Stránská skála

Origins of the Upper Paleolithic in the Brno Basin
Moravia, Czech Republic

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Peabody Museum of Archaeology and Ethnology
Harvard University
Cambridge, Massachusetts 2003
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Original design: Janis Owens
Cover design: Nancy Lambert-Brown, Borgo Design
Composition: Wren Fournier and Donna Dickerson
Editing: Carolyn White and Wren Fournier
Proofreading: Janice Herndon
Production management: Donna Dickerson
Typefaces: Monotype Copperplate 31ab, Bitstream Latin 725, Monotype Times New Roman CE, Monotype Times New Roman
Text stock: 60 lb. Joy White Offset
Cover stock: 80 lb. Passport Tale, Smooth Finish Cover
Printed by Thomson-Shore, Inc.
Manufactured in the United States of America

Cover illustration: Levallais artifacts (adapted from figure 7.6).

Figure 1.2 was reproduced from J. Svoboda, Stránská skála. Bohunický typ v brněnské kotlině, 1987, courtesy of Nakladatelství Academia, Prague, the Archives of the Institute of Archaeology, ASCR, Brno, and the Moravian Museum, Brno.

Figures 1.8, 1.9, 2.3, 2.6, 2.7, 4.3, 4.5, 6.1, 7.4, 7.5, 7.7, 10.20, B.5, B.6, D.2, and D.4 were reproduced from J. Svoboda, “Brno-Stránská skála (k.o. Slatina, okr. Brno-město),” Práhled výzkumů 41(2000):76-80, courtesy of Práhled výzkumů.

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ISBN 0-87365-551-6

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Library of Congress Cataloging-in-Publication Data
Stránská skála : origins of the Upper Paleolithic in the Brno Basin, Moravia, Czech Republic / editors, Jiří A. Svoboda, Ofer Bar-Yosef ; contributors, Ofer Bar-Yosef ... [et al.].
  p. cm. -- (Bulletin / American School of Prehistoric Research ; 47)
Includes bibliographical references. ISBN 0-87365-551-6 (pbk. : alk. paper)
  1. Stránská skála Site (Czech Republic)

GN772.2.A8S77 2003
943.7--dc22
2003057969
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The purpose of this chapter is to present an attribute analysis of the lithic technology of the collections from Stránská skála (Ss) IIIc and IIId procured during the 1997–1999 excavations of the Institute of Archaeology, Brno, and the Peabody Museum, Harvard University. A general description of the technological attributes of these Bohumian assemblages is provided first, followed by a more specific analysis designed to place these assemblages within the context of the Middle to Upper Paleolithic transition in Central Europe and other regions of western Eurasia.

The study of lithic technology has become a vital tool for prehistorians attempting to understand the significance of the Middle to Upper Paleolithic transition (Volkman 1983, 1989; Bergman 1987; Pelegrin 1990, 1995). Refitting studies, specifically, have been central in advancing the study of lithic variability beyond the allocation of retouched artifacts into established typologies (Volkman 1983, 1989; Usik 1989; Van Peer 1992; Svboda and Škrée 1995; Škrée 1996). Despite the power of the approach, however, the fact that not all assemblages are readily amenable to refitting ensures a continued role for attribute analysis in the technological study of the Middle to Upper Paleolithic transition (Ohnuma 1986; Azoury 1986; Bergman 1987). Attribute analysis—the study of quantifiable trends in large samples of lithic artifacts (Movius et al. 1968)—offers an alternative approach to studying hominid flintknapping behavior, which is more widely applicable than, if not as powerful as, the refitting approach. Yet these two alternatives are not opposed endeavors. For although they are often used in isolation, technological studies based on refitting and attribute analysis are in fact complementary. The present volume and its dual technological studies of the Stránská skála assemblages (i.e., the present chapter and Škrée chap. 7, this volume) represent a model for a “combined arms” approach to understanding technological change at the Middle to Upper Paleolithic transition.

While possessing its own advantages, attribute analysis does not represent an epistemology different from that of traditional lithic typology. A technological attribute analysis of a stone tool collection partitions lithic variability into defined categories for a specific purpose, in the same way that a retouched tool typology breaks the continuum of retouched artifacts into types (Tostevin 2003). In other words, technological studies such as attribute analysis and even the chaîne opératoire approach are as much typological exercises as is the application of Bordes’ Lower and Middle Paleolithic typology (Bordes 1961). As such, all technological
studies must obey the rules for the proper application of a typology. The purpose of a typological system (i.e., the attributes and attribute-states, in this case) must be explicit and integral to its structure, since every typological framework has particular functions but represents only one of many possible ways of dividing up variability for the purposes of the particular research question (Adams and Adams 1991). A reason must be given for why a particular structure is adopted for a particular research question.

For the present study, the attribute analysis of the Ss-IIc and Ss-IIId collections has been designed for two purposes. First, an attribute analysis of these collections is necessary in order to communicate the general nature of the assemblages for the benefit of lithic scholars worldwide who have not had the opportunity to view the collection firsthand. This task has necessitated the application of a suite of technological variables utilized by various scholars (Baumler 1988; Bergman 1987; Crew 1975; Dibble 1995; Henry 1989; Meignen 1995, personal communication; Pelcin 1996; Van Peer 1992) in the hope that the widest range of possible questions can be answered with the data and interpretations presented in this chapter. The publication of such a general technological structure of these assemblages is as important as analyses specific to a particular research question, as the former will help stimulate further research among scholars who are not yet familiar with the Paleolithic record of central Europe and the Czech Republic, in particular.

The second purpose of this attribute analysis is to place the technological data from these assemblages within the context of the larger, specific research question, of the in situ origin versus intrusive origin of the Early Upper Paleolithic in the central European region. Across western Eurasia, newly published radiometric dates have pushed the chronological appearance of Upper Paleolithic industries back to 40,000 years before present (b.p.) in western Europe (Bischoff et al. 1989; Cabrera Valdés and Bischoff 1989; Straus 1989, 1994; Rink et al. 1996a), 43,000 b.p. in Southeastern Europe (Kozlowski and Ginter 1982), and 47/46,000 b.p. in the Levant (Marks 1983; Bar-Yosef et al. 1996), giving more support to the interpretation that the phenomenon of the Middle to Upper Paleolithic transition had an east to west geographic progression (Kozlowski 1990; Otte and Keeley 1990; Mellars 1996; Bar-Yosef et al. 1996).

Determining the potential role of the Ss-IIc and Ss-IIId assemblages, and the Bohunician industrial type in general, in this apparent geographical progression is a vital step in understanding how the Middle to Upper Paleolithic transition occurred. Consequently, these two assemblages have been studied in the context of a larger research project designed to address the meaning of the temporal and geographical progression of the Upper Paleolithic across the Levant, central Europe, and eastern Europe through the study of changes in lithic technology within and between regions at the Middle to Upper Paleolithic transition (Tostevin 2000a, 2000b).

This culture-historical question can be successfully addressed using the principle of "technological style," namely that material culture traditions can be described based on the variation in how artifacts are made (Kroeber 1940:329; Lechtman 1977; Hughes 1987; Pinch and Bijker 1987; Lemonnier 1986, 1992). Ethnoarchaeology and archaeometry have demonstrated covariance of technological variability with population groups that share other learned traditions (Lechtman 1977; Hodder 1979; Longacre 1981; Braithwaite 1982; Wiessner 1983, 1990; Childs 1991; Aronson, Skibo, and Stark 1994; Stark 1995). Due to this covariance, the presence of a specific method for making artifacts, that is, a technological style, can be used as an analytical proxy for the presence of the learned tradition that produces artifacts in this way, as well as the population that manifests this particular learned tradition.

Lithic technology is well suited to the application of the technological style concept (e.g., Leroi-Gourhan 1943; Bar-Yosef 1991), although it has been applied to many other material culture media as well, including metallurgy, ceramics, wood, and others (e.g., Lechtman 1977; Mahias 1993; Chilton 1998; Lemonnier 1986). With each material culture medium, the theoretical amount of variability possible between the technological styles of two populations varies, depending upon the give-and-take between functional requirements on artifact production within that medium and the socially mediated rules of artifact production (i.e., technological style) specific to the social context of that medium’s production and use. The amount of technological style variance between different cultural contexts (agricultural vs. forager, high vs. low socioeconomic status, religious vs. secular, etc.). While not as variable as a additive medium such as ceramics, lithic technology presents a theoretically high amount of variability (technological style, mostly due to the prevalence of equifinality in lithic reduction and the familial nature of the process by which flintknapping is learned and transmitted from one person to another.

These points make the principle of technological style appropriate for identifying changes in the learned traditions of different populations of flintknappers throughout time. Thus, by quantitatively measuring the degree of similarity or dissimilarity between the technological styles of lithic assemblages through time in one regio
it is possible to characterize the continuity or discontinuity of the learned traditions, and thus perhaps populations, in that region. Parsimony, the concept that the simplest explanation is the most probable, can then be used to distinguish an intrusive diffusion event from an independent innovation event for the origin of the Upper Paleolithic in a particular region by testing the goodness of fit between the actual degree of continuity/discontinuity within a region through time and the expected continuity/discontinuity for each type of event.

The present attribute analysis is thus designed to partition the lithic variability in the Ss-IIIc and Ss-IIIId collections in such a way as to facilitate answering this larger research question. The organization of the lithic attributes is consequently dictated more by the anthropological method and theory integral to the technological style concept than to more common forms of lithic analysis.

**METHODOLOGY**

The flintknapping process is often divided into the following behavioral categories: procurement of raw material, creation of one or more striking platforms, optional decortication, initial blank production, repreparation of platform and debitage surfaces, late blank production, blank selection for tools, application of retouch, reshaping of tools, and discard of exhausted pieces. These categories of the operational sequence are commonsensical, based on the experience of modern flintknappers and examinations of the archaeological record. These categories are also, of course, arbitrary. As such, they might be expected to serve as the units of analysis for the evaluation of the goodness of fit between the archaeological record and the expectations of a diffusive origin versus an independent innovation origin for the Upper Paleolithic in a region.

Before accepting these behavioral categories as the analytical units for the attribute analysis, however, it is first necessary to choose behavioral steps within the flintknapping process that are suitable for ultimately answering the research question. For instance, it is necessary that each individual flintknapping behavior within the production process for making stone tools be paired with an attribute analysis in the typological structure to serve as an analytical proxy for the behavioral step. This requirement of the technological style concept unites the lithic analyst’s attributes to the meaningful learned behavior behind the production of the assemblage. Only with this connection can the attribute analysis address the issue at hand: the continuity versus discontinuity in learned behaviors, and thus perhaps populations, within regions through time.

Thus each behavioral step within the flintknapping process in this study must be paired with an attribute or analysis that serves as a proxy of the behavior and not just as a morphological characterization of the final artifact form. By avoiding attributes that only inform about the final form of artifacts, it is possible to avoid gauging variability controlled by environmental forces rather than the variability in technological style desired. The behavioral steps within the flintknapping process must be delineated with respect to the method by which the behaviors are to be reconstructed, rather than by a commonsensical view of the flintknapping process alone.

Fortunately, a combination of experimental archaeology and the attribute analysis approach to lithic studies fulfills these requirements. Controlled experiments on flake fracture mechanics have demonstrated that a flintknapper has control over a number of independent operational steps during the process of making stone tools (Speth 1972, 1974, 1975, 1981; Bonnichsen 1977; Dibble and Whittaker 1981; Cotterell, Kamminga, and Dickson 1985; Dibble and Pelcin 1995; Pelcin 1996; Dibble 1997). Specifically, flintknapping steps related to platform treatment, external platform angle, platform thickness, dorsal scar ridge morphology, and subsequent placement of retouch are all functionally independent, and together they determine the morphology of each flake and tool (see Pelcin 1996; Dibble 1997). The independence on a flake-by-flake basis of knapping behaviors allows the division of the operational sequence into roughly independent domains of knapping behavior:

1. core modification
2. platform maintenance
3. direction of core exploitation
4. dorsal surface convexity system
5. tool manufacture

Thus, a flintknapper can make independent choices between each of the five domains. He or she can choose a particular core orientation and convexity management technique, specific platform angle and preparation, how many platforms he or she will use for a sequence of removals, a specific dorsal ridge pattern to serve as the nerve-guide for the propagation of the flakes, and where to place different types of retouch on the resulting blanks. None of these choices from the five knapping domains impinge on any other. Within each domain, however, there are several behavioral steps present, each with its own set of equivalent options (sensu Sackett
that may in fact affect the choice of an option in another step within that same domain (experiments have not tried to control for this issue). The dependence within domains and independence between domains dictate the structure of the present attribute analysis.

The anthropological theory behind distinguishing events of diffusion from independent innovation allows us to use a quantitative measure of similarity/dissimilarity in the technological styles between temporally successive assemblages within a region and between regions in order to evaluate the likelihood of one scenario versus the other (Tostevin 2000b). In this evaluation, however, a pair-wise comparison between two temporally successive assemblages within a region cannot result in a simple summation of the number of flintknapping steps (within domains) in which a significant difference exists between the two options, as this would bias the results through the interdependence of the units. It is thus necessary to avoid counting the same units of analysis twice, a situation known in statistics as Galton’s Problem (Tylor 1961; Thomas 1986:448). In order to quantify pair-wise assemblage comparisons, therefore, the knapping steps in which significantly different options were used between assemblages are first summed within their specific knapping domain and then divided by the total number of steps within that domain. The resulting numerical values of all five domains are then summed up to produce a measure ranging from zero (for assemblages with identical operational sequences) to five (for entirely different operational sequences). This procedure thus scales the measure of difference according to the variability seen between these five domains.

Although some degree of interdependence has been avoided with the above methodology, it must be noted that this study introduces its own bias in the structuring of pair-wise assemblage comparisons. Specifically, as the number of steps within each of the five domains differs, the steps in different domains are not weighted evenly. This situation is intentional, in that the number of steps within a domain reflects the potential for functional constraints to affect the choice of knapping options within that domain. Thus, tool manufacture, which consists of the alteration of the cutting edge(s) and/or hafting surfaces, is the most influenced by functional utility and has the largest number of steps (16) within the domain. Direction of core exploitation, on the other hand, has little or no effect on the functional utility of the resulting products and is constrained only through the social mediation between the desires and skills of the individual flintknapper and the social milieu in which a group’s learned tradition is physically expressed as stone tool production. Direction of core exploitation, therefore, has only two behavioral steps. This bias in the structure of the pair-wise comparisons should be kept in mind when evaluating the similarity/dissimilarity between assemblages traditionally grouped together based on tool typology alone.

By compiling the analytical comparisons, tests, and attribute analyses according to the knapping behaviors for each step within the five independent knapping domains, a system is created to enable rigorous identification of specific knapping behaviors within each domain used to create a particular assemblage (Baumler 1988; Bergman 1987; Bordes 1961; Crew 1975; Dibble 1995; Dibble and Whittaker 1981; Geneste 1985; Henry 1989; Hours 1974; Kuhn 1990, 1995; Meignen 1994, personal communication; Movius et al. 1968; Ohnuma 1986; Pelcin 1996; Speth 1981; Van Peer 1992, 1998; Volkman 1989). Most of the analyses are univariate tests and comparisons of pairs of flake and core attributes, using the principles of dimensional change during reduction (Holmes 1919; Frison 1968; Newcomer 1971; Collins 1975; Jelinek 1976; Stahle and Dunn 1982; Henry 1989; Dibble 1987) and cortical change during reduction (Sullivan and Rosen 1985; Geneste 1985; Mauldin and Amick 1989; Baumler 1989; Ahler 1989a, 1989b; Dibble 1995). The heterogeneous origin of these attribute analyses makes a detailed discussion of their application and reasoning necessary.

The following discussion presents the five knapping domains and the behavioral categories within each that are relevant to the present study. The number of behavioral categories or steps within each domain ranges between two and sixteen. After the description of the possible behavioral variants that represent choices available to the flintknapper within a particular behavioral category, I present the attribute analyses used to identify which option was chosen by the flintknappers to produce a particular assemblage. These characterizations of the cumulative behaviors used by the knappers for each step usually consist of a measurement of the central tendency of the variability within the particular knapping step. It is necessary to average out the variability within each step since one can find almost every knapping option used, if only to a small extent, in any given assemblage. This omnipresence of knapping options is a large source of potential bias in analyses that rely on a small number of refittings or on anecdotal treatment of a few individual pieces without reference to the dominant tendency evidenced in the unrefit debitage. The characterizations of the flintknappers’ choices for a particular behavioral step include...
both metric or continuous variables and discontinuous or categorical variables. Inferences based on available refittings are also used.

**DOMAIN 1. CORE MODIFICATION**

The first domain in which the flintknapper can choose from many equivalent options in order to produce cutting edges out of a block of stone is the modification of the raw material into a core. This domain includes two behavioral categories that are relevant to the present study: core orientation and core management.

**STEP 1. CORE ORIENTATION**

The orientation of the raw material as a core begins the exploitation for blanks suitable for immediate use or subsequent retouching. While the original form of the raw material, whether block, nodule, or core-on-flake, is determined by the nature of the raw material source, the orientation of that original form constitutes the flintknapper’s first option. Some raw material forms affect nearly all of the options, as in pebble industries such as Tata (Vértes 1964). Yet even among potentially “restrictive” raw materials, it has been shown that technological variation is possible, as with the Levalloisian industries made on pebbles in the Italian Pontian (Kuhn 1995). Among the assemblages studied in this research, the possible variants of core orientation include:

1. **Longitudinal.** The narrower and longer of the available surfaces is exploited for the majority of the debitage removals from the block.
2. **Broad-face.** The wider surface, usually with the largest surface area, is exploited for the majority of the debitage removals from the block.
3. **Discoidal.** Two surfaces, whose secant joint forms the circumference of the core, are alternately exploited. One or both surfaces are often conical in cross section, resulting in most of the debitage removals terminating at the point of the cone. When both surfaces are used alternately as the debitage and platform surfaces for removals, this is termed a bifacial discord orientation (Boëda 1993). When one surface comes to be used for the majority of the debitage and yet retains its conical cross section, this is termed a unifacial discord orientation (Jaubert, Lorblanchet, and Laville 1990; Jaubert 1993).

The attribute analyses used to identify which of the above variants were chosen by flintknappers in a particular assemblage involve both continuous and discontinuous variables.

First, before identifying how the cores in a given assemblage were oriented according to the three variants listed above, it is necessary to identify which specific surface on each core served as the “debitage surface.” While most surfaces on Paleolithic cores show the scars of some past removals, usually only one or two surfaces were chosen to serve as the surface(s) from which most of the blanks were removed from that core. The other available surfaces served as platform surfaces or unretouched areas. This is a distinction that pertains only to the production of flakes and is not a distinction in the utility of flakes removed from either type of platform; flakes removed from a “platform surface” could be just as suitable for hominin use as flakes removed from the debitage surface. Indeed, core tablets, a particular type of flake removed from the platform surface, were preferentially chosen for tools in certain periods of the Paleolithic. To standardize and objectify the criteria used in deciding which of the available core surfaces fulfilled the role of the debitage surface, one first counts the number of scars on each core surface. The surface with the higher number of flake scars is likely to be the debitage surface. A minimum size of one centimeter (cm) for flake scars standardizes such comparisons.

Second, to corroborate this criterion, one determines which surface was last used to remove flakes by counting the number of scars on each core surface that preserve the negative of the removal’s bulb of percussion. The surface with the most, or dominant number of, negative bulbs of percussion represents the last surface from which flakes were removed, and thus is likely to represent the debitage surface. Conversely, the dominant location(s) of core platform surfaces is determined by identifying the core surface(s) with the fewer scars and the fewer negatives of bulbs of percussion (Van Peer 1992:23, fig. 12). The latter criterion cannot be used without some degree of interpretation, however, as exhausted cores often evidence the last removals from surfaces that did not produce the majority of the debitage during the use-life of the core.

Fortunately, this problem itself can be remedied by using a more objective criterion for determining the cumulative, assemblage-wide tendencies to place platforms in given locations. This is accomplished by arbitrarily dividing each core surface into four sectors (sensu Crew 1975) labeled A, B, C, and D clockwise around the core (Figure 8.1). The choice of the first sector (A) on
the first surface (Surface 1) is made based on the greatest number of bulbar negatives within that sector. (This definition always results in sector A of Surface 1 being the richest in bulbar negatives in all assemblages.) Each flake scar in the four sectors is then noted according to its direction of propagation, from the theoretical directions of A, B, C, and D as established by the orientation of the core sector A. This directional data by core section is then evaluated using the assumption that the greater the number of scars within a given sector that originated from the direction of that sector (for instance, scars from direction B within sector B), the more likely it is that the edge of that core sector served as a platform during the core reduction. This type of analysis is robust enough to determine accurately which sectors served as platforms during most of reduction, even if the last removals bias the appearance of bulbar negatives toward sectors that never served as platforms until the exhaustion of the cores.

**Step 2. Core Management**

Throughout the exploitation of a core, the flintknapper is faced with the need to continue the reduction of the core, that is, to prevent the premature exhaustion of the core through the strategic removal of flakes to adjust the convexities of the various core surfaces. These removals may represent unique reparation flakes or frequent and regular removals. Numerous options are available as choices for the flintknapper within this second behavioral category of core modification, called “Core Management.” Within the context of the present study, the options available for core management, which are not mutually exclusive, include:

1. Débordant removals. The convexity of the debitage surface of a core may be perpetuated by removing flakes or blades along the two lateral edges of the core, thus leaving a convexity along the longitudinal center of the core (Meignen and Bar-Yosef 1988). The isolated center of the core can then be removed, flattening the debitage surface again. Débordant removals are then necessary to begin the process again. This convexity management option thus entails systematic and regular removals rather than periodic reparation.

2. Circumferential removals. The convexity of the debitage surface of a core may be perpetuated by continually removing flakes from the whole circumference or periphery of a core. If such removals meet in the center of the debitage surface without leaving a mass too large to remove with subsequent removals, this management option allows the continuation of exploitation until exhaustion.

3. Frontal crests. The convexity of the debitage surface of a core may be both created and perpetuated by establishing a central ridge or crest, through the removal of a line of flakes, down the long axis of the debitage surface. This crest, which may be either bifacial or unifacial, serves as the arise or nervure-guide (sensu Bordes 1961; Boéda 1986; Van Peer 1992) down which the force of a flintknapper’s blow can propagate to remove a flake. This crested removal leaves two ridges, its lateral edges, which can serve as nervure-guides for subsequent removals. This technique may be used to commence exploitation of a core or to repair the longitudinal convexity of a reduction in progress.
4. Lateral crests. This convexity management option utilizes the same principles as the frontal crest but is not created on the front of a debitage surface but behind one. By choosing to create two lateral crests, or crête arrières (Tixier 1984), on either side of a debitage surface, it is possible to narrow the debitage surface and thus manage its lateral convexity by means of removals from these lateral crests up the sides of the core.

5. Side blade removals. This convexity management option is relatively rare and represents an alteration of the reduction strategy from the use of a relatively broad debitage surface, which may be exhausted or irreparable, to the use of the lateral edge of this broad surface. In some ways, this option consists of removing numerous débordant flakes or blades from a surface situated on the side of the original surface.

The identification of which convexity management option is characteristic of a particular assemblage is made through an examination of the cores themselves and refits when available. A few products can be suggestive of one of the options, but they are usually not exclusively diagnostic. For instance, éclats débordants may share the same morphology with frontal crested blades and lateral crested blades despite their distinct roles in core reduction.

**DOMAIN 2. PLATFORM MAINTENANCE**

The knapping domain, known as "platform maintenance," includes the steps whereby the flintknapper modifies the platform surface and platform edge before each removal.

**STEP 1. DEBITAGE PLATFORM TREATMENT**

Platform treatment, whether prepared, abraded, or unprepared, changes the exterior angle of the platform and thus affects the resulting mass of the flake. Many treatment options are available (Inizan, Roche, and Tixier 1992:79–82), including the following ten platform treatment types:

1. Plain. One scar serves as the platform surface.
2. Cortical. No treatment of the platform surface as the majority of the platform consists of cortex.
3. Dihedral. Two scars serve as the platform surface.
4. Faceted. Three or more regular scars, originating from the top of the platform, serve as the platform surface.
5. Chapeau de gendarme. A faceted platform which, when seen face-on, possesses a symmetrical profile of two ridges with a valley between (Inizan, Roche, and Tixier 1992:80).
6. Scarred. Three or more irregular scars, not necessarily originating from the top of the platform, serve as the platform surface.
7. Punctiform. A tiny point, of a millimeter or two in thickness, represents the whole platform surface.
8. Linear. A thin scar, of a millimeter or two in thickness, represents the whole platform surface.
9. Removed. Platform surface is sufficiently removed by retouch to prevent a clear identification.
10. Broken/crushed. Platform surface is damaged by postdepositional forces or during the removal of the piece, sufficient to prevent a clear identification.

For pair-wise comparisons between assemblages, the choice of platform treatment for a particular assemblage is represented by the relative frequency of blanks with “prepared” platforms (types 3–6) versus “unprepared” platforms (types 1–2, 7–8). The comparison is standardized by means of a G likelihood ratio test (approximating the chi-square distribution) (Sokal and Rohlf 1995:686–697) between these frequencies.

**STEP 2. EXTERIOR PLATFORM ANGLE**

A flintknapper controls the exterior platform angle—the angle between the dorsal surface and the platform surface—in order to affect, with the platform thickness, the mass or size of the flake to be struck off the core (see Dibble and Pelcin 1995). The assemblage-wide choices of treatment of the exterior platform angle are characterized for the present study by means of the central tendency statistic, the mean and standard deviation of the individual exterior platform angle (EPA) measurements for intact blanks, and proximal fragments. The EPA is taken with a goniometer immediately behind the point of percussion visible on the platform surface (Dibble and Pelcin 1995; Dibble 1997). The EPA is the extant angle and thus, by means of beveling or the removal of small flakes behind the platform, may measure greater than 90 degrees.
STEP 3. PLATFORM THICKNESS

A flintknapper controls the platform thickness—the distance into the platform from the edge of the dorsal surface where the point of percussion falls—in order to affect, with the exterior platform angle, the mass or size of the flake to be struck off the core (see Dibble and Pelcin 1995; Dibble 1997). The assemblage-wide choices of platform thickness are characterized for the present study by means of the central tendency statistic: the mean and standard deviation of the individual platform thickness (PT) measurements for intact blanks and proximal fragments. PT is taken with a digital caliper immediately behind the point of percussion visible on the platform surface, perpendicular to the flake surface.

DOMAIN 3. DIRECTION OF CORE EXPLOITATION

The direction of core exploitation, the third behavioral domain used in this study, concerns the variability resulting from different options for removing flakes from single to multiple platform cores, creating debitage with particular dorsal scar patterns. Theoretically, the dominant directional strategy used in each assemblage may be characterized by the relative frequencies of different dorsal scar patterns evidenced among the debitage as well as cores in the assemblage. Dibble’s (1995) problem with Boča’s reconstruction of level IIa from Biache Saint-Vaast (1988), however, serves as a warning against the straight typology of either debitage or core scar patterns. The reduction strategy in an assemblage may drastically change as a core becomes exhausted.

For this study, therefore, the dominant direction of core exploitation is determined using the principles of dimensional change during core reduction (Holmes 1919; Frison 1968; Newcomer 1971; Collins 1975; Jelinek 1976; Stahle and Dunn 1982; Henry 1989; Dibble 1987) and cortical change of debitage during core reduction (Sullivan and Rosen 1985; Geneste 1985; Mauldin and Amick 1989; Baumler 1988; Ahler 1989a, 1989b; Dibble 1995). As a core is reduced, it becomes shorter due to platform rejuvenation and the general subtractive nature of flintknapping. As the core gets shorter, so do the flakes struck off the cores. Thus, assuming that the general trend is for longer blanks to be produced earlier in core reduction and shorter blanks to be produced later, with the understanding that no particular blank can be absolutely placed in a stage of reduction based on its length, a correlation between debitage length and debitage dorsal scar pattern in an assemblage can indicate whether a change of directional strategy occurred during the continued reduction of the cores. A similar correlation exists between debitage pieces with high versus low amounts of cortex and the relative position of the piece earlier and later in the process of core reduction.

STEP 1. DIRECTION OF CORTEX REMOVAL

Cortex removal may or may not be a separate step in a given lithic operational sequence. If undertaken, however, a cross-tabulation between the percentage of cortex for cortical debitage and the dorsal scar pattern on that debitage indicates any change in the direction of core exploitation as reduction continues (Baumler 1988). By their very nature, flakes with a percentage of cortex as high as 99–91 percent are less likely to evidence many dorsal scars, so these flakes tend to have a unidirectional scar pattern regardless of the use of an alternative pattern of reduction. Pieces with less cortex, and thus more dorsal scars, however, are clearer indicators of the existence of a particular reduction pattern during decortication.

STEP 2. DIRECTION OF BLANK REMOVAL

Similarly, a cross-tabulation between blank length and dorsal scar pattern of noncortical blanks indicates any change in the direction of core exploitation as reduction continues. Any tendency in core scar patterns can serve as corroborating of the debitage data, but this is of minor importance given the propensity of exhausted cores to be unrepresentative of the majority of core exploitation. The following attributes are needed to perform these analyses:

1. Percentage cortex. The dorsal surface of debitage blanks, excluding the platform, may be said to be covered in cortex, including old patinated and incipient fractures given the type and condition of the raw material, in the following proportions: (a) 0 percent; (b) 1–10 percent; (c) 11–40 percent; (d) 41–60 percent; (e) 61–90 percent; (f) 91–99 percent; (g) 100 percent (Dibble 1995)

2. Direction and number of scars per blank sector. Each debitage blank is conceptually divided into four sectors (A–D; see fig. 8.1; Crew 1975; Meignen and Bar-Yosef 1988; Baumler 1988). Within each sector of the blank, the number of scars from directions A (distal), B (right lateral), C (proximate), and D (left lateral) are noted, using ripples and hackles or lancettes as indicators of scar directions.
3. Dorsal scar pattern. Using the observations of the number and direction of scars on the dorsal surface by sector to interpret the scar pattern for the whole piece, we can place each blank into one of the following attribute states (Volkman 1989; Meignen, personal communication):

a. Unidirectional. All scars come from the proximal part of the flake, sector C.
b. Unidirectional convergent. All scars converge from the intersection of sectors B and D with sector C toward the distal end of the piece. This category may be subsumed within the preceding "unidirectional" category.
c. Bidirectional. Scars come from both the proximal and distal ends of the flake, sectors A and C.
d. Crossed. At least one scar originates from one of the lateral directions, sectors B and D. The flake may only have lateral scars or it may have some proximal scars as well.
e. Subcentripetal. Scars originate from three sectors, including the direction of flake propagation.

If it is impossible to distinguish between two directions during the reading of a given scar and both of those directions are already accounted for by other scars, a specific interpretation other than "unknown" is warranted.

The number of dorsal scars on debitage blanks is an important consideration for the analysis of both steps within this domain. Flakes with few dorsal scars are less likely to evidence the more complex directional reduction options. For instance, a flake with two scars can only evidence unidirectional, bidirectional, crossed, or subcentripetal reduction directions (subcentripetal in this case is only possible if the direction of flake propagation is different from the two dorsal scars). Thus, a centripetal option cannot be evidenced on a flake with fewer than three dorsal scars. In order to avoid biasing the analyses of these two steps in favor of the simpler directional reduction strategies, we have used only flakes with three or more dorsal scars to illustrate the change of dorsal scar pattern as debitage decreases in size and cortex decreases in percentage of dorsal surface covered.

**DOMAIN 4. DORSAL SURFACE CONVEXITY SYSTEM**

A flintknapper chooses the mass of each flake he or she strikes off of a core by controlling the interaction between the exterior platform angle and the platform thickness. He or she also has an independent choice of which pattern of ridges between scars on the exterior of the core to exploit for each flake removal. The nerve-guide, or ridge pattern, defines the convexity of the core surface, and therefore determines how the force of the flintknapper's hammer blow exits the core along the ridges and produces the desired flake (sensu Bordes 1961; Boèda 1986; Van Peer 1992). Thus, this choice of where to strike the core relative to the extant ridge pattern is one of the fundamental decision-events in the flintknapping operational sequence. A categorical attribute based on the pattern of the ridges themselves is currently inadvisable, as the extreme variability does not lend itself to easy characterization or interassemblage comparison. It is possible, however, to quantify the behavioral choices made by flintknappers in the course of controlling the ridge system through the four attributes described below.

**STEP 1. LONGITUDINAL CONVEXITY: DEBITAGE LAMINARITY**

The ratio of debitage blank length to width serves as an analytical proxy for flintknappers' behavioral tendencies to select longitudinal ridge patterns for debitage production (resulting in products of blade dimensions) versus dispersed ridge patterns (resulting in products of flake dimensions). Thus, high laminarity (great length compared to width) is an indicator of selection for a ridge pattern in which the convexity is distributed along the longitudinal axis, that is, the distal to proximal axis. Low laminarity (great width compared to the length) is thus an indicator of selection for a ridge pattern in which the convexity is distributed along the lateral (right to left) axis. In interassemblage comparisons, the mean and standard deviation of the length/width ratio is used in a student's t-test between the assemblages.

Note that debitage length is measured with a digital caliper, as the maximum distance along the axis of flake propagation, "from the proximal to distal end along a line perpendicular to striking platform width" (Andrefsky 1998: figure 5.8c). Debitage width is measured at the midpoint of the length, perpendicular to the axis of flake propagation (Bergman 1987).
STEP 2. SHAPE OF CONVEXITY: DEBITAGE LATERAL EDGES

The categorization of the lateral edge shapes evidenced in an assemblage serves as an analytical proxy for flintknappers’ tendencies to choose to strike along particularly shaped convexities, for instance, convexities produced by the exploitation of parallel, convergent, expanding, or diffuse ridge patterns. The significance of different options utilized for this behavioral step in two assemblages is determined through a G likelihood ratio test. The five debitage lateral edge types (based on Bergman 1987) are as follows:

1. Parallel. Edges are parallel for the majority of the blank length.
2. Converging. Edges converge toward the distal end of the piece for the majority of the blank length.
3. Expanding. Edges are divergent, expanding toward the distal end of the piece for the majority of the blank length.
4. Ovoid. Edges both expand and converge, producing rounded lateral edges.
5. Unknown. Piece is too retouched, broken, or has insufficient regularity to fit into typology.

STEP 3. CURVATURE OF CONVEXITY: DEBITAGE PROFILE

The categorization of the longitudinal profile of debitage pieces evidenced in an assemblage serves as an analytical proxy for the flintknappers’ behavioral tendencies to utilize flat, curved, or twisted longitudinal convexities on core surfaces for debitage production. The significance of different options utilized for this behavioral step in two assemblages is determined through a G likelihood ratio test. The debitage profile types are the following:

1. Straight. This attribute-state depends upon a measure of the curvature of the blank profile, that is, the distance between the midpoint of the length on the ventral surface of the piece to the top of the table surface on which the distal and proximal tips rest. For straight profiles, this measurement does not exceed one-eighth of the blank length.
2. Curved. The curvature measurement exceeds one-eighth of the blank length.
3. Concorde-type (sensu Meignen and Bar-Yosef 1991). The distal-most one-third of the blank length bends down at a striking angle. This attribute-state can be subsumed under “curved” in general comparisons.
4. Twisted to left. Distal tip of the piece is twisted at least 45 degrees to the left of a flat profile.
5. Twisted to right. Distal tip of the piece is twisted at least 45 degrees to the right of a flat profile.
   This attribute-state can be subsumed with “twisted left” into a general category.
6. Unknown. Piece is too retouched, broken, or has insufficient regularity to fit into typology.

STEP 4. LATERAL CONVEXITY: DEBITAGE CROSS-SECTION

The categorization of the cross section of debitage pieces evidenced in an assemblage serves as an analytical proxy for the behavioral tendencies to utilize convexities defined by one versus two or more ridges as nervures-guides in the propagation of debitage products. This attribute is assessed at the midpoint of the blank length. The significance of different options utilized for this behavioral step in two assemblages is determined through a G likelihood ratio test. The debitage cross-section types (Meignen, personal communication, 1995) are as follows:

1. Triangular. Effectively only one ridge present on the dorsal surface.
2. Right-triangular. One lateral edge is vertical in cross section and serves as the only dorsal ridge.
3. Trapezoidal. Effectively two or more ridges present on the dorsal surface.
4. Lenticoidal. No dorsal ridges present. Cross-section convexity is similar to a lens.
5. Domed. Multiple ridges form an extremely convex, almost hemispherical cross section.
6. Unknown. Piece too retouched, broken, or has insufficient regularity to fit into typology.

For more generalized comparisons between assemblages, types 4 and 5 can be subsumed into an “other” category, and types 1 and 2 may be subsumed into a general “triangular” type.

STEP 5. VERTICAL CONVEXITY

The ratio of debitage blank width to thickness serves as an analytical proxy for flintknappers’ tendencies to utilize tall, laterally-centralized convexities versus flat, laterally-diffuse convexities. This approach to evaluating debitage convexities quantifies the volumetric conception (sensu Boëda 1994) of the debitage production
within an assemblage. In interassemblage comparisons, the mean and standard deviation of the width/thickness ratio is used in a student's t-test between the assemblages. Note that debitage thickness is measured at the midpoint of the length, perpendicular to both the axis of flake propagation and blank width.

**DOMAIN 5. TOOL MANUFACTURE**

The final domain in the lithic operational sequence for the present research is "tool manufacture." The first fourteen steps within this domain consist of the knappers' selection of particular blank types to retouch into tools. The last two steps within the domain relate to qualitative issues of retouch, such as how the cutting edges and/or hafting surfaces are shaped by retouch. Because tool manufacture directly affects the working edge of stone tools, this domain is expected to show more influence than others from differences in the functional utility of different tool forms. Yet significant tradition-sensitive variation is also likely to be present, given the broad variations in tool manufacture behavior across many similar environments in western Eurasia. This fact is reflected in the higher number of steps within the tool manufacture domain, proportionally lessening each step's significance in a quantitative evaluation of the tradition-sensitive steps of the operational sequence.

**STEPS 1–14. BLANK SELECTION CRITERIA:**

The potential selection criteria include dimensions as well as shape attributes. For each assemblage, each potential criterion for blank selection is statistically tested for deviation between the tool sample and the debitage sample using student's t-tests and G likelihood ratio tests where appropriate. Fisher's Exact Test (Sokal and Rohlf 1995:730–736) is used in four-cell cross-tabulations when the G likelihood ratio becomes inappropriate. The counts and frequencies used for each test do not include indeterminate pieces for each attribute. The blank criteria include previously defined attributes (blank lamination, length, width, thickness, dorsal scar pattern, presence or absence of cortex, lateral edges, profile, cross section, platform type or presence/absence of preparation, and EPA/PT ratio) and three other attributes. These three attributes are as follows:

1. **Axis of propagation** (Bergman 1987). Propagation of flakes reflects the dorsal surface convexities of the core and is often preserved on retouched tools, unlike many technological attributes.

2. **Distal terminus** (Bergman 1987). The distal end of a flake is often a functional edge and this attribute represents selection for a particular type of edge.

   a. **Blunt.** Dorsal view of the distal end of the flake is blunt. This attribute-state includes feathered terminations and vertical terminations.

   b. **Pointed.** Dorsal view of the distal end of the flake is pointed. This attribute-state includes feathered terminations and vertical terminations.

3. **Impact placement.** This attribute describes the knappers' choices to follow or not to follow dorsal surface ridges immediately behind the platform. Of similar attributes that represent some of the variability of the nervure-guide system, this attribute is most often preserved on retouched tools and so is a better choice for evaluating blank selection criteria pertinent to the dorsal surface convexity system. This attribute was recorded for some assemblages included in this study but not for SS-IIIc or SS-IIIId.

   a. **On-ridge.** Point of percussion on the platform lies immediately behind a ridge on the dorsal surface of the flake. This ridge must intersect the platform–dorsal surface edge.

   b. **Off-ridge.** Point of percussion on the platform does not lie immediately behind a ridge on the dorsal surface of the flake. This attribute-state includes those pieces with a point of percussion between two ridges.

   c. **Flat-scar.** The juncture between the platform and dorsal surfaces has no ridges.

**STEP 15. APPLICATION OF UNIQUE RETOUCH**

This behavioral category differentiates flintknappers' choices of retouch types. The characterization of this choice is a qualitative operation, to be sure, but it is potentially meaningful given the appearance of such
different retouch applications as the flat bifacial retouch of the central European Micoquian and Szeletian industries (Allsworth-Jones 1986, 1989; Valoch 1990b), the carinated retouch of Aurignacian industries, and the Quina-type retouch of certain Mousterian industries.

**STEP 16. LOCATION OF RETOUCH**

Flintknappers' tendencies to choose particular locations for the application of retouch is gauged according to the types defined in Bordes' (1961) and Hours' (1974) type-lists for the Lower and Middle Paleolithic versus the Upper and Epi-Paleolithic respectively. The present analysis did not oppose the two type-lists, as this would negate the effort to avoid reifying analytical categories. The two lists were used solely to corroborate the published type-lists for each assemblage. The characterization of each assemblage as dominated by Middle or Upper Paleolithic types was made using the published type-lists. For Ss-IIIc and Ss-IIId, please refer to Svo-boda (chap. 2, this volume).

**ATTRIBUTE ANALYSIS OF THE TECHNOLOGY OF SS-IIIc**

**GENERAL DESCRIPTION OF THE ASSEMBLAGE**

During the 1997 and 1999 field seasons at the Ss-IIIc locality, situated to the north and up-slope from the original locality of Ss-IIIa (see fig. 1.8), 2,495 objects were provenienced in three dimensions within the matrix of the lower Bohunician paleosol of Layer 5 (table 8.1). Of these 2,495 objects, 45 later proved to be unworked, naturally occurring Stránská skála hornstone, 494 were described as gelifica to denote the analyst's inability to recognize human activity on the piece due to postdepositional frost-fracture, and 314 pieces were described as shatter due to the inability to orient the flake debris despite evidence of human alteration of the pieces.

Table 8.1 presents a general description of the object types comprising the assemblage. Of the 2,495 objects provenienced, 1,488 lithic artifacts were studied in detail for the present attribute analysis, although most analyses were suitable for only the complete flakes and tools of the assemblage (n = 731). Table 8.2 presents a categorization of the debitage types in the assemblage for complete flakes and tools. The overall nature of the artifacts, the number of blades and Levallois products, and the presence of crested pieces confirms the industrial affiliation of this assemblage as "Bohunician" as defined by Valoch (1976), Oliva (1984), and Svo-boda (1987).

The radiocarbon date of 38,300±1,100 B.P. (AA-32058; please note that this date is uncalibrated as are all other dates in this chapter) from this locality associates the assemblage with the later portion of the Bohunician occupation of the Brno Basin.

Although it has long been recognized that the Strán-ská skála localities are situated on top of an abundant supply of Jurassic hornstone raw material (Svo-boda 1980, 1983), attribute analysis of the assemblage confirms the interpretation of Ss-IIIc as a raw material workshop. Raw material extraction, initial core preparation, and substantial core reduction occurred on site. The abundance of cortical flakes (table 8.3; cortical pieces represent 60.2% of the complete flakes and tools) clearly indicates that primary core preparation occurred on site. The almost equal percentages of cores versus debitage by weight (table 8.4; 38.4% and 37.5% respectively) and the paucity of tools (table 8.1; 201 tools/1,173 flakes/114 cores) indicates that neither cores nor tools were extensively reduced, corroborating the interpretation that the Ss-IIIc locality was not a hunting-specific retooling camp.

<table>
<thead>
<tr>
<th>Object</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flakes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete</td>
<td>638</td>
<td>25.6</td>
</tr>
<tr>
<td>Proximal fragments</td>
<td>258</td>
<td>10.3</td>
</tr>
<tr>
<td>Medial fragment</td>
<td>86</td>
<td>3.4</td>
</tr>
<tr>
<td>Distal fragments</td>
<td>191</td>
<td>7.7</td>
</tr>
<tr>
<td>Tools</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete</td>
<td>93</td>
<td>3.7</td>
</tr>
<tr>
<td>Proximal fragments</td>
<td>31</td>
<td>1.2</td>
</tr>
<tr>
<td>Medial fragment</td>
<td>62</td>
<td>2.5</td>
</tr>
<tr>
<td>Distal fragments</td>
<td>15</td>
<td>.6</td>
</tr>
<tr>
<td>Cores</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete</td>
<td>51</td>
<td>2.0</td>
</tr>
<tr>
<td>Fragments</td>
<td>63</td>
<td>2.5</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shatter</td>
<td>314</td>
<td>12.6</td>
</tr>
<tr>
<td>Too small (&lt; 2.0 cm)</td>
<td>136</td>
<td>5.4</td>
</tr>
<tr>
<td>Gelifrac</td>
<td>494</td>
<td>19.8</td>
</tr>
<tr>
<td>Hammerstone</td>
<td>5</td>
<td>.2</td>
</tr>
<tr>
<td>Limonite</td>
<td>2</td>
<td>.1</td>
</tr>
<tr>
<td>Ochre</td>
<td>3</td>
<td>.1</td>
</tr>
<tr>
<td>Manuports</td>
<td>8</td>
<td>.3</td>
</tr>
<tr>
<td>Unworked</td>
<td>45</td>
<td>1.8</td>
</tr>
<tr>
<td>Total</td>
<td>2,495</td>
<td>99.8</td>
</tr>
</tbody>
</table>
SS-IIIC OPERATIONAL SEQUENCE

The following presentation of the results of the attribute analysis is conducted according to the five domains and their respective steps as defined above.

CORE MODIFICATION DOMAIN

The first domain, core modification, concerns the initial removals of flakes that delineate the knapping surfaces of the core. The first step in this domain, core orientation, is characterized by the distinction between different core forms, based upon an examination of extant core morphology (table 8.5; see also Skrdla, chap. 7, this volume) and an evaluation of where platforms were located during most of core exploitation. Table 8.6 presents the cumulative, assemblage-wide tendency for bulbar negatives to appear on given core surfaces (Surface 1, Surface 2, and Surface 3) and within given core sectors (A, B, C, and D). In the case of SS-IIIC, it is clear that bulbar negatives are much more frequent on Surface 1 than on Surface 2, with hardly any bulbar negatives on a third surface. Table 8.7, showing the number of scars within each core sector that originated from the direction of that sector, corroborates the view that core sector 1A served as a dominant direction for reduction, with sector 1C serving as a secondary exploitation direction, at least in extant cores. The data on scars from direction A on Surface 2 (i.e., 2A) show fewer cores with high numbers of scars in this sector than in IC, suggesting that the 2A scars are platform preparation scars for the removals of 1A. In all, core modification in SS-IIIC entails a longitudinal blade Flake core orientation, as evidenced in the identification of the narrow and long core face as the primary debitage surface in the assemblage.

The second step in this domain, core management, includes the knapping options that allow the knapper to continue reducing the core form to exhaustion through specific modifications of the surface convexities. In the case of SS-IIIC, core management utilized lateral débordant removals and, in particular instances, the subsequent removal of blades from the narrow side of the core, situated 90 degrees to the previous surface, after the flattening of the front face of the core. This is a peculiarity of the Bohunician industry (see Ginter et al. 1996). This is adequately evidenced in the core morphologies (table 8.5) and Skrdla’s refittings (chap. 7 this volume).

<table>
<thead>
<tr>
<th>Debitage type</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flakes</td>
<td>421</td>
<td>57.6</td>
</tr>
<tr>
<td>Blades</td>
<td>166</td>
<td>22.7</td>
</tr>
<tr>
<td>Levallois products</td>
<td>38</td>
<td>5.2</td>
</tr>
<tr>
<td>Crested</td>
<td>89</td>
<td>12.2</td>
</tr>
<tr>
<td>Core trimming elements</td>
<td>17</td>
<td>2.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>731</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Table 8.3
SS-IIIC, percentage of cortex on dorsal surface of complete flakes and tools.

<table>
<thead>
<tr>
<th>Percent of cortex</th>
<th>Frequency</th>
<th>Percent of assemblage</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>29</td>
<td>4.0</td>
</tr>
<tr>
<td>99–91%</td>
<td>17</td>
<td>2.3</td>
</tr>
<tr>
<td>90–61%</td>
<td>68</td>
<td>9.3</td>
</tr>
<tr>
<td>60–41%</td>
<td>73</td>
<td>10.0</td>
</tr>
<tr>
<td>40–11%</td>
<td>183</td>
<td>25.0</td>
</tr>
<tr>
<td>10–1%</td>
<td>70</td>
<td>9.6</td>
</tr>
<tr>
<td>0%</td>
<td>291</td>
<td>39.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>731</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Table 8.4
SS-IIIC, weight of lithic artifacts by type (to nearest gram).

<table>
<thead>
<tr>
<th>Artifact type</th>
<th>Mean</th>
<th>N</th>
<th>Standard deviation</th>
<th>Sum</th>
<th>% of total sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flakes</td>
<td>5.76</td>
<td>1,173</td>
<td>7.10</td>
<td>6,756</td>
<td>37.5</td>
</tr>
<tr>
<td>Tools</td>
<td>9.56</td>
<td>201</td>
<td>13.66</td>
<td>1,922</td>
<td>10.7</td>
</tr>
<tr>
<td>Cores</td>
<td>60.74</td>
<td>114</td>
<td>49.74</td>
<td>6,924</td>
<td>38.4</td>
</tr>
<tr>
<td>Shatter</td>
<td>7.70</td>
<td>314</td>
<td>11.24</td>
<td>2,417</td>
<td>13.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>10.00</td>
<td>1,802</td>
<td>20.16</td>
<td>18,019</td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

PLATFORM MAINTENANCE

The next knapping domain, platform maintenance, includes the steps whereby the flintknapper modifies the platform surface and platform edge before each removal. These steps include platform treatment options, external platform angle, and platform thickness. Platform maintenance in SS-IIIC includes a good amount of platform preparation, up to 42 percent of the debitage (table 8.8). Measurements of external platform angles (table 8.9)
Table 8.5
Ss-IIIc, core types, based on extant core morphology.

<table>
<thead>
<tr>
<th>Core type</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>One platform</td>
<td>11</td>
<td>21.6</td>
</tr>
<tr>
<td>Opposed platform</td>
<td>18</td>
<td>35.3</td>
</tr>
<tr>
<td>One platform Levallois</td>
<td>1</td>
<td>2.0</td>
</tr>
<tr>
<td>Opposed platform Levallois</td>
<td>2</td>
<td>3.9</td>
</tr>
<tr>
<td>Crossed</td>
<td>1</td>
<td>2.0</td>
</tr>
<tr>
<td>Discoidal</td>
<td>5</td>
<td>9.8</td>
</tr>
<tr>
<td>Head-foot</td>
<td>1</td>
<td>2.0</td>
</tr>
<tr>
<td>Multisurface</td>
<td>3</td>
<td>5.9</td>
</tr>
<tr>
<td>Tested nodule</td>
<td>9</td>
<td>17.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>51</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Table 8.6
Ss-IIIc, percentage of intact cores (n = 51) by number of bulbar negatives on each core surface.

<table>
<thead>
<tr>
<th>Number of bulbar negatives</th>
<th>Core surface 1</th>
<th>Core surface 2</th>
<th>Core surface 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>.0</td>
<td>35.3</td>
<td>84.3</td>
</tr>
<tr>
<td>1</td>
<td>13.7</td>
<td>27.5</td>
<td>9.8</td>
</tr>
<tr>
<td>2</td>
<td>25.5</td>
<td>17.7</td>
<td>5.9</td>
</tr>
<tr>
<td>3</td>
<td>19.6</td>
<td>13.7</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>13.7</td>
<td>5.8</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>17.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>2.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>2.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>3.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8.7
Ss-IIIc, core sector preparation. Percent of intact cores (n = 51) by number of scars in sector of origin (A, B, C, D) by surface (1, 2, 3).

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>.0</td>
<td>78.4</td>
<td>49.0</td>
<td>84.3</td>
<td>43.1</td>
<td>76.5</td>
<td>84.3</td>
<td>80.4</td>
<td>86.3</td>
<td>100.0</td>
<td>98.0</td>
<td>98.0</td>
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<tr>
<td>1</td>
<td>13.7</td>
<td>17.6</td>
<td>7.7</td>
<td>5.9</td>
<td>15.7</td>
<td>13.7</td>
<td>3.9</td>
<td>9.7</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>2</td>
<td>9.8</td>
<td>.0</td>
<td>11.8</td>
<td>3.9</td>
<td>25.5</td>
<td>3.9</td>
<td>5.9</td>
<td>3.9</td>
<td>3.9</td>
<td>2.0</td>
<td>2.0</td>
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</tr>
<tr>
<td>3</td>
<td>13.7</td>
<td>4.0</td>
<td>11.8</td>
<td>2.0</td>
<td>7.8</td>
<td>3.9</td>
<td>3.9</td>
<td>7.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>19.6</td>
<td>7.7</td>
<td>3.9</td>
<td>5.9</td>
<td>2.0</td>
<td>.0</td>
<td>2.0</td>
<td>2.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>23.5</td>
<td>2.0</td>
<td>.0</td>
<td>.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>9.8</td>
<td>2.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>7</td>
<td>2.0</td>
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<td>8</td>
<td>2.0</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;10</td>
<td>5.9</td>
<td>2.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8.8
Ss-IIIc, platform types for complete and proximal fragments of flakes and tools.

<table>
<thead>
<tr>
<th>Platform type</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain</td>
<td>337</td>
<td>33.0</td>
</tr>
<tr>
<td>Cortical</td>
<td>78</td>
<td>7.6</td>
</tr>
<tr>
<td>Dihedral</td>
<td>69</td>
<td>6.8</td>
</tr>
<tr>
<td>Faceted</td>
<td>117</td>
<td>11.5</td>
</tr>
<tr>
<td>Chapeau</td>
<td>3</td>
<td>0.3</td>
</tr>
<tr>
<td>Scarred</td>
<td>134</td>
<td>13.1</td>
</tr>
<tr>
<td>Punctiform</td>
<td>8</td>
<td>0.8</td>
</tr>
<tr>
<td>Linear</td>
<td>21</td>
<td>2.1</td>
</tr>
<tr>
<td>Removed</td>
<td>9</td>
<td>0.9</td>
</tr>
<tr>
<td>Indeterminate</td>
<td>244</td>
<td>23.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,020</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Table 8.9
Ss-IIIc, external platform angle (degrees) descriptive statistics for all intact platforms.

<table>
<thead>
<tr>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>664</td>
<td>33</td>
<td>138</td>
<td>84.93</td>
<td>15.05</td>
</tr>
</tbody>
</table>

Table 8.10
Ss-IIIc, platform thickness (mm) descriptive statistics for all intact platforms.

<table>
<thead>
<tr>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>741</td>
<td>0.4</td>
<td>18.3</td>
<td>4.55</td>
<td>2.52</td>
</tr>
</tbody>
</table>
Table 8.11
Ss-IIIC, presence of platform lipping.

<table>
<thead>
<tr>
<th>Platform lipping</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lipped</td>
<td>312</td>
<td>41.4</td>
</tr>
<tr>
<td>Not lipped</td>
<td>442</td>
<td>58.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>754</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

and platform thickness (table 8.10) indicate tendencies around 85 degrees and 4.6 mm respectively. Over 40 percent of platforms are lipped (table 8.11). Although not sufficient as an indicator of soft hammer percussion (Ohnuma and Bergman 1982), lipped platforms are suggestive of the use of soft hammer in this assemblage.

**Direction of Core Exploitation**

The next knapping domain, direction of core exploitation, concerns the variability resulting from different options of removing flakes from single- to multiple-platform cores, creating debitage with particular dorsal scar patterns. The dominant strategy used in the assemblage was determined using the principles of cortical change of debitage during core reduction and dimensional change during core reduction. Table 8.12 presents the cross-tabulation of debitage and tools according to percentage of cortex and dorsal scar pattern for all categories. By removing the debitage and tools with dorsal scar patterns noted as indeterminate to clarify the pattern, it is possible to see (table 8.13 and fig. 8.2) that blanks with the most cortex were produced unidirectionally (here laying aside the 99 to 91% cortex flakes due to the small sample size), while crossed scar patterns (i.e., one lateral direction plus the direction of the flake propagation) became dominant as the percentage of cortex decreased. This trend in the cortex-dorsal scar pattern data suggests a shift of direction of exploitation during the decortication of the cores.

The second behavioral step in this domain is the direction of blank exploitation, that is, the removal of noncortical pieces. Table 8.14 shows the cross-tabulation of debitage and tools according to dorsal scar pattern and blank length (separated into quartiles so that one quarter of the sample population lies within each of the four length ranges). By removing the debitage and tools with dorsal scar patterns noted as indeterminate to clarify the pattern, it is possible to see (table 8.15) that the largest noncortical blanks are bidirectional, while the smaller ones are unidirectional, suggesting a shift from bidirectional reduction at the beginning of core exploitation to unidirectional reduction at the end of core exploitation (fig. 8.3).

Table 8.12
Ss-IIIC, dorsal scar pattern by percent of cortex for complete flakes and tools (excluding flakes with fewer than three scars).

<table>
<thead>
<tr>
<th>Pattern</th>
<th>99–91%</th>
<th>90–61%</th>
<th>60–41%</th>
<th>40–11%</th>
<th>10–1%</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unidirectional:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Count</td>
<td>2</td>
<td>11</td>
<td>13</td>
<td>41</td>
<td>12</td>
<td>79</td>
</tr>
<tr>
<td>% within cortex</td>
<td>40.0</td>
<td>32.4</td>
<td>27.1</td>
<td>27.3</td>
<td>18.5</td>
<td>26.2</td>
</tr>
<tr>
<td><strong>Bidirectional:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Count</td>
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<td>20.8</td>
<td>16.7</td>
<td>15.4</td>
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</tr>
<tr>
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<td></td>
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</tr>
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<td>22.9</td>
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<tr>
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<td>8.8</td>
<td>10.4</td>
<td>19.3</td>
<td>16.9</td>
<td>16.6</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>4</td>
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<td>7</td>
</tr>
<tr>
<td>% within cortex</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2.7</td>
<td>4.6</td>
<td>2.3</td>
</tr>
<tr>
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<td></td>
<td></td>
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</tr>
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<td>14.0</td>
<td>20.0</td>
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<td>150</td>
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<td>100.0</td>
<td>100.0</td>
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</tr>
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</table>
Table 8.13
Ss-IIIC, dorsal scar pattern by percent of cortex for complete flakes and tools (excluding indeterminates and flakes with fewer than three scars).

<table>
<thead>
<tr>
<th>Pattern</th>
<th>99–91%</th>
<th>90–61%</th>
<th>60–41%</th>
<th>40–11%</th>
<th>10–1%</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Count</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Unidirectional:</td>
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<td>11</td>
<td>13</td>
<td>41</td>
<td>12</td>
<td>79</td>
</tr>
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<td>40.0</td>
<td>36.7</td>
<td>33.3</td>
<td>31.8</td>
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<td>52</td>
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<td>20.0</td>
<td>20.0</td>
<td>25.6</td>
<td>19.4</td>
<td>19.2</td>
<td>20.4</td>
</tr>
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<td>11</td>
<td>30</td>
<td>16</td>
<td>67</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>33.3</td>
<td>28.2</td>
<td>23.3</td>
<td>30.8</td>
<td>26.3</td>
</tr>
<tr>
<td>Subcentripetal:</td>
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<td>3</td>
<td>5</td>
<td>29</td>
<td>11</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>40.0</td>
<td>10.0</td>
<td>12.8</td>
<td>22.5</td>
<td>21.2</td>
<td>19.6</td>
</tr>
<tr>
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<td>0</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>7</td>
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<td></td>
<td>-</td>
<td>-</td>
<td>0</td>
<td>3.1</td>
<td>5.8</td>
<td>2.7</td>
</tr>
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<td>Total:</td>
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<td>40</td>
<td>129</td>
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<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
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<tr>
<td>% within cortex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 8.2
Ss-IIIC, dorsal scar pattern by percent cortex (for complete flakes and tools, except for indeterminates and flakes with fewer than three scars).
Table 8.14
Ss-IIIC, dorsal scar pattern by blank length (mm) by quartiles cross-tabulation for complete non-cortical flakes and tools (excluding flakes with fewer than three scars).

<table>
<thead>
<tr>
<th>Pattern</th>
<th>&gt;44</th>
<th>44–36</th>
<th>36–27</th>
<th>&lt;27</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td>Unidirectional:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Count</td>
<td>11</td>
<td>12</td>
<td>11</td>
<td>18</td>
<td>52</td>
</tr>
<tr>
<td>% within quartiles</td>
<td>16.4</td>
<td>17.6</td>
<td>16.4</td>
<td>26.9</td>
<td>19.3</td>
</tr>
<tr>
<td>Bidirectional:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Count</td>
<td>19</td>
<td>16</td>
<td>13</td>
<td>5</td>
<td>53</td>
</tr>
<tr>
<td>% within quartiles</td>
<td>28.4</td>
<td>23.5</td>
<td>19.4</td>
<td>7.5</td>
<td>19.7</td>
</tr>
<tr>
<td>Crossed:</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Count</td>
<td>5</td>
<td>11</td>
<td>13</td>
<td>12</td>
<td>41</td>
</tr>
<tr>
<td>% within quartiles</td>
<td>7.5</td>
<td>16.2</td>
<td>19.4</td>
<td>17.9</td>
<td>15.2</td>
</tr>
<tr>
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<td></td>
<td></td>
</tr>
<tr>
<td>Count</td>
<td>15</td>
<td>8</td>
<td>9</td>
<td>5</td>
<td>37</td>
</tr>
<tr>
<td>% within quartiles</td>
<td>22.4</td>
<td>11.8</td>
<td>13.4</td>
<td>7.5</td>
<td>13.8</td>
</tr>
<tr>
<td>Centripetal:</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Count</td>
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<td>1</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>% within quartiles</td>
<td>1.5</td>
<td>4.4</td>
<td>1.5</td>
<td>-</td>
<td>1.9</td>
</tr>
<tr>
<td>Indeterminate:</td>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Count</td>
<td>16</td>
<td>18</td>
<td>20</td>
<td>27</td>
<td>81</td>
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<td>% within quartiles</td>
<td>23.9</td>
<td>26.5</td>
<td>29.9</td>
<td>40.3</td>
<td>30.1</td>
</tr>
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<td>Total:</td>
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<td></td>
<td></td>
</tr>
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<td>Count</td>
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<td>67</td>
<td>67</td>
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<td>100.0</td>
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Table 8.15
Ss-IIIC, dorsal scar pattern by blank length (mm) by quartiles cross-tabulation for complete non-cortical flakes and tools (excluding indeterminates and flakes with fewer than three scars).

<table>
<thead>
<tr>
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<th>36–28</th>
<th>&lt;28</th>
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<td>Unidirectional:</td>
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<td></td>
<td></td>
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<tr>
<td>Count</td>
<td>10</td>
<td>12</td>
<td>8</td>
<td>22</td>
<td>52</td>
</tr>
<tr>
<td>% within quartiles</td>
<td>21.3</td>
<td>25.5</td>
<td>17.0</td>
<td>46.8</td>
<td>27.7</td>
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<td>Bidirectional:</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Count</td>
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<td>16</td>
<td>14</td>
<td>5</td>
<td>53</td>
</tr>
<tr>
<td>% within quartiles</td>
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<td>10.6</td>
<td>28.2</td>
</tr>
<tr>
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<td></td>
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</tr>
<tr>
<td>Count</td>
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<td>13</td>
<td>15</td>
<td>41</td>
</tr>
<tr>
<td>% within quartiles</td>
<td>8.5</td>
<td>19.1</td>
<td>27.7</td>
<td>31.9</td>
<td>21.8</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Count</td>
<td>15</td>
<td>7</td>
<td>10</td>
<td>5</td>
<td>37</td>
</tr>
<tr>
<td>% within quartiles</td>
<td>31.9</td>
<td>14.9</td>
<td>21.3</td>
<td>10.6</td>
<td>19.7</td>
</tr>
<tr>
<td>Centripetal:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Count</td>
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<td>3</td>
<td>2</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>% within quartiles</td>
<td>-</td>
<td>6.4</td>
<td>4.3</td>
<td>-</td>
<td>2.7</td>
</tr>
<tr>
<td>Total:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>47</td>
<td>47</td>
<td>47</td>
<td>188</td>
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<td>100.0</td>
<td>100.0</td>
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<td>100.0</td>
</tr>
</tbody>
</table>
Blank Length (mm) in Quartiles

Figure 8.3
Ss-IIIc, dorsal scar pattern by blank length in quartiles (for complete flakes and tools, except for indeterminates and flakes with fewer than three scars).

Table 8.16
Ss-IIIc, frequencies of lateral edge, profile, and cross-section types for complete flakes and tools.

<table>
<thead>
<tr>
<th>Type</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lateral edge</strong></td>
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</tr>
<tr>
<td>Parallel</td>
<td>288</td>
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</tr>
<tr>
<td>Convergent</td>
<td>114</td>
<td>15.6</td>
</tr>
<tr>
<td>Expanding</td>
<td>125</td>
<td>17.1</td>
</tr>
<tr>
<td>Ovoid</td>
<td>179</td>
<td>24.5</td>
</tr>
<tr>
<td>Indeterminate</td>
<td>25</td>
<td>3.4</td>
</tr>
<tr>
<td>Total</td>
<td>731</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>Profile</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Straight</td>
<td>411</td>
<td>56.2</td>
</tr>
<tr>
<td>Curved or concord</td>
<td>184</td>
<td>25.2</td>
</tr>
<tr>
<td>Twisted</td>
<td>136</td>
<td>18.6</td>
</tr>
<tr>
<td>Total</td>
<td>731</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>Cross section</strong></td>
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<td></td>
</tr>
<tr>
<td>Triangular</td>
<td>293</td>
<td>40.1</td>
</tr>
<tr>
<td>Trapezoidal</td>
<td>341</td>
<td>46.6</td>
</tr>
<tr>
<td>Other</td>
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<td>12.3</td>
</tr>
<tr>
<td>Indeterminate</td>
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<td>1.0</td>
</tr>
<tr>
<td>Total</td>
<td>731</td>
<td>100.0</td>
</tr>
</tbody>
</table>

DORSAL SURFACE CONVEXITY SYSTEM

The dorsal surface convexity system domain includes the knapping steps that encapsulate the cumulative choice of nervure-guide or ridge pattern(s) of the core exterior for the production of blanks. These steps are quantified by three categorical attributes (lateral edge type, profile type, and cross-section type) and two continuous variables (laminarity or length/width ratio and use of convexity or width/thickness ratio). Table 8.16

Table 8.17
Ss-IIIc, descriptive statistics for blank dimensions for complete flakes and tools.

<table>
<thead>
<tr>
<th>Blank dimension</th>
<th>N</th>
<th>Range</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (mm)</td>
<td>731</td>
<td>80</td>
<td>37.96</td>
<td>13.38</td>
</tr>
<tr>
<td>Width (mm)</td>
<td>731</td>
<td>53</td>
<td>22.87</td>
<td>7.94</td>
</tr>
<tr>
<td>Thickness (mm)</td>
<td>731</td>
<td>32</td>
<td>6.36</td>
<td>3.30</td>
</tr>
<tr>
<td>Length/width ratio</td>
<td>731</td>
<td>4.73</td>
<td>1.8161</td>
<td>.8002</td>
</tr>
<tr>
<td>Width/thickness ratio</td>
<td>731</td>
<td>12.01</td>
<td>4.1499</td>
<td>1.8389</td>
</tr>
</tbody>
</table>
presents the counts and frequencies of lateral edge types, the counts and frequencies of profile types, and the counts and frequencies of cross-section types; table 8.17, with the mean and standard deviation for all blank dimensions, presents the longitudinal convexity and vertical convexity for the Ss-IIlc blanks. The doral convexity system used in the Ss-IIIc assemblage shows a propensity for relatively high longitudinal convexity (i.e., laminarity, mean length/width ratio = 1.82), thin products (width/thickness mean of 4.15), and diffuse ridges (varied lateral edges).

**Tool Manufacture**

The final domain in the lithic operational sequence is tool manufacture. The first step within this domain consists of the knappers' selection of particular blank types to retouch into tools. The potential selection criteria include dimensions (laminarity, length, width, thickness, and EPA/PT ratio) as well as categorical attributes (dorsal scar pattern, corticality, axis of propagation, lateral edges, distal terminus, profile, cross section, and platform type). Each potential criterion for blank selection is statistically tested for deviation between the tool sample and the debitage sample using the student's t-test or G likelihood ratio (approximating the chi-square distribution; Sokal and Rohlf 1995) when appropriate (table 8.18). Only tool types comprising retouched pieces are considered tools for this purpose (i.e., Levallois products are not included). Longer, thicker, and wider blanks were chosen for retouching into tools as well as blanks with smaller exterior platform angle/platform thickness ratios. The remaining two steps within the tool manufacture domain relate to issues of retouch. No unique type of retouch is evidenced in the tool types in this assemblage. Upper Paleolithic tool types dominate the tool kit (Svoboda, chap. 2 this volume).

**ATTRIBUTE ANALYSIS OF THE TECHNOLOGY OF Ss-IIIId**

**General Description of the Assemblage**

During the 1998 field season at the Ss-IIIId locality, situated immediately to the south and downslope from the original locality of Ss-III (see fig. 1.8), only 214 objects were provenienced in three dimensions within the matrix of the lower Bohunican paleosol of Layer 5, as the excavation trench appears to have hit the southern limit of the original Ss-III concentration (see table 8.19). Of these 214 objects, one later proved to be unworked, naturally occurring Stránská skála hornstone, 75 were described as gelifacts to denote the analyst's inability to recognize human activity on the piece due to postdepositional frost-fracture, and 35 pieces were described as shatter due to the inability to orient the flake debris despite evidence of human alteration of the pieces. Table 8.19 presents a general description of the object types that make up the assemblage. Of the 214 objects provenienced, 73 lithic artifacts were studied in detail for the present attribute analysis, although most analyses were suitable for only the complete flakes and tools of the assemblage (n = 27). Table 8.20 presents a categorization of the debitage types in the assemblage. The overall nature of the artifacts, the number of blades and Levallois products, and the presence of crested pieces confirms the industrial affiliation of this assemblage as "Bohunician" as defined by Valoch (1976), Oliva (1984), and Svoboda (1987). The radiocarbon dates of 37,900±1,100 B.P. (AA-32059), 37,270±990 B.P. (AA-32060), 35,080±830 B.P. (AA-32061), 34,530±830–740 B.P. (GrA-11504), and 35,320±320–300 B.P. (GrA-11808) from this locality associate the assemblage with the latest portion of the Bohunician occupation of the Brno Basin, contemporary with the Szeletian (Svoboda, Ložek, and Vlček 1996).

Unlike locality Ss-IIlc, locality Ss-IIIId has a much higher proportion of tools to flakes and cores, substantiating the earlier recognition that the original locality of Ss-III, to which it is assumed Ss-IIIId should belong, is richer in tools but poorer in situ debitage production. This view is corroborated by the greater percentage of noncortical blanks at Ss-IIIId compared to Ss-IIlc (compare table 8.21 and table 8.3; 51.9% vs. 39.8%) and the higher percentage of tools compared to flakes and cores by weight (compare table 8.22 and table 8.4; 20.4% vs. 10.7%). Thus, locality Ss-IIIId represents a slightly different use of the landscape of the Brno Basin, although the proximity between all of the Stránská skála localities makes it unlikely that either Ss-III or Ss-IIIId represents a specialized retouching site.

**SS-IIIId Operational Sequence**

The small size of the Ss-IIIId collection makes a reliable reconstruction of the operational sequence inappropriate. For purposes of description, however, the following discussion presents the extant data on the assemblage.

**Core Modification Domain**

Core modification in Ss-IIIId is impossible to evaluate quantitatively due to the paucity of cores in the assemblage (table 8.23).
Table 8.18

<table>
<thead>
<tr>
<th>Blank selection criteria</th>
<th>Debitage blanks</th>
<th>Tools</th>
<th>Significance value</th>
<th>Selected trait</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laminarity</td>
<td>mean = 1.8316</td>
<td>mean 1.7166</td>
<td>p = .158</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>sd = .8118</td>
<td>sd = .6961</td>
<td>t = 1.420</td>
<td></td>
</tr>
<tr>
<td></td>
<td>n = 671</td>
<td>n = 87</td>
<td>df = 118.534</td>
<td>Equal variances not</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>assumed (F = 5.395,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>p = .020)</td>
</tr>
<tr>
<td>Length</td>
<td>mean = 37.58</td>
<td>mean 42.93</td>
<td>p = .001</td>
<td>Longer</td>
</tr>
<tr>
<td></td>
<td>sd = 13.23</td>
<td>sd = 15.41</td>
<td>t = -3.482</td>
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<td>n = 87</td>
<td>df = 756</td>
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<td>mean 26.80</td>
<td>p = .000</td>
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<td>sd = 9.90</td>
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</tr>
<tr>
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<td>n = 671</td>
<td>n = 87</td>
<td>df = 99.852</td>
<td>Equal variances not</td>
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<td></td>
<td>assumed (F = 6.541,</td>
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<td></td>
<td></td>
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<tr>
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<td>mean 7.51</td>
<td>p = .001</td>
<td>Thicker</td>
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<td>t = -3.386</td>
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<td>n = 87</td>
<td>df = 756</td>
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<td>Dorsal scar pattern</td>
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<td></td>
<td>None</td>
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<tr>
<td>Counts:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unidirect. = 191</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bidirect. = 107</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other = 214</td>
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<td></td>
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</tr>
<tr>
<td>Presence of cortex</td>
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<tr>
<td>Counts:</td>
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<tr>
<td>Noncortical = 267</td>
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<td></td>
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<tr>
<td>Cortical = 404</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axis of propagation</td>
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<td></td>
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</tr>
<tr>
<td>Counts:</td>
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</tr>
<tr>
<td>Straight = 499</td>
<td></td>
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</tr>
<tr>
<td>Turned = 169</td>
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<td></td>
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<td></td>
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<td>None</td>
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<tr>
<td>Counts:</td>
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<td></td>
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<tr>
<td>Parallel = 268</td>
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<tr>
<td>Convergent = 105</td>
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<td></td>
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<tr>
<td>Expanding = 116</td>
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<td></td>
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<tr>
<td>Ovoid = 160</td>
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<td></td>
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<tr>
<td>Distal terminus</td>
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<td>Counts:</td>
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<td>Pointed = 181</td>
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<tr>
<td>Counts:</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Straight = 377</td>
<td></td>
<td></td>
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<tr>
<td>Curved = 169</td>
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<td></td>
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<td>Cross section</td>
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<td>None</td>
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<td>Counts:</td>
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<tr>
<td>Triangular = 275</td>
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<td></td>
<td></td>
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<tr>
<td>Trapezoidal = 307</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Other = 85</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Platform preparation</td>
<td></td>
<td></td>
<td></td>
<td>None</td>
</tr>
<tr>
<td>Counts:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unprepared = 415</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Prepared = 301</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact placement</td>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>EPA/PT ratio</td>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>mean = 27.6492</td>
<td></td>
<td></td>
<td></td>
<td>Smaller ratio</td>
</tr>
<tr>
<td>sd = 24.2629</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n = 618</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 8.19
Ss-IIIId, general assemblage description of provenienced objects comprising the Ss-IIIId assemblage.

<table>
<thead>
<tr>
<th>Type</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flakes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete</td>
<td>17</td>
<td>7.9</td>
</tr>
<tr>
<td>Proximal fragments</td>
<td>8</td>
<td>3.7</td>
</tr>
<tr>
<td>Medial fragments</td>
<td>5</td>
<td>2.3</td>
</tr>
<tr>
<td>Distal fragments</td>
<td>8</td>
<td>3.7</td>
</tr>
<tr>
<td><strong>Tools</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete</td>
<td>10</td>
<td>4.7</td>
</tr>
<tr>
<td>Proximal fragments</td>
<td>4</td>
<td>1.9</td>
</tr>
<tr>
<td>Medial fragments</td>
<td>12</td>
<td>5.6</td>
</tr>
<tr>
<td>Distal fragments</td>
<td>5</td>
<td>2.3</td>
</tr>
<tr>
<td><strong>Cores</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete</td>
<td>2</td>
<td>.9</td>
</tr>
<tr>
<td>Fragments</td>
<td>2</td>
<td>.9</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shatter</td>
<td>35</td>
<td>16.4</td>
</tr>
<tr>
<td>Too small (&lt;2.0 cm)</td>
<td>27</td>
<td>12.6</td>
</tr>
<tr>
<td>Gelifrac</td>
<td>75</td>
<td>35.0</td>
</tr>
<tr>
<td>Ochre</td>
<td>1</td>
<td>.5</td>
</tr>
<tr>
<td>Manuport</td>
<td>2</td>
<td>.9</td>
</tr>
<tr>
<td>Unworked</td>
<td>1</td>
<td>.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>214</td>
<td>99.8</td>
</tr>
</tbody>
</table>

Platform Maintenance

Platform maintenance includes a good amount of platform preparation, up to 66 percent of the debitage (table 8.24). Measurements of external platform angles (table 8.25) and platform thickness (table 8.26) indicate tendencies around 83 degrees and 5.6 mm respectively. Over 45 percent of the platforms are lipped (table 8.27). Although not sufficient as an indicator of soft hammer percussion (Ohnuma and Bergman 1982), lipped platforms are suggestive of the use of soft hammer in this assemblage.

Direction of Core Exploitation

A dynamic analysis of the direction of core exploitation is impossible due to the limited number of intact flakes and tools in the Ss-IIIId assemblage, but a general picture can be reached from the blank dorsal scar pattern (tables 8.28, 8.29). There is a slightly greater percentage of unidirectional blanks among the cortical pieces and a slightly greater percentage of bidirectional blanks among the noncortical pieces. These differences are consistent with previous dorsal scar patterns in Bohunician assemblages (Tostevin 2000b).

Table 8.20
Ss-IIIId, debitage types for complete flakes and tools.

<table>
<thead>
<tr>
<th>Debitage type</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flakes</td>
<td>17</td>
<td>63.0</td>
</tr>
<tr>
<td>Blades</td>
<td>6</td>
<td>22.2</td>
</tr>
<tr>
<td>Crested</td>
<td>3</td>
<td>11.1</td>
</tr>
<tr>
<td>Core trimming elements</td>
<td>1</td>
<td>3.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>27</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 8.21
Ss-IIIId, percentage of cortex on dorsal surface of complete flakes and tools.

<table>
<thead>
<tr>
<th>Percent of cortex</th>
<th>Frequency</th>
<th>Percent of assemblage</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>2</td>
<td>7.4</td>
</tr>
<tr>
<td>90–61%</td>
<td>1</td>
<td>3.7</td>
</tr>
<tr>
<td>60–41%</td>
<td>1</td>
<td>3.7</td>
</tr>
<tr>
<td>40–11%</td>
<td>9</td>
<td>33.3</td>
</tr>
<tr>
<td>0%</td>
<td>14</td>
<td>51.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>27</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 8.22
Ss-IIIId, weight of lithic artifacts by type (to nearest gram).

<table>
<thead>
<tr>
<th>Artifact type</th>
<th>Mean</th>
<th>N</th>
<th>Standard deviation</th>
<th>Sum</th>
<th>Percent of total sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flakes</td>
<td>7.71</td>
<td>38</td>
<td>9.85</td>
<td>293</td>
<td>35.1</td>
</tr>
<tr>
<td>Tools</td>
<td>5.48</td>
<td>31</td>
<td>6.80</td>
<td>170</td>
<td>20.4</td>
</tr>
<tr>
<td>Cores</td>
<td>63.00</td>
<td>4</td>
<td>61.55</td>
<td>252</td>
<td>30.2</td>
</tr>
<tr>
<td>Shatter</td>
<td>3.41</td>
<td>35</td>
<td>3.54</td>
<td>119</td>
<td>14.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>7.73</td>
<td>108</td>
<td>16.69</td>
<td>834</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 8.23
Ss-IIIId, core types based on extant core morphology.

<table>
<thead>
<tr>
<th>Core type</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Platform</td>
<td>i</td>
<td>50.0</td>
</tr>
<tr>
<td>Tested Nodule</td>
<td>1</td>
<td>50.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Dorsal Surface Convexity System

The analysis of the attributes serving as the proxies for the steps within the dorsal surface convexity domain are given in tables 8.30 and 8.31. The ridge system used in the
Table 8.24
Ss-IIId, platform types for complete and proximal fragments of flakes and tools.

<table>
<thead>
<tr>
<th>Platform type</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain</td>
<td>9</td>
<td>23.1</td>
</tr>
<tr>
<td>Cortical</td>
<td>3</td>
<td>7.7</td>
</tr>
<tr>
<td>Dihedral</td>
<td>3</td>
<td>7.7</td>
</tr>
<tr>
<td>Faceted</td>
<td>5</td>
<td>12.8</td>
</tr>
<tr>
<td>Scarred</td>
<td>7</td>
<td>17.9</td>
</tr>
<tr>
<td>Retouched</td>
<td>2</td>
<td>5.1</td>
</tr>
<tr>
<td>Indeterminate</td>
<td>10</td>
<td>25.6</td>
</tr>
<tr>
<td>Total</td>
<td>39</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 8.25
Ss-IIId, external platform angle (degrees) descriptive statistics for all intact platforms.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>External</td>
<td>19</td>
<td>70</td>
<td>121</td>
<td>12.36</td>
</tr>
<tr>
<td>platform angle</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8.26
Ss-IIId, platform thickness (mm) descriptive statistics for all intact platforms.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Platform thickness</td>
<td>24</td>
<td>2</td>
<td>11</td>
<td>5.64</td>
<td>2.86</td>
</tr>
</tbody>
</table>

Table 8.27
Ss-IIId, presence of platform lipping.

<table>
<thead>
<tr>
<th>Platform lipping</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not lipped</td>
<td>12</td>
<td>54.5</td>
</tr>
<tr>
<td>Lipped</td>
<td>10</td>
<td>45.5</td>
</tr>
<tr>
<td>Total</td>
<td>22</td>
<td>100.0</td>
</tr>
</tbody>
</table>

SS-IIIC IN ITS REGIONAL AND INTERREGIONAL CONTEXTS

While the assemblage from Ss-IIId certainly fits technologically within the Bohunician industrial type, it possesses too few intact artifacts to allow us to conduct an attribute analysis that would place it more closely within the larger variability of central Europe or other regions at the Middle to Upper Paleolithic transition. Ss-IIIC, however, can be compared to other assemblages within and without the region that date between 60 and 30 ka B.P., a relatively large time frame to place any Middle to Upper Paleolithic transition within the context of what happened before and after. The inclusion of Ss-IIIC in a construction of the central European sequence of change between 60 and 30 ka B.P. can be conducted on the basis of pair-wise comparisons between assemblages. Most of these assemblage pairs are chronologically related. Thus, the central European sequence begins with the comparison of the earliest assemblage after 60 ka B.P. with the assemblage dated immediately thereafter. The next comparison pairs that second assemblage with its immediate successor, and so on till the latest assemblage between 60 and 30 ka B.P. has been examined. Several comparisons are made between assemblages that are not chronologically immediately successive, for instance between Kūňa Cave, Layer 7a, and Vedrovice V. For although the Bohunician assemblages from Stránská škála chronologically lie between them, the possibility of a multiple-phyla scenario makes it necessary to consider the cultural relationships between the Szeletian of Vedrovice V and the Micoquian of Kūňa Cave, Layer 7a. Chronologically, Ss-IIIC comes after Ss-IIla but before the mean date of the Ss-III assemblage. Comparisons between Ss-IIlc and Kūňa Cave, Layer 7a, and Vedrovice V are provided for a possible multiple-phyla scenario.

For each pair-wise assemblage comparison, the lithic data collected from each assemblage are organized into a series of tables containing the individual steps of the operational sequence according to the five knapping domains (core modification, platform maintenance, direction of core exploitation, dorsal surface convexity system, and tool manufacture; see table 8.32). The first column within these tables lists each knapping step in the sequence within the behavioral domains. The next two columns contain a characterization of the cumulative behaviors used by the knappers for each step of the sequence in the production of the two assemblages, respectively. These characterizations usually consist of a measurement of the central tendency of the variability within the particular knapping step. The number of artifacts and the frequencies for the various attribute-states

Ss-IIId assemblage shows a propensity for parallel ridges, relatively high longitudinal convexity (i.e., laminarity), and thin products (width/thickness mean of 3.89 mm).

Tool Manufacture
No comparison of variables between debitage and tools for blank selection criteria was possible for Ss-IIId given the paucity of both blanks and tools.
Table 8.28
Ss-IIIId, dorsal scar pattern by percent of cortex for complete flakes and tools.

<table>
<thead>
<tr>
<th>Pattern</th>
<th>90–61%</th>
<th>60–41%</th>
<th>40–11%</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unidirectional:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Count</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>% within cortex</td>
<td>-</td>
<td>100.0</td>
<td>22.2</td>
<td>27.3</td>
</tr>
<tr>
<td>Bidirectional:</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Count</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>% within cortex</td>
<td>-</td>
<td>-</td>
<td>11.1</td>
<td>9.1</td>
</tr>
<tr>
<td>Subcentripetal:</td>
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<td></td>
</tr>
<tr>
<td>Count</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>% within cortex</td>
<td>-</td>
<td>-</td>
<td>11.1</td>
<td>9.1</td>
</tr>
<tr>
<td>Indeterminate:</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Count</td>
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<td>0</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>% within cortex</td>
<td>100.0</td>
<td>-</td>
<td>55.6</td>
<td>54.5</td>
</tr>
<tr>
<td>Total:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Count</td>
<td>1</td>
<td>1</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>% within cortex</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 8.29
Ss-IIIId, dorsal scar pattern by blank length (mm) in quartiles for complete noncortical flakes and tools.

<table>
<thead>
<tr>
<th>Pattern</th>
<th>&gt; 56</th>
<th>56–39</th>
<th>39–30</th>
<th>&lt; 30</th>
<th>Total</th>
</tr>
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<tr>
<td>Unidirectional:</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Count</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>% within quartiles</td>
<td>-</td>
<td>-</td>
<td>25.0</td>
<td>33.3</td>
<td>14.3</td>
</tr>
<tr>
<td>Bidirectional:</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
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<td>0</td>
<td>2</td>
<td>0</td>
<td>3</td>
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<tr>
<td>% within quartiles</td>
<td>33.3</td>
<td>-</td>
<td>50.0</td>
<td>-</td>
<td>21.4</td>
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<tr>
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<td>0</td>
<td>1</td>
</tr>
<tr>
<td>% within quartiles</td>
<td>-</td>
<td>25.0</td>
<td>-</td>
<td>-</td>
<td>7.1</td>
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</tr>
<tr>
<td>Count</td>
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<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>% within quartiles</td>
<td>-</td>
<td>25.0</td>
<td>-</td>
<td>-</td>
<td>7.1</td>
</tr>
<tr>
<td>Centripetal:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Count</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>% within quartiles</td>
<td>33.3</td>
<td>25.0</td>
<td>-</td>
<td>-</td>
<td>14.3</td>
</tr>
<tr>
<td>Indeterminate:</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Count</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>% within quartiles</td>
<td>33.3</td>
<td>25.0</td>
<td>25.0</td>
<td>66.7</td>
<td>35.7</td>
</tr>
<tr>
<td>Total:</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Count</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>14</td>
</tr>
<tr>
<td>% within quartiles</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

are provided for categorical attributes. The number of artifacts and the mean and standard deviation are also provided for continuous variables. The fourth column contains a judgment of the significance of any difference between the assemblages' choice of option for each step in the operational sequence. This judgment is qualitative, or quantitative, depending upon the nature of the type of lithic data available; steps related to data taken
Table 8.30
Ss-IIIId, frequencies of lateral edge, profile, and cross-section types for complete flakes and tools.

<table>
<thead>
<tr>
<th>Type</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral edge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parallel</td>
<td>10</td>
<td>37.1</td>
</tr>
<tr>
<td>Convergent</td>
<td>3</td>
<td>11.1</td>
</tr>
<tr>
<td>Expanding</td>
<td>2</td>
<td>7.4</td>
</tr>
<tr>
<td>Ovoid</td>
<td>5</td>
<td>18.5</td>
</tr>
<tr>
<td>Indeterminate</td>
<td>7</td>
<td>25.9</td>
</tr>
<tr>
<td>Total</td>
<td>27</td>
<td>100.0</td>
</tr>
<tr>
<td>Profile</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Straight</td>
<td>12</td>
<td>44.4</td>
</tr>
<tr>
<td>Curved or concord</td>
<td>7</td>
<td>25.9</td>
</tr>
<tr>
<td>Twisted</td>
<td>6</td>
<td>22.2</td>
</tr>
<tr>
<td>Indeterminate</td>
<td>2</td>
<td>7.4</td>
</tr>
<tr>
<td>Total</td>
<td>27</td>
<td>100.0</td>
</tr>
<tr>
<td>Cross section</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Triangular</td>
<td>10</td>
<td>37.0</td>
</tr>
<tr>
<td>Trapezoidal</td>
<td>10</td>
<td>37.0</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>7.4</td>
</tr>
<tr>
<td>Indeterminate</td>
<td>5</td>
<td>18.5</td>
</tr>
<tr>
<td>Total</td>
<td>27</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 8.31
Ss-IIIId, descriptive statistics for blank dimensions for complete flakes and tools.

<table>
<thead>
<tr>
<th>Blank dimension</th>
<th>N</th>
<th>Range</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (mm)</td>
<td>27</td>
<td>67</td>
<td>44.45</td>
<td>17.67</td>
</tr>
<tr>
<td>Width (mm)</td>
<td>27</td>
<td>48</td>
<td>25.72</td>
<td>11.04</td>
</tr>
<tr>
<td>Thickness (mm)</td>
<td>27</td>
<td>16</td>
<td>7.38</td>
<td>3.47</td>
</tr>
<tr>
<td>Length/width ratio</td>
<td>27</td>
<td>3.74</td>
<td>1.8801</td>
<td>.8022</td>
</tr>
<tr>
<td>Width/thickness ratio</td>
<td>27</td>
<td>6.73</td>
<td>3.8891</td>
<td>1.6479</td>
</tr>
</tbody>
</table>

from cores is often qualitative while steps related to data taken from flakes and tools is mostly quantitative. A p value in this column indicates the probability that the data obtained from the two assemblages were randomly derived samples from the same population (i.e., with the assumption that they were produced by the same cumulative behaviors). Although a significance level of 5 percent is admittedly an arbitrary choice, this value has become traditional practice in the sciences and is used here for all statistical tests. The choice of the test, the student's t-test, G likelihood ratio (approximating the chi-square distribution), or Fisher's Exact Test (Sokal and Rohlf 1995), is given in the description of each knapping domain and its steps earlier in this chapter. The details of blank selection criteria statistical tests are provided in table 8.18.

To produce a quantitative measure of the difference between assemblages, one cannot simply sum up the number of operational steps in which a significant difference is judged to exist between the two options as this would bias the results through the interdependence of the units (as in Galton’s Problem mentioned earlier). In order to quantify the pair-wise assemblage comparisons, therefore, the knapping steps in which significantly different options were used between assemblages are first summed within their specific flintknapping domain (i.e., within the independent categories of core modification, platform maintenance, direction of core exploitation, blank production, and tool manufacture) and divided by the total number of steps within that domain. The resulting numerical value of all five domains are then summed up to produce a measure ranging from zero (for assemblages with identical operational sequences) to five (for entirely different operational sequences). This procedure scales the measure of difference according to the variability seen between these five knapping domains and lessens the problem of interdependent variables. For instance, in table 8.32, the total number of significant differences between the behavioral flintknapping options used in the Ss-IIIc assemblage and the assemblage from Ss-IIIa, level 4, is 10 out of a total of 27 comparisons. Using this proportion (10/27) would ignore Galton’s Problem. Therefore, the measure of difference is weighted by the five behavioral domains, producing a value of 1.50 out of 5.0.

Tables 8.32 through 8.35 present the pair-wise comparisons between Ss-IIIc and its chronologically adjacent assemblages from central Europe, Ss-IIIa level 4, Ss-III, the Szeletian site of Vedrovice V, and the Micoquian assemblage of Kúlna Cave, Layer 7a.

CONCLUSIONS: SS-IIIIC IN THE MIDDLE TO UPPER PALEOLITHIC TRANSITION

Now that the central European sequence of change has been reconstructed with Ss-IIIc in its chronological position, it is possible to assess the degree of continuity/discontinuity present in central Europe between 60 and 30 ka B.P. (see table 8.36 for the list of sample assemblages). It is immediately clear from table 8.37 that the operational sequences of the sample assemblages differ to varying
degrees, following the “technological style” principle. This variance in the technological style between the assemblages is quantified using the measure of difference derived by counting differences in options chosen in knapping steps according to the behavioral domain (varying between zero and five). Indeed, by examining the results of the individual pair-wise comparisons between Central European assemblages into Table 8.37, it is possible to perceive a rough picture of the sequence of behavioral change that occurred in this region between 60 and 30 ka b.p.

The first pair-wise comparison, between Külna 7a and Ss-IIIa level 4, produces the largest measure of difference within this region (3.76). The immediately subsequent comparison, between the two Bohunician assemblages of Ss-IIIa-4 and Ss-III, demonstrates the extremely close similarity (0.98) between these assemblages. The minor difference between Bohunician assemblages is due mainly to the more highly retouched condition of the later assemblage. Placing Ss-IIIc chronologically between Ss-IIIa-4 and Ss-III provides two pair-wise comparisons with the new collection. The former assemblage differs to the same degree with the earlier and later Bohunician assemblages (1.50), the differences laying in the dorsal surface convexity system. While a value of 1.50 is not large, it is larger than expected given the close proximity of Ss-IIIc to Ss-IIIa. It is possible that the Ss-IIIc assemblage is chronologically later in the palimpsest of the larger Ss-IIIa-c locality, given the later radiocarbon date, and so has deviated through time in its technological style from the early part of the palimpsest. Despite this level of difference, the Ss-IIIc, Ss-IIIa, and Ss-III assemblages are much more alike than not, and therefore warrant inclusion under one industrial name, the Bohunician.

When we place these measures of difference in their regional and temporal context, we see that a marked change in flintknapning behaviors occurred between the activities that created the assemblage of Külna, Layer 7a and those that created the Bohunician assemblages of Ss-IIIa (3.76) and Ss-IIIc (3.41). The last Bohunician assemblage (Ss-III) differs with the Szeletian site to a lesser degree (3.22) than with the Micoquian site; indeed, it is closer in behavioral details to Vedrovice V than Vedrovice V is to the Micoquian (3.64). This turns on its head the traditional view of the close relationship between the late Middle Paleolithic of Külna Cave and the Central European Szeletian. When retouch index fossils are not given the primary role in determining cultural affiliations, the Szeletian appears more similar to the subsequent Aurignacian (2.91) than it does to the purportedly ancestral Micoquian. A very similar measure of difference is evidenced between the Bohunician of Ss-III and the subsequent Aurignacian (2.93) and between the Szeletian and Aurignacian (2.91), yet the specific options shared between the comparisons differ. Ss-IIIc differs to a lesser degree with the Szeletian of Vedrovice V (2.60), primarily due to similarities in the directionality of decortication not shared by the Bohunician assemblages of Ss-IIIa-4 and Ss-III. The greater similarity between Ss-IIIc and Vedrovice V is suggestive, given the longer coexistence and chance for acculturation between Bohunician and Szeletian on the landscape by the time of the deposition of Ss-IIIc compared to Ss-IIIa-4. Why the even later assemblage of Ss-III should be more dissimilar to Vedrovice V than is Ss-IIIc is curious but may be a result of locality Ss-III’s more reduced tool kit (i.e., more tools and fewer cores and debitage) compared to either Ss-IIIc or Vedrovice V. As always, the Central European sequence at the Middle to Upper Paleolithic will remain an exciting research topic until the relationship between the Bohunician and the Szeletian, contemporaries for at least 4,000 years in the Brno Basin, is elucidated.

One can support the evidence of the single value measure of difference between assemblages by looking at the specific details of each step comparison. It is clear, for instance, that the longitudinal core orientation shared by all later assemblages does not have an antecedent in the earliest assemblage, Külna, Layer 7a. Nor does this early assemblage possess the antecedents for the particular shift in direction of core exploitation shared by the Bohunician and the later Aurignacian assemblages. Of all five domains, only the tool manufacture domain shows many similarities between Külna, Layer 7a and Vedrovice V. It is thus possible to argue based on the presence and absence of antecedent behaviors that Central Europe witnessed a discontinuity, a strong break in flintknapning behaviors between the Micoquian and Bohunician occupation of the landscape.

Table 8.37 also presents the measures of difference for pair-wise comparisons between assemblages within Eastern Europe and the Levant between 30 and 60 ka b.p. as well as between regions. These results originate from a larger research project predating the 1997–1999 excavations at Stránská skála, which was designed to use the changes in the details of flintknapning behaviors within and between regional contexts to test the archaeological record against the hypotheses of diffusion versus independent innovation as the prime mover for the appearance of the Upper Paleolithic in each region. The results, presented in detail elsewhere (Tostevin 2000a, 2000b), strongly suggest that the pattern of change in Central Europe is related to the changes in the Levant.
Table 8.32

<table>
<thead>
<tr>
<th>Flintknapping steps by domain</th>
<th>Ss-IIIa-4</th>
<th>Ss-IIIc</th>
<th>Significant difference?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core modification</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Core orientation</td>
<td>Longitudinal</td>
<td>Longitudinal</td>
<td>No</td>
</tr>
<tr>
<td>Core management</td>
<td>Débordants &amp; side blade removals</td>
<td>Débordants &amp; side blade removals</td>
<td>No</td>
</tr>
<tr>
<td>Number of changes/two steps</td>
<td></td>
<td></td>
<td>0/2 = 0</td>
</tr>
<tr>
<td>Platform maintenance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Platform treatment</td>
<td>Unprepared: 58%</td>
<td>Unprepared: 58%</td>
<td>No, p = .96</td>
</tr>
<tr>
<td></td>
<td>Prepared: 42%</td>
<td>Prepared: 42%</td>
<td>n = 448</td>
</tr>
<tr>
<td></td>
<td>n = 448</td>
<td>n = 767</td>
<td></td>
</tr>
<tr>
<td>External platform angle (degrees)</td>
<td>mean: 85.2</td>
<td>mean: 84.9</td>
<td>No, p = .77</td>
</tr>
<tr>
<td></td>
<td>s.d.: 15.3</td>
<td>s.d.: 15.0</td>
<td>n = 664</td>
</tr>
<tr>
<td></td>
<td>n = 425</td>
<td>n = 644</td>
<td></td>
</tr>
<tr>
<td>Platform thickness</td>
<td>mean: 4.8</td>
<td>mean: 4.6</td>
<td>No, p = .07</td>
</tr>
<tr>
<td></td>
<td>s.d.: 2.5</td>
<td>s.d.: 2.5</td>
<td>n = 741</td>
</tr>
<tr>
<td></td>
<td>n = 433</td>
<td>n = 741</td>
<td></td>
</tr>
<tr>
<td>Number of changes/three steps</td>
<td></td>
<td></td>
<td>0/3 = 0</td>
</tr>
<tr>
<td>Direction of core exploitation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direction of cortex removal</td>
<td>Unidirectional</td>
<td>Unidirectional changing to crossed</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Bidirectional changing to unidirectional</td>
<td>Bidirectional changing to unidirectional</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Dorsal surface convexity system</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Longitudinal convexity: length/width ratio</td>
<td>mean: 1.71</td>
<td>mean: 1.82</td>
<td>Yes, p = .01</td>
</tr>
<tr>
<td></td>
<td>s.d.: 0.67</td>
<td>s.d.: 0.80</td>
<td>n = 502</td>
</tr>
<tr>
<td></td>
<td>n = 502</td>
<td>n = 731</td>
<td></td>
</tr>
<tr>
<td>Shape of convexity: lateral edges of blanks</td>
<td>Parallel: 49%</td>
<td>Parallel: 41%</td>
<td>Yes, p = .00</td>
</tr>
<tr>
<td></td>
<td>Convergent: 24%</td>
<td>Convergent: 16%</td>
<td>n = 498</td>
</tr>
<tr>
<td></td>
<td>Expanding: 17%</td>
<td>Expanding: 18%</td>
<td>n = 706</td>
</tr>
<tr>
<td></td>
<td>Ovoid: 11%</td>
<td>Ovoid: 25%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>n = 489</td>
<td>n = 706</td>
<td></td>
</tr>
<tr>
<td>Curvature of convexity: profile of blanks</td>
<td>Straight: 54%</td>
<td>Straight: 56%</td>
<td>No, p = .28</td>
</tr>
<tr>
<td></td>
<td>Curved: 29%</td>
<td>Curved: 25%</td>
<td>n = 731</td>
</tr>
<tr>
<td></td>
<td>Twisted: 17%</td>
<td>Twisted: 19%</td>
<td>n = 731</td>
</tr>
<tr>
<td>Lateral convexity: cross section of blanks</td>
<td>Triangular: 45%</td>
<td>Triangular: 41%</td>
<td>Yes, p = .00</td>
</tr>
<tr>
<td></td>
<td>Trapezoidal: 50%</td>
<td>Trapezoidal: 47%</td>
<td>n = 495</td>
</tr>
<tr>
<td></td>
<td>'Other: 5%</td>
<td>Other: 12%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>n = 495</td>
<td>n = 724</td>
<td></td>
</tr>
<tr>
<td>Vertical convexity: width/thickness ratio</td>
<td>mean: 4.03</td>
<td>mean: 4.15</td>
<td>No, p = .28</td>
</tr>
<tr>
<td></td>
<td>s.d.: 1.83</td>
<td>s.d.: 1.83</td>
<td>n = 731</td>
</tr>
<tr>
<td></td>
<td>n = 502</td>
<td>n = 731</td>
<td></td>
</tr>
<tr>
<td>Number of changes/five steps</td>
<td></td>
<td></td>
<td>3/5 = 0.6</td>
</tr>
</tbody>
</table>

continued on next page

and Eastern Europe. Two discontinuities are evidenced in all three regions between 60 and 30 ka B.P.

When examining quantitative dissimilarity between assemblages through time in each region (table 8.37), the Middle Paleolithic assemblage in each region is succeeded by an assemblage with an extremely different technological style. Whether “transitional” or “Upper Paleolithic,” these three post-Middle Paleolithic assemblages are in fact quite similar to each other. The pairwise comparisons between Boker Tachtit level 1 and the
Table 8.32, continued

<table>
<thead>
<tr>
<th>Flintknapping steps by domain</th>
<th>Ss-IIIa-4</th>
<th>Ss-IIIc</th>
<th>Significant difference?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tool manufacture</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Selection for laminarity of blanks</td>
<td>More laminar, p = .05</td>
<td>Same as debitage, p = .16</td>
<td>Yes</td>
</tr>
<tr>
<td>Selection: length</td>
<td>Longer, p = .00</td>
<td>Longer, p = .00</td>
<td>No</td>
</tr>
<tr>
<td>Selection: width</td>
<td>Wider, p = .00</td>
<td>Wider, p = .00</td>
<td>No</td>
</tr>
<tr>
<td>Selection: thickness</td>
<td>Thicker, p = .00</td>
<td>Thicker, p = .00</td>
<td>No</td>
</tr>
<tr>
<td>Selection: dorsal scars</td>
<td>Bidirectional, p = .00</td>
<td>Same as debitage, p = .236</td>
<td>Yes</td>
</tr>
<tr>
<td>Selection: cortex</td>
<td>Noncortical, p = .00</td>
<td>Same as debitage, p = .49</td>
<td>Yes</td>
</tr>
<tr>
<td>Selection: axis of propagation</td>
<td>Same as debitage, p = .31</td>
<td>Same as debitage, p = .44</td>
<td>No</td>
</tr>
<tr>
<td>Selection: lateral edges</td>
<td>Same as debitage, p = .49</td>
<td>Same as debitage, p = .631</td>
<td>No</td>
</tr>
<tr>
<td>Selection: distal terminus</td>
<td>Same as debitage, p = .38</td>
<td>Same as debitage, p = .61</td>
<td>No</td>
</tr>
<tr>
<td>Selection: profile</td>
<td>Same as debitage, p = .09</td>
<td>Same as debitage, p = .93</td>
<td>No</td>
</tr>
<tr>
<td>Selection: cross section</td>
<td>Trapezoidal, p = .00</td>
<td>Same as debitage, p = .24</td>
<td>Yes</td>
</tr>
<tr>
<td>Selection: platform type</td>
<td>Prepared, p = .00</td>
<td>Same as debitage, p = .36</td>
<td>Yes</td>
</tr>
<tr>
<td>Selection: impact placement</td>
<td>Same as debitage, p = .17</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Selection: EPA/PT ratio</td>
<td>Same as debitage, p = .16</td>
<td>Smaller ratio, p = .00</td>
<td>Yes</td>
</tr>
<tr>
<td>Unique types of retouch</td>
<td>Normal retouch</td>
<td>Normal retouch</td>
<td>No</td>
</tr>
<tr>
<td>Tool types</td>
<td>UP tools dominate</td>
<td>UP tools dominate</td>
<td></td>
</tr>
<tr>
<td>Number of changes/16 steps</td>
<td></td>
<td>6/15 = 0.4</td>
<td></td>
</tr>
</tbody>
</table>

Total measure of difference weighted by behavioral domains 1.50

earliest Bohunician assemblage, Ss-IIIa-4, in Central Europe (producing a difference value of 1.93) and between Boker Tachtit level 1 and the first non-Middle Paleolithic assemblage in eastern Europe, Korolevo II Complex II (producing a value of 1.93), are extremely surprising given their geographical separation. The first comparison is less than twice as different as the value between the Stránská skála Bohunician assemblages themselves (Ss-IIIa level 4 and Ss-III, producing a value of 0.98) or between the directly stratified Levantine Aurignacian assemblages at Kebara Cave (Units II and I, producing a value of 1.51) or the immediately adjacent assemblages of Ss-IIIa-4 and Ss-IIIc (1.50). Comparison of Boker Tachtit level 2 to Ss-IIIa level 4 produces a value (1.40), which is actually closer than the value between the European Aurignacian (Ss-IIIa level 3 and Ss-IIa level 4) and the Levantine Aurignacian assemblages of Kebara II and I (1.81), although Boker Tachtit level 2 shows fewer similarities with Korolevo II Complex II (2.26). These comparisons point to a common behavioral phenomenon appearing after the last Middle Paleolithic assemblage in each region.

In order to use the antecedent principle (Tostevin 2003) to determine whether or not the Upper Paleolithic appeared as in situ innovation within a region or by diffusion between regions, it is important to investigate the contingency of the knapping behaviors beyond a simple comparison of the measure of difference between assemblages. This is vital, since the summation of assemblage differences condenses all of the variability between assemblages into one value, so that two different assemblages may appear equally similar to a third but not possess similar options between them. This is not the case, however, with the behavioral options employed in the different steps of the operational sequences of Boker Tachtit level 1, Ss-IIIa level 4, and Korolevo II Complex II. When examining the specific knapping options used in these three assemblages, their antecedents cannot be found within the details of the Middle Paleolithic operational sequences in each region. Further, the same specific options that make these assemblages so different from the preceding Middle Paleolithic assemblages are in fact common to all three assemblages. Despite the geographical distances separating them, the assemblages of Boker Tachtit level 1, Ss-IIIa level 4, and Korolevo II Complex II all possess a specific and unique cluster of knapping options.

 Parsimony favors the conclusion that all three assemblages share the same behavioral package that diffused from one region to another, appearing first in the Levant at 47/46,000 B.P., next in Central Europe by 42,000 B.P., and finally in eastern Europe by 38,000 B.P. (Tostevin 2000a). The entire operational sequence is not exactly the same in each assemblage, but this variance is to be expected in any diffused set of behaviors. For instance, although the differences between Ss-IIIa-4 and Korolevo II-II are greater than the differences between these assemblages and Boker Tachtit level 1 (2.56 vs. 1.93), the behaviors within the diffused package would have continued to deviate through time and space, a process Deetz
Table 8.33

<table>
<thead>
<tr>
<th>Flintknapping steps by domain</th>
<th>Ss-IIIc</th>
<th>Ss-III</th>
<th>Significant Difference?</th>
</tr>
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<tbody>
<tr>
<td><strong>Core modification</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Core orientation</td>
<td>Longitudinal</td>
<td>Longitudinal</td>
<td>No</td>
</tr>
<tr>
<td>Core management</td>
<td>Débordants &amp; side blade removals</td>
<td>Débordants &amp; side blade removals</td>
<td>No</td>
</tr>
<tr>
<td>Number of changes/two steps</td>
<td>0/2 = 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Platform maintenance</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Platform treatment</td>
<td>Unprepared: 58%</td>
<td>Unprepared: 55%</td>
<td>No, p = .28</td>
</tr>
<tr>
<td></td>
<td>Prepared: 42%</td>
<td>Prepared: 45%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>n = 767</td>
<td>n = 367</td>
<td></td>
</tr>
<tr>
<td>External platform angle (degrees)</td>
<td>mean: 84.9</td>
<td>mean: 86.4</td>
<td>No, p = .15</td>
</tr>
<tr>
<td></td>
<td>s.d.: 15.0</td>
<td>s.d.: 14.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>n = 664</td>
<td>n = 340</td>
<td></td>
</tr>
<tr>
<td>Platform thickness</td>
<td>mean: 4.6</td>
<td>mean: 4.42</td>
<td>No, p = .37</td>
</tr>
<tr>
<td></td>
<td>s.d.: 2.5</td>
<td>s.d.: 2.16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>n = 741</td>
<td>n = 344</td>
<td></td>
</tr>
<tr>
<td>Number of changes/three steps</td>
<td>0/3 = 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Direction of core exploitation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direction of cortex removal</td>
<td>Unidirectional changing to crossed</td>
<td>Unidirectional</td>
<td>Yes</td>
</tr>
<tr>
<td>Direction of blank removal</td>
<td>Bidirectional changing to unidirectional</td>
<td>Bidirectional changing to unidirectional</td>
<td>No</td>
</tr>
<tr>
<td>Number of changes/two steps</td>
<td>1/2 = 0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Dorsal surface convexity system</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Longitudinal convexity: length/width ratio</td>
<td>mean: 1.82</td>
<td>mean: 1.83</td>
<td>No, p = .72</td>
</tr>
<tr>
<td></td>
<td>s.d.: 0.80</td>
<td>s.d.: 0.74</td>
<td></td>
</tr>
<tr>
<td></td>
<td>n = 731</td>
<td>n = 397</td>
<td></td>
</tr>
<tr>
<td>Shape of convexity: lateral edges of blanks</td>
<td>Parallel: 41%</td>
<td>Parallel: 59%</td>
<td>Yes, p = .00</td>
</tr>
<tr>
<td></td>
<td>Convergent: 16%</td>
<td>Convergent: 17%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Expanding: 18%</td>
<td>Expanding: 10%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ovoid: 25%</td>
<td>Ovoid: 14%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>n = 706</td>
<td>n = 395</td>
<td></td>
</tr>
<tr>
<td>Curvature of convexity: profile of blanks</td>
<td>Straight: 56%</td>
<td>Straight: 47%</td>
<td>Yes, p = .01</td>
</tr>
<tr>
<td></td>
<td>Curved: 25%</td>
<td>Curved: 30%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Twisted: 19%</td>
<td>Twisted: 23%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>n = 731</td>
<td>n = 396</td>
<td></td>
</tr>
<tr>
<td>Lateral convexity: cross section of blanks</td>
<td>Triangular: 41%</td>
<td>Triangular: 40%</td>
<td>Yes, p = .00</td>
</tr>
<tr>
<td></td>
<td>Trapezoidal: 47%</td>
<td>Trapezoidal: 55%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other: 12%</td>
<td>Other: 5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>n = 724</td>
<td>n = 397</td>
<td></td>
</tr>
<tr>
<td>Vertical convexity: width/thickness ratio</td>
<td>mean: 4.15</td>
<td>mean: 3.98</td>
<td>No, p = .15</td>
</tr>
<tr>
<td></td>
<td>s.d.: 1.84</td>
<td>s.d.: 1.73</td>
<td></td>
</tr>
<tr>
<td></td>
<td>n = 731</td>
<td>n = 397</td>
<td></td>
</tr>
<tr>
<td>Number of changes/five steps</td>
<td>3/5 = 0.6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

and Dethlefsen (1965) called the Doppler Effect, as the package proceeded down two paths, one toward Central Europe, and one to eastern Europe. This deviation, at least through time, can even be measured between the slightly earlier occupation of Ss-IIIa-4 and the immediately adjacent Ss-IIIc, producing a difference of 1.50.

Further research is needed within each region to increase the sample of assemblages representative of the
Table 8.33, continued

<table>
<thead>
<tr>
<th>Flintknapping steps by domain</th>
<th>Ss-IIIc</th>
<th>Ss-III</th>
<th>Significant Difference?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tool manufacture</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Selection for laminarity of blanks</td>
<td>Same as debitage, p = .16</td>
<td>Same as debitage, p = .40</td>
<td>No</td>
</tr>
<tr>
<td>Selection: length</td>
<td>Longer, p = .00</td>
<td>Longer, p = .00</td>
<td>No</td>
</tr>
<tr>
<td>Selection: width</td>
<td>Wider, p = .00</td>
<td>Wider, p = .00</td>
<td>No</td>
</tr>
<tr>
<td>Selection: thickness</td>
<td>Thicker, p = .00</td>
<td>Thicker, p = .05</td>
<td>No</td>
</tr>
<tr>
<td>Selection: dorsal scars</td>
<td>Same as debitage, p = .236</td>
<td>Bidirectional, p = .00</td>
<td>Yes</td>
</tr>
<tr>
<td>Selection: cortex</td>
<td>Same as debitage, p = .49</td>
<td>Noncortical, p = .00</td>
<td>Yes</td>
</tr>
<tr>
<td>Selection: axis of propagation</td>
<td>Same as debitage, p = .44</td>
<td>Same as debitage, p = .99</td>
<td>No</td>
</tr>
<tr>
<td>Selection: lateral edges</td>
<td>Same as debitage, p = .631</td>
<td>Convergent, p = .00</td>
<td>Yes</td>
</tr>
<tr>
<td>Selection: distal terminus</td>
<td>Same as debitage, p = .61</td>
<td>Pointed, p = .00</td>
<td>Yes</td>
</tr>
<tr>
<td>Selection: profile</td>
<td>Same as debitage, p = .93</td>
<td>Same as debitage, p = .78</td>
<td>No</td>
</tr>
<tr>
<td>Selection: cross section</td>
<td>Same as debitage, p = .24</td>
<td>Trapezoidal, p = .02</td>
<td>Yes</td>
</tr>
<tr>
<td>Selection: platform type</td>
<td>Same as debitage, p = .36</td>
<td>Prepared, p = .00</td>
<td>Yes</td>
</tr>
<tr>
<td>Selection: impact placement</td>
<td>N/A</td>
<td>Same as debitage, p = .07</td>
<td>N/A</td>
</tr>
<tr>
<td>Selection: EPA/PT ratio</td>
<td>Smaller, p = .00</td>
<td>Smaller, p = .00</td>
<td>No</td>
</tr>
<tr>
<td>Unique types of retouch</td>
<td>Normal retouch</td>
<td>Normal retouch</td>
<td>No</td>
</tr>
<tr>
<td>Tool types</td>
<td>UP tools dominate</td>
<td>UP tools dominate</td>
<td>No</td>
</tr>
<tr>
<td>Number of changes/16 steps</td>
<td></td>
<td></td>
<td>6/15 = 0.4</td>
</tr>
<tr>
<td>Total measure of difference weighted by behavioral domains</td>
<td></td>
<td></td>
<td>1.50</td>
</tr>
</tbody>
</table>

period between 60,000 and 30,000 B.P. Yet the current data supports the conclusion that these three assemblages (Boker Tachtit level 1, Ss-IIIa level 4, and Korolevo II Complex II) represent the diffusion of a phenomenon we may call the Bohunician Behavioral Package, named after the Central European industry marking its northwesternmost distribution. (It does not appear to have reached Western Europe.) This appellation is only fitting given the fact that central and eastern European scholars (Valoch 1990a; Kozlowski 1990; Ginter et al. 1996; Demidenko and Usik 1993a) were the first to notice morphological similarities among these disparate assemblages. The regional origin of this behavioral package should be sought in adjacent localities, including southeastern Europe, the Nile Valley, and Anatolia.

The Bohunician Behavioral Package is the first of two diffusion events evidenced by this research. The second is the “Aurignacian Behavioral Package,” which introduced a distinctive new suite of knapping options to the Levant (Kebbara Cave Unit II) and Central Europe (Ss-IIa-4 and Ss-IIIa-3) (Tostevin 2000a, 2000b). As with its predecessor, the Aurignacian Behavioral Package did not possess sufficient antecedents within any of the three regions studied to warrant an in situ appearance in these regions.

Discussion of the consequences of this research for the Middle to Upper Paleolithic transition in each of the three regions is beyond the scope of this chapter. Nevertheless, the attribute analysis of Ss-IIIc, designed with the purpose of addressing regional questions of continuity in learned behaviors, has produced results that will hopefully stimulate further research. If indeed the hominids who created the assemblage from Ss-IIIc and Ss-IIIId are behavioral descendents (perhaps even biological descendents) of a diffusion event that struck both Eastern and Central Europe from the Levant three thousand years earlier, the people we see reflected in the archaeological record of these sites may only be a type of “second generation” Central Europeans, and not the natives we once assumed.

REFERENCES

Adams, W. Y., and E. W. Adams

Ahler, S.

Table 8.34

<table>
<thead>
<tr>
<th>Flintknapping steps by domain</th>
<th>Ss-IIIc</th>
<th>Vedrovice V</th>
<th>Significant difference?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Core modification</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Core orientation</td>
<td>Longitudinal</td>
<td>Longitudinal</td>
<td>No</td>
</tr>
<tr>
<td>Core management</td>
<td>Dédorants &amp; side blade removals</td>
<td>Lateral core tablets, changes of orientation</td>
<td>Yes</td>
</tr>
<tr>
<td>Number of changes/two steps</td>
<td>1/2 = 0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Platform maintenance</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Platform treatment</td>
<td>Unprepared: 58% (n = 767)</td>
<td>Unprepared: 61% (n = 380)</td>
<td>No, p = .41</td>
</tr>
<tr>
<td></td>
<td>Prepared: 42% (n = 664)</td>
<td>Prepared: 40% (n = 341)</td>
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</tr>
<tr>
<td></td>
<td>mean: 64.9</td>
<td>mean: 89.0</td>
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</tr>
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<td></td>
<td>s.d.: 15.0</td>
<td>s.d.: 17.4</td>
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</tr>
<tr>
<td>External platform angle (degrees)</td>
<td>2/3 = 0.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Platform thickness</td>
<td>mean: 4.55</td>
<td>mean: 5.00</td>
<td>Yes, p = .04</td>
</tr>
<tr>
<td></td>
<td>s.d.: 2.52</td>
<td>s.d.: 3.64</td>
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</tr>
<tr>
<td></td>
<td>n = 741</td>
<td>n = 358</td>
<td></td>
</tr>
<tr>
<td>Number of changes/three steps</td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Direction of core exploitation</strong></td>
<td>Unidirectional</td>
<td>Unidirectional changing to bidirectional</td>
<td>Yes</td>
</tr>
<tr>
<td>Direction of cortex removal</td>
<td>Bidirectional changing to unidirectional</td>
<td>Bidirectional changing to unidirectional</td>
<td>No</td>
</tr>
<tr>
<td>Number of changes/two steps</td>
<td>1/2 = 0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Dorsal surface convexity system</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longitudinal convexity: length/width ratio</td>
<td>mean: 1.82 (n = 731)</td>
<td>mean: 1.50 (n = 473)</td>
<td>Yes, p = .00</td>
</tr>
<tr>
<td></td>
<td>s.d.: 0.80</td>
<td>s.d.: 0.59</td>
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</tr>
<tr>
<td></td>
<td>mean: 731</td>
<td>n = 473</td>
<td></td>
</tr>
<tr>
<td>Shape of convexity: lateral edges of blanks</td>
<td>Parallel: 41% (n = 706)</td>
<td>Parallel: 39% (n = 410)</td>
<td>Yes, p = .00</td>
</tr>
<tr>
<td></td>
<td>Convergent: 16%</td>
<td>Convergent: 15%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Expanding: 18%</td>
<td>Expanding: 31%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ovoid: 25%</td>
<td>Ovoid: 14%</td>
<td></td>
</tr>
<tr>
<td>Curvature of convexity: profile of blanks</td>
<td>Straight: 56% (n = 731)</td>
<td>Straight: 64% (n = 419)</td>
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</tr>
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<td>Curved: 25%</td>
<td>Curved: 16%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Twisted: 19%</td>
<td>Twisted: 20%</td>
<td></td>
</tr>
<tr>
<td>Lateral convexity: cross section of blanks</td>
<td>Triangular: 41% (n = 724)</td>
<td>Triangular: 50% (n = 431)</td>
<td>Yes, p = .00</td>
</tr>
<tr>
<td></td>
<td>Trapezoidal: 47%</td>
<td>Trapezoidal: 29%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other: 12%</td>
<td>Other: 21%</td>
<td></td>
</tr>
<tr>
<td>Vertical convexity: width/thickness ratio</td>
<td>mean: 4.15 (n = 731)</td>
<td>mean: 4.26 (n = 473)</td>
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</tr>
<tr>
<td></td>
<td>s.d.: 1.84</td>
<td>s.d.: 1.84</td>
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</tr>
<tr>
<td>Number of changes/five steps</td>
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continued on next page
Table 8.34, continued

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<th>Flintknapping steps by domain</th>
<th>Ss-IIIc</th>
<th>Vedrovice V</th>
<th>Significant difference?</th>
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<tbody>
<tr>
<td>Tool manufacture</td>
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<td></td>
<td></td>
</tr>
<tr>
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<td>Same as debitage, p = .16</td>
<td>Same as debitage, p = .27</td>
<td>No</td>
</tr>
<tr>
<td>Selection: length</td>
<td>Longer, p = .00</td>
<td>Longer, p = .00</td>
<td>No</td>
</tr>
<tr>
<td>Selection: width</td>
<td>Wider, p = .00</td>
<td>Wider, p = .00</td>
<td>No</td>
</tr>
<tr>
<td>Selection: thickness</td>
<td>Thicker, p = .00</td>
<td>Thicker, p = .00</td>
<td>No</td>
</tr>
<tr>
<td>Selection: dorsal scars</td>
<td>Same as debitage, p = .236</td>
<td>Same as debitage, p = .77</td>
<td>No</td>
</tr>
<tr>
<td>Selection: cortex</td>
<td>Same as debitage, p = .49</td>
<td>Same as debitage, p = .31</td>
<td>No</td>
</tr>
<tr>
<td>Selection: axis of propagation</td>
<td>Same as debitage, p = .44</td>
<td>Straight, p = .02</td>
<td>No</td>
</tr>
<tr>
<td>Selection: lateral edges</td>
<td>Same as debitage, p = .631</td>
<td>Same as debitage, p = .08</td>
<td>No</td>
</tr>
<tr>
<td>Selection: distal terminus</td>
<td>Same as debitage, p = .61</td>
<td>Same as debitage, p = .71</td>
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</tr>
<tr>
<td>Selection: profile</td>
<td>Same as debitage, p = .93</td>
<td>Same as debitage, p = .84</td>
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</tr>
<tr>
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<td>Same as debitage, p = .24</td>
<td>Same as debitage, p = .78</td>
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<tr>
<td>Selection: platform type</td>
<td>Same as debitage, p = .36</td>
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</tr>
<tr>
<td>Selection: impact placement</td>
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<td>Same as debitage, p = .90</td>
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</tr>
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<td>Selection: EPA/PT ratio</td>
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<td>Smaller, p = .01</td>
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</tr>
<tr>
<td>Unique types of retouch</td>
<td>Normal retouch</td>
<td>Flat bifacial retouch</td>
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<td>Tool types</td>
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</tr>
<tr>
<td>Number of changes/16 steps</td>
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<td>2/15 = 0.13</td>
<td></td>
</tr>
</tbody>
</table>

Total measure of difference weighted by behavioral domains 2.60

Andrefsky, W., Jr.

Aronson, M., J. M. Skibo, and M. T. Stark

Azoury, I.

Bar-Yosef, O.

Bar-Yosef, O., and A. Belfer-Cohen


Baumler, M. F.
### Table 8.35

<table>
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<tr>
<th>Flintknapping steps by domain</th>
<th>Ss-IIIc</th>
<th>Kūlna 7a</th>
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<td><strong>Core modification</strong></td>
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<td>Core orientation</td>
<td>Longitudinal</td>
<td>Unifacial discoidal</td>
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<td>Core management</td>
<td>Débordants &amp; side blade removals</td>
<td>Centripetal removals, secant surfaces</td>
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<tr>
<td>Number of changes/two steps</td>
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<tr>
<td>Platform maintenance</td>
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<tr>
<td>Platform treatment</td>
<td>Unprepared: 58% (n = 767)</td>
<td>Unprepared: 58% (n = 167)</td>
<td>No, <em>p</em> = .93</td>
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<td></td>
<td>Prepared: 42% (n = 664)</td>
<td>Prepared: 42% (n = 153)</td>
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<tr>
<td></td>
<td>mean: 84.9 s.d.: 15.0</td>
<td>mean: 83.8 s.d.: 14.8</td>
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<tr>
<td></td>
<td>n = 741</td>
<td>n = 153</td>
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<tr>
<td>Direction of core exploitation</td>
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<td>Direction of cortex removal</td>
<td>Unidirectional</td>
<td>Unidirectional changing to crossed</td>
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<td>Bidirectional changing to unidirectional</td>
<td>Subcentripetal changing to unidirectional</td>
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<td>Dorsal surface convexity system</td>
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<tr>
<td>Longitudinal convexity: length/width ratio</td>
<td>mean: 1.82 s.d.: 0.80 (n = 731)</td>
<td>mean: 1.45 s.d.: 0.51 (n = 231)</td>
<td>Yes, <em>p</em> = .00</td>
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<td>Shape of convexity: lateral edges of blanks</td>
<td>Parallel: 41% Convergent: 16% Expanding: 18% Ovoid: 25% (n = 706)</td>
<td>Parallel: 55% Convergent: 12% Expanding: 19% Ovoid: 14% (n = 172)</td>
<td>Yes, <em>p</em> = .00</td>
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<td>Curvature of convexity: profile of blanks</td>
<td>Straight: 56% Curved: 25% Twisted: 19% (n = 731)</td>
<td>Straight: 64% Curved: 22% Twisted: 14% (n = 195)</td>
<td>No, <em>p</em> = .12</td>
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<tr>
<td>Lateral convexity: cross section of blanks</td>
<td>Triangular: 41% Trapezoidal: 47% Other: 12% (n = 724)</td>
<td>Triangular: 39% Trapezoidal: 54% Other: 7% (n = 200)</td>
<td>No, <em>p</em> = .05</td>
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<td>Vertical convexity: width/thickness ratio</td>
<td>mean: 4.15 s.d.: 1.84 (n = 731)</td>
<td>mean: 2.84 s.d.: 1.08 (n = 231)</td>
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<th>Külna 7a</th>
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<td><strong>Stone manufacture</strong></td>
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<td>Longer, p = .00</td>
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<tr>
<td>Selection: width</td>
<td>Wider, p = .00</td>
<td>Same asdebitage, p = .17</td>
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<tr>
<td>Selection: thickness</td>
<td>Thicker, p = .00</td>
<td>Same asdebitage, p = .12</td>
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<td>Selection: dorsal scars</td>
<td>Same asdebitage, p = .236</td>
<td>Unidirectional, p = .02</td>
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<td>Selection: cortex</td>
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<td>Same asdebitage, p = .07</td>
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<td>Selection: axis of propagation</td>
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<td>Same asdebitage, p = .45</td>
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<td>Selection: lateral edges</td>
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<td>Same asdebitage, p = .07</td>
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<td>Same asdebitage, p = .48</td>
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<td>Selection: profile</td>
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<td>Same asdebitage, p = .51</td>
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<td>Selection: cross section</td>
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<td>Same asdebitage, p = .51</td>
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<td>Normal retouch</td>
<td>Flat bifacial retouch</td>
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<td>UP tools dominate</td>
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oëda, Eric
1986 “Approche technologique du concept Levallois et évaluation de son champ d’application: étude de trois gisements saaliens et weichsélins de la France septentrionale.” Ph.D. Dissertation, Université de Paris X.


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Childs, S. T.

Chilton, E. S.
Table 8.36
Central European, Eastern European, and Levantine sample assemblages. All dates are radiocarbon dates unless otherwise noted. Industrial affiliations are for descriptive purposes only.

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<td>Svoboda &amp; Simán 1989;</td>
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<td>Svoboda 1983, 1991;</td>
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<td>35,320 ± 320–300</td>
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Table 8.36, continued

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<td>Kebara</td>
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<td>Marks 1983; Marks &amp; Volkman 1983a, 1983b; Volkman 1983, 1989</td>
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<td>Kebara</td>
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<td>Demidenko &amp; Usik 1993a, 1993b; Gladilin 1989; Gladilin &amp; Demidenko 1990, Usik 1989</td>
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<td>Gladilin 1989; Gladilin &amp; Demidenko 1990; Usik 1989</td>
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Table 8.37
Measurement of the difference in flintknapping behaviors among assemblages for all regions.

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<th>Regional sequence of change</th>
<th>Comparison of assemblages through time</th>
<th>Measure of difference (Max. = 5, Min. = 0)</th>
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<td>Kůlna 7a vs. Ss-IIIa-4</td>
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<td>Ss-III vs. Vedrovice V</td>
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<td>Kůlna 7a vs. Vedrovice V</td>
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<td>Boker Tachtit 2 vs. Kebara IV</td>
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<td>Boker Tachtit 2 vs. Ss-IIIa-4</td>
<td>1.40</td>
</tr>
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<td>Boker Tachtit 2 vs. Korojevo II-II</td>
<td>2.26</td>
</tr>
<tr>
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<td>Kebara I vs. Ss-IIIa-3 &amp; Ss-IIa-4</td>
<td>1.81</td>
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