did not have clear enough use-wear patterns to make a determination (Table 8-3). In short, it would appear that hafting tends to be associated with heavily retouched, often rejuvenated tools, which therefore may be considered "curated."

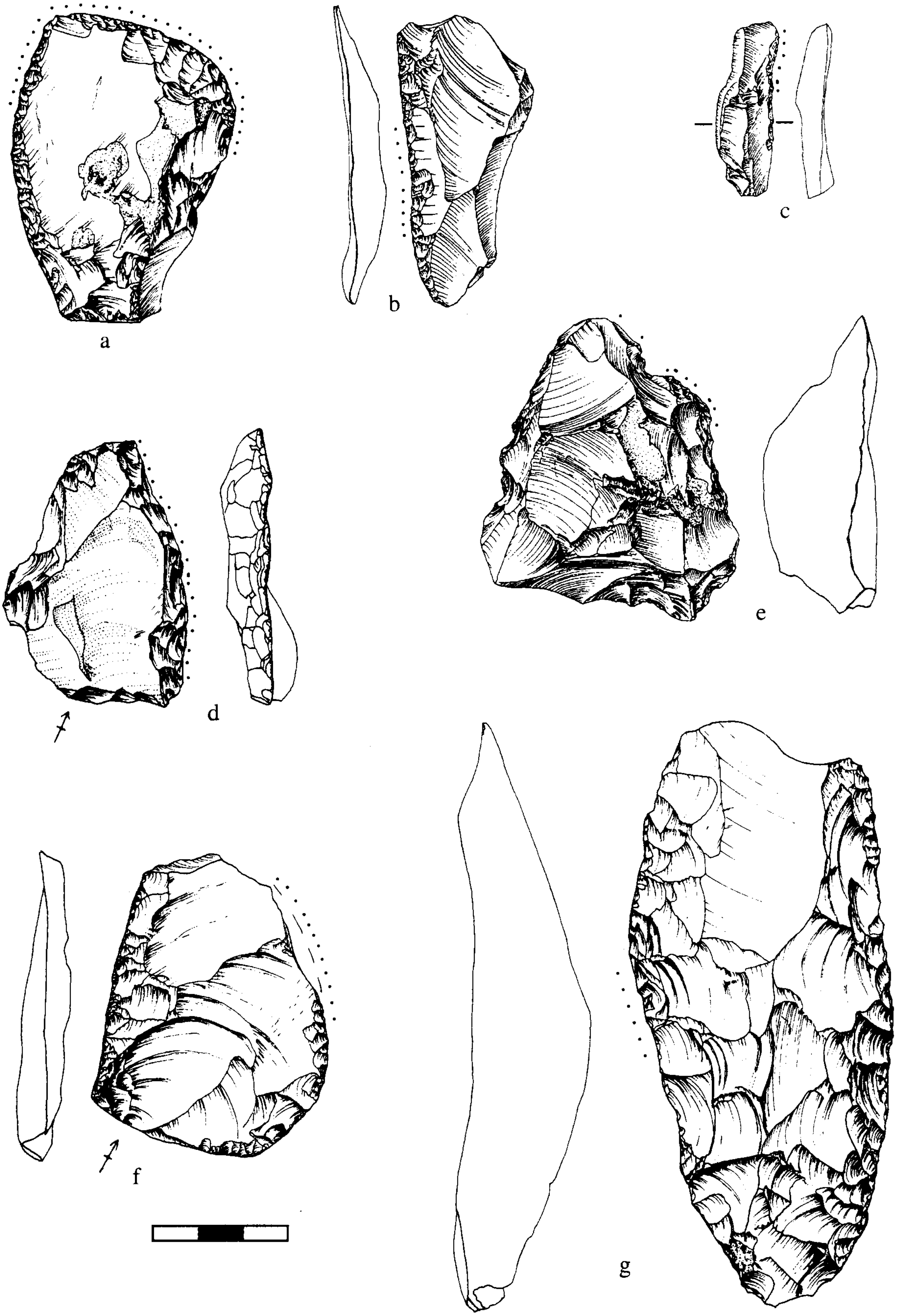

Fig. 8-8—Starosele, functional types, Level 1 *(a-d)*, Level 3 *(e)*, and Level 4 *(a,f-g)*: *a*–scraper->knife; *b,c,g*–knives; *d,e,f*–scrapers. Stippling indicates the tool edge; dashes indicate the extent of the haft element.

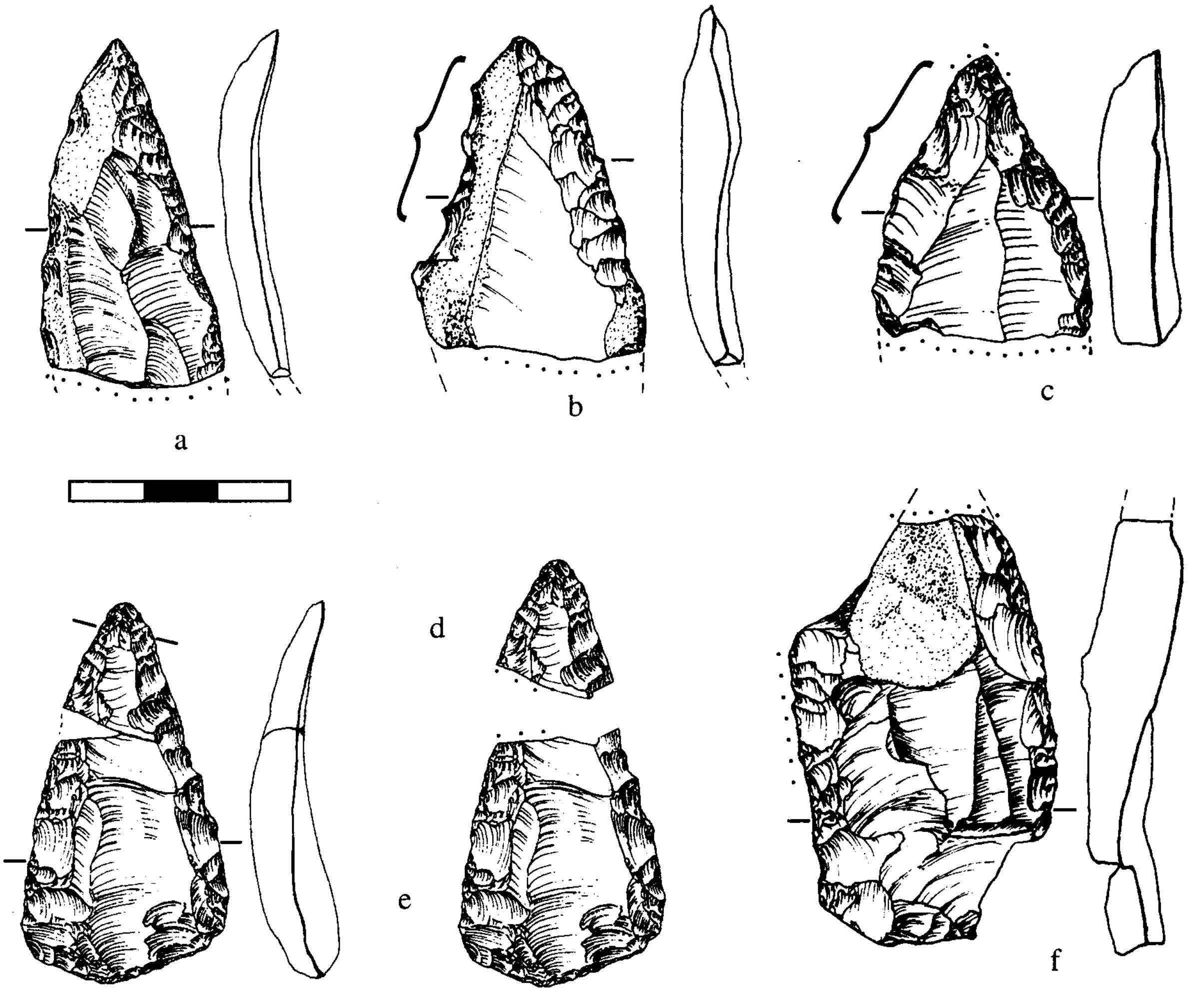

Fig. 8-9—Starosele, functional types, Level 1 *(a-c,e)* and Level 4 *(b,f)*: hafted burins. Stippling indicates the tool edge; dashes indicate the extent of the haft element; brackets indicate portion of tool that was hafted.

Form and Function

How does tool function compare to form? At times, it matches well, but at other times, it does not even come close. On one level, the pieces with edges used as burins were never recognized as burins, per se, but when the form of the working edge is considered, all functional burins have very similar working edges. In this case, however, the working edge is so small, relative to the whole piece—and is often the result of a break or snap—that morphologically, the piece tends to be dominated by other attributes. This is seen very clearly in that the functional burins were typed morphologically as scrapers, points, denticulates, and bifacial foliates (Table 8-4).

Morphological scrapers are a different problem. Of the 51 scrapers studied from all levels, 11 showed no use. Of the remainder, 17 (42.5%) were used for scraping or a combination of scraping and cutting, only 7 (17.5%) were used only for cutting, while 5 (12.5%) were used for both penetration and cutting (functional points). The remaining 11 (27.5%) exhibited other uses, quite apart from what their morphology might predict. Thus, while there is some positive link between the implied function of the nomenclature and actual function, it is not

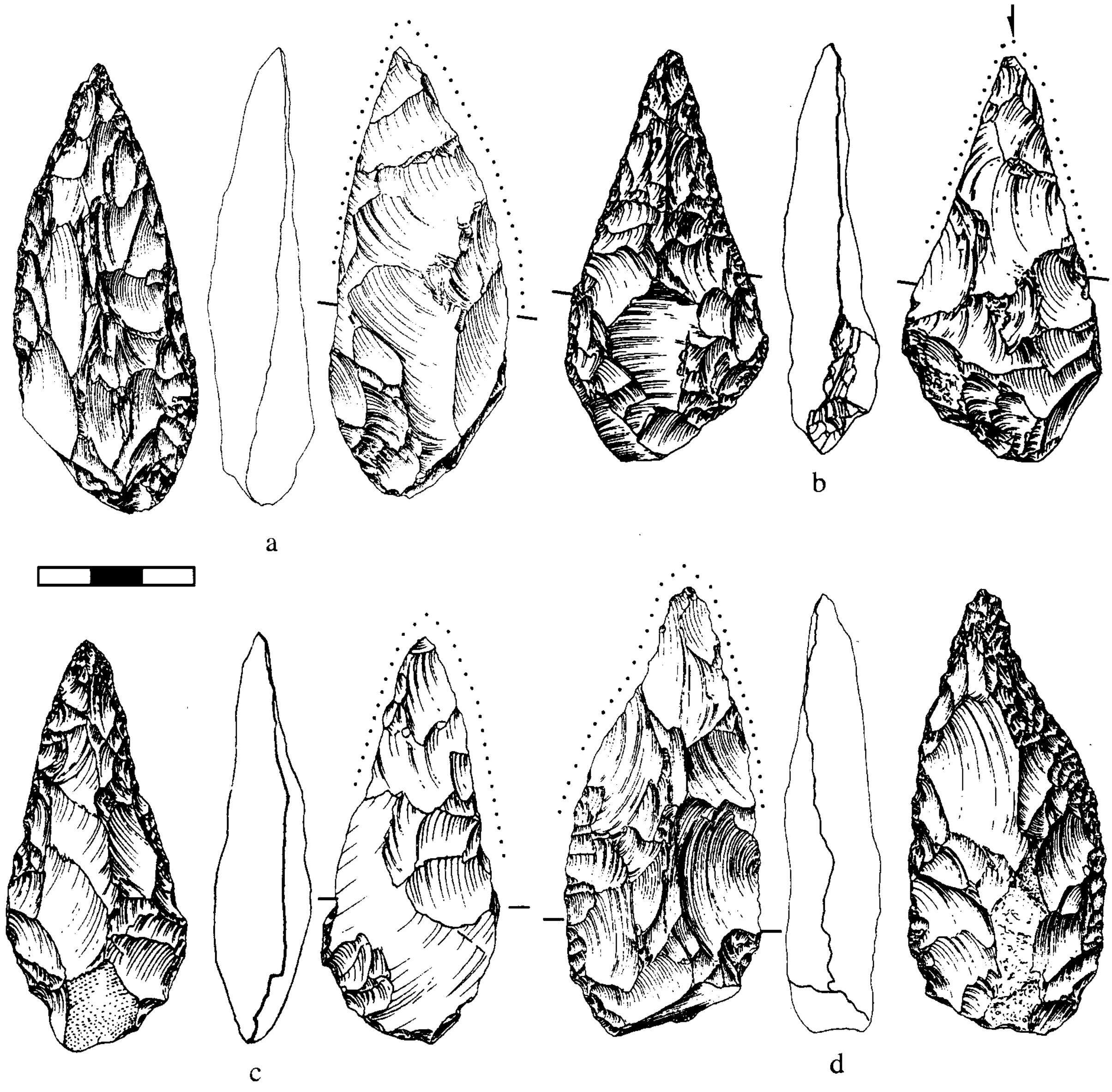

Fig. 8-10—Starosele, functional types, Level 1: bifacial points. Stippling indicates the tool edge; dashes indicate the extent of the haft element.

even 50%. If, however, cutting and scraping are combined, since they often are interrelated motions, then over 70% of the morphological scrapers might be considered correctly identified.

Morphological points, not surprisingly, are somewhat better correlated with actual function than the scrapers. Of the morphological points with wear-traces, a full 50% shows penetration as the initial use. It is important, however, to realize that almost all of these were further used for cutting; this is also true for the bifacial foliates. Thus, a functional distinction between a "projectile" and a knife may not be meaningful in this context. It is hardly likely that the high level of combined use is a coincidence. Rather, it appears that such dual use was a normal, habitual pattern in the Middle Paleolithic at Starosele.

It is the other morphological tool types that suggest a wide range of actual use, relative to their morphological class. This is seen very clearly for the denticulates, no more than 37.5% of which were used the same way. While other types have small samples, they too suggest a

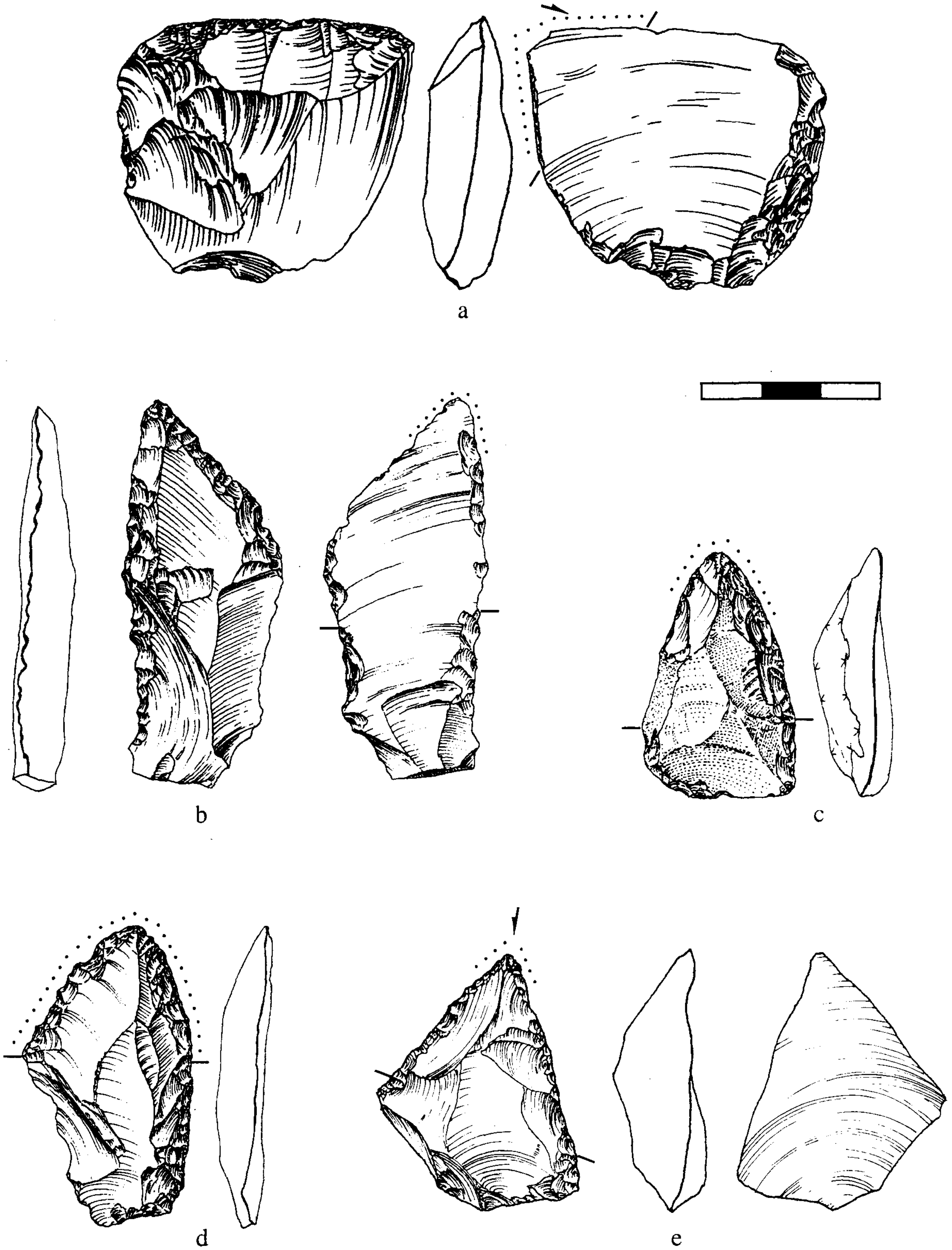

Fig. 8-11—Starosele, functional types, Level 1 *(a)*, Level 3 *(b-d)*, and Level 4 *(e)*: unifacial points. Stippling indicates the tool edge; dashes indicate the extent of the haft element.

wide range of uses. In addition, contrary to morphological typology, not all retouch relates to a tool edge. For instance, a retouched edge of a Level 4 "scraper" was instead apparently an intentional backing for prehension (fig. 8-8a). Opposite is the actual, unretouched tool edge with wear traces indicating hide scraping. In a like manner, virtually all of the retouch on the hafted burins merely facilitated the hafting (fig. 8-9).

Curation

Curated tools (and technology) should have an intrinsically greater worth than ones not curated (Shott 1989). Their recognition may depend as much on cultural systemic context as it does on form. For Starosele, however, it would be difficult to regard any contextual relations as especially noteworthy. Starosele technology also is strictly utilitarian. If there is a difference in intrinsic value, it is one expressed by aspects of manufacture, and use-life. The former is ably covered by Marks and Monigal (1998), as are some details of use-life, especially resharpening of bifacial foliates. From a use-wear perspective, the bifacial foliates also can be readily demonstrated to have had a greater value than the unifacial tools. Greater emphasis was placed in their manufacture and optional maintenance. They had extended use-lives that often ended with the recycling of fragmented pieces.

By definition, stone tools from archeological sites represent a terminal state of use. They were either intentionally discarded or were lost. Intentional discard would imply, on the one hand, spent or exhausted items no longer suitable for either maintenance or recycling; that is, tools at the end of their use-life. Loss, on the other, implies that the tool was still serviceable. There may not be an easy way to distinguish intentional discard from loss; information about the state of tool use-life must be found elsewhere.

Sequential Tool Use

Wear trace use-life evaluations offer complementary and significant new information to that afforded by tool form. For Starosele unifacial tools, they are the prime means to this assessment; for the bifacial foliates, a more exact way. Yet, optional maintenance through resharpening tool edges may result in a loss of critical use-life information. This loss could be the case especially for hand-held tools used on hard contact materials, for which there is a narrow contact zone and no invasive wear traces. In contrast, a hafted tool without evidence of use (a Level 1 unifacial point) would indicate resharpening removed the telltale wear traces from the tool edge, masking a relatively long use-life. Theoretically, a hand-held tool edge could be replaced completely, leaving no evidence of prior use. For Starosele, however, this problem is either not serious, since only a single example is even possibly like this, or it pertains primarily to the 13 artifacts classed as unknowns, plus the four seemingly unused but well made ones. So the problem of optional maintenance confusion can be discounted or isolated to a maximum of 17 artifacts not classed in the use-wear analysis as tools but which were retouched.

For all tools, use-wear information on sequential use and recycling relate to use-life and the question of curation. For analytical purposes, those tools with evidence for resharpening, sequential use, or recycling are classed as curated. This definition, however, includes tools that may have undergone such modifications during a single episode of use, lasting no more than minutes.

COMPARISON OF RESULTS BY LEVEL

In Level 1, all examined tools appear to be formal rather than ad hoc. Of the sixteen hand-held examples, 30% of the cut/scrape tools appear to have been curated, but none of the hafted cut/scrape tools was. The curated, hafted tools include two burins (2 out of 6), of which one is recycled from a broken biface, and three points (3 out of 8). Overall, the percentages of curated unifacial tools for hand-held (18.75%) and hafted (23.5%) are not very different, but favor the hafted tools that relate to different functional groups. A dramatically different percentage exists for the other eight bifacial tools, of which six (75%) had been curated (figs. 8-1h; 8-10).

Maintenance of bifacial tool edges is the key to understanding the bifacial foliates. Conchoidal fracture creates razor sharp edges, even without further retouch. Retouch of any kind changes the geometry of the tool edge, but not necessarily its sharpness. Retouch extends the employed portion of the edge by simply creating more edge per unit length. Equally valuable, it allows for choice in the cross-sectional shape of the tool edge, so that functionally more desirable characteristics can be achieved and maintained through resharpening. The bifacial foliates are specialized tools, although not the only ones at Starosele. Where they differ in concept from the other tools is in their relative maintainability (see Bleed 1989); that is, they appear to have been intentionally designed for a longer use-life than a unifacial tool of similar function.

The Level 2 sample has three tools, all formal and unifacial, of which one was hand-held and two were hafted. Only a point was classified as curated, accounting for 50% of the hafted tools.

Of the thirty-one unifacial tools studied from Level 3, fifteen were hand-held and sixteen hafted. Some could be described as ad hoc, because there is little if any modification of the tool blank beyond what could be accounted for by use alone. The hand-held tools include only one curated item, a cut/scrape tool; none of the hafted ones with similar function were curated. Curated, hafted tools include one (1 of 3) burin and six (85.7%) points (fig. 8-11b-d). Two curated points on unmodified tool blanks are classed as ad hoc, and the remainder has the most minimal of edge preparation. Overall, curated tool percentages for hand-held (6.6%) and hafted (43.75%) differ substantially from the Level 1 unifacial tools, which generally have a more "finished" appearance but are less likely to be curated. The on-site production of tools, the greater diversity of raw material, and some reliance on local flints (Marks and Monigal 1998) all seem consistent with the high proportion of curated tools in Level 3.

Level 4 is similar to Level 2 in having a very small use-wear sample: seven, of which four were hand-held and three were hafted. One hand-held cut/scrape tool (fig. 8-8f) and one hafted burin were classified as curated.

IMPLICATIONS FOR UNDERSTANDING TOOL USE AND ACTIVITIES

With the possible exception of Level 2, for which we simply have too little data, the archeological levels have a nearly identical range of functional tool categories. Because the levels (other than Level 2) express approximately the same range of activities, a discussion of use-wear results for Starosele as a whole is appropriate. Hide working is present, along with the fabrication of wood and bone objects. Of the latter, some must have been handles. The killing and butchering of game is clearly evident, too.

A difference between the levels is most starkly drawn in the curated tools and their implications for understanding activity, in a comparison between Levels 1 and 3. As Marks and Monigal (1998) note, the technologies and their placement within a chaîne opératoire differ significantly. Level 1 exhibits post-production tool importation, tool maintenance, and recycling of secondary tool products. Raw material acquisition was off-site, although exactly how far is unknown (Marks and Monigal 1998). Nevertheless, the artifacts are carefully made and, especially the bifacial foliates, occasionally were curated. Level 3 differs in that, for at least part of the assemblage, all phases of tool manufacture, use, and maintenance are present. Yet, the assemblage is attenuated and haphazard in appearance. There was also a greater reliance on a wider range of flint resources, including some of poor quality locally available flint (Marks and Monigal 1998). The tools include at least some truly expedient ones. Most of the formal tools look not much better and display varying degrees of marginal retouch. Yet, relative to Level 1, there appears to be a much higher rate of tool curation.

CONCLUSIONS

When looking at a record of perhaps more than 40,000 years, it seems unreasonable to trace exact historical connections among Starosele's occupants. Different groups could and actually did solve at least some technological problems in the same, or nearly same, way at Starosele. From the use-wear evidence, it appears that the Level 3 tools parallel choices made before and after at Starosele. In this respect—and in spite of its many unique qualities—Level 3 is similar to the other cultural levels.

Middle Paleolithic studies, mostly in the absence of use-wear analysis, have wildly speculated on the subject of hand-held versus hafted tools (see Chase 1989: 332; Holdaway 1989). Microwear analysis is not just *a* way to evaluate tool hafting, but indeed is *the* preferred way to systematically make these evaluations (Anderson-Gerfaud and Helmer 1987; Beyries 1987a; Mellars 1989: 351; Shea 1988, 1990), because wear traces show general processes of use, prehension, and hafting. The use-wear evaluations at Starosele are especially robust. They are based first and foremost on experimental replicas that assuredly were attached to a handle or foreshaft and others that assuredly were not. The evidence in this study of hand-held and hafted tools is unambiguous and emphatic. Hafted tools are neither unique to Starosele nor did they begin late in its archaeological record. Instead, hafted technologies in Crimea would have had to precede the occupations at Starosele, as their use is consistent and equally well-developed throughout its archeological record. The question now becomes, what are the systematic differences between functional tool categories, some of which were hand-held and others hafted? Hand-held tools were mostly used on medium hard to hard materials (hard wood to bone, and antler) regardless of cultural level. From one cultural level to the next, hafted tools display greater variability in contact materials, but exhibit two maintenance tool clusters—hard contact material tools and soft contact material tools—plus projectile points for killing and butchering game and for defense.

This and the following two chapters are a further step—albeit a modest one—in understanding Middle Paleolithic behavior and decision making. Microscopic evidence of Starosele stone tool use convincingly expresses information about a wide range of technological and behavioral issues that would not otherwise be available. Although vital to this and other analyses, these issues extend beyond tool function and typological comparison. Perhaps foremost among these is the dichotomization of hand-held and hafted tools at Starosele. Evaluation of use-life and the likelihood of tool curation are other significant contributions. Along with the insights of tool function and activity, these lines of information provide a novel, if not unique, opportunity to recognize systematic cultural responses, and some aspects of cognition at Starosele.

Chapter 9

MICROSCOPIC RESIDUE ANALYSIS OF STONE TOOLS FROM THE MIDDLE PALEOLITHIC SITE OF STAROSELE

BRUCE L. HARDY

INTRODUCTION

Prehistoric stone tools offer some of the best potential for reconstructing past human behavior, yet their function is not well understood. Traditional inferences of tool function from ethnographic analogy, and experimental replication and use of tools can do little more than help define the possible range of tool uses. Use-wear analysis can give evidence of use-action (slicing, incising, whittling, scraping, etc.) and relative hardness of the use-material. Microscopic residue analysis, the technique used in the current study, can allow identification of use-action and the specific material on which a tool was used (use-material). This technique relies on microscopic identification of actual traces of the use-material which adhere to the tool surface (Anderson 1980; Anderson-Gerfaud 1981, 1986, 1990; Briuer 1976; Fullagar and Field 1997; Gorski 1997; Hardy 1994; Hardy and Garufi 1998; Hurcombe 1992; Jahren et al. 1997; Loy 1983, 1985, 1986, 1987, 1993; Loy and Nelson 1987; Loy and Wood 1990; Loy and Hardy 1992; Loy et al. 1992; Shafer and Holloway 1979; Sobolik 1996). This chapter will discuss the results of microscopic residue analyses of stone tools from the Middle Paleolithic site of Starosele, Crimea. A portion of these tools was also examined for use-wear traces by a separate investigator (see Chapter 8).

Residues identified microscopically are typically divided into broad categories of plant and animal. Specific identification of plant residues relies on the presence of diagnostic morphological features that can be compared to modern and published materials. Plant residues that have been previously identified on archeological tools include wood fragments, root and tuber remains, starch grains, raphides, phytoliths, and nonspecific plant tissues. Wood fragments are recognized by the presence of diagnostic anatomy including specific vessel elements (e.g., tracheids), pitting, and tyloses. Depending on the anatomical parts visible, wood residues are potentially identifiable to species (Hoadley 1990; Hardy 1994; Hardy and Garufi 1998).

Root and tuber tissues from archeological contexts are typically identifiable to a specific taxon when viewed with a scanning electron microscope (Hather 1993; Mason et al. 1994). However, these starchy storage organs also contain inclusions within their cells which are more readily identifiable, namely starch grains, various calcium oxalate crystals, and phytoliths. Starch grains are visible under light microscopy as highly reflected particles which can be distinguished from sediment particles through examination under cross-polarized light (Banks 1975; Loy et al. 1992). Cross-polarization produces a characteristic extinction cross which resembles a Maltese cross. When one of the polarizing filters is rotated, the arms of the cross rotate. Size and morphology of the grains can sometimes be diagnostic of species of origin (Banks 1975). Starch grains are found in various parts of plants, but are often concentrated in storage organs such as roots or tubers (Fahn 1982). Raphides, needle-like calcium oxalate crystals, and other calcium oxalate druses form in the storage organs of some plants (Fahn 1982) and are sometimes found in association with starch grains on tool surfaces. Phytoliths, commonly used to aid in paleoenvironmental reconstruction, can be used to identify specific plants based on shape (e.g., Pearsall 1989). All of these plant parts have been used to help more specifically identify plant remains found on tool surfaces (Briuer 1976; Shafer and Holloway 1979; Loy et al. 1992; Jahren 1996; Sobolik 1996). While specific diagnostic features described above are not always visible, residues are identifiable as plant based on the appearance of cells and the presence of cell walls. The general term "plant tissue" refers to residues with recognizable cellular structure. Species of origin for these tissues is often unknown, but the presence of other plant materials, such as starch grains and raphides, provides additional evidence as to their possible origin. While specific identification may be difficult or impossible, the identification of residue as plant nonetheless provides valuable archeological information.

Animal residues, including blood, hair, feathers, collagen, bone, and antler, are somewhat less commonly identified on stone tools, at least microscopically. Blood is one of the most frequently identified residues, although it is often detected immunologically (e.g., Newman 1996; but see Eisele 1995 for potential problems). While blood residues can be identified microscopically (Briuer 1976; Hardy 1994; Loy 1993; Loy and Dixon 1998; Loy and Hardy 1992), their morphology varies greatly. Depending on the thickness of the residue, blood stains on stone tools can range in color from clear to yellow to red to black. Typically, the blood residue will appear as thin overlapping plates that get darker as the residue gets thicker with occasional drying cracks similar to cracks formed in drying mud. It is also possible to observe intact red blood cells on some tools (e.g., Loy and Dixon 1998). Overall, however, blood is difficult to recognize since mineral deposits and certain types of sediment can be mistaken for blood residues. Because of this widely varied morphology and the potential to mistake other residues for blood, microscopic identification of blood residues is best strengthened by corroborating evidence such as the presence of animal fibers or the use of a confirmatory chemical technique such as immunology or DNA analysis (e.g., Hardy et al. 1997; Loy and Dixon 1998; Newman 1996).

Animal fibers include hair, feathers, and fragments of bone or antler. Hairs are distinguishable from other fibers by the presence of overlapping scales on the cuticle, the outermost layer of the hair (Brunner and Koman 1974). Scale patterns differ between species and can have diagnostic value, but they vary on different parts of the body and even on different parts of an individual hair (from root to tip). Furthermore, closely related species do not share similar scale patterns, making it difficult to determine higher taxonomic levels, such as Family, without species identification.

The downy barbules of feathers—thin, birefringent fibers under reflected light microscopy—can survive and be detected on stone tool surfaces. The barbules are characterized by nodes and internodes similar in appearance to bamboo stems. Nodes of some feathers have prongs projecting from them, which, together with node shape, can be diagnostic to the Order level (Chandler 1916; Brom 1986).

Bone and antler fragments are sometimes visible as long opaque fibers that are not highly birefringent. More typically, however, bone and antler fragments appear as masses of granular material. Diagnostic anatomy is usually lacking and identification is based primarily on comparison with modern materials (Hardy 1994).

Besides identifying the residues, analysts must attempt to show that the residues are use-related. The best way to do this is to examine the patterning of the residue on the surface of the tool. Residues which are concentrated along one edge or which are smeared back from an edge are likely to be use-related. Experiments with replicated tools on a variety of materials have been used to help establish typical patterns of residues associated with certain tasks and use-actions (Hardy 1994; Hardy and Garufi 1998). Terms for use-actions in this study follow widely accepted categories and include slicing, incising, scraping, planing, whittling, and boring (Hardy and Garufi 1998; Keeley 1980; Mansur-Franchomme 1982; see Table 9-1).

Further confidence that a residue is use-related can be established by comparing residue patterning with the distribution of use-wear. For example, a flake used to cut a groove in a piece of wood (use-action of slicing or incising) will typically have wood tissue confined in a zone along the working edge of the tool that penetrated the wood. This same area will often have striations running parallel to the working edge of the tool in the same area as the residue. How far this zone of residue and wear extends back from the edge of the tool will depend on how deeply the tool penetrated the material. In order to distinguish between slicing and incising, diagnostic wood anatomy would have to be preserved. Slicing involves moving the cutting tool perpendicular to the long-axis of the wood, thereby cutting a cross-section. An incising use-action moves the tool parallel to the long axis of the wood and typically cuts radial sections. If these sections are not visible, or if the wood has been cut obliquely, slicing and incising cannot be distinguished (Hardy and Garufi 1998).

By contrast, a flake used with a whittling motion (similar to using a pocket knife) will have wood residue smeared from the edge at an angle perpendicular or oblique to the tool edge on the surface in contact with the wood. The contact surface of the flake may also be characterized by polish and striations running roughly perpendicular to the working edge (Hardy and Garufi 1998). The upper surface will have more randomly distributed residue near the edge. Although the examples described here involve woodworking, the residue patterning from processing other materials with the same use-action is similar with some variation depending on hardness, duration of use, amount of water present, etc.

By using both use-wear and microscopic residue analysis, we can get a much clearer picture of prehistoric stone tool function. Both of these techniques were performed on a sample of tools from the Middle Paleolithic site of Starosele, Crimea, Ukraine (for use-wear results see Chapter 8), originally excavated between 1952 and 1956 by Alexander Formozov (1954, 1958). New excavations were conducted from 1993 to 1995 as part of the Joint Ukrainian/American Middle Paleolithic of Crimea project (Marks and Chabai 1998; Marks et al. 1997, 1998) which provided the sample for this analysis.

METHODS

A sample of 116 stone artifacts was examined for microscopic residues. All artifacts were placed unwashed in individual plastic bags as they were excavated until the time of analysis in order not to lose any possible residues. The artifacts came from Levels 1-4 and range in age from approximately 40,000-80,000 BP (Marks et al. 1998), with the majority from Level 3, approximately 50,000 BP. Each artifact was examined under reflected light at magnifications of 100 to 500 diameters for the presence of residues related to tool use. The location of residues was recorded on line drawings in order to facilitate recognition of any patterning in residue distribution and to aid in the prediction of use-actions. Residues were photographed and identified morphologically based on comparison with modern and published materials. In addition, sediments immediately surrounding the tool were examined for the presence of residues. If residues were found in the sediment as well as on a tool, they were not considered to be related to tool use. Only when residues were confined to a tool and were not present in the sediment were they interpreted as being use-related (Hardy 1994; Hardy et al. 1997; Hardy and Garufi 1998). Occasionally, residues were removed from the tool surface for examination under a scanning electron microscope to help confirm identification. After residue analysis was complete, 31 of the artifacts were sent to Marvin Kay of the University of Arkansas for thorough use-wear analysis (Chapter 8). The use of two different techniques of functional analysis performed by two independent researchers served to both cross-check the functional interpretations and increase the amount of

TABLE 9-1
Starosele, Use-actions and Residue Patterns

Use-Action	*Edge Morphology*	*Orientation*	*Motion*	*Result*	*Residue Pattern*
slicing/incising	unretouched	edge parallel to direction of movement, tool perpendicular to use-material	uni- or bidirectional	creates vertical cut in material	residue smeared along lines roughly parallel to tool edge; extent of residue varies depending on how deeply the tool penetrates use-material; patterning similar on dorsal and ventral surfaces
whittling	unretouched	working angle usually <60o	pushed or pulled along material	creates oblique cut in material	residue smeared along lines roughly perpendicular to edge on one surface; residue scattered near edge on other surface
planing	retouched	tool edge perpendicular to direction of motion, ventral surface toward material	pushed or pulled along material	retouched edge removes fragments of material	residue smeared along lines roughly perpendicular to tool edge on ventral surface, residue scattered on dorsal surface, often trapped in flake scars
scraping	retouched	same as planing, dorsal surface toward material	pushed or pulled along material	retouched edge removes fragments of material	residue smeared along lines roughly perpendicular to tool edge on dorsal surface with pockets of residue in flake scars; residue scattered on ventral surface confined near edge
boring	pointed, often retouched	point in contact with material	twisting	creates conical hole in material	residue smeared along lines perpendicular to long axis of point and confined near tip; extent of residue depends on how deeply tool penetrates material

functional information obtained (Chapter 10).

RESULTS

Residue Types Observed: Plants

Plant tissue was found on 35% of the tools examined from Starosele and included several different types of tissue. Starch grains were visible both scattered on tool surfaces and within cells of plant tissue adhering to tool surfaces. Although the plants of origin have not been identified, the presence of large numbers of starch grains suggests that they may derive from starchy storage organs such as roots or tubers. Raphides were found in association with some of the starch residues and also lend support to the idea that these residues come from starchy storage organs. Two patterns of residue characterized starch grains on the Starosele tools. In one pattern, starch grains are smeared in lines that form approximately a 60-90° angle with the edge of the tool. This type of patterning is consistent with a whittling (if the edge is unretouched) or scraping/planing (if the edge is retouched) use-action as seen in woodworking experiments (Hardy and Garufi 1998; and see Table 9-1). Applying these use-actions to tubers would suggest that tools were being used to remove cortical tissue. In a second pattern, starch grains and other plant tissues are scattered across both the dorsal and ventral surfaces of a tool but confined to one end or area. Taken together with use-wear observations, this pattern suggests that the starchy material may be related to a binding or mastic used in hafting (see below and Chapter 8).

Further evidence of hafting is found on one tool in the form of a possible mastic (STR95-26). This pointed flake has patches of a highly reflective black substance scattered over the proximal half of its dorsal and ventral surfaces. Morphologically, this substance resembles resin or bitumen observed on hafted tools from a variety of time periods (Collins 1981; Tankersley 1994; Hardy, personal observation), including Middle Paleolithic sites (Boëda et al. 1996). Chemical analysis, such as gas chromatography/mass spectrometry would be necessary to confirm this identification.

Residue Types Observed: Animal

Animal residues occur on 3.5% of the tools from Starosele and include hair fragments and feather barbules. Hair fragments are present on one scraper, one pointed piece, and two chips. The fragments on the scraper and pointed piece have scale patterns visible and therefore may be identifiable to species. However, as mentioned above, the identification of isolated hair fragments is difficult due to variations in scale patterns on different parts of the body and different parts of an individual hair. At present, specific identifications have not been possible although the hairs are not human in origin.

Feathers occur on two tools and have been preliminarily identified to the Order level. Feather fragments on both tools, a scraper (STR95-3) and a point (STR95-6), have heart shaped nodes with no projections and are identified as Order Anseriformes which include swans, geese, and ducks (Brom 1986). The point also has feather barbules with one projecting prong at each node indicative of the Order Falconiformes, raptors (Brom 1986). Although bird bones are present at the site, including partridge (Order Galliformes), choughs, jackdaws (both Order Piciformes), and swifts (Order Apodiformes), Anseriform and Falconiform bones are lacking (Chapter 1). Nevertheless, the feather fragments on the tools suggest that the inhabitants of Starosele were exploiting avian resources.

Results by Tool Type

The broad categories of tool types examined include scrapers, denticulates, points, blades, cores, flakes, and chips (<3 cm). Because typological categories often suggest function by their names (e.g., scrapers) and because tool types are traditionally used to divide up lithic samples, it is useful to examine the residue analysis results by tool type (Table 9-2).

TABLE 9-2
Starosele, Summary of Tool Function by Type and Level

	Residues		*Hafted*	*Use-Action*						
Tool Type	*Plant*	*Animal*		*Scraping*	*Planing*	*Slicing/Incising*	*Whittling*	*Boring*	*Indeterminate*	*Total Examined*
Levels 1, 2										
Scraper	5	1	2	2	1	1	–	–	1	5
Bifacial point	1	–	1	–	–	–	–	–	1	1
Level 3										
Scraper	8	–	3	2	1	–	–	–	9	12
Denticulate	3	1	2	–	1	–	–	–	3	4
Point	1	1	1	–	–	1	–	–	–	1
Core	–	–	–	–	–	1	–	–	–	1
Flake	11	–	1	–	–	2	2	–	11	15
Chip	10	–	–	–	–	–	–	–	71	71
Level 4										
Point	1	–	1	–	–	–	–	–	1	1
Scraper	1	1	1	2	–	–	–	–	2	3

Scrapers

A total of 20 scrapers were examined (Table 9-2). Fourteen (70%) had some form of plant residue, two (10%) had animal residues, and four (20%) had no visible residues. Plant residues consisted of various types of plant tissue, starch grains, and raphides. Animal residues include both hair and feather fragments. Patterning of residues and interpretation of use-actions are illustrated in the following examples.

STR95-16, simple convex sidescraper (fig. 9-1). This artifact has small fragments of plant residue adhering to its surface. Plant cells are cut longitudinally into thin sections, several of which start at the retouched edge and run toward the center of the tool. The thinness of the sections of the plant tissue suggests that it is related to the use of the tool. If the residues were modern contaminants, one would expect to find the outer cortex of the plant tissue or part visible and a thicker fragment with more cell types represented, as in the case of a root growing over a tool. Specific identification of the plant tissue has not been possible, but the patterning on the tool clearly suggests that it was used in either in processing plant material or as part of a haft. Use-wear suggests that the plant tissue is related to a binding or mastic, or perhaps even remains of the haft itself (Chapter 10).

STR95-10, double convex sidescraper (fig. 9-2). This scraper, despite its large size (approximately 13 cm in length) and uniform unifacial retouch, preserves little functional

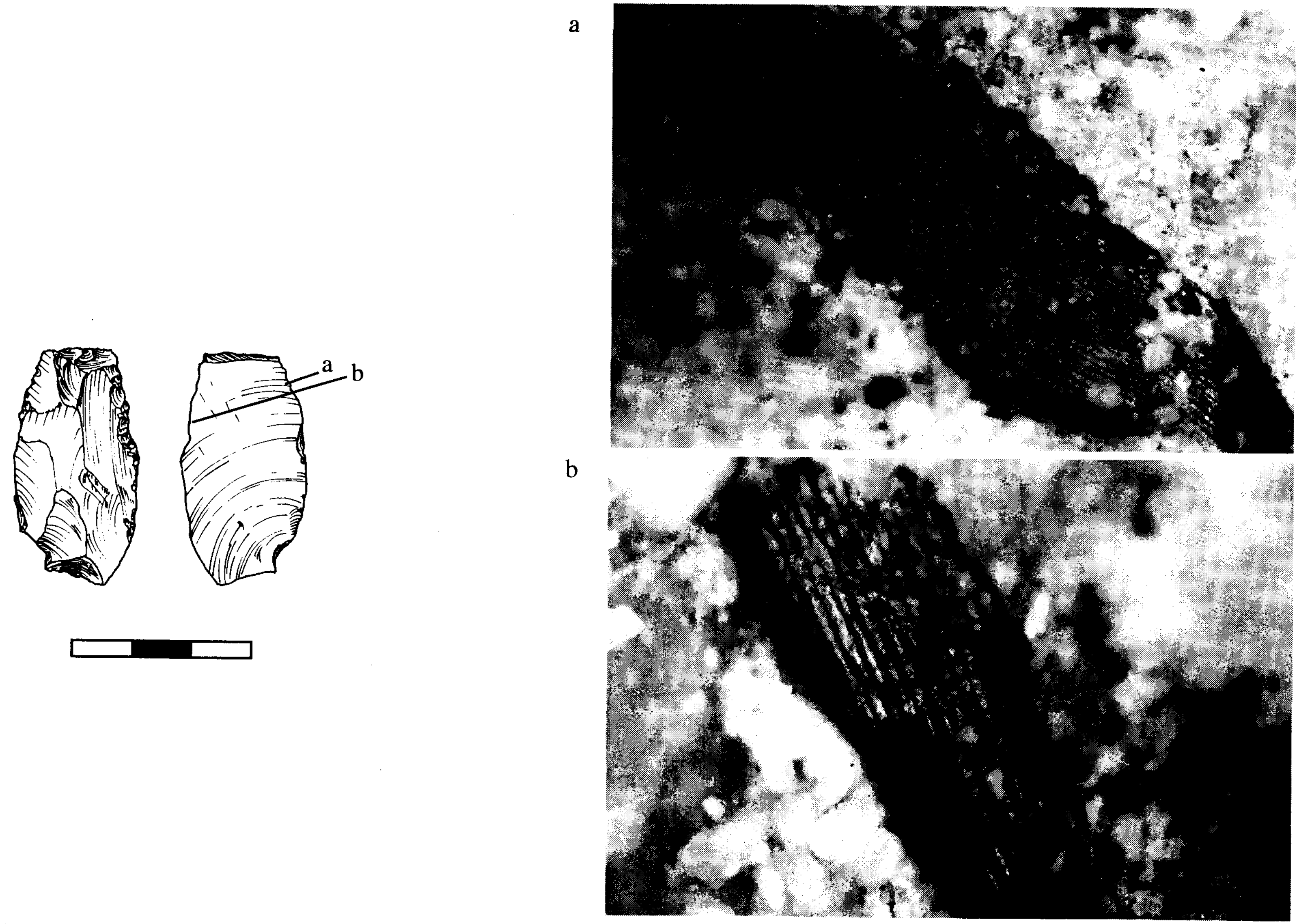

Fig. 9-1—Starosele Level 3 (STR95-16), simple sidescraper: *a*–thin section of plant tissue adhering to edge of tool (original magnification 100x); *b*–another fragment of the same plant tissue (original magnification 200x).

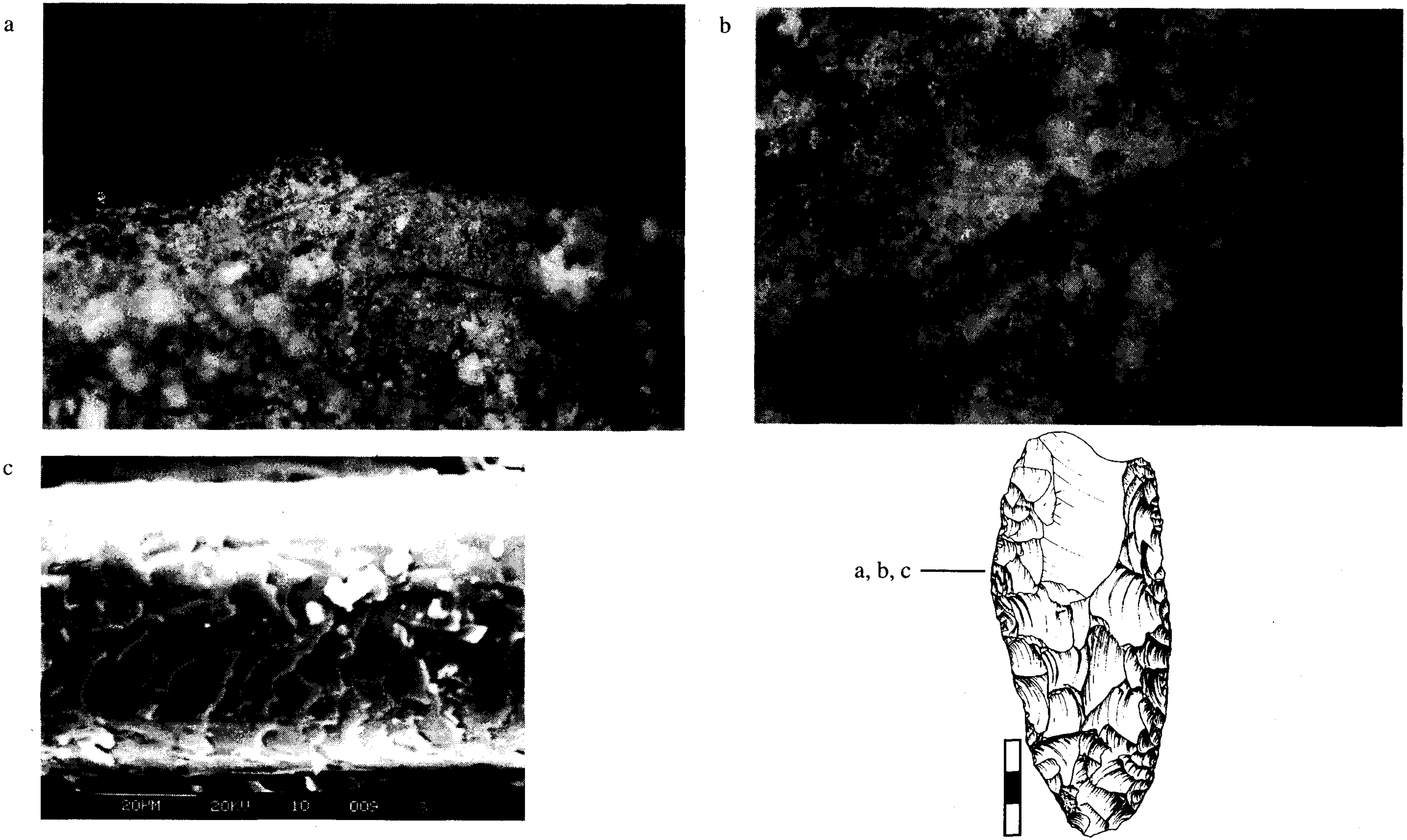

Fig. 9-2—Starosele Level 4 (STR95-10), double convex sidescraper: *a*–hair fragment on tool edge, note that hair is partially trapped under tool matrix (original magnification 50x); *b*–same hair fragment with medulla visible (original magnification 100x); *c*–scanning electron photomicrograph of another hair fragment from the same tool with scales clearly visible.

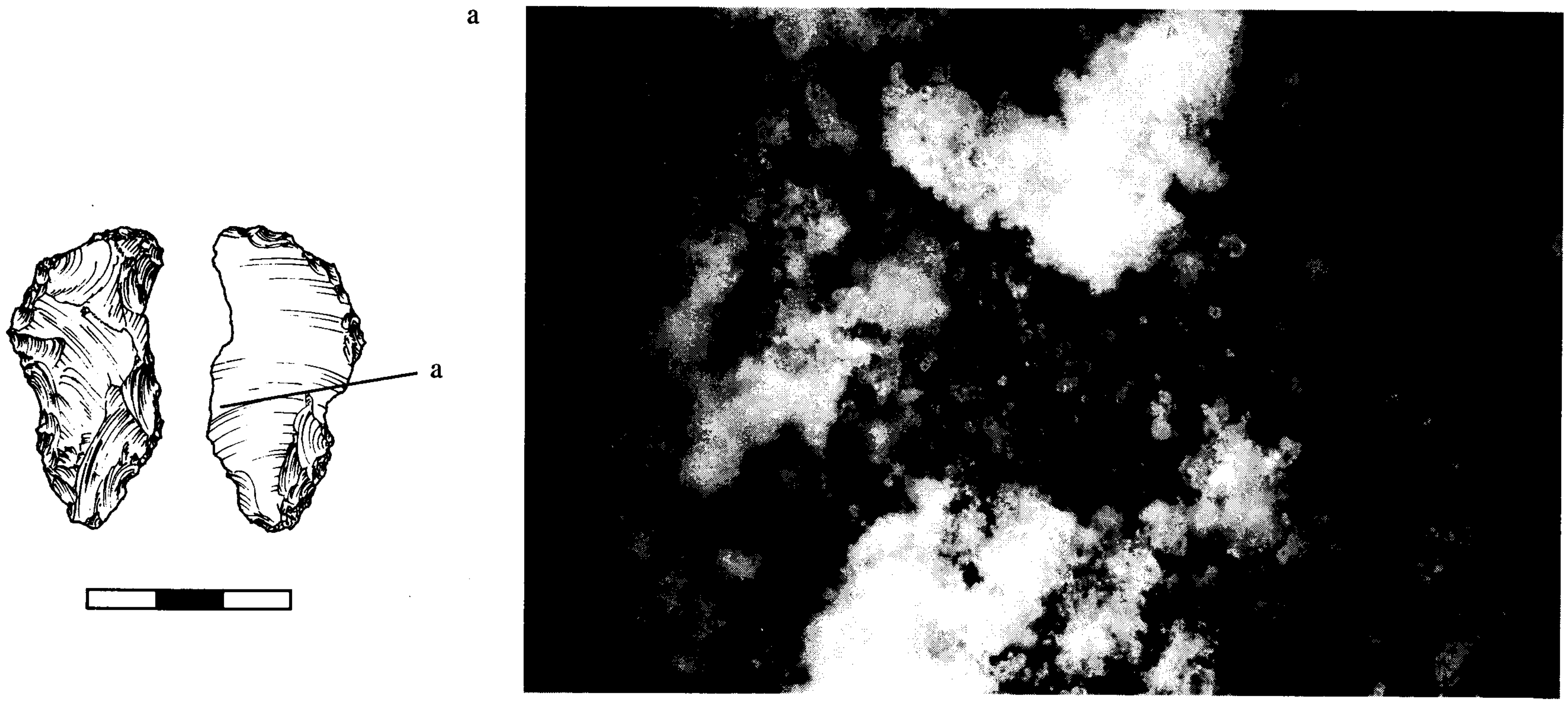

Fig. 9-3—Starosele Level 3 (STR95-23), denticulate: *a*–mass of starch grains viewed under cross-polarized light, note extinction crosses (original magnification 500x).

evidence. The only residues present are several hair fragments which are found on both the dorsal and ventral surfaces on the edge of the tool. The hair is partially trapped underneath the matrix adhering to the tool (fig. 9-2a,b) and has a visible medulla and scale pattern. No other functional evidence is present on the tool except for a few striations that are located in approximately the same area as the hairs (Chapter 8). As mentioned previously, the identification of isolated hair fragments is often difficult due to variations in scale pattern across the body and on different portions of the hair (Brunner and Koman 1974). In an attempt to better discern the scale pattern, one of the hair fragments was removed from the tool and examined with scanning electron microscopy (fig. 9-2c). At present, the exact species has not been identified, although it is possible to rule out humans (the most likely contaminant). The presence of only a few hairs on a tool does not provide good patterning with which to interpret function. Nevertheless, the placement of hair fragments on an edge and on both sides of the tool in the same location suggests that the residue is related to use. It is not possible based on this evidence, however, to attribute a specific task to this tool.

Denticulates

Four denticulates are included in the sample, three of which had plant residues on their surfaces. All three of these had starch grains concentrated in one area. STR95-23, for example, has large amounts of starch along one edge (fig. 9-3) in a pattern similar to that produced by a scraping use-action in modern experiments (Hardy and Garufi 1998). The same pattern appears on another denticulate and suggests that these tools may have been used to scrape a starchy substance, possibly some kind of root or tuber based on the large amount of starch present. Alternatively, the starch may be part of a binding or mastic to aid in hafting (Chapter 10). If this is the case, the denticulate edges may have been under the haft and were not necessarily working edges. Once again, a clearer picture comes when residue and use-wear techniques are combined. Given the use-wear evidence for these tools, the residues are most likely related to hafting. The fourth example (STR95-13), which also appears to have been hafted, has two types of animal residue. One is a degraded hair fragment with a scale pattern visible, while the other is a small fragment of insect exoskeleton (fig. 9-4). Although it would be tempting to conclude that this tool was used in the processing of mammals as well as insects, both residues are isolated and not covered by matrix, making it impossible to confidently attribute them to tool use.

Pointed Pieces

Three artifacts in the sample have convergent retouched edges and could be classified as either points or convergent scrapers. They are referred to here as points based on the combination of residue and use-wear evidence, which suggests that these tools may have been hafted. Residue evidence for hafting comes from two sources: the distribution of starch grains and plant tissue on the proximal one-half to two-thirds of the tool and possible mastic residue on one tool. Two of the pointed pieces have starch and plant tissue concentrated on the proximal portion of the tool in the same area where use-wear (striations) indicates hafting. The third pointed artifact (STR95-26) has an unidentified substance, which morphologically resembles a resinous mastic (fig. 9-5). It, too, is confined to the proximal one-half of the tool. The patterning and appearance of this residue are suggestive of a mastic based on comparisons with experimental and published materials (Boëda et al. 1996). However, this identification remains tentative in the absence of chemical analysis to confirm its origin. In addition to possible hafting residues, one point (STR95-6) also has feather barbule fragments on its tip that appears to be use-related (see Chapter 10 for a full description).

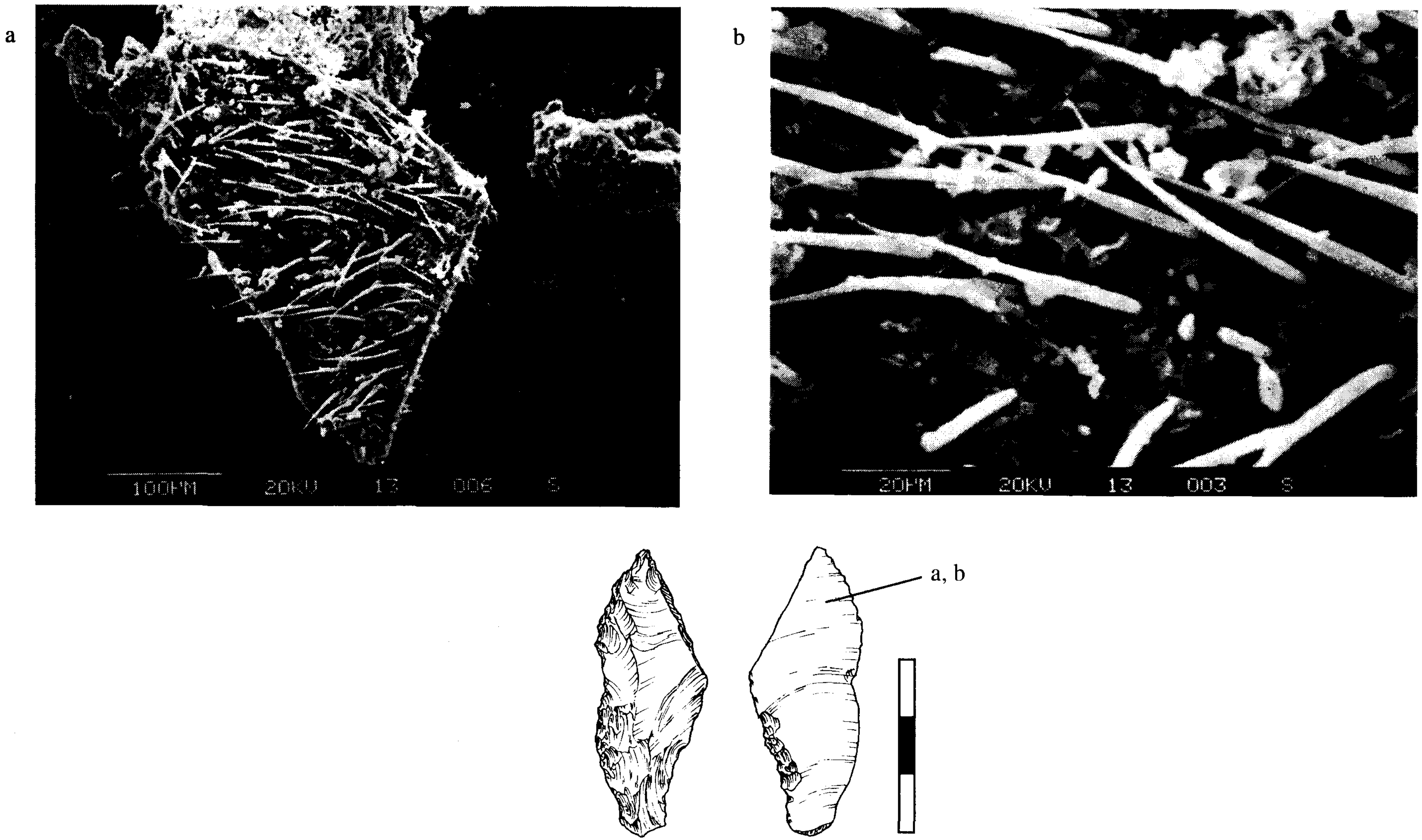

Fig. 9-4—Starosele Level 3 (STR95-13), simple convex sidescraper with inverse retouch: *a*–scanning electron photomicrograph of insect exoskeleton fragment; *b*–same fragment at higher magnification.

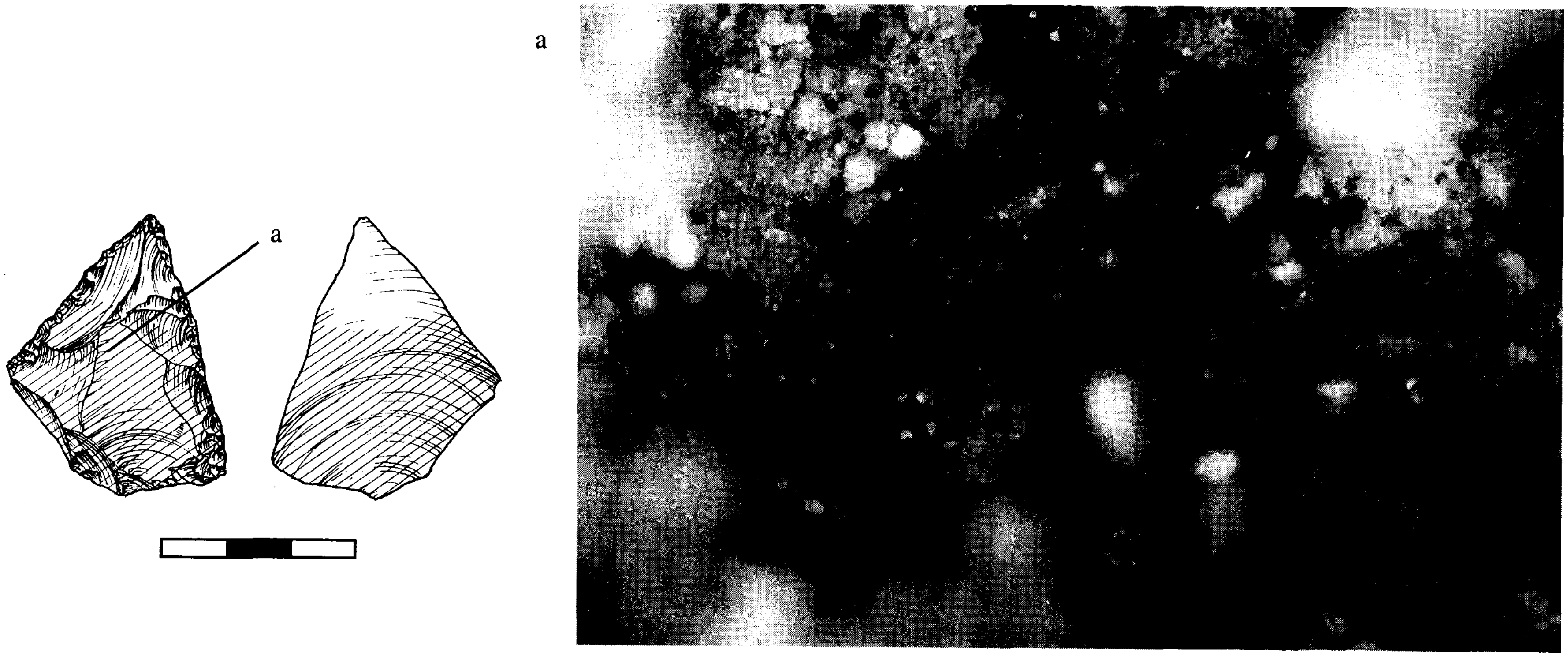

Fig. 9-5—Starosele Level 4 (STR95-26), sub-trapezoidal point: *a*–possible mastic (original magnification 100x).

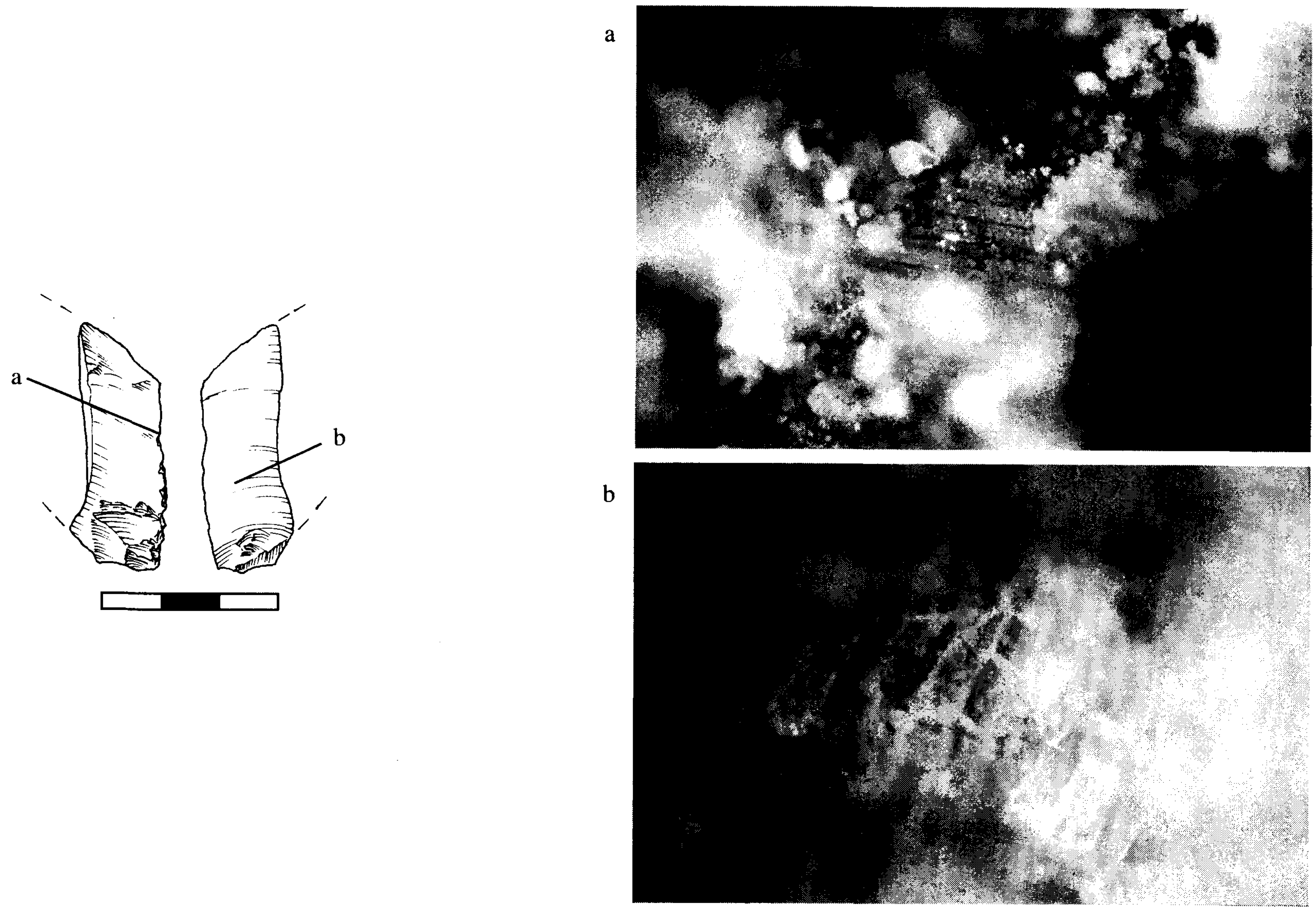

Fig. 9-6—Starosele Level 3 (STR95-27), use-retouched blade: *a*–striations on tool edge, bright particles within striations are starch grains (original magnification 500x); *b*–plant tissue (original magnification 500x).

Core

One unifacial, discoidal core was examined. This core has some scattered, isolated plant fragments with visible cellular structure that do not appear to be patterned. No starch grains or raphides are present.

Retouched Blade

A blade with unifacial retouch along one edge again shows evidence for the processing of starchy plants. Plant tissue and starch grains are smeared back from the retouched edge (fig. 9-6). Their distribution, particularly starch grains located within striations, suggests that the tool was used to scrape a relatively hard starchy substance.

Flakes

A total of 14 unmodified flakes were examined for residues. As with other artifact types, the majority of them show evidence of plant material. Eleven of the fifteen (73.3%) have some type of plant residue, either starch grains or plant tissue. The residue is typically patterned to indicate a slicing type of use-action. A slicing use-action will usually produce residues in lines roughly parallel to the edge of the tool and will often be accompanied by striations, particularly if the use-material is hard. How far the residue extends away from the edge of the tool will depend on how deeply the tool cuts in to the use-material (Hardy and Garufi 1998; and see Table 9-1). No animal residues are present and only one flake has possible hafting evidence.

Chips (<3 cm)

Seventy-one small flakes classified as chips or debitage were included in the residue analysis. The majority of these (61 of 71) did not have any residues. Eight had plant fragments in the form of starch grains or plant tissue and one had an isolated degraded hair fragment. Those chips that do have residues may be flakes from resharpening episodes during the use-life of a tool.

TABLE 9-3
Possible Roots and Tubers Exploited at Starosele

Species	Common name
Pastinaca sativa	(wild parsnip)
Daucus carota	(wild carrot)
Beta vulgaris	(sugar beet)
Raphinus sativa	(fodder radish)
Tragopogon porrifolius	(salsify, oyster plant)
Scorzonerahis panica	(black salsify)
Typha spp.	(cattails)

DISCUSSION

The identification of starch grains, raphides, plant tissue, hair, and feather remains on the stone tools from Starosele provides evidence for exploitation of a wide range of resources. Some of these resources, particularly the plants and birds, are not usually included in discussions of Middle Paleolithic subsistence and economy due to poor recovery technique, previous intellectual biases, and sometimes, preservation problems. The evidence further suggests that many of the tools were hafted, a practice which is still disputed in the Middle Paleolithic.

Plants

The traditional wisdom in archeology is that plant remains only survive under unusual conditions of preservation, particularly when looking at Paleolithic sites. However, the identification of plant remains from Paleolithic contexts is becoming increasingly common as archeologists have realized that plant remains can survive and have modified their recovery techniques accordingly. At Starosele, stone tools were removed from the ground and placed into plastic bags with minimal handling and no washing, thus allowing plant fragments adhering to the tool surfaces to be observed. Microscopic analysis of sediments (e.g., Mason et al. 1994), as well as microscopic examination of artifacts for residues (e.g., Anderson 1980; Anderson-Gerfaud 1981, 1986, 1990; Fullagar and Field 1997; Hardy and Garufi 1998; Loy et al. 1992; Sobolik 1996), have helped to demonstrate that preservation of plant remains may be more common than is typically believed, at least on a microscopic level.

Although the fragmentary nature of the plant residues on tools from Starosele makes specific identification difficult, it is nonetheless possible to discuss the probable origin of these residues based on certain morphological characteristics. As mentioned earlier, starch grains are produced in various parts of plants, but are typically concentrated in starchy storage organs such as roots and tubers (Fahn 1982). The large number of starch grains present on many of the Starosele tools suggests that they may come from starchy storage organs. Were the hominids of Starosele exploiting roots and tubers? If so, was it for consumption or for some other purpose?

The starch grains and associated plant tissues are clearly patterned on many of the tools—either concentrated in one area of a tool or smeared back from one edge. They are found on both retouched and unmodified edges. This type of patterning suggests processing of starchy material either with a whittling, slicing, or scraping motion and may be due to removal of cortex or cutting of the material into smaller pieces. However, some of the patterning is also consistent with the use of a starchy substance as part of a haft. Whether these are indeed food remains or whether they are being exploited for use in hafts, the next question is, can they be identified more specifically? The identification of parenchymous tissue from roots and tubers generally requires examination with a scanning electron microscope (Hather 1992, 1994; Mason et al. 1994). Because examination of the Starosele residues was primarily limited to light microscopy, more specific identification is difficult. However, it is still possible to consider the range of starchy materials that may have been available for exploitation.

Although most of the tools in this study come from Level 3, Levels 1, 2, and 4 are also represented. Starchy residues are found on tools from all four levels. The sample thus spans a time period from approximately 80,000-40,000 BP (Marks et al. 1998) during which the climate varied. Level 4, the oldest level, appears to have been an open steppe-meadow environment, while a cold-steppe phase dominated in Level 3. Levels 2 and 1 appear to have been warmer with steppe regions, a closed canopy, and a nearby meadow zone (Chapter 11). The topographical location of Starosele, in close proximity to a canyon, may have further contributed to local environmental variability with regards to temperature and humidity. All four levels at Starosele show some amount of steppe, often with a mix of other environments. This general type of environment can contain a number of potentially edible roots or tubers from the Family Astraceae/Compositae (Mason et al. 1994), including wild parsnips, wild carrots, sugar beets, salsify, and cattails (Table 9-3). In addition to their potential use as food items, these starchy substances could have been exploited for use as a binding or mastic in hafting.

Not all of the plant tissue on the Starosele tools comes from starchy material. Some of it likely derives from wood, although diagnostic anatomical criteria is lacking. Wood was clearly being exploited in the Middle Paleolithic (Anderson-Gerfaud 1981, 1986, 1990; Beyries 1987b, 1988) and even as far back as 400,000 years ago (Thieme 1997). While it is not possible to recreate the exact uses of wood at Starosele, some tools have traces of wood from hafting.

Animals

Animal residues are comparatively rare on the tools examined from Starosele. It is clear from the zooarcheological analysis (Chapter 1) that stone tools were being used in the processing of animals. The presence of cutmarks and percussion damage on bone is corroborated by the presence of hair on 3 tools. Hairs on STR95-10 (fig. 9-2) are trapped under the matrix adhering to the tool surface and are found on the tool edge. This location supports the interpretation that the hair is related to tool use, but does not provide sufficient information to accurately interpret the use-action of this tool. The morphology of the edge, unifacially retouched, suggests that a scraping or planing motion is more likely than a cutting motion.

The utilization of bird resources is evidenced by feather barbules on 2 tools from Starosele. Avian resources are not often included in discussions of hominid subsistence despite the fact that bird bones are often present at sites (e.g., Eastham 1989). The identification of feathers through residue analysis suggests that hominids were exploiting birds although the exact nature of that exploitation remains speculative. The presence of feathers from both predator birds and waterfowl could be due activities unrelated to hominids, but the patterning of the feathers on the tool surfaces argue that these residues are use-related.

Hafting

Evidence for hafting in the Middle Paleolithic is becoming increasingly common. Shea (1988, 1989, 1992, 1998) has suggested that evidence for hafting exists in the Levant in the form of impact fractures on pointed tools. Anderson-Gerfaud (1981, 1986, 1990) and Beyries (1987b, 1988) have both found use-wear evidence for hafting from Mousterian sites in France. Most recently, Boëda et al. (1996) have identified the remains of a mastic (bitumen) from Middle Paleolithic tools from Umm el Tlel in Syria. At Starosele, wear patterning consistent with hafting is visible on a wide variety of tool types (Chapter 8) and the starch and other plant tissues may be related to a binding or mastic, or may represent part of the haft itself. The tools with hafting evidence include scrapers, denticulates, and pointed pieces. The hafting of these tools may have been for increased leverage for plant and animal processing or it may be evidence for use of some tools as thrusting spears or projectiles. Increased leverage and ability to hunt from a distance are both potential advantages of hafting (Brace 1995). In order to understand fully the role of hafting in the subsistence and economy of the hominids of Starosele, the acquisition, manufacture, and curation of hafts must be considered.

Patterns of Tool Use

Although the sample sizes are small, certain trends in tool use are discernible. Among the broad typological categories represented, all are in some way associated with plant processing, either in the form of residues related to tool use or residues related to tool hafts. However, the results also suggest that these typological categories do not represent specialized classes of tool use. Scrapers, denticulates, and flakes all have evidence for both animal and plant processing, suggesting that many tools may have served multiple functions. Scrapers have the largest sample size of any typological category (N=20). Patterned plant residues are present on 70% of the tools, while animal residues are present on only 15%. While this may reflect a predominance of plant processing activities or be an artifact of sample size, it is also possible that animal residues are under-represented at the site due to either differential preservation or difficulty in recognition. This same pattern was also seen at the Middle Paleolithic site of La Quina, France (Hardy 1994; Hardy et al. 1997). Form and function vary. Hafting is also not limited to any one tool category, but seems rather to have been a common practice for most tool types, particularly retouched pieces. Hafting appears to have served multiple functions as well, including facilitation of increased leverage for cutting or scraping activities as well as thrusting or projectile technology. Tools appear to have been used for a variety of tasks from wood and plant processing to possible cutting of meat and bird exploitation. The broad range of tool uses seen at Starosele most likely reflects a similarly broad range of economic and subsistence resources being exploited.

Interpretations of changing patterns of tool use through time are limited since, with the exception of Level 3, sample sizes are small. Level 4, the oldest occupation, which seems to reflect a relatively short human occupation (Chapter 7), has evidence for both plant and animal processing. Level 4 also has evidence of hafting in the form of starch distribution and possible resinous mastic. If this last residue is indeed a resinous mastic, this would represent the earliest evidence to date of this kind of hafting. Level 3 has a much more complex archeological component, including a diverse lithic assemblage and a hearth (Marks and Monigal 1998), and this complexity seems to also be reflected in tool use. Scrapers, denticulates, points, and flakes all show evidence of hafting, some of which may be related to use of tools as thrusting spears or projectiles. The resources exploited with stone tools include mammals, birds, and starchy and woody plants. Several of the tools also show evidence for use on multiple materials with multiple use-actions (see Chapter 10). Levels 1 and 2 probably represent short occupations. The residue sample is small, but includes evidence for hafting, starchy plant processing and bird exploitation.

Evidence for hafting and exploitation of plants is found in all levels at Starosele. Evidence of animal processing is much less common on the lithics, although the faunal remains clearly indicate that this was a major activity at the site (Chapter 1). Despite some variation through time, the overall picture of tool use at Starosele is one of the exploitation of a wide range of resources, both plant and animal.

CONCLUSIONS

Microscopic residue analysis of artifacts from Starosele has allowed the recovery of otherwise undetectable information. The presence of starch and other plant material would not have been noticed with any other analytical technique. Furthermore, the exploitation of avian resources, as suggested by the presence of feather barbule fragments, would traditionally have been given little emphasis. The results of the residue analysis suggest the exploitation of a wide range of resources including mammals, birds, woody plants, and starchy plants (roots or tubers), among others. Furthermore, residues of starchy plant material concentrated in certain areas of some tools supports the use-wear evidence of hafting of a variety of tools at Starosele. When the results of the residue analysis are combined with those from the use-wear analysis, presented in the following chapter, an even more detailed picture of tool use at Starosele emerges.

Appendix, Chapter 9

Starosele, Summary of Residue Results (chips excluded)

Specimen	*Tool Class*	*Residues*	*Hafted*	*Use-action*	*Interpretation*
Levels 1, 2					
STR95- 1	scraper	raphides, starch grains	X	indet.	hafted, unknown use
STR95- 2	scraper	starch grains		scraping	scraping plant
STR95- 3	scraper	plant tissue, raphides, feathers		slicing	slicing plant, processing bird?
STR95- 28	scraper	plant tissue		planing	planing plant
STR95- 30	scraper	raphides, plant tissue	X	scraping	hafted, scraping plant
STR95- 31	bifacial point	raphides	X	indet.	hafted, unknown use
Level 3					
STR95- 4	core	none			unused
STR95- 5	flake	starch grains, plant tissue		whittling	whittling plant
STR95- 6	point	starch grains, raphides, feathers	X	slicing	hafted thrusting/projectile, slicing bird
STR95- 7	flake	nothing			unused
STR95- 8	scraper	nothing			unused
STR95- 9	scraper	nothing			unused
STR95- 11	scraper	plant tissue		scraping	scraping plant
STR95- 12	scraper	nothing			unused
STR95- 13	denticulate	insect, hair		indet.	unknown use
STR95- 14	scraper	plant tissue, starch grains		indet.	processing plant
STR95- 15	scraper	plant tissue, starch grains	X	planing	hafted, planing plant
STR95- 16	scraper	plant tissue	X	indet.	hafted, processing plant
STR95- 17	scraper	plant tissue		indet.	processing plant
STR95- 18	denticulate	plant, starch grains	X	indet.	hafted, denticulate edge under haft
STR95- 19	scraper	plant		indet.	processing plant
STR95- 20	denticulate	plant, starch grains		planing	planing plant
STR95- 22	scraper	nothing			unused
STR95- 23	denticulate	starch grains	X	indet.	hafted, unknown use
STR95- 24	scraper	starch grains	X	indet.	hafted, plant processing on tip
STR95- 27	scraper	plant tissue, starch grains		scraping	scraping plant
STR95- 00-2	flake	starch grains		slicing	slicing plant
STR95- 00-3	flake	hair		indet.	unknown use
STR95- 00-4	flake	plant tissue, starch grains		indet.	processing plant
STR95- 00-5	flake	starch grains	X	indet.	hafted, unknown use
STR95- 00-6	flake	starch grains		indet.	unknown use
STR95- 00-7	flake	nothing			unused
STR95- 00-8	flake	starch grains		indet.	unknown use
STR95- 00-9	flake	nothing			unused
STR95- 00-10	flake	nothing			unused
STR95- 00-11	flake	plant tissue, starch grains		whittling	whittling plant
STR95- 00-12	flake	starch grains		indet.	unknown use
STR95- 00-13	flake	nothing			unused
STR95- 00-14	flake	starch grains		indet.	unknown use
STR95- 00-15	flake	plant tissue, starch grains		slicing	slicing plant
STR95- 00-19	flake	nothing			unused
STR95- 00-21	flake	starch grains		indet.	unknown use
STR95- 00-30	flake	plant tissue		indet.	unknown use
STR95- 00-59	flake	plant tissue		indet.	unknown use
STR95- 00-66	flake	nothing			unused
Level 4					
STR95- 10	scraper	hair		indet.	processing mammals?
STR95- 21	scraper	starch grains	X	scraping	hafted, scraping plant
STR95- 25	scraper	starch grains		scraping	scraping plant
STR95- 26	point	possible mastic	X	indet.	hafted, unknown use

Chapter 10

STONE TOOL FUNCTION AT STAROSELE: COMBINING RESIDUE AND USE-WEAR EVIDENCE

BRUCE L. HARDY and MARVIN KAY

INTRODUCTION

The recent history of paleoanthropological research into the Middle Paleolithic has been shaped by the debate over the origins of modern humans and the place of Neanderthals in human phylogeny (e.g., Kuhn 1995; Lieberman and Shea 1994; Marean 1998; Mellars 1996; Shea 1998; Stiner 1994), and Neanderthal behavior (Binford 1981, 1984, 1985; Cachel 1997; Chase 1986, 1989; Grayson and Delpech 1994; Klein 1995; Marean 1998; Marean and Kim 1998; Mellars 1996). In the context of this debate, investigations into the behavior of Middle Paleolithic hominids have usually focused on identifying differences in their behavior in contrast to anatomically modern humans (Binford 1981, 1984, 1985; Cachel 1997; Chase 1986, 1989; Grayson and Delpech 1994; Klein 1995; Marean 1998; Marean and Kim 1998; Mellars 1996). A common theme of many avenues of research is to explain the transition to "modern human behavior" (Marean 1998). Underlying this approach is an assumption that Middle Paleolithic hominids had behaviors that were not modern (or less than modern).

Faunal analysis and zooarcheology have contributed the vast majority of information for the reconstruction of Neanderthal subsistence. Neanderthals have been variously portrayed as obligate scavengers (Binford 1981, 1984, 1985) or opportunistic scavengers (Stiner 1991, 1994; Stiner and Kuhn 1992). Others counter and infer Neanderthals were hunters (Chase 1989; Berger and Trinkaus 1995; Geist 1981; Lieberman and Shea 1994; Shea 1988, 1989, 1993, 1998) who engaged in either close-quarter battles (Berger and Trinkaus 1995; Geist 1981) or assisted hunting using stone-tipped spears (e.g., Lieberman and Shea 1994; Shea 1988, 1989, 1993, 1998). With a few notable exceptions (Beyries 1987b, 1988; Anderson 1980; Anderson-Gerfaud 1981, 1986, 1990; Hardy 1994; Shea 1988, 1989, 1993, 1998), these reconstructions are bereft of essential knowledge of how stone tools actually were used, gripped, or attached to a handle.

This chapter offers a methodology of microscopic residue and use-wear analysis for investigating the function of and materials exploited by stone tools. By combining techniques, we have developed a more detailed picture of stone tool function. Use-wear analysis can identify use-action, hafting traces, relative hardness of the contact material, and sometimes, broad categories of contact material. Residue analysis can provide insight into use-action by the patterning of residues on a tool, while also specifically identifying a used material such as plant versus animal, hair, or starch. Furthermore, the independent observations of the two techniques cross-check one another. When they agree, the argument about tool function is stronger, significantly more detailed, and affords a more accurate evaluation of tool use. Although specific to the Middle Paleolithic of Starosele, our research has broader implications for understanding subsistence pursuits and other behaviors of Neanderthals.

SAMPLE

Thirty-one artifacts ranging in age from approximately 40,000-80,000 BP from the 1995 excavation of Starosele were independently assessed (Table 10-1). The majority (20 or 64.5%) are from Level 3. Two (6.45%) are from Level 1. Levels 2 and 4 account, respectively, for four (12.9%) and five (16.12%). Following Marks and Monigal's classification (Marks and Monigal 1998), there are 19 scrapers, five points (one from Level 2 is bifacial), one denticulate, and two each for retouched pieces, cores, and flakes; the breakdown by level is provided in Table 10-1.

TABLE 10-1
Starosele, Formal Tool Classes by Level for Residue and Use-Wear Sample

	Level 1	*Level 2*	*Level 3*	*Level 4*	*Total*
Scrapers	1	3	11	4	19
Points	1	1	2	1	5
Denticulates	–	–	1	–	1
Retouched Pieces	–	–	2	–	2
Cores	–	–	2	–	2
Flakes	–	–	2	–	2
Total	2	4	20	5	31

METHODS

The use-wear and residue methods used by the authors are detailed in the preceding chapters, along with their independent results. At the time of excavation, the artifacts destined for specialized analyses were placed unwashed into individual plastic bags and were sent for residue analysis. Hardy performed light reflected microscopy at magnifications ranging from 100-500x to identify use-related residues and occasionally removed residues for further examination using scanning electron microscopy. Once the residue analysis was complete, the artifacts were forwarded to Kay, who cleaned then analyzed them using a differential-interference binocular microscope with polarized light Nomarski optics at magnification ranges of 100 to 400 diameters. Hardy and Kay were neither aware of the other's methodology, nor did they discuss any of the results until both sets of analyses were finished. Use-wear and residue observations were recorded on plan drawings (Hardy) or photographs (Kay) of the artifacts. This method of recording allowed direct comparisons of the relative positions of functional evidence (e.g., fig. 10-1) and was used to arrive at a final interpretation of tool function. For recognition of prehension or of hafting, the use-wear evidence took priority.

RESULTS

The separate results of use-wear and residue analyses for the 31 artifacts considered here are reported in Chapters 8 and 9. However, comparing the use-wear and residue evidence for each tool provides a more complete picture of tool use. A large percentage (80.6%) of the artifacts had both types of functional evidence and the distribution of this evidence was compared to ascertain how much the two studies agreed. Tools compared this way fell into one of four categories:

complete agreement—both types of traces had the same overall distribution (other than for hard contact materials) or no functional evidence was found at all (26);

consistent—predictably, only use-wear traces indicative of hard material contact were present along a tool edge (1);

new insight—both kinds of traces were present but their distributions only partly overlapped (2); and,

not applicable—only use-wear evidence was observed (2).

Twenty-six of the thirty-one artifacts (83.9%) were in complete agreement on the trace distribution data. Not all artifacts showed evidence of use. Three Level 3 artifacts (STR95-7, 9, 12; Table 10-2) had neither residues nor use-wear. The remainder had consistent residue and use-wear evidence and were either hand-held (8/31, or 25.8%) or hafted (15/31, or 43.4%). For these tools, the used edge(s) was clearly identified by both residues and use-wear.

Classed as consistent with predictions was a single hafted burin from Level 3 (STR95-22; Table 10-2) used on a medium hard contact material. The tool lacked residues for both the haft element and the tool edge.

Two other artifacts from Level 3 were classed as not applicable because they had no residues. Both were hand-held core tools according to the use-wear evidence. The unifacial discoidal core (STR95-4, Table 10-2) was used on medium hard materials as a scraper plane on its opposing ends; the other, an orthogonal core (STR95-8, Table 10-2), was a cut/scrape tool used on soft to medium hard materials.

The residue and use-wear evidence partly overlapped for the remaining two tools (STR95-3, 26; Table 10-2). For one (STR95-3) the use-wear was classed potentially as pseudo-wear, but it was in exactly the same location with raphides and plant tissue. On the surface opposite this portion of the tool, there were Falconiforme feather barbules, but no use-wear. We both regarded our independent results as inconclusive for this artifact. However, when its residues are compared to the use-wear evidence, a more plausible explanation is apparent. It appears likely this tool was hafted and was used to cut or scrape (i.e., to butcher or process) a raptor. For the other artifact (STR95-26, Chapter 9, fig. 9-5), a clear tool edge was identified by use-wear. At one end of the tool edge and continuing across the ventral surface was a black resin. It is possible, perhaps likely, the resin indicates a hafting mastic. Thus, for these two tools, the combined results afforded new insights that would not have been apparent were our results not compared.

In summary, the comparison of residues and use-wear produced completely comparable results in over 83% of the cases. This percentage is a conservative measure, as the results for two other tools (6.45%) provided complementary information and truly new insights, and a third tool (3.22%) had use-wear which predicted the actual lack of residues. The most conservative estimate of our comparative "success" rate is thus more than 83%; the most optimistic view would place our success rate at over 92% when considering the complementary information that results by combining both approaches.

It is also clear from this comparison that neither technique by itself is fully adequate to address functional information pertaining to all artifacts in the sample. The use-wear analysis fairs somewhat better than that for residues, as wear traces occur on three tools (STR95-4, 8, 22; Table 10-2) for which there are no corresponding residues. For two other specimens (STR95-3, 26; Table 10-2) the use-wear analysis by itself would have seriously overlooked functional evidence afforded only by residues. Given these results, the most satisfactory way to address stone tool function is, not surprisingly, to do both types of study and then compare the information.

TABLE 10-2

Starosele, Residue and Use-Wear Results for Individual Artifacts

Specimen	*Level*	*Tool Class*	*Hafting Evidence (Use Wear and Residue*	*Other Residue*	*Other Use-Wear*	*Interpretation*
STR95-1	1	scraper (point)	prox. ½-striae, starch grains, raphides	none	impact striae	hafted projectile pt., soft to med. hard
STR95-2	2	scraper	prox. ½-striae, microplating	starch grains in lines moving back from edge	striae/microplating along edges	hafted scraper, soft to med. hard starchy plant
STR95-3	2	scraper	none	plant tissue, raphides, feather barbules (Falconiforme)	none	inconclusive
STR95-4	3	discoidal core	none	none	microplating	hand-held, cutting/scraping med. hard
STR95-5	3	flake	none	plant tissue, starch grains	edge damage, microplating, striae	hand-held burin, gouging soft to med. hard plant, cutting on opposite edge
STR95-6	3	semi-leaf point	prox. ⅓- striae, starch grains, plant tissue	feather barbules (Anseriformes, Falconiformes)	impact striae, striae parallel and oblique to edge	hafted multi-use projectile pt./butchery tool
STR95-7	3	flake	none	none	none	unknown
STR95-8	3	orthogonal core	none	none	striae parallel and oblique to edge, invasive cutting along opposite edge	unhafted cutting/scraping soft to med. hard
STR95-9	3	scraper	none	none	none	unknown
STR95-10	4	scraper	none	hair fragments	striae parallel to edge in same spot as hair	unhafted, light cutting/butchery
STR95-11	3	scraper	striae, microplating, recrystallization, desiccation cracks	plant tissue	striae parallel to longitudinal axis, edge rounding	hafted scraper, med. hard plant
STR95-12	3	scraper	none	none	none	unknown
STR95-13	3	scraper	prox. ½- striae, microplating	hair fragment, insect exoskeleton fragment	impact striae, edge rounding along one side near tip	hafted projectile point/knife, soft to med. hard
STR95-14	3	scraper/point	prox. ⅓- striae, microplating, starch grains, plant fibers	none	impact striae	hafted point, soft to med. hard
STR95-15	3	scraper	prox. ¼- striae, microplating, starch grains, plant tissue	2 types of plant tissue on opposite edges	striae parallel to one edge, striae perpendicular and oblique to opposite edge, striae parallel to distal edge with rounding	hafted knife/scraper, cutting/scraping plant, gouging hard material with distal end

STR95-16	3	scraper	none	plant tissue on opposite ends	one edge-complex invasive striae, microplating opposite edge-striae parallel to longitudinal axis crosscut by invasive transverse striae	hand-held invasive cutting tool, soft to med. hard plant
STR95-17	3	scraper	none	plant tissue on one edge	microplating, striae parallel to one edge, edge rounding and striae on opposite edge	unhafted, cutting/scraping, soft to med. hard, plant on one edge
STR95-18	3	scraper	prox. ¾- striae, microplating, plant tissue, starch grains	none	striae parallel to longitudinal axis on distal edge, narrow contact zone	hafted burin, gouging med. to hard
STR95-19	3	scraper	none	plant tissue along edge with wear	striae, multiple orientations	unhafted, cutting/scraping med. hard plant
STR95-20	3	denticulate	none	plant tissue with starch grains *along edge with wear*	microplating, edge damage, narrow contact zone	unhafted, cutting/scraping hard plant
STR95-21	4	scraper	none	starch grains along one edge	striae parallel, transverse and oblique to edge, invasive	hand-held cutting/scraping soft to hard plant
STR95-22	3	scraper	none	none	striae transverse and parallel to longitudinal axis, abrasives	hafted?, burin, med. hard
STR95-23	3	denticulate	prox. ½- striae, microplating, starch grains	none	distal edge, microplating, striae parallel and perpendicular to longitudinal axis	hafted, gouging soft to med. soft
STR95-24	3	point	prox. ⅓- striae, microplating, plant tissue	starch grains along one edge near tip	impact striae, microplating, edge faceting	hafted point, soft to med. hard, starch grains present on one edge
STR95-25	4	scraper	prox. ⅓- striae, starch grains	none	microplating, sequenced striae perpendicular to edge	hafted burin, soft to hard
STR95-26	4	point	prox. ½- black residue (mastic?)	none	striae oblique and transverse, microplating along one edge	hafted?, cutting/scraping med. hard
STR95-27	3	retouched blade	prox. ½- plant tissue, black residue	none	impact striae, cutting striae, edge damage	hafted point, cutting/scraping soft to med. soft
STR95-28	2	scraper	none	plant tissue along edge with wear	striae parallel and oblique to edge, microplating	hand-held, cutting/scraping med. hard *plant*
STR95-29	4	scraper	prox. ⅓- striae transverse and parallel longitudinal axis	scattered plant tissue and raphides	striae parallel to distal edge	hafted burin, soft to med. hard
STR95-30	1	scraper	prox. ½- striae, microplating, plant tissue and raphides	none	microplating, edge rounding	hafted scraper, soft
STR95-31	2	bifacial point	prox. ½- striae parallel and transverse to longitudinal axis, raphides	none	distal 1/3- striae transverse to longitudinal axis, microplating	hafted point, soft to med. hard

RESULTS BY FORMAL CLASSIFICATION

There is a detailed formal typology for the Starosele assemblages (Marks and Monigal 1998), but because this study is concerned with tool function and because sample sizes are relatively small, artifacts were grouped into broad tool classes, including scrapers, points, denticulates, retouched blades, flakes and cores (Table 10-1). For the discussion of results by tool type, we have considered Levels 1-4 as a single sample. Differences based on stratigraphic level will be discussed below.

Scrapers

The sample contained 19 scrapers which were used in a variety of ways ranging from hafted points, to processing plant and animal, to unknown use or were unused. Ten out of 19 (52.63%) have hafting evidence in the form of striae confined to one portion of the tool (Chapter 8). Six of the 10 (60%) have plant tissue, starch grains, or raphides confined to the same area as the use-wear striae suggesting the use of starchy plants as part of a binding or mastic. Two of the hafted pieces are typologically categorized as scrapers but have edges that converge to a point. Impact striae found close to the tips of these artifacts suggest that they were used as hafted points or projectiles. The remaining hafted scrapers were used on materials ranging from soft to hard. Residues suggest that the majority of these materials were plant, but animal residues are present as well (see Chapter 9 for discussion of possible under-representation of animal residues). Hand-held scrapers (9/19, 47.3%) show a similar pattern with materials ranging from soft to hard. Results were inconclusive on 3/19 (15.9%) scrapers. Two of these have no identifiable use-wear or residue traces. The third has both plant tissue and Falconiforme feather barbule fragments (Brom 1986; Chapter 9), but they are insufficiently patterned to suggest a specific use.

In several cases, scrapers appear to have served multiple functions. STR95-15, for example, appears to have been used differently on each of its edges (fig. 10-1). The proximal ¼ of the tool shows striae and microplating consistent with hafting wear (see Kay 1996, 1997, Chapter 8). Starch grains and plant tissue are distributed over approximately the same area and may have been part of a binding or mastic. This hafted tool has three potential working edges. Figure 10-1a-b shows striations oriented roughly perpendicular to one edge and plant tissue located in the same location on the dorsal surface. The wear patterning suggests the edge was used for scraping plant material (Chapter 8; Hardy and Garufi 1998). The opposite edge (fig. 10-1c-d) has striations running parallel to it and a different type of plant tissue in the same location on the dorsal surface. The plant tissue has long rectangular cells, which may come from woody plants, but diagnostic anatomy is lacking to confirm this identification. This edge is interpreted as having been used to slice or cut hard plant material. Finally, the transverse edge at the far end also has use-wear indicating that it was used to gouge a relatively hard material. No residues were found on this edge. Thus, residue and use-wear analyses both support evidence of hafting and use of two edges in different ways. In addition, use-wear also indicates that the distal edge was used.

Other scrapers show a similar convergence of evidence. Artifact STR95-10, for example, is a large double straight sidescraper approximately 10 cm in length. Despite its large size and extensive retouch, it shows little evidence of use. The only use-wear traces are an isolated patch of striations that run roughly parallel to the tool edge. The only residue evidence for function are several hair fragments trapped under the adhering matrix on both the dorsal and ventral surfaces in almost exactly the same location as the use-wear (see Chapter 9, fig. 9-2). The hair fragments alone, despite the fact that they occur on the tool edge, are insufficient evidence of tool function. However, the recognition of use-wear in the

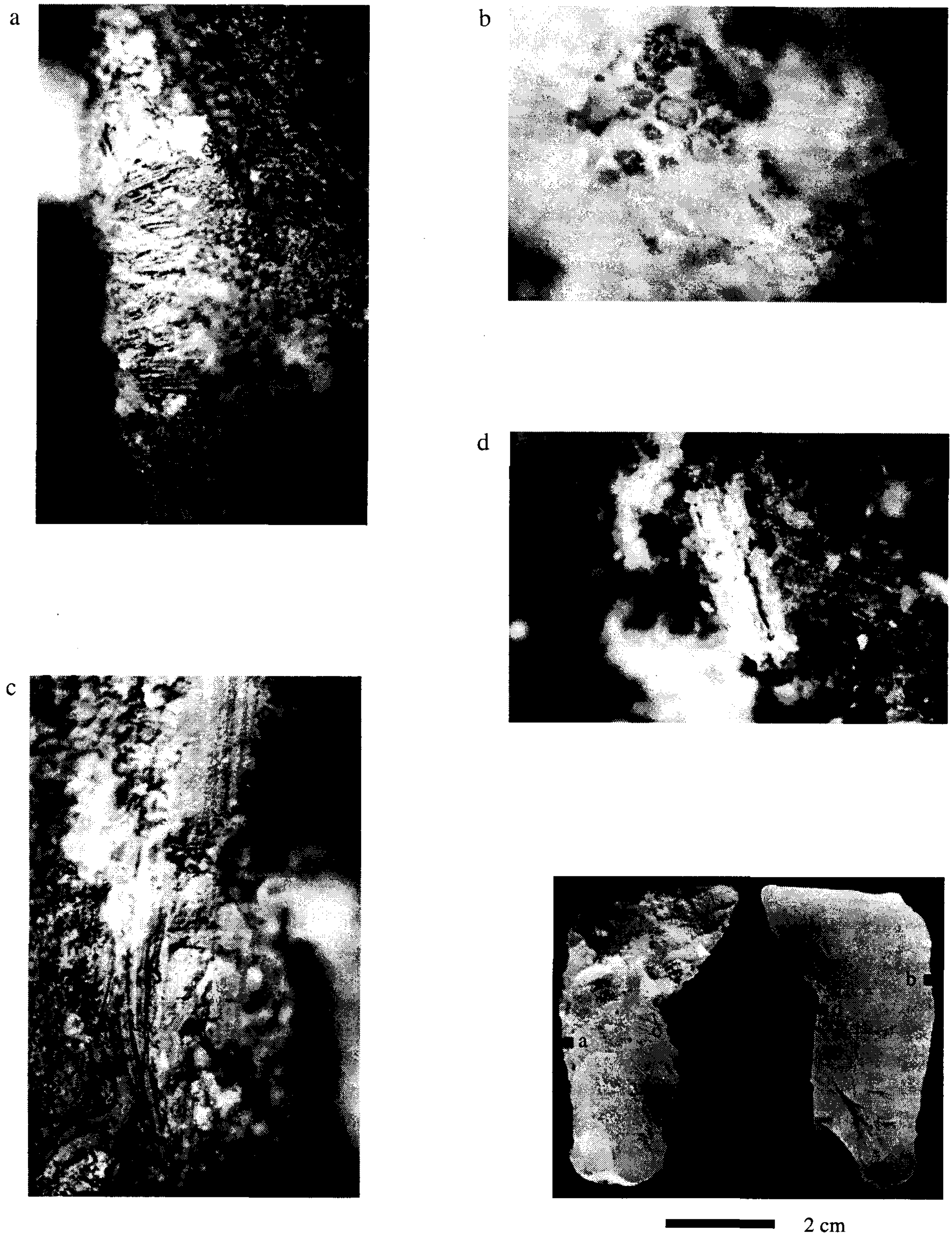

Fig. 10-1—Starosele Level 3 (STR95-15), *a*–striae perpendicular to tool edge (original magnification 400x); *b*–plant tissue in association with striae (original magnification 500x); *c*–striae parallel to tool edge (original magnification 400x); *d*–rectangular plant cells associated with striae (original magnification 100x).

same location suggests that both the hair fragments and the striae are use-related. The nature and orientation of the striae suggest that the tool was used for light cutting of a relatively soft material. The hair residues suggest that this soft material was animal hide or muscle tissue and that the tool was used for light-duty butchery. The hair fragments preserve scale patterns and are potentially identifiable to species (Brunner and Koman 1974). Work is under way to specifically identify the hair fragments (see Chapter 9 for a discussion of the problems involved with identifying isolated hair fragments).

Our results also indicate that typology and presumed working edges are not necessarily accurate predictors of function. STR95-18 is typologically classified was an atypical endscraper on a retouched blade. The retouched edges, almost denticulate in nature, converge at one end. The other end is a snap with subsequent light retouch. The retouched, denticulate-like edges appear to be the most likely working edges. However, approximately 3/4 of the tool surface, all except the snapped edge, exhibits hafting striae and plant tissue fragments with starch grains (fig. 10-2a, b, c). Thus, the most likely working edges appear to have been covered by a haft. The snapped edge, by contrast, shows use-wear consistent with working a relatively hard material (fig. 10-2d).

Thus, scrapers show a variety of different uses, and were both hafted and unhafted. They do not form a coherent functional category, but seem rather to reflect a variety of uses with ad hoc or multiple use of some artifacts. The resources exploited are diverse: ranging from soft to hard material, from starchy plant to hard plant (possibly wood), and including mammalian and avian tissues.

Denticulates

One artifact is classified as a denticulate. This artifact has hafting striae on its proximal half and starch grains distributed across the same area. Use-wear indicates that the distal edge was used on a soft to medium soft material.

Points

Five artifacts are typologically classified as points. All of these have evidence of hafting and may have been used as thrusting or projectile tips. STR95-6, however, served multiple purposes. The proximal third of the artifact has hafting striae and starch grains (fig. 10-3a). The tip has impact striae supporting the interpretation of the use of this tool as a projectile or thrusting point (fig. 10-3b). Furthermore, this artifact has striae running both parallel and oblique to the edge near the tip, suggesting a complex cutting motion on a soft to medium hard material (fig. 10-3c). The area with the cutting striations also has two types of feather barbules identified as coming from Order Anseriformes (geese, ducks, swans) and Falconiformes (raptors) (fig. 10-3d). This tool shows evidence of use as a hafted thrusting or projectile point followed by cutting of a soft to medium hard material, possibly avian feathers or muscle tissue. Once again, the use-wear and residue evidence are complementary and allow for a refinement of the functional interpretation.

Cores

Two cores were analyzed, one discoidal and one orthogonal. Both have use-wear suggesting use on soft to medium hard material. There are no residues present and no evidence for hafting.

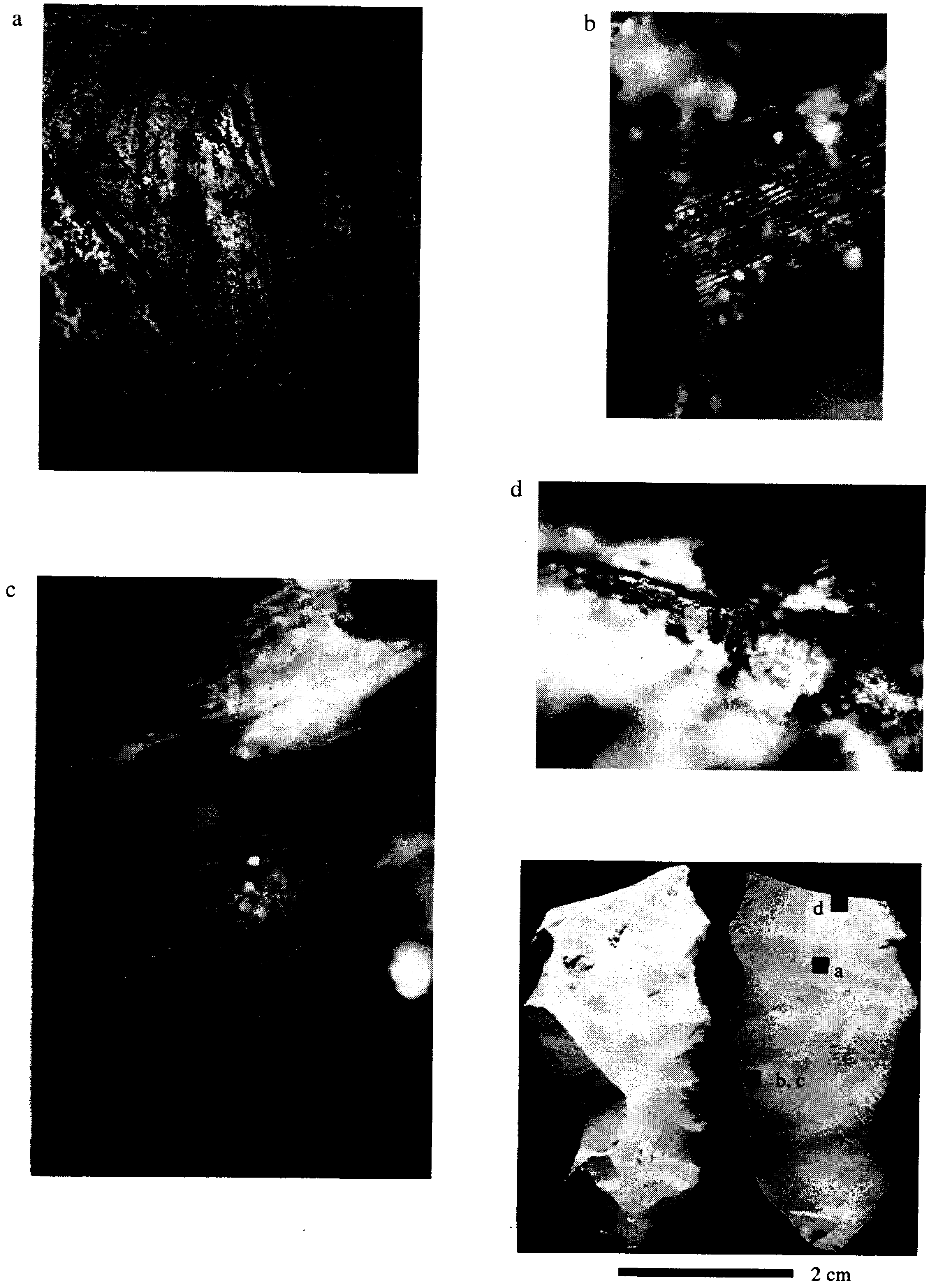

Fig. 10-2—Starosele Level 3 (STR95-18), *a*–hafting striae (original magnification 200x); *b*–plant tissue (original magnification 100x); *c*–higher magnification of (b) showing starch grain within plant tissue (original magnification 500x); *d*–wear along snapped edge (original magnification 400x).

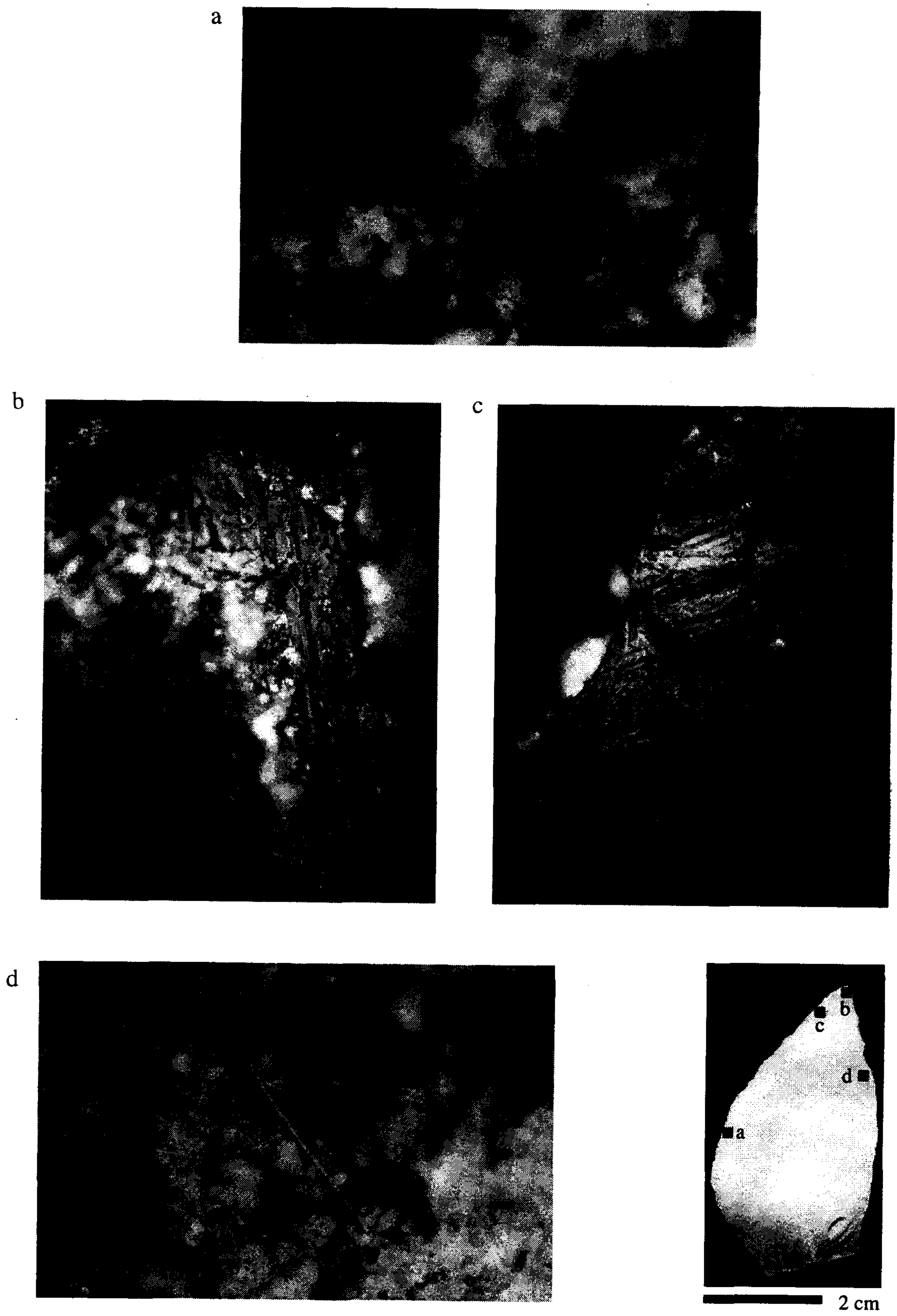

Fig. 10-3—Starosele Level 3 (STR95-6), *a*–starch grains associated with haft (original magnification 500x), *b*–impact striae (original magnification 400x), *c*–complex series of striae from cutting (original magnification 400x), *d*–feather barbule fragment (original magnification 100x).

Flakes

Of the two unmodified flakes examined, one appears to be unused. The other has edge damage, microplating, and striae associated with plant tissue and starch grains. This edge may have been used as a burin to gouge soft to medium hard plant.

Retouched pieces

Two artifacts are categorized as retouched pieces. The proximal half of one artifact has plant tissue and an amorphous black substance that may be a resin used in hafting. The opposite end has impact and cutting striae suggesting that it was used as both a projectile or thrusting point as well as a cutting tool (Chapter 9, fig. 9-6). The other retouched piece was unhafted and used to cut or scrape hard plant material, as evidenced by plant tissues and use-wear.

Results by Level

The sample sizes for each level, with the exception of Level 3 (N=20), are very small (Level 1, N=2; Level 2, N=4; Level 4, N=5), making it difficult to examine tool use trends through time. Nevertheless, some observations are possible based on the presence of certain types of evidence. Hafting, for example, is found in all four levels. All four levels also have evidence for plant exploitation, either for use in hafting or being processed by the working edge of the tool. Levels 2 and 3 have feather barbule fragments suggesting use of avian resources. Hair fragments indicative of mammal exploitation are only found in Level 4, but this is possibly due to differential preservation or recognition (Chapter 9). Projectile or thrusting points are present in all but Level 4 in this sample and Level 4 has evidence for projectile or thrusting points from Kay's use-wear only sample (Chapter 8). More detailed observations of changing tool use through time are described in Kay's use-wear chapter.

DISCUSSION

Contrary to the perception that Middle Paleolithic people focused mainly on meat exploitation, plant residues are common on the tools from Starosele. Carnivory in the Middle Paleolithic is emphasized in the literature for several reasons. First, modern high-latitude foragers are most often used as an ethnographic model for Neanderthal behavior (Cachel 1997). High-latitude foragers are generally heavily reliant on meat because they are inhabit extreme cold climates where plant productivity is limited. Neanderthals would presumably have also been limited in their access to plant resources because they were living in glacial conditions (Cachel 1997). However, plant foods can be found in extreme cold environments on a seasonal or periodic basis (Roebroeks et al. 1992; Cachel 1997). Furthermore, the climates of the late Pleistocene varied extensively and would have witnessed a variety of habitats (Roebroeks et al. 1992). The Neanderthals themselves occupied a range of latitudes from northern Europe to modern-day Israel (Mellars 1996).

The assumption that plant resources were unavailable stems partially from differential preservation of macroscopic plant remains and animal bones. Particularly for early time periods, the accepted wisdom is that plant remains do not survive except under unusual conditions of preservation (Mason et al. 1994). Because of this general belief, plant remains may not be targeted for fine-scale recovery techniques. However, as more researchers look for plant remains, more are being discovered (Mason et al. 1994; Hardy 1994; Hardy and Garufi 1998). The application of microscopic residue analysis of stone tools to Middle

Paleolithic contexts has potential for increasing recovery rates of plant remains and providing another line of evidence for Neanderthal subsistence reconstruction.

At least some of the plant remains on Starosele tools are related to binding or mastic for hafting. Evidence for hafting of tools in the Middle Paleolithic has been found at a number of sites. Shea (1988, 1989, 1993, 1998) has found evidence of hafting in the form of impact fractures on the tips of tools at Kebara, Tabun, Qafzeh, Hayonim, and Tor Faraj. Anderson-Gerfaud (1981, 1986, 1990) and Beyries (1987b, 1988) have reported use-wear evidence of hafting at numerous Mousterian sites in France. Boëda et al. (1996) have recently identified traces of bitumen used as a mastic at Umm el Tlel, Syria. The hafted tools at Starosele include scrapers, denticulates, and points. Scrapers and denticulates have been reported as hafted by both Anderson-Gerfaud (1981, 1986, 1990) and Beyries (1987b, 1988) in the Middle Paleolithic of Europe, while Shea reports hafting of pointed pieces (Levallois flakes and Mousterian points) in the Levantine Mousterian (1988, 1989, 1993, 1998). At Starosele, both of these types of hafting are seen. Scrapers and denticulates are hafted and used for a variety of purposes with the haft presumably providing increased leverage during use (Brace 1995). Pointed pieces appear to have been hafted at Starosele as well. Shea interprets hafted points from the Levant as spear points, either thrusting or projectile. Pointed pieces from Starosele appear to have been used as projectile or thrusting points as well. The presence of thrusting or projectile technology provides several advantages in acquisition of meat. The hominid is removed from some of the danger associated with the capture of large or dangerous prey because of the increased range of the weapon (Shea 1998; Brace 1995). The wounds caused by hafted stone points may also be more severe and thus increase hunting success (Shea 1998). The presence of this type of technology argues against the close-quarters battle technique of hunting suggested by some (Geist 1981; Berger and Trinkaus 1995). In addition to being used as projectile or thrusting armatures, the points from Starosele also have evidence for use as cutting tools.

Boëda et al.'s (1996) report of bitumen on Middle Paleolithic tools suggests that hafting was at least sometimes accomplished with the aid of a mastic. Hafting evidence at Starosele provides further support of the use of mastics or bindings as part of a haft. The starch grains and plant material located in areas of use-wear on the proximal portions of a number of tools are most likely explained as traces of binding or mastic. These two findings suggest that hafting may have involved not only preparation of a handle for the haft, but the collections and preparation of binding and mastic as well. These factors may be important in the reconstruction of subsistence related activities.

Functional analyses of stone tools from Starosele also indicate that a wide range of resources was being exploited, including mammals, birds, and plants (wood, starchy storage organs). Faunal remains at Middle Paleolithic sites are typically dominated by species of large mammals. Small mammals and birds are usually less well-represented, either because they were not as heavily exploited or because their remains do not preserve as well. The recognition of feather fragments on stone tool surfaces provides another method of recovery of avian remains. While it is not possible to say whether the Starosele hominids were capturing birds for food or for some other reason, the recovery of feather fragments from stone tools may serve to encourage researchers to consider the possible significance of avian resources in future reconstructions of subsistence, as some have done in the past (e.g., Eastham 1989).

CONCLUSIONS

While certain finds, such as wooden spears at Lehringen (Movius 1950) and Schöningen (Thieme 1997), clearly indicate that plants were at least occasionally utilized in the Middle

Paleolithic or earlier, plants as an exploitable resource are generally ignored. Authors will often make little more than a passing remark that plants may have been important in Middle Paleolithic subsistence (e.g., Shea 1998; Cachel 1997). This is partially due to the fact that little evidence for plant exploitation exists. The current study provides both a method for recognition of plant exploitation and evidence that plants were being use as Starosele. While much work remains to be done on specific identification of these plant residues (Chapter 9), the evidence thus far suggests the exploitation of both woody plants and starchy storage organs. Although the starchy storage organs appear to have provided material for hafting, they were probably also utilized for food (Mason et al. 1994).

Functional analyses at Starosele, therefore, have provided evidence for behavior and resource exploitation not usually associated with the Middle Paleolithic. Furthermore, the study has implications for interpreting stone tool typologies as they relate to function. Traditional typological categories often have names that imply function (e.g., hand-axe, scraper). Artifact categories are usually divided into a large number of sub-categories (e.g., convex sidescraper, concave sidescraper, double convergent convex sidescraper) resulting in as many as 63 different tool types for the Mousterian, at least in Western Europe (Bordes 1961). It is unlikely, however, that each of these tool types had a discrete function. Functional analysis of stone tools at Starosele suggests multiple use of tools and no clear correlation between typological category and tool function. While we do not wish to suggest that typological categories serve no purpose, the current evidence suggests that they should not be equated with particular functions, at least at Starosele.

Finally, the results obtained from this study would not have been possible without performing both microscopic use-wear and residue analysis. Each of the techniques alone, as presented in the preceding chapters, provides valuable information about stone tool function. However, by combining the two techniques, the results can be cross-checked and greater confidence can be placed on the functional interpretations. Furthermore, the two lines of evidence both augment and complement each other, allowing for more accurate and detailed functional reconstruction. This combination of functional analyses can provide a valuable new line of evidence for reconstruction of Neanderthal subsistence and behavior.

The analysis of stone tools at Starosele allowed the testing of a new combination of techniques. The results exceeded all expectations. A combination of use-wear and residue analysis allowed detailed functional interpretations. The behaviors reflected in these results included hafting of a variety of tool types as well as the exploitation of a wide range of resources, both plant and animal. Our results suggest that the debate over Neanderthal behavior and its difference or similarity with that of anatomically modern humans can greatly benefit from the functional analysis of stone tools.

Chapter 11

WESTERN CRIMEAN MIDDLE PALEOLITHIC PALEOENVIRONMENT AND PALEOECONOMY

VICTOR P. CHABAI, ANTHONY E. MARKS, and KATHERINE MONIGAL

INTRODUCTION

The environmental studies presented in this volume cover a relatively large segment of the Late Pleistocene of Crimea: from the Last Interglacial to the Denekamp Interstadial. These studies may be viewed as the beginning of a large-scale environmental reconstruction of the Crimean Pleistocene, since much more work is still needed. The other research presented in this volume mainly deals with various economic activities of the Middle Paleolithic populations in Crimea. Some of these, the patterning of raw material exploitation, for instance, were discussed in the first volume, as well (Chabai and Marks 1998). Now, because of additional available information on Late Pleistocene environments and subsistence activities, our original views need to be revised and expanded.

The paleoenvironmental reconstructions provided by A. K. Markova, C. Mikhailesku, and N. Gerasimenko add much needed insight to western Crimean landscape evolution over the last 100,000 years and give us better control over chronology, especially where the absolute dates fell short. The faunal studies conducted by A. Burke and M. Patou-Mathis highlight the unique nature of Crimean Middle Paleolithic cultures; while others debate whether Middle Paleolithic subsistence was based on scavenging (e.g., Binford 1981, Stiner 1994), the results presented here offer unequivocal proof not just of hunting, but of highly specialized hunting, at least since the beginning of the Last Glacial. Use-wear and residue analyses presented in Part III of this volume further underscore the vast technological adaptations of the Crimean Middle Paleolithic hominids, who were not completely dependent on animal foods, but used a variety of plant and bird resources as well.

This chapter incorporates the results of previous chapters and attempts a synthesis of the paleoenvironment and paleoeconomy of the western Crimean Middle Paleolithic. Its task is four-fold: the correlation of occupations at Kabazi II, Kabazi V, and Starosele based on absolute dates, malacology, microfauna, and palynology; the reconstruction of the changing environment of these three sites; the patterning of subsistence and animal processing; and the reconstruction of land-use patterns.

CHRONOLOGICAL AND PALEOENVIRONMENTAL CORRELATIONS

Chronological correlations among sites have been an important goal of investigations into the Crimean Middle Paleolithic since the end of the 1940s (e.g., Danilova 1946; Pidoplichko 1952; Cherdyntsev and Meshkov 1952). In recent years, these have been largely limited to using absolute dates from AMS, ESR, and U-Series methods (Hedges et al. 1996; Pettitt 1997; Rink et al. 1998; McKinney 1998). Correlations based solely on absolute dates from Kabazi II, Starosele, and Kabazi V, however, now can be refined with the additional data from the pollen, microfauna, and malacofauna studies reported in this volume. While this is a major improvement, all sites do not have the same range of information. Palynological studies were done for the Kabazi II sequence, only; while pollen samples were taken from the profile at Starosele, it will be some time before they can be studied. There were rich microfaunal remains at Starosele, but no microfauna was preserved at Kabazi II, and only small samples were obtained from Kabazi V. The sediments of Starosele were extremely rich in snails; the snail samples from Kabazi V are very limited. Therefore, the detailed environmental information available for each of the three sites is incomplete. Yet, the sites are fairly close to each other—Kabazi II and Kabazi V are located on the same massif and Starosele is only 20 km away—so that it is reasonable to incorporate data from all three sites in reconstructing the paleoenvironments of this area, and, in doing so, also improve our correlations among sites and their archeological levels (fig. 11-1).

The approach taken here will be chronological, using the extraordinarily complete pollen sequence from Kabazi II (see fig. 6-1 and Table 6-1) as the primary framework. This will be complimented by additional information from microfauna, snails, and absolute dates. While all are not always in agreement, the degree of comparability is striking and, as a result, the strength of the conclusions is enhanced.

Last Interglacial

The Last Interglacial was identified by N. Gerasimenko in pollen zones I through IV in the Kabazi II sequence (Chapter 6). Pollen zones I (a xerothermic optimum) and IV (a hygrothermic optimum) are separated by a relatively cold stage represented by pollen zones II and III. These findings are confirmed by the Kabazi II snail samples from the corresponding deposits in the sequence (sample nos. 614 through 629; no snail samples were available for the deposits comprising pollen zone I). The deposits corresponding to pollen zones II and III contain snails indicative of xeric steppe landscapes, such as *Chondrus bidens*, *Ch. bidens natio pygmaea*, and *Helicella dejecta* (snail sample nos. 626-629 [zone II] and 625-619 [zone III], see Table 5-5). An increase of *Helix lucorum taurica*—a snail found in mesophytic steppes—in the snail samples corresponding to pollen zone III indicates that the environment was becoming progressively more humid and bush-small tree stands were becoming larger. Although the malacological sample for the deposits corresponding to pollen zone IV (sample nos. 614-618) is rather small, it does support the palynological results of a hygrothermic optimum. The samples contain only temperate snail species: *Helix lucorum taurica* and *Helix vulgaris*.

On the whole, the period covered by pollen zones I through IV was characterized by warm and humid conditions, as well as by forested landscapes, fully consistent with the conditions expected during the Last Interglacial. A more precise characterization of the Eem in Crimea is presented in Chapter 6.

Our knowledge of human occupation during the Crimean Last Interglacial is very limited. The lowest archeological horizons at Kabazi II (-930; -980; -1037/-1050; -1080; -1100; -1135/ -1145), all from within a Last Interglacial soil, have not yet been excavated beyond a very small, deep test pit which permitted the recovery of a very few artifacts and pollen samples. Due to the limited excavations in this area, the depositional processes of Unit IV are unknown.

Early Glacial Stadial

According to N. Gerasimenko, the cold and humid conditions of this stadial led to a sharp reduction of broad-leaved trees and an increase of shrub-arboreous formations (Chapter 6). The landscapes at this time were characterized by forest-steppe (pollen zone V). The archeological Level III/3 at Kabazi II Unit III was formed during this time. An ESR/LU date

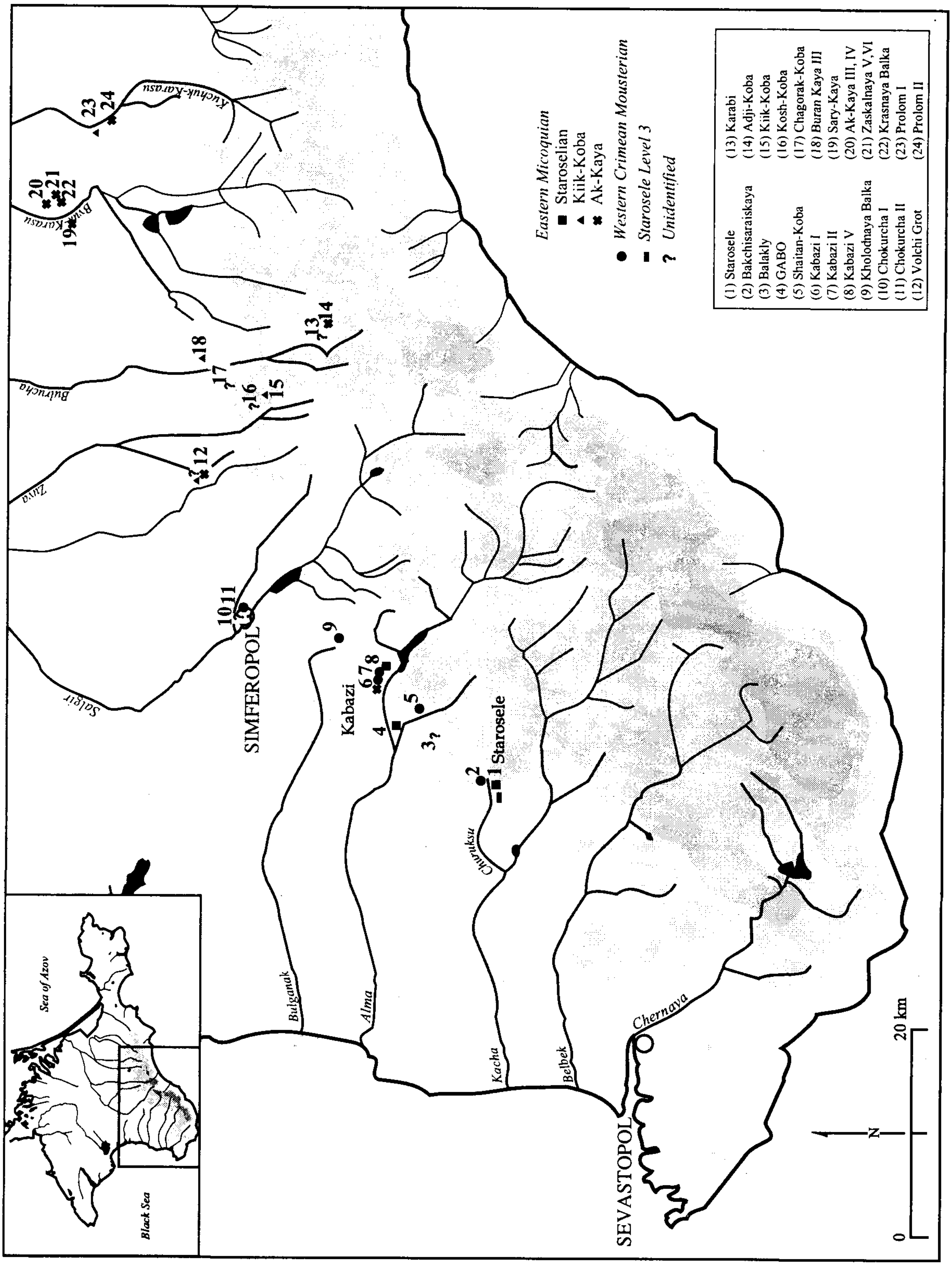

Fig. 11-1—Middle Paleolithic sites and lithic industries of western Crimea

of 69±5 ka from this level (Rink et al. 1998) seems too young for this stadial. In addition, J. Rink proposed two variants of the Level III/3 dating: 53±4 or 70±5 ka, but neither appears acceptable, given the pollen data (Table 11-1). The preceding pollen zone IV corresponds without a doubt to interglacial conditions, and is conspicuous in its high content of broad-leaved tree pollen, while the following pollen zone V shows all of the earmarks of stadial conditions. Based on both pollen content and correlations with firmly dated sequences in neighboring regions, it would appear that these two zones represent the Eem Interglacial and the Early Glacial stadial, and we therefore would expect the corresponding archeological levels at Kabazi II to be dated before 100,000 BP.

Early Glacial Interstadials

It is not clear which interstadial or interstadials are defined in the Kabazi-II sequence as pollen zone VI. Taking into account the possible correlation of the Kabazi II and Molodova I sequences (Chapter 6), it is most probable that pollen zone VI corresponds to the Krutitsa Interstadial (Amersfoort + Brörup). On the other hand, there is some discussion whether or not what has been recognized as the Krutitsa in Eastern Europe might comprise both interstadials of the Early Glacial (Amerfoort-Brörup and Odderade) In any case, this pollen zone clearly precedes the beginning of the Pleniglacial (pollen zone VII).

Pollen zone VI is characterized by forest-steppe vegetation of a specific type: broad-leaved and birch formations in combination with meadow grass coenoses. This type of vegetation occurs only during relatively humid and moderate climatic conditions. Malacofauna from Kabazi II Level III/2, within pollen zone VI (sample no. IIIe), indicates conditions more humid and warm than seen in the snail fauna in the immediately succeeding stadial of Levels III/1A-III/1 (sample nos. IIIa-IIId). C. Mikhailesku also describes the snail sample from Starosele Level 4 as corresponding to more humid and colder climatic conditions than prevail today. His conclusion that the malacofauna from Starosele Level 4 dates to the Mikulino (Eem) disagrees with his own interpretation of the climatic conditions that existed during formation of this level (Chapter 5). Unfortunately, these samples from Kabazi II (sample no. IIIe, 16 shells) and Starosele Level 4 (467 shells) are quite different in size and are thereby difficult to correlate with each other. According to Mikhailesku, however, the landscapes near Starosele at this time were more forested than today—a conclusion in good agreement with the pollen data indicating the Early Glacial interstadials. The same kind of agreement is seen in the microfaunal studies, which indicate meadow steppe conditions for the time of the Starosele Level 4 sedimentation (Chapter 4). The large mammal fauna assemblage from Starosele Level 4 exhibits a mixture of woodland (*Cervus sp.*) and steppe (*Equus*, *Saiga tatarica*, Bos/bison) animals, with the latter type dominating (Chapter 1). Finally, Level 4 is situated at the very top of an interglacial soil, which is in secondary position (Marks et al. 1998). From this, it is clear that Level 4 at Starosele formed after the Last Interglacial.

For Kabazi II Level III/2, neither the ESR nor U-series dates correspond to the generally accepted dates for the Early Glacial interstadials. The same is true of Starosele Level 4 as dated by ESR/LU (linear uptake). The ESR/RU (recent uptake) and U-Series dates for Starosele Level 4, however, do correspond to the expected date for the end of the Early Glacial (Table 11-1).

The archeological occupations associated with these Early Glacial interstadials are therefore Kabazi II Level III/2 and Starosele Level 4.

ka BP	Glacial Stage	Vegetation/Climate	Kabazi II				Starosele				Kabazi V		
			Levels	*U-Series*	*ESR*	*AMS*	*Levels*	*U-Series*	*ESR*	*AMS*	*Levels*	*U-Series*	*ESR*
32	Arcy (Denekamp)	forest-steppe; climatic amelioration	horizon -195										
35	Stadial	xerophytic steppe; arid and cold; harsh continental climate	II/1A II/1 II/2 II/3 II/4 II/5	39.8±5	32±6	 31.55±.6 35.1±.85 32.2±.9 33.4±1							
38	Les Cottés	pine forest, shrubs and steppe; inclement continental climate	II/6--II/7 II/7AB II/7C--II/7E		32±2								
42	Hengelo	forest-steppe vegetation, broad-leaved forest (birch) +pine + meadow steppe; moderate climate	II/7F8 II/8C IIA/1		39±3		1 2	 about 60 (?)	>41.2±3.6	41.2±1.8 42.5±3.6			
58	Stadial	pine forest, shrubs and steppe; inclement continental climate	IIA/2 IIA/2-3										
62	Moershoofd	forest-steppe vegetation, broad-leaved forest + meadow steppe, moderate climate	IIA/3-IIA/3B IIA/4					?			II/3 through II/4A; (II/7 ?)		
78 (?)	Stadial	xerophytic steppe, continental climate	IIA/4B III/1A-III/1				3	about 67.5 (?)	42±4.7		III/1; III/1A III/2; III/3	73.3±6	55±4
105	Odderade (?) Brörup Amersfoort	forest-steppe vegetation, broad-leaved (birch) forest + meadow steppe, humid moderate climate	III/2	54±3	61±1 (LU)		4	>80	48±11 (LU) 77±6 (RU)				
118	Stadial	shrub-arboreous formations, cold and humid	III/3		53±4 or 70±5 69±5 (LU)								
	hygrothermic optimum	broad-leaved forests, warm and humid	IV										
	Eem	pine and broad-leaved forests, an increase in humidity	horizon -930										
		pine and broad-leaved forests, cooler and slightly drier	horizons: -980; -1037--1050;										
128	xerothermic optimum	warm hornbeam-oak forests	-1080;1100; -1135--1145										

Table 11-1—Correlation of glacial stages, the Kabazi II pollen sequence, and archeological levels of Kabazi II, Starosele, Kabazi V

Stadial: The Beginning of the Pleniglacial

Pollen zone VII at Kabazi II corresponds to the stadial at the beginning of the Pleniglacial. The vegetation during this stadial was characterized by a drastic depletion of broad-leaved trees and an increase of generally mesic grass coenoses, but with prominent features of xerophytization. The landscape becomes steppic and the climate becomes continental (Chapter 6).

Malacofauna from the same stratigraphic position in the Kabazi II sequence also indicate steppic landscapes (sample nos. IIIa-IIId). The increasing aridity and predominance of steppe landscapes has been noted in the snail and microfaunal samples from Starosele, in the sterile layer between Levels 4 and 3, and in Level 3 (Chapters 4 and 5). The same is true for the snails and microfaunal samples from Kabazi V Unit III. Furthermore, according to A. K. Markova, some microfauna species found in Kabazi V Levels III/3 and III/2, such as the yellow steppe lemming *Eolagurus luteus*, are characteristic of dry steppic, desert, or semi-desert areas (Chapter 4). On the other hand, the faunal analyses note the presence of woodland (*Cervus elaphus*) and forest (*Sus scrofa*) dwelling species both in Starosele Level 3 and Kabazi V Unit III (Chapters 1 and 2). It is the only case when the megafauna indicate the simultaneous presence of woodland, forest, steppe (*Equus*, *Saiga tatarica*), and boreal species (one possible example of *Rangifer sp.* from both Starosele and Kabazi V). Such a mixture of terrains appears to be a characteristic feature of environmental conditions at the beginning of the Pleniglacial.

The U-series dates of 73.3±6 ka (Kabazi V Level III/1) and "about 67.5 ka" (Starosele Level 3) are reasonably consistent with each other (McKinney 1998), as well as with the known beginning of the Pleniglacial (Table 11-1). These dates are not, however, consistent with the ESR dates for Starosele Level 3 and Kabazi V Levels III/1 and III/1A (Rink et al. 1998), which are too late to correspond with the beginning of the Pleniglacial. In addition, the ESR dating for Kabazi V shows an unreasonable hiatus between Levels III/1 and III/1A (Chabai and Marks 1998: 356). According to J. Rink, the best age for Level III/1 is about 26 to 30 ka (Rink et al. 1998: 339). If that date for Kabazi V Level III/1 were accepted, it would mean that Unit III would date to the Denekamp Interstadial and the uppermost levels of Kabazi V Unit II would be at least as young or even younger. Taking into account the climatic characteristics of the Denekamp Interstadial (see below) and the implications for the malacofauna and microfaunal samples from Kabazi II Units II and III, such a correlation is untenable.

The ESR dates for Starosele result in similar problems: Levels 3 and 1 are statistically the same age, about 40 ka (Rink et al. 1998: 331). Should these be correct, we would need to assume that Starosele Levels 1, 2, and 3 date to the Hengelo Interstadial. If this assumption were accepted for Levels 1 and 2 (see below), the microfauna and malacofauna data from Level 3 would not correspond with any of the known interstadials. While it might be possible to correlate Starosele Level 3 with the stadial conditions between Moershoofd and Hengelo, this stadial was characterized by more mesic microfauna and malacofauna than is seen at Starosele Level 3. Thus, it is most likely that Kabazi II Levels III/1 and III/1A, Starosele Level 3, and Kabazi V Levels III/1, III/1A, III/2, and III/3 all fall into the first stadial of the Pleniglacial.

Moershoofd Interstadial

Pollen zone VIII at Kabazi II corresponds to the Moershoofd Interstadial and is characterized by a combination of broad-leaved forests and meadow steppe; in other words, it was a time of forest-steppe landscapes and moderate climatic conditions (Chapter 6). The microfauna from Kabazi V Unit II are characterized by species preferring more favorable conditions than those of Unit III. According to A. K. Markova, the rodents from Kabazi V Unit II were associated with forest-steppe landscapes. The presence in the microfauna assemblage of such species as the yellow-necked mouse (*Apodemus flavicollis*), indicates the growth of broad-leaved forests in the vicinity of the Kabazi cuesta. Moreover, these forests had to contain the yellow-necked mouse's preferred foods of nuts, acorns, and seeds produced by such trees as beech, oak, hazelnut, maple, and lime (Chapter 4). At least three of these five trees (beech, oak, and hazelnut) were found in the pollen spectra of pollen zone VIII (Chapter 6). Consistent with this, Mikhailesku noted the mesophilic character of the malacofauna from Kabazi V Unit II (Chapter 5).

At the same time, in the snail sample from Starosele Level 2, xerophile species predominate, although the number of mesophile species in the level is significantly greater than those in Level 3. C. Mikhailesku also noted the progressive increase in mesophile snails from Level 3 to Level 1 at Starosele. A. K. Markova, using the rodent data, reconstructed the local environment as containing a meadow steppe landscape and a moderate climate. Therefore, both the snails and rodents from Starosele Level 2 indicate a moderate climate, which might be associated with interstadial conditions. In addition, the megafauna at Starosele Level 2 and at Kabazi V Unit II suggests a mixture of woodland (*Cervus sp.*) and steppe (*Equus, Saiga tatarica*) environments. It should be noted that the variety of woodland species is more pronounced in the faunal assemblage of Kabazi V (*Cervus elaphus, Sus scrofa*), than it is at Starosele Level 2, but this may be a factor of small sample size at the latter site.

Two tooth samples from Starosele Level 2 produced U-series ages from 47.5 to 63 ka, with U/Th plots indicating an age of about 60 ka (McKinney 1998: 350). This date corresponds well with the Moershoofd Interstadial (Table 11-1). However, the overlying Level 1 corresponds to the Hengelo Interstadial and there is no visible stratigraphical break, sediments, or fauna between Levels 2 and 1 which might be associated with the stadial that falls between the Moershoofd and Hengelo. In fact, the two levels are separated by a single episode of cliff exfoliation, indicating no significant temporal differences between the two. McKinney (1998) also noted that the 60 ka date may be unreliable because only two teeth were plotted and that further confirmation of it is needed. Thus, the correlation of Starosele Level 2 with the Moershoofd Interstadial is still uncertain. In any case, Starosele Level 2 indicates interstadial conditions: it might be Moershoofd or, more likely, Hengelo.

In sum, Kabazi II Levels IIA/3-IIA/3B and IIA/4, Kabazi V Unit II, and possibly Starosele Level 2, were occupied during the Moershoofd Interstadial (Table 11-1).

Middle Glacial Stadial

Pollen zone IX at Kabazi II appears to correspond to a stadial between the Moershoofd and Hengelo Interstadials (Table 11-1). The deterioration of the climate towards more continental conditions resulted in the contraction of local forest belts and a meadow steppe landscape. While the decline of arboreous and broad-leaved pollen definitely points to stadial conditions, the climate was not as harsh as the previous and following stadials. The climate of this stadial was less harsh than during the preceding and following stadials (Chapter 6). Two levels, IIA/2 and IIA/2-3, at Kabazi II are associated with this stadial. The faunal assemblage from Kabazi II Level IIA/2 consists mainly of steppe species, but the existence of some nearby woodland is attested to by a few bones of *Cervus elaphus* (Chapter 4). Unfortunately, the levels belonging to this stadial are not dated.

Hengelo Interstadial

Pollen zone X at Kabazi II corresponds to the Hengelo Interstadial. The landscapes were covered by a forest-steppe vegetation, consisting of broad-leaved trees and meadow grasses. In addition, pine was an important element in the pollen spectra. A decrease of xerophytes suggests relatively humid conditions and the presence of broad-leaved trees and pine suggests a mild or moderately continental climate (Chapter 6).

The Starosele Level 1 microfauna and malacofauna document increasing humidity, as compared with the lower levels (Chapters 4 and 5). The rodent assemblage from Starosele Level 1 comprises both forest and open landscape species. The former include the yellow-necked mouse *Apodemus flavicollis*, seen in the previous interstadial at Kabazi V Unit II, and is a typical dweller of broad-leaved forests. The common vole *Microtus arvalis obscurus* is prominent in this level; it prefers meadow and steppe biotopes. Overall, the microfauna in Starosele Level 1 suggest climatic warming connected with an interstadial. In spite of the pronounced predominance of steppic megafauna (equids, *Saiga tatarica*, Bos/bison), the faunal assemblages from both Starosele Level 1 and Kabazi II Level II/8 contain some woodland-dwelling animals, such as *Cervus elaphus* (Chapters 1 and 3; Chabai 1998a).

The archeological occupations of Starosele Level 1 and Kabazi II Levels IIA/1, II/8C, and II/7F8 (II/8) correspond to the Hengelo Interstadial. The AMS and ESR dates for these levels do not contradict this proposed correlation (Table 11-1). It is also probable that Starosele Level 2 corresponds to Hengelo, as well (see above: Moershoofd Interstadial).

Les Cottés Interphasial

Pollen zone XI at Kabazi II was recognized as belonging to an interphasial; that is, having conditions transitional between an interstadial and a stadial. The landscapes were characterized by forest-steppe. The forest vegetation consisted mainly of pine trees, with a significant decrease in broad-leaved trees in comparison with Hengelo Interstadial. Thus, the climate was becoming more inclement, although not rigorously so: grass coenoses were mesophytic (Chapter 6). Malacofauna from the corresponding deposits at Kabazi II (sample nos. II and IId) predominates in *Helicella dejecta*, *Chondrus bidens,* and *Helicella krynikii,* all steppe xerophiles, suggesting arid and probably colder climatic conditions (Chapter 5).

Archeological occupations of Kabazi II Levels II/7E, II/7D, II/7C, II/7AB, II/7, and II/6, correspond to the Les Cottés Interphasial. The ESR and U-series ages for Levels II/7B and II/7, however, are not completely reliable. According to C. McKinney, the age of Kabazi II Unit II, as a single unit, is 39.8±5 ka (McKinney 1998: 348). The ESR/LU produced two dates of 34±2 ka and 29±3 ka. The mean ESR/LU date for Level II/7B was calculated by J. Rink as 32±2 ka (Rink et al. 1998: 333, Table 13-4). In addition, he suggests that the lack of thermoluminescence dosimetry "may bias the ages in the direction of being too young" (Rink et al. 1998: 337). In any case, all these dates are not in dramatic disagreement with the commonly accepted age of the Les Cottés Interphasial (Table 11-1). The upper limit of this stage at Kabazi II has been recorded by two AMS dates for the uppermost Levels II/5 (33.4±1 ka) and II/4 (32.2±9 ka) that correspond to the pollen hiatus between zones XI and XII (Chapter 6; Hedges et al. 1996).

Middle Glacial Stadial

Pollen zone XII corresponds to the stadial environment that falls between Les Cottés and Arcy (Denekamp). The vegetation of that stadial was of typical steppe type, with a predominance of xerophytic grasses. The broad-leaved forests and even the pines had almost disappeared, indicating cold and arid environmental conditions. The climate becomes one of harsh continental type (Chapter 6). The pollen results are corroborated by the snail fauna from Kabazi II (sample nos. IIa and IIc). According to C. Mikhailesku, these samples are characterized by a predominance of xerophile species, indicating to him a cold and arid environment (Chapter 5).

Levels II/3, II/2, II/1, and II/1A at Kabazi II are associated with this stadial (Table 11-1). The faunal assemblages from these levels, studied by N. Belan, show the presence of only steppic species (Chabai 1998a). The presence of *Cervus elaphus* was noted for Level II/5 (pollen hiatus). This could be evidence that Level II/5 belongs to Les Cottés Interphasial, rather than to this stadial.

An ESR/LU date of 32±6 ka for Level II/1A does not discount—but does not prove—this proposed correlation. Both AMS dates for Levels II/1 (31.55±.6) and II/2 (35.100±.85) are in good agreement with the commonly accepted age for this stadial (Hedges et al. 1996). At the same time, it is worth noting that the AMS date for Level II/2 is not consistent with the AMS dates for Levels II/4 and II/5 (Table 11-1). According to J. Rink's analyses of the AMS and ESR dates, the age of these levels (II/1 down to II/5) lies in the range of 30-35 ka (Rink et al. 1998: 336). That conclusion does not contradict the proposed correlation.

Arcy (Denekamp) Interstadial

The Arcy (Denekamp) climatic amelioration is documented in pollen zone XIII at Kabazi II. The landscapes surrounding the site become forest-steppe, where the forests consist of broad-leaved trees and pines. The steppe was characterized by the predominance of mesophytes and was of meadow character (Chapter 6). Archeological Horizon -195 at Kabazi II corresponds with this pollen zone. Neither ESR nor AMS dates are available for this horizon.

No archeological level is associated with the final stadial of the Kabazi II pollen sequence documented in pollen zone XIV.

Paleoenvironment of the Western Crimean Middle Paleolithic

This brief summary of the paleoenvironmental reconstructions covers about 100,000 years: from the Last Interglacial to the Arcy (Denekamp) Interstadial. As was noted by N. Gerasimenko, the evolution of Late Pleistocene climates in Crimea shows a cyclical pattern. All stages of Crimean vegetation evolution correspond to both the vegetational succession documented for the Eastern European Plain, as well as to the major climatic stages of the Late Pleistocene. The Crimean Peninsula, however, possesses regional climatic peculiarities due to its latitude (45° North) and influence of the Mediterranean regime, and was always milder than the regions directly to the north. During the Last Interglacial and Early Glacial interstadials, the climatic conditions were mild to moderate, but always humid. Forest and/or forest-steppe landscapes predominated. A decrease in temperature and an increase in aridity, as well as a predominance of open steppe landscapes are well documented for the following Pleniglacial, and especially for the second half of the Pleniglacial. The harshest continental conditions were seen in the stadial between Les Cottés and Arcy (Denekamp). Yet, the absence of arcto-boreal vegetation suggests that the environmental conditions of the Crimean foothills were milder than were the ones of the Eastern European Plain (Chapter 6).

SUBSISTENCE

The faunal studies of Kabazi II, Kabazi V, and Starosele all indicate that hunting was highly specialized and focused upon herd species, such as horse and saiga, which lived in the open landscapes of the Crimean steppe. Although other species of steppe, woodland, riparian, and mountain environments may have provided additional food resources, they were never significant—frequently represented by only a few bones per individual—relative to equids and saiga. These two species provided the economic base for the inhabitants of all these sites over the whole span of their occupations, from early Würm through the Denekamp Interstadial (Chapters 1-3; Chabai 1998a).

Within this uniform dependence on steppe forms, their exploitation and processing do show a number of differences, as well as similarities, from site to site and occupation to occupation, ranging from simple primary butchering to the more extensive treatment of carcasses. Unfortunately, while the faunal analysis for Starosele is complete, that for Kabazi II is ongoing; to date only 4 levels have been analyzed in detail (II/7E, II/8C, IIA/1, IIA/2). For Kabazi V, only some of the levels in Units II and III have been analyzed; Unit IV, only recently uncovered, has not been examined. The analysis for Kabazi V Unit I is complete, but these are disturbed and mixed deposits that have little relevance for this summary. Given the data currently available, occupation levels at the three sites fall into two groups: primary butchering (Kabazi II Levels II/7E, II/8C, IIA/1, and IIA/2 and Starosele Levels 1, 2, 4) and extensive carcass treatment (Kabazi V Units II and III, Starosele Level 3).

Primary Butchering

In spite of their quite different settings in the landscape, primary butchering appears to have been the dominant activity during most occupations at Kabazi II (Levels II/7E, II/8C, IIA/1, and IIA/2) and Starosele (Levels 1, 2, and 4). In these occupations, freshly killed (either quite nearby or on-site) animals were dismembered and summarily butchered. In most cases, it appears that there was some consumption of meat, but the important meat-bearing units were then taken off-site. The occupations falling into this site type also differ from the second butchering strategy described here by their focus on very few prey species.

Species Representation at Primary Butchering Stations

Equids, almost exclusively *Equus hydruntinus*, dominate the faunal assemblages from Kabazi II Levels II/7E-II/A2 and Starosele Levels 1, 2, 4, in both number of remains (NISP) and the minimum number of individuals (MNI) (fig. 11-2). In the faunal assemblages of Kabazi II, equid NISP ranges from 95.0% to 99.5%, while the equid MNI ranges from 81.8% to 88.9%. A similar pattern characterizes the faunal assemblages of Starosele Levels 1, 2, and 4: the equid NISP (prey species only) is 92.8% to 98.2%, while the MNI's are lower at 50.0% to 63.2%. In this, Starosele exhibits slightly greater species diversity: four to five prey species were identified there, compared with the prey species from of Kabazi II Levels II/7E (3 species), II/8C (2 species), IIA/1 (2 species), and IIA/2 (4 species).

The "secondary" species at Starosele—*Cervus elaphus*, *Rupicapra rupicapra*, saiga, and Bos/bison—are represented by relatively few bones in comparison to the overall sample sizes (see Chapter 1), but are certainly not out of place in this area of Crimea with nearby steppe, woodland, mountainous, and riparian terrains. They might represent evidence of opportunistic hunting or of carnivore activity after humans left the site.

For the occupations exhibiting primary butchering activities, carnivores occur in significant number only at Starosele Level 1, where four species were identified: fox, hyena,

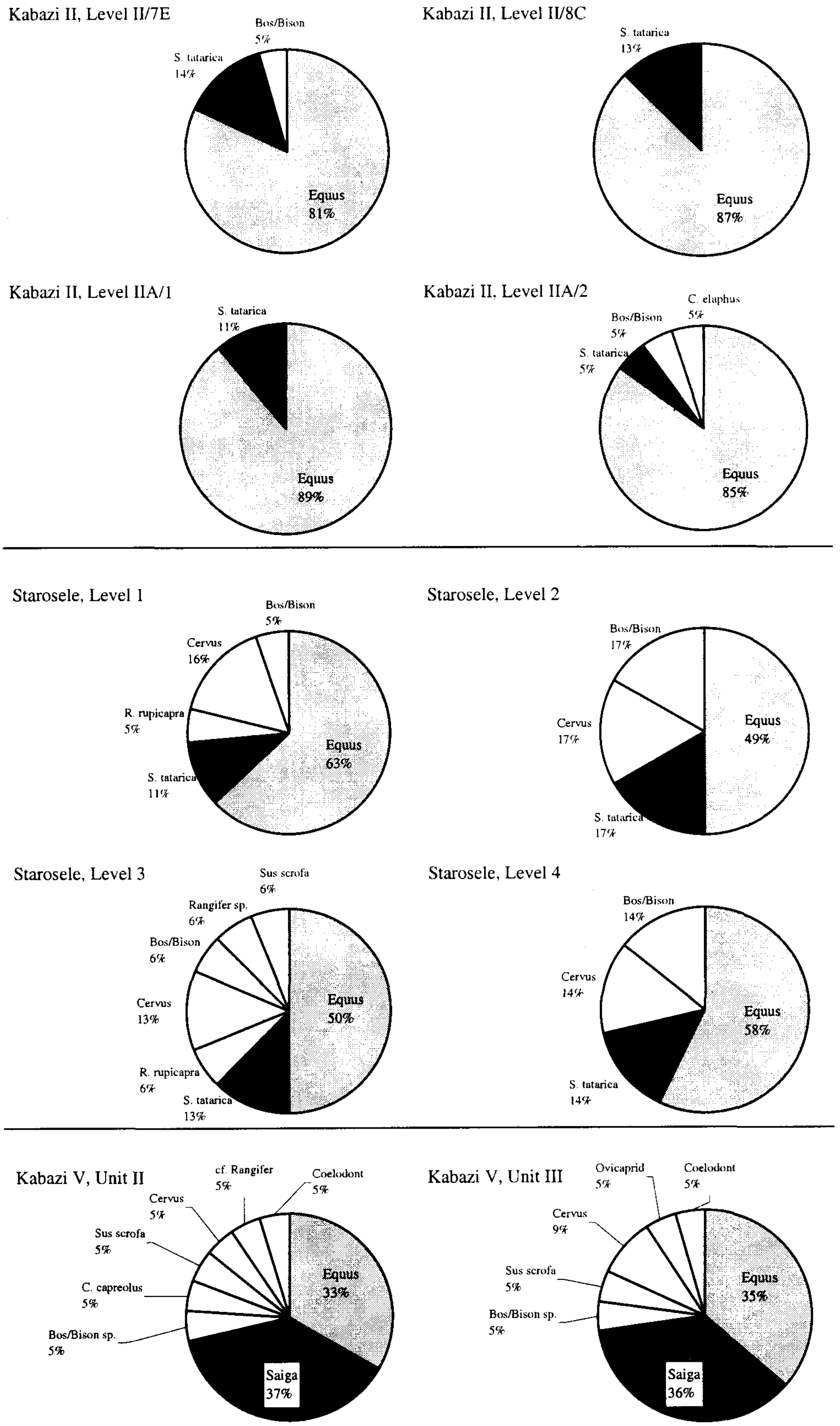

Fig. 11-2—Percentages of prey species (in MNI) at Kabazi II, Starosele, and Kabazi V.

wolf, and bear (MNI=1 in all cases). Such non-prey species representation is matched only in Starosele Level 3, which exhibits a different butchery strategy. Evidence for gnawing by hyena or hyena-sized scavengers in Level 1 was identified on 9.3% of identifiable bone, there was a negligible number with dissolution due to partial digestion (3 of 3652 bones), and six bones showed surficial polishing which might be due to carnivore regurgitation or licking.

Element representation patterns of equid in Starosele Levels 1 show no indication at all of carnivore ravaging, suggesting that carnivores played a small role in the history of the faunal assemblage. The presence of these carnivores at Starosele Level 1 probably relates more to the specific topographic situation at the site and to the probable presence of surface water in the box canyon, compared to its probable absence in the immediate vicinity of Kabazi II and Kabazi V. The absence of carnivores at Starosele Level 4 and at Kabazi II Levels II/8C, IIA/1, and IIA/2 may well relate, in the case of Level 4, to a small sample size and to the probable rapid covering of that surface by additional fluvial aggradation. In the case of the Kabazi II Levels II/8C, IIA/1, and IIA/2 occupations, they were covered quickly: only a single panther was identified in Kabazi II Level II/7E, and by only two bones, which may have washed in from the slope above.

Seasonality in Primary Butchering Stations

On the basis of herd age structure, three main seasons of hunting were identified for the primary butchering sites: springtime for Kabazi II Levels II/7E and IIA/2; winter for Kabazi II Levels II/8C and IIA/1; and late summer/fall for Starosele Levels 1, 2, and 4 (Chapters 1 and 3). This strongly indicates that horses were available on the second ridge of the Crimean Mountains year-round, at least during the improved climatic conditions of the Hengelo interstadial (Kabazi II Levels II/8C and IIA/1, Starosele Level 1) and the Les Cottés Interphasial (Kabazi II Level II/7E).

Patterns of Primary Butchering

After initial processing, two kinds of provisioning strategies were used at Kabazi II (Chapter 3). In Levels II/7E and IIA/2, element representation suggests that the most nutritious bones were taken off-site, while the bones with less nutritive value were left behind, for a "reverse gourmet strategy" (Binford 1978). A quite different pattern ("reverse bulk strategy") was employed at Kabazi II Levels II/8C and IIA/1, in which all of the more or less nutritious elements were taken out of the site. As described by M. Patou-Mathis (Chapter 3), the reverse gourmet strategy corresponded to springtime hunting, while the reverse bulk strategy corresponded to wintertime hunting. In addition, the amount of bones smashed for marrow was much greater in the levels employing the reverse gourmet strategy than in those employing the reverse bulk strategy, indicating that marrow, as well as the choice parts of the animals, may have been taken off site or consumed on-site.

Element representation patterns of equids at Starosele Level 4 (Chapter 1) indicate that the occupants also transported meat-bearing units off-site. The absence of axial skeleton elements and upper limb bones in this assemblage points to an "reverse gourmet strategy." Elements most rich in marrow—metapodials, ulnae, tibiae and phalanges—make up the better part of the assemblage, and the degree of fragmentation, plus evidence of green bone flaking, suggests that these bones were processed on-site for marrow extraction. The high percentage of heads may also indicate their processing for tongue and brains. While at the site, the occupants probably consumed the meat on the pelvis, scapula, and lower limbs; all of these are less useful in terms of meat utility and less likely to be transported. Although very small in number, the bones of *Cervus*, saiga, and Bos/bison appear to follow a similar pattern: these species are represented by only the marrow-rich lower limb units (A. Burke personal communication).

For the "secondary" species in Starosele Levels 1 and 2, in spite of the very small sample sizes, there does appear to be transport of heads and lower limbs into the site. With the exception of *Rupicapra rupicapra* (represented by a radius and ulna in level 1), the other species would have been killed at some distance from the site (that is, probably not within the box canyon) and so it is expected that they would display some differential transport. On the other hand, according to A. Burke (Chapter 1), equid bone was neither transported to or away from the site at Starosele Levels 1 and 2. Based on element representation of equids and numerous bones displaying cut marks, whole carcasses were butchered on-site, and presumably, either consumed or only the meat taken off-site. These levels also display significant numbers of bones with cut marks indicative of disarticulation and chopping. The degree of bone fragmentation (up to 70% of the bone was less than 25% complete), as well as the high density of fragmented bones in the site area, might be evidence of on-site marrow extraction in both Levels 1 and 2. As Level 1 contained a good amount of bone charcoal, at least a portion of the fragmented bone may be attributed to the production of suitable bone for fuel.

More Intensive Faunal Exploitation at Secondary Stations

While the polar opposite of primary butchering might be seen in the extremely extensive processing of prey animals at a true base camp, there are intermediate stages along this continuum where carcasses are more fully processed than at primary butchering sites, but are less intensively utilized than at base camps. At such stations, one would expect to find differential representation of meat units transported to the site for secondary processing and extensive disarticulation and meat removal. Secondary processing activities might also include processing requiring more time and energy, such as the extraction of marrow, grease, tongue, and brains. These activities are seen at Starosele Level 3 and at Kabazi V Units II and III.

Species Representation at Secondary Butchering Stations

Kabazi V Units II and III display far more species diversity than seen in any of the other occupations described here: eight prey species in Unit II and nine in Unit III (fig. 11-2). In spite of such diversity, it is still equids and saiga that dominate the assemblages by far; other prey species (including Bos/bison, *Capreolus capreolus, Sus scrofa, Cervus, Ovicaprid,* and *Coelodonta*) account for only 5-9% each of the MNI of prey species in these units. Because of severe bone fragmentation, elements definitely attributable to *Equus hydruntinus* account for 9.7% of NISP (prey species only) in Unit II and for only 10.87% in Unit III. *Equus caballus* (0.8% NISP) is even rarer, occurring only in Unit II (Chapter 2). Thus, the horse bone is mainly identified only to genus; *Equus sp.*=41.2 % in Unit II and 46.7% in Unit III. Given the faunal assemblages at the other sites, it is most likely that the vast majority of these bones actually refer to *Equus hydruntinus*. In NISP of prey species, the combined equid bones dominate the fauna assemblages of Unit II (51.7%) and Unit III (57.6%), while saiga varies from 38.7% (Unit II) to 35.9% (Unit III). On the other hand, by the number of individuals, saiga and *Equus* are nearly identical: 33% MNI each in Unit II, and 33% *Equus* and 38% saiga in Unit III. Thus, in contrast to the other occupations described here, both *Equus* and saiga were the preferred prey species during these occupations. The other prey species were most likely hunted as they were encountered in the valley below the site.

The other distinctive feature of the Kabazi V Units II and III fauna assemblages is a relatively high percentage of carnivore remains, including *Crocuta crocuta, Ursus sp., cf. Vulpes,* and canid. Combined, they represent 13% (Unit II) and 15% (Unit III) of the total MNI. In spite of this rather significant presence of carnivores at the site, each species is represented by only one to five identifiable bones, and the very extensive taphonomic analysis performed by A. Burke (Chapter 2) found carnivore damage on only 0.9% and 0.7% of the identifiable bone in Units II and III. Carnivores, therefore, contributed insignificantly to the accumulation and destruction of the Kabazi V faunal assemblages, and probably only occupied the site intermittently, when humans were not present.

At Starosele Level 3, as at all other occupations, the dominant prey species is *Equus hydruntinus* (Chapter 1). Here, however, it represents only 50.0% MNI and 87.8% NISP of prey animals. Other prey species represented in Level 3 include saiga, *Cervus elaphus, Rupicapra rupicapra,* Bos/Bison, pig, and possibly, reindeer, which is represented by a single bone fragment (fig. 11-2).

As at Kabazi V, there is a relatively significant number of carnivores in the Starosele Level 3 assemblage, including hyena, bear, fox, and canids. With the exception of two *Vulpes vulpes*, the MNI's for each of these is 1. Although the element representation indicates no significant carnivore ravaging, equid humeri do reflect some carnivore patterning of the assemblage. Gnaw marks were observed on 7.2% of identifiable bones, along with a few exhibiting partial digestion. On the other hand, the faunal assemblage as a whole demonstrates patterning that can only be due to humans, there is some evidence for gnaw marks overlying human-caused cut marks on bone, and the preservation of the *Vulpes vulpes* shows that it had denned at the site, so carnivores probably came to the site only after humans had left it and did not contribute to the prey-species assemblage.

Seasonality in Secondary Butchering Stations

While mortality and season of death were not extensively investigated in this site type, the age of fetal remains in Kabazi V Units II and III show that gravid equids were being hunted in the late summer/early fall. Juvenile saiga remains represent both late summer and winter deaths. Bone charcoal in these units might be evidence of a fall-winter occupation, as well. Taken together, along with the evidence for processing activities, it appears that Units II and III had a number of short-lived occupations from summer through early winter. This is similar to the pattern at Starosele Level 1, where a series of fetal equid remains indicate occupation of the site for one to three months during late summer/fall (Chapters 1 and 2).

Patterns of Secondary Butchering

The results of the Kabazi V faunal analysis shed little light on butchery patterns at the site since the archeological levels within each unit were collapsed and the counts of element representation include all taxa, both prey and non-prey species. While all body parts appear to be represented in Units II and III (see Table 2-3), indicating that whole carcasses or large portions of carcasses were brought to the site and presumably, consumed, it is impossible to know whether this is the case for the prey species, or whether the inclusion of non-prey species in the table is skewing the data. There does appear to be a clear over-representation of podial elements and skulls, signifying that units that are poor in meat and requiring more intensive processing were brought into the site. Cutmarks are concentrated on the podial elements and lower limb bones show a high degree of fragmentation suggesting that they were smashed for marrow extraction and then used as fuel. Therefore, at the very least, extra limb units were brought to the site, disarticulated, and processed for meat, marrow, and grease. Skulls have a middling meat utility index but might be differentially transported to the site for tongue and brains. This was certainly the case in Unit III where the number of lower teeth present is three times that of upper teeth. The Kabazi V occupations were, however, almost assuredly ephemeral and must represent secondary butchering patterns given the very low ratios of bones to individual animals.

In Starosele Level 3, the element representations of equids display a high proportion of mandibles and axial skeleton elements. A. Burke (Chapter 1) further notes that marrow weight appears to be a significant factor in the element representation in Level 3, and that there was transport into the site of additional units rich in marrow. Concomitant with these findings, long bones show a very high degree of fragmentation. It appears, then, that along with processing of freshly killed equids, some additional units requiring more processing, including those rich in marrow and mandibles, were brought to the site. This is the case not only for equids, but also for the other, less important prey species: saiga, cervid, red deer, and chamois.

These butchering and transport activities, the prey-species diversity, evidence for a longer period of site occupation are all expected characteristics of a base camp. Other factors, such as the presence of only a single fireplace, a moderate density of lithic artifacts, and clear clustering of lithic materials, however, all indicate that Starosele Level 3, and probably Kabazi V, was not intensively or consistently enough occupied to be considered a true base camp, but does display more complex economic activities than the primary butchering type occupations.

Western Crimean Middle Paleolithic Faunal Exploitation

Kabazi II and Starosele Levels 1, 2, and 4 provide clear evidence for a highly specialized hunting strategy focussed on a small horse, *Equus hydruntinus,* over a significant amount of time: from the Early Glacial stadial to the Denekamp Interstadial. Without question, this horse was not the only animal available for hunting in Crimea; in fact, it was not the only herd animal during that time span. The Kabazi II, Starosele, and Kabazi V sequences document at least four steppe-dwelling herd species (*Equus hydruntinus, Equus caballus, Saiga tatarica,* and Bos/bison), two woodland species (*Cervus elaphus* and *Capreolus capreolus*), one forest-dwelling species (*Sus scrofa*), and one mountain-dwelling species (*Rupicapra rupicapra*) (fig. 11-2). Moreover, the faunal assemblage from Formozov's excavations at Starosele included *Mammuthus primigenius* (Vereshchagin and Baryshnikov 1981), which was widespread in eastern Crimea, at least to the east of the Salgir River (Ernst 1934; Kolosov 1986). All of these animals were preyed upon by humans, without apparent specialization, during the Middle Paleolithic in eastern Crimea, as well as in the Northern Caucasus, which has similar paleoenvironmental conditions to those in Crimea.

How then can the true dominance of *Equus hydruntinus* in the western Crimean assemblages be explained? Without question, the topographic setting of western Crimean Middle Paleolithic sites, and as allowed by their hunting equipment, permitted hunters to drive small groups of animals into the enclosed areas along cuestas cliffs, such as the Kanly-Dere box canyon at Starosele, where they killed them. Taking into account the Kabazi II data, where the occupations of Levels II/7E, II/8C, IIA/1, and IIA/2 might represent single kill and butchery episodes for each level, this hunting method permitted killing from 7 to 18 horses at a time (Chapter 3).

It appears that during the spring, the slaughtered groups were larger (16 to 18 kills per hunt), compared with the winter when from 7 to 8 horses were killed at a time. The difference is most probably explained in the seasonal shifts in horse herd composition over the year, with a greater abundance of larger horse herds during the spring than during the winter. This reflects the types of primary butchering seen at Kabazi II. With an abundance of well-fed animals available in the spring, only the choice parts were taken away; during the winter, when fewer and thinner animals were available, all body parts were taken away from the kill sites and, presumably, taken to occupation sites nearby.

The processing of horse carcasses at Kabazi II and Starosele exhibit some differences in the apparent consumption vs. transport of meat. Both patterns of primary butchering, reverse bulk strategy and reverse gourmet strategy, employed at Kabazi II, resulted in the transportation of meat-bearing parts off-site. Marrow, after being extracted, was either taken off-site or was immediately consumed. In sum, the main site function was limited to primary butchering. Such site use is valid not only for the levels reported in this volume, but for the whole sequence at Kabazi II (Units II, IIA, and III) (N. Belan, A. Burke, and M. Patou-Mathis, personal communication).

Primary butchering took place in all of four levels of Starosele, followed by varying amounts of more intensive secondary processing, and, in the case of Level 4, transportation of meat-rich parts off-site. In Levels 1, 2, and 3, it is probable that horses were consumed on-site or, at least, meat on the bone was not taken off-site. What cannot be answered, however, is whether other soft tissue items, such as hides were taken off-site. Certainly, in terms of meat consumption based on bone presence, it is unlikely that these occupations at Starosele functioned as specialized meat procuring loci. This does not mean, however, that they saw a full range of activities normally associated with a base camp. Rather, compared with those occupations at Kabazi II, the ones at Starosele probably saw somewhat longer visits with their concomitant increase in different activities.

At Starosele Level 3, primary butchering was supplemented both by the importation of additional units requiring intensive processing into the site area, as well as by secondary butchering. Again, there is no evidence for element transport off-site. In this sense, Level 3 is further along the continuum toward a base camp than any of the other occupations at Starosele and Kabazi II. The presence of some primary butchering at Starosele most probably relates to box canyon, itself, where nearby kills can be posited.

The faunal assemblages at Kabazi V indicate that the occupants practiced specialized hunting of two species, *Saiga tatarica* and *Equus*, and brought portions of these carcasses to the site for secondary processing, and presumably, consumption.

Thus, the occupations at Kabazi II, Kabazi V, and Starosele represent many activities along the continuum from the initial processing of freshly killed animals to consumption of body parts requiring extensive processing. In a number of occupations, there is evidence for transport of meat or marrow rich units out of or into the sites. The occupations at Kabazi II, Kabazi V, and Starosele showing transport must therefore be parts of a complex of sites, since none can exist alone. The head and feet of equids at Kabazi V and Starosele Level 3 must have been obtained at primary butchering sites, while the meat bearing parts of animals butchered at Kabazi II and Starosele Level 4 must have been taken to some other locality for consumption. The situation at Starosele is more complex and probably relates to the topography around the site, as well as to the nearby presence of surface water. Here, the purity of the idealized extremes of faunal exploitation seen above becomes blurred by a mixture of site functions. In this regard, all these sites indicate that Middle Paleolithic land use in western Crimea was varied and complex.

SETTLEMENT TYPES

The reconstruction of settlement systems for the Middle Paleolithic of Western Crimea is a rather futile endeavor considering the small of the area and the paucity of sites with securely known temporal, economic, and lithic patterning (Kabazi II, Kabazi V, Starosele, and to some extent, Shaitan Koba). Reconstruction is further hampered by the great temporal spread of the known occupations, from the beginning of the Early Glacial to as late as the Les Cottés Interphasial. Using only "contemporaneous" sites would result in extremely small samples and make any conclusions overly speculative.

On the other hand, all Middle Paleolithic sites in western Crimea, regardless of age, shared the same topographic situation and had essentially the same resources (with a few temporally associated exceptions). The major difference through time was climatic; the expansion and contraction of the forest cover at the edge of the Crimean Mountains, as well as fluctuations in water sources. Yet, in spite of these climatic fluctuations, there was very little change in the dominant prey species, and throughout the Last Glacial, steppe animals were hunted almost to the exclusion of other forms.

Thus, it seems reasonable to view these many occupations in terms of site type, where animal exploitation and raw material economy are seen as factors determining the nature of site occupations and functions. Previous attempts to reconstruct settlement patterns for all of Crimea (Chabai et al. 1995; Chabai and Marks 1998) were based on raw material economy, since virtually no reliable information on faunal exploitation was available for the western Crimean sites (better data were, however, available for a number of sites in eastern Crimea). In the first attempt, only the sites of Shaitan-Koba, Kabazi I, Kabazi II (Unit II), and Chokurcha II were used for western Crimea (Chabai et al. 1995: 69-70), since Kabazi V was still being studied and Starosele, as published by Formozov (1958), was problematic. With the limited data available, it is perhaps not surprising that all these sites fell within a single "occupation type" characterized by low occupational intensity. On the other hand, what little faunal data were available suggested two patterns of exploitation: one wherein two prey species dominated and there was a moderate ratio of bones per MNI, and the other wherein a single prey species dominated and there was a high ratio of bones per MNI.

With the additional data presented in this volume, the question of western Crimean site types may be revisited more productively. While the initial observations were valid, it is now clear that greater complexity was present in western Crimea, although two basic patterns do pertain throughout. The first of these is that *Equus hydruntinus* is always the dominant prey species, although the degree of dominance varies, as discussed above. The second pattern, which is uniform for western Crimean sites, is that all sites represent non-intensive occupations. While there is variability in the intensity of occupation, none of the occupations can be considered a base camp as the center of a radiating settlement system, as envisioned by Mortensen (1972).

Based on patterns of hunting and carcass processing, distance to raw material, and the amount of on-site tool production, five types of stations can be identified. As with the types of butchering patterns, site types are not discrete, but fall along the continuum from clearly ephemeral to true base camps.

With the new faunal data, it is now possible to document what might best be called ephemeral butchering stations. At these "occupations," mainly *Equus hydruntinus* was killed and butchered, followed by transport off-site of meat-bearing bones; the amount and type of meat taken away was dependant upon the season of the year. At the "purest" of these—with the fewest number of activities—finished tools were brought to the loci where horses were killed and butchered. There is almost no evidence for core reduction or even tool rejuvenation and, given the small numbers of tools present, it is possible that some tools were even taken away after use. During these occupations, the nearest raw material was about 5 km distant.

This extreme ephemeral, single activity site type is present at Kabazi II for both the Western Crimean Mousterian and the Crimean Micoquian occupations (Levels IIA/2-III/3), and the Crimean Micoquian occupation at Starosele Level 4. It is not associated with any particular environmental setting, since it is found during the first stadial of the Last Glacial

(Kabazi II Level III/3 and Starosele Level 4), during an interstadial of the Early Glacial (Kabazi II Level III/2), during the first stadial of the Pleniglacial (Kabazi II Levels III/1 and 1A), during the moderate climatic conditions of the Moershoofd Interstadial (Kabazi II Level IIA/4), and during the stadial before the Hengelo Interstadial (Kabazi II Level IIA/2). It is most likely, therefore, that this site type was associated with the specific topographic relationships among the Kabazi Mountain slope, the position of the Alma River relative to that slope, and the prevailing vegetation along the slope and in the bottom of the valley. These characteristics must have made this place particularly advantageous for hunting horse. It is possible that the whole of the Kabazi Mountain western slope might have been equally productive, with Kabazi II being a fortuitous remnant of a much larger killing/butchering field.

A similar ephemeral site type is also present at Kabazi II and, perhaps, at Chokurcha II, as well. At these sites (another 15 occupations at Kabazi II), the dominant activity remained killing and primary butchering but, in addition, raw materials were carried onto the sites, and core reduction and tool production took place there. All of these occupations belong to the Western Crimean Mousterian and all post-date the extreme ephemeral site type described above.

With this site type, too, there is no correlation with environmental conditions. The earliest occurrences are found during the Hengelo Interstadial (Kabazi II Levels IIA/1, II/8C, and II/7F8 [II/8]), they continue during the Les Cottés Interphasial (Kabazi II Levels II/7E through II/6), and end during the stadial conditions between Les Cottés and Denekamp (Kabazi II Levels II/4 through II/1A).

How, then, can this apparent shift in raw material economy be accounted for when there was no shift in the type of animal exploitation? Is it some indirect indication of the developmental changes that took place during the Western Crimean Mousterian (Chabai 1998a, 1998b)? In fact, the most parsimonious explanation is quite mundane. The rich flint outcrop on the southern slope of Mt. Milnaya, just a kilometer upstream from Kabazi Mountain, was not exposed prior to the Hengelo Interstadial. While this was hypothesized (Chabai and Marks 1998: 365), new palynological data confirm that the Alma River Valley saw the beginning of major down cutting only during the Moershoofd. Its effects would have been clear by the Hengelo, at which time the flint source would have been available for exploitation. Before then, raw materials appear to have been acquired from the Bodrak Valley, some 5 km distant. While both sources would normally be considered "local" (Geneste 1985), the difference between one and five kilometers appears to have been sufficient so that raw material transport costs became negligible. Thus, this apparent shift can be associated with the effects of immediately available raw material, without appealing to any changes in basic raw material economy. The differences seen are no more than the predictable range of variation predicated by distance from raw material, within a single raw material economy.

On the continuum from highly ephemeral single activity kill/butchering sites to true base camps, there are numerous intermediate possibilities. One of these is seen at Starosele Levels 1 and 2. In these cases, the same basic activity took place as in the ephemeral site types: killing and primary butchering, mostly of horses. Yet, because there is no evidence for transport off-site of meat-bearing bones, it is assumed that the meat and marrow were consumed on-site. In addition, at least one multiple-use fireplace was found in Level 1 (the shape of the fireplace was distinct but there was a spread of bone charcoal around the fireplace, indicating that it had been previously used). Both of these factors, along with seasonality data (see above) suggest somewhat longer periods of occupation than seen at Kabazi II. Aside from the omnipresent equids, a minor amount of bones of *Saiga tatarica*, *Cervus elaphus*, *Cervus sp.*, Bos/bison, and *Rupicapra rupicapra* occur in these assemblages as well. This also suggests longer occupations than seen at Kabazi II in that there might have been time for encounter hunting around the site. Thus, both the faunal remains and site features suggest that the Starosele Levels 1 and 2 occupations may be considered short-term, multi-activity camps, rather than single activity loci.

Following the logic used for Kabazi II, the additional time spent at Starosele should be reflected in a wider range of raw material use than seen at ephemeral stations. At Starosele, there is poor quality flint immediately available, but the nearest source of good flint was most likely in the Bodrak Valley, some 10 to 12 km from the site. The lithic materials from Starosele Levels 1 and 2 clearly show that the vast majority of raw material was imported into the site as either finished tools or as blanks for tool production (Marks and Monigal 1998). In this, these occupations are similar to the highly ephemeral single activity occupations of the pre-Hengelo periods at Kabazi II. A major difference is apparent, however. In the Starosele assemblages, there is ample evidence for on-site bifacial foliate production and rejuvenation, plus unifacial tool production on the waste from these. Such patterns of tool production reflect a longer period of residency at Starosele than at Kabazi II, but it must be borne in mind that the Starosele assemblages fall within the Crimean Micoquian (Staroselian) with its developed bifacial reduction technology. The bifacial foliate tools function both as tools and as cores, providing blanks for unifacial tool production. Therefore, the pattern of raw material economy at Starosele is not quite comparable with either of those seen in the Kabazi II Western Crimean Mousterian and Crimean Micoquian.

Additional data from use-wear (Chapter 8) and residue analyses (Chapter 9) reinforces the notion that a wider range of activities, including some non-lithic tool maintenance, and even some hide processing, also took place. In this, it is possible that the absence of evidence for exportation of meat-bearing bones merely reflects a more complex and extensive exploitation of horse carcasses than seen at Kabazi II.

Starosele Level 1, and probably Level 2, dates to the Hengelo Interstadial. The box canyon where Starosele is found would have been an excellent place to hunt horses, by driving small groups into the canyon, and it is likely that surface water was available at the bottom of the canyon during part of the year. This would have made it a relatively attractive place, in spite of the winds, for camping for more than a few hours.

Another type of site is seen at the eight occupations of Kabazi V Units II and III, and, most likely, at Shaitan Koba, in the occupations of the lower and upper horizons. This site type might best be thought of as a temporary camp, unassociated with primary butchering.

These occupations at Kabazi V and Shaitan Koba show an absence of primary butchering, the importation of the meat-bearing or marrow-rich skeletal elements, a dominance of horse but with a significant component of saiga, and are located in true rock shelters. Other uniting elements are the rather ephemeral nature of the individual occupations, although fireplaces are common, and the presence of minor numbers of bones from forest animals. Here, as at Starosele, however, the presence of carnivores complicates the interpretation of these forest-dweller skeletal remains.

The two sites differ, however, in resource availability: the nearest flint to Kabazi V was 5 km distant, while Shaitan Koba lies within the flint-rich Bodrak Valley. This difference is clearly reflected in the raw material economy of each site, a difference that is compounded by Kabazi V being Crimean Micoquian, while Shaitan Koba is Western Crimean Mousterian. Again, the difference between a unifacial and a bifacial technology is clearly seen here. At Kabazi V, most artifacts were imported into the site, although in some cases the imported items were either blocks or early stage cores which permitted some on-site blank and tool production. At Shaitan Koba, there are good numbers of cores, as well as debitage from core reduction and tool production. Thus, the sites are linked more by the nature of their animal processing, than by their assemblages.

As for all the other site types, the temporary camps are not associated with a single time period or glacial stage. Kabazi V Units II and III extend from the first stadial of the Pleniglacial to the Moershoofd Interstadial. Shaitan-Koba is not well dated but, based on technological patterns, including Levallois cores and a high degree of platform faceting, it would correlate with Kabazi II Levels IIA/2 through II/7, which span the time from the stadial preceding the Hengelo to the Les Cottés Interphasial.

Finally, a single occupation, Starosele Level 3, seems to fall somewhat further along the continuum toward a true base camp, without actually reaching that status. The faunal exploitation includes primary and secondary butchering of mainly *Equus hydruntinus*, as well as the importation of marrow rich bones into the site area. The number of prey-species represented in the faunal assemblage (seven) is similar to that seen in Kabazi V, but other than horse (50% of the total MNI), the prey-species are represented by few individuals per species (fig. 11-2). The lithic assemblage is completely different both technologically and typologically from all other assemblages: it simply has no analog in Crimea. This makes comparisons difficult, but certain patterns are clear. Although raw material was imported into the site, it was not as tools or preforms, but as small river worn cobbles. In addition, the people utilized some immediately available nodules of poor quality raw material, a trait foreign to other occupations. While the technology of Level 3 was wholly unifacial, there is no indication of either Levallois technique or of purposeful production of elongated blanks (as seen in the unifacial Western Crimean Mousterian). The Level 3 assemblage displays considerably less technological and typological complexity than any of the other assemblages described here, yet use-wear and residue analyses clearly document a wider range of site activities, including extensive animal, bird, plant, and wood processing, plus cutting and hide scraping.

The occupation has one rather amorphous fireplace; artifact densities are not high but clustering is evident (Marks and Monigal 1998). These factors suggest that, although a number of activities were carried out on-site and food was brought into the site, the duration of occupation was not very long. Had it been, the artifact densities would have been higher, the artifact clustering would have been less distinct, and, one presumes, additional fireplaces would have been found. Yet, it should not be forgotten that the area exposed was quite limited and was apparently at the southern edge of what must have been a considerably larger concentration (Marks et al. 1998). Thus, it might well be that the apparently contradictory elements seen in the excavated area would not have been present in the center of the site and that this occupation might represent a true base camp.

Since the lithic assemblage is neither Western Crimean Mousterian nor Crimean Micoquian, its relevance to the other Crimean industries is unknown. The assemblage is associated with stadial climatic conditions, and probably dates to the first Pleniglacial stadial. It might therefore be contemporary with Kabazi V Unit III.

Western Crimean Middle Paleolithic Land Use

The relationships, or lack thereof, among lithic industries, environmental conditions, temporal placement, raw material economies, and fauna processing patterns engender both expected and some unexpected conclusions. Perhaps the most striking conclusion is that regardless of the industry involved or the environmental conditions that pertained, all sites show strong evidence for an almost single-minded emphasis on the hunting of *Equus hydruntinus*. This is true even during those interstadials when woodland-dwelling species would have been relatively abundant. The only significant variation from this is the hunting of saiga at Kabazi V. It is also abundantly clear from the evidence that there was no relationship between lithic industry and site type. This should not be a surprise, but the clarity of the data is striking. It is particularly marked at Kabazi II, where highly ephemeral, single activity kill/butchering loci are associated with both the Western Crimean Mousterian and the Crimean Micoquian through a number of different environmental settings. This is repeated for a different site type for the Crimean Micoquian at Kabazi V and the Western Crimean Mousterian of Shaitan-Koba.

While consistent inter-site correlations are hard to find, there are some striking intra-site correlations. Thus, while there are two industries present at Kabazi II over a very long period, during which climatic conditions swung from stadial to interstadial conditions, all occupations were essentially highly ephemeral single activity loci where horses where killed, butchered and, in part, taken away. At Kabazi V and at Shaitan-Koba, multiple discrete occupations were all of the same type: meat was brought in, raw material was reduced and tools produced. At Starosele, two different industries, one Crimean Micoquian and the other unknown and unnamed, show both greater tendencies for longer occupations and for more activities taking place during the occupations than at the other three sites.

It seems clear that the basic economic strategy of both the Western Crimean Mousterian and Crimean Micoquian was the specialized hunting of *Equus hydruntinus*. There is evidence for this taking place virtually year-round. It is not surprising, therefore, that the localities most favorable for such hunting would be visited and revisited by hunters. Yet, such localities have other aspects that make them more or less unsuitable for habitation beyond hunting. The open slope of Kabazi Mountain, situated between the Alma River and the cliffs of the mountain, must have provided a narrow band through which horses had to pass as they headed in or out of the narrow but sheltered valley upstream of the mountain. While hunting apparently was optimal along this band, it is not likely to have provided any protection from the weather or any immediately available surface water. It is not unexpected, therefore, that meat-bearing parts of the butchered horses were carried off. The distances may not have been far. Certainly, during interstadials, there must have been well-developed gallery forests along the Alma River, where habitation sites might have existed. Given the massive erosion of the valley bottoms during Moershoofd/Hengelo, as well as during the Upper Paleolithic (Ferring 1998), any evidence of such sites would be long gone.

The case of Starosele is different. The box canyon itself, not to mention the steep cliffs forming it, would have been an excellent area in which to either trap small groups of horses or to run them off the cliffs into the box canyon. Yet, unlike Kabazi Mountain, the box canyon is sheltered and contained surface water, at least during part of the year. As such, it would have been more suitable for longer periods of residence; perhaps not for permanent occupations, since in the winter, the winds through the box canyon must have been ferocious, but for long enough periods that a greater range of activities became archeologically visible. It certainly would not have mattered whether the inhabitants were of the Western Crimean Mousterian or Crimean Micoquian affiliation; the advantages of the setting itself would have encouraged similar site uses.

The same pattern can be seen at Kabazi V and Shaitan-Koba. These are the only true rock shelter sites studied and that alone must be partly responsible for some of the similarities. The multiple but quite separate and rather sparse artifact levels point strongly to traditional, yet ephemeral places to camp. That either or both raw material and faunal remains were imported into these sites indicates that some other factor made them desirable for temporary habitation. While the view today of the Alma Valley from Kabazi V is spectacular, prior to the erosion beginning in Moershoofd the rock shelter would not have been far above the bottom of the mountain slope. In both cases, it may have been a combination of the rock shelter itself and their positioning near the mouths of narrow valleys along which animals may well have passed with some regularity. Being even slightly above the valley floors, they would not have been places for actual kills or for primary butchery and this certainly can explain their apparent absence at both sites. In spite of the variability discussed above, the overall conclusion must be that the combination of specific local topographic and resource distributions tended to define the types of sites most suitable in each setting regardless of the "industry" involved.

A second conclusion is that, aside from the anomalous Starosele Level 3, not a single site could have functioned without different types of sites in the surrounding landscape. At the most obvious level, the Kabazi II and Starosele Level 4 kill/primary butchering sites exported the meat bearing animal parts to somewhere else. Kabazi V and Shaitan-Koba had to be supplied with meat and, in the case of Kabazi V, with raw material, as well, from other places. Even in the case of Starosele Level 1, where both primary and secondary butchering took place, along with local consumption, that occupation could not have existed without some other localities where raw material was acquired and made into the tools and preforms carried into Starosele. In short, during all periods and for both the Western Crimean Mousterian and the Crimean Micoquian, the settlement patterns must have been rather complex, involving a number of complimentary site types that permitted effective exploitation of the landscape. This clearly indicates that a circulating settlement system, as defined by Mortensen (1972), was not used in western Crimea. Whether a radiating system with true base camps existed cannot be determined with the data presently available, or likely to be available, given the post-occupational, massive down-cutting within the Alma and adjacent valleys. Yet, this possibility should not be dismissed, since there are indications of such a system in eastern Crimea at Zaskalnaya (Kolosov 1986). Only when it is possible to integrate western and eastern Crimea, using data of comparable quality, might this question be resolved.

CONCLUSIONS

The absolute dating of the western Crimean Middle Paleolithic is essential to our understanding of the area, since it does not show the great temporal depth seen in the adjacent Near East, or in parts of Western Europe. On the other hand, it lasts considerably longer than the Middle Paleolithic in many other areas, including the Near East. The earliest Middle Paleolithic, the Crimean Micoquian, dates only to the first stadial after the Last Interglacial. The latest Crimean Micoquian in the west is dated to ca. 40,000 BP, although in eastern Crimea it lasts until after 30,000 BP (Marks in press; Pettitt 1997) and may well be as late in the west.

The Western Crimean Mousterian is not as long lived as the Crimean Micoquian, appearing only during the stadial between Moershoofd and Hengelo, but it lasted until the stadial between Les Cottés and Denekamp. Thus, these two "industries" overlapped for some considerable time.

The Crimean Micoquian appears to be part of a larger cultural zone that included the northern slope of the Caucasus. The Western Crimean Mousterian, on the other hand, appears to have no base in either Crimea (it is unknown in eastern Crimea) or the Caucasus. Rather, it would appear to be related to the Molodova I and Molodova V Levallois-Mousterian, which disappears about the time the Western Crimean Mousterian appears in western Crimea.

Although Crimea underwent major climatic changes from the first stadial after the Last Interglacial until the end of the Les Cottés Interphasial, with corresponding changes in vegetation, the fauna exploited by all people throughout this period remained essentially the same. Not only was emphasis placed on steppe animals, but *Equus hydruntinus* was preferred over other horses and over saiga, not to mention mammoth and even reindeer. Given the climatic changes, it is unlikely that this preference always reflected the mere numerical dominance of that species on the steppe and in the valleys of the second range of the Crimean Mountains. Rather, it appears that it was deliberately chosen for extensive exploitation from a wide range of available prey.

In western Crimea, both the Western Crimean Mousterian and the Crimean Micoquian maintained similar site types over long periods of time that were more determined by local resource patterning and a basic tendency for mobility than they were by any specific "cultural" tradition. It is clear that western Crimea is too small to have supported the two viable, ongoing populations of the Western Crimean Mousterian and the Crimean Micoquian. In fact, the seemingly habitable parts of the whole Crimean Peninsula are too small. Thus, Crimea must be viewed as part of larger areas in which the two industries existed. Yet, before whole areas can be considered, the relationships between western and eastern Crimea must be elucidated. A good start has been made, but a great deal more work will be required before a true understanding of the complexities of the Crimean Middle Paleolithic can be achieved.

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New evidence from the Mesolithic of the Southern Alps.*DERWICH E.*, Entre la mort et l'enterrement - défunt dans la culture à céramique linéaire dans le cadre de la médecine légale. *WEINER J.*, Notched extraction tools made of rock and flint from the Late Neolithic Flint-Mine "Lousberg" in Aachen, Northrhine-Westphalia (Germany). *VAN BERG P.-L.* et *CAUWE N. avec la collaboration de LINGURSKI M.* La Vénus du géomètre. *SPINDLER K.*, Summary report on the mummified glacier corpse found at Hauslabjoch in the Ötztal Alps. **Volume 11, novembre 1996 :** *MONIGAL K., MARKS A.E., DEMIDENKO YU.E., USIK V.I, RINK W.J., SCHWARCZ H.P., FERRING C.R. et MCKINNEY C.*, Nouvelles découvertes de restes humains au site Paléolithique moyen de Starosele, Crimée (Ukraine). *YAMADA M. et STEPANCHYK B.N.*, Etude sur les méthodes de production lithique en Crimée occidentale (Ukraine). *YAMADA M. et SYTNIK A.S.*,Nouvelle étude sur les modes de production lithique levaloisienne dans le site de Molodova V (Ukraine). *BOGUTSKIJ A. B., SYTNIK A.S. et YAMADA M.*, Nouvelles perspectives de recherches sur le Paléolithique ancien et moyen dans la Plaine Russe Occidentale. *YANEVICH A. A., MARKS A. E. and UERPMANN H.P.*, A Bone Handle from Buran-Kaya III : the Earliest known in the Crimea. *KHOLUSHKIN YU. P. and ROSTOVTSEV P.S.*, Problem of statistical grounding of the criteria for identification of the Mousterian facies in the Central Asia. *DEREVIANKO A.P., PETRIN V.T. and KRIVOSHAPKIN A.I.*, The Paleolithic complexes of the North-Eastern slope of Arts-Bogdo (Mongolia). *PRASLOV N.D. et SOULERJYTSKY L.D.*, De nouvelles données chronologiques pour le Paléolithique de Kostienki-Sur-Don. *STRAUS L.G., OTTE M., GAUTIER A., HAESAERTS P., LÓPEZ BAYÓN I., LACROIX Ph., MARTINEZ A., MILLER R., ORPHAL J. and STUTZ A.*, Late Quaternary Prehistoric Investigations in Southern Belgium. *RIPOLL LÓPEZ S.*, Quelques réflexions autour de l'art paléolithique le plus méridional d'Europe. OWEN L.R. and PORR M., Report on the Conference "Ethno-Analogy and the Reconstruction of Prehistoric Artefact Use and Production". P. HAESEARTS AND D. CAHEN, The SC-004 research network "prehistory and evolution of the environment during the last 100.000 years in the great european plain": an overview.*WANSARD G.*, Correlations between loessic deposits of the Eurasian area (Germany-Austria-Czechia-Hungary-Russia-Siberia-China) based on the TL Stratigraphy method. *DAMBLON F.*, Palaeobotanical study of representative upper palaeolithic sites in the central european plain : a contribution to the sc-004 project. *DAMBLON F. and HAESAERTS P.*, Radiocarbon chronology of representative upper palaeolithic sites in the central european plain : a contribution to the sc-004 project. *Marcel OTTE, Pierre NOIRET and Ignacio LÓPEZ BAYÓN*, Aspects of the Upper Palaeolithic in Central Europe. *HERMAN C. F. and VERMEERSCH P. M.*, Late glacial central Europe: in search of hunting practices. *SEMAL P.*, Taxonomic specificity of fossil collagen molecules in enzyme linked immuno assay. *ORBAN R., SEMAL P. and ORVANOVA E.*, Hominid remains from the northern european plain : and up-date to the catalogue of fossil hominids. Comptes rendus.

IV COLLECTION CARNET DU PATRIMOINE

Volume 20, 1997 "Découvrir la Préhistoire". Sous la direction de Marcel OTTE, Professeur à l'Université de Liège et Président de Préhistoire Liégeoise; Laurence HENRY, Archéologue et Secrétaire de Préhistoire Liégeoise. Edité par le Ministère de la Région Wallonne. Direction Générale de l'Aménagement du territoire, du logement et du Patrimoine - Division du Patrimoine 1997. (200 FB - 4,9 EURO).

Au cours de la préhistoire, toute société se constitue : l'homme et ses valeurs se forment progressivement au fil d'un temps extrêmement long. Durant quelques millions d'années apparaissent successivement notre constitution anatomique, notre langage, nos croyances, notre pensée. L'aventure se termine aux confins de l'histoire, lorsque les textes en donnent un reflet biaisé par le choix intentionnel des informations à maintenir. L'Archéologie préhistorique interroge des traces matérielles maintenues spontanément à travers les âges donc objectivement représentatives des modes de vie, des conceptions métaphysiques et des processus évolutifs propres à notre espèce. Cette si longue "histoire" fut souvent négligée par les manuels produits par des historiens orientés vers les grands faits de guerre ou d'expansion, non vers des phénomènes culturels généraux. Cette plaquette a pour vocation de pallier quelque peu cette déficience dans l'attente où les maîtres en histoire des civilisations soient aussi ceux en histoire des peuples. Réalisés par des archéologues qui se veulent historiens, cette publication invite à une réflexion généreuse et attentive sur la nature de l'homme et sa lente transformation.

LA PRÉHISTOIRE : UNE SCIENCE WALLONNE

Sollicité par la Région wallonne, cet ouvrage collectif, réalisé par l'A.S.B.L. Préhistoire Liégeoise, présente les données principales de notre patrimoine préhistorique.

Destiné à un large public et plus spécifiquement au milieu scolaire, la publication est conçue selon les grandes périodes de la préhistoire en insistant sur les caractéristiques propres à la préhistoire wallonne et sur les lieux visitables (sites et musées).

Coordonné par les deux auteurs de cette note, il constitue avant tout le fruit d'un travail d'amis passionnés de préhistoire et anciens étudiants de l'Université de Liège. Dès à présent, nous remercions vivement tous ceux qui ont particpé à cette réalisation.

Enfin, nous tenons à exprimer notre profonde gratitude à la Division du Patrimoine du Ministère de la Région wallonne et plus particulièrement à Monsieur André Matthys, Inspecteur Général, qui nous a donné l'occasion d'éditer ce fasicule dans le cadre des Journées du Patrimoine 1997 consacrées au patrimoine archéologique.

On peut légitimement considérer que la préhistoire fut née en Belgique. Vers 1820, Ph. Ch. Schmerling, Professeur à l'Université de Liège, démontre la haute ancienneté de l'homme contemporain d'animaux disparus (Engis). Dans les années 1860, Ed. Dupont (Bruxelles) établit, grâce à ses fouilles dans le Bassin mosan, la première chronologie correcte du Paléolithique supérieur européen. En 1886, M. de Puydt, J. Fraipont et M. Lohest (Liège) associent les Néandertaliens aux Moustériens et aux sépultures exhumées à Spy (Namur). En 1885, le premier "Néolithique" est découvert à Omal (Liège) par M. de Puydt et son équipe, démontrant la diffusion de la première agriculture dans nos régions.

Entretemps, les tranchées hennuyères prouvent l'importance de l'industrie minière à Spiennes (Hainaut), dès le Néolithique moyen (IV^{e} millénaire) et les nappes alluviales successivement taillées dans le Bassin de la Haine démontrent l'évolution des industries les plus anciennes du pays : de 500 à 100.000 ans environ (E. de Munck, D. Cahen). Plus récemment, le site de la Belle Roche (Sprimont) démontre une présence humaine, d'un style différent, dans les Ardennes et attribuée au "Pléistocène moyen Ancien", vers 500.000 ans (J.M. Cordy, Liège). Les fouilles menées à la grotte Scladina (Andenne) permettent la mise au jour des restes d'un enfant néandertalien, le mieux étudié de ce siècle en Belgique (D. Bonjean, Liège). Des fouilles aussi fructueuses ont concerné également l'Aurignacien (Trou Magrite), le Gravettien (Huccorgne) et le Mésolithique (Freyr) en collaboration entre Liège et Albuquerque (L. Strauss). Le Magdalénien fut approché par les fouilles à Chaleux (E. Teheux), Furfooz (N. Cauwe), le Trou da Somme (J.-M. Léotard). L'Arhensbourgien (8.400 ans) est désormais bien connu par les fouilles à Remouchamps menées par M. Dewez. Dernièrement, la longue séquence du Trou Walou (Trooz) illustre l'évolution complète du Paléolithique supérieur en Région wallonne (M. Dewez, M. Toussaint, E. Teheux, Chr. Draily). Durant les mêmes phases, les sites "tjongériens" de Meer (Anvers) éclairent le comportement de ces "derniers chasseurs de l'Alleröd, vers 9.000 ans (Fr. Van Noten et D. Cahen, Tervuren). Les sites mésolithiques ont entretemps livré les étonnantes découvertes de sépultures collectives (Margaux, Autours, Bois Laiterie par N. Cauwe) et celui de la station Leduc à Remouchamps montre l'organisation spatiale d'un campement de cet âge. Les remous suscités par les fouilles effectuées sur la place Saint-Lambert (Liège) sont trop connus pour en rendre davantage compte ici (M. Otte et J.-M. Léotard). De gigantesques sites du Néolithique ancien (VI^{e} millénaire) ont été explorés systématiquement : Darion (D. Cahen, I. Jadin); Vaux et Borset (J.-P. Caspar et J. Docquier). Ils illustrent des modes d'auto-défense et de protection, probablement liés à la présence des Mésolithiques contemporains. Une série de monuments mégalithiques furent explorés et interprétés récemment, tel l'ensemble de Wéris (Fr. Hubert, M. Toussaint), Lamseul (M. Toussaint et I. Jadin) et Gomery (N. Cauwe et M. Toussaint). Dans les Ardennes, divers sites de refuge ou d'habitat ("oppoda") et de sépulture ("tombelles") complètent le modèle de peuplement celtique de la haute Belgique (A. Cahen-Delhaye, V. Hurt et P.P. Bonenfant).

Un panorama complet de la préhistoire belge a ainsi été renouvelé totalement lors des fouilles récentes. Non seulement, il apporte des informations mises à jour, mais aussi, il facilite l'intégration de ces données dans un contexte international large où, souvent, notre pays a joué un rôle intermédiaire primordial. Ce n'est donc pas ainsi le patrimoine wallon qui y fut illustré mais bien une partie de l'histoire européenne.

Marcel OTTE et Laurence HENRY

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