

On the Difficulty of the Middle-Upper Paleolithic Transitions

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BEHAVIORAL ADAPTATIONS AND HOMININ PHYLOGENY

The most recent Upper Paleolithic culture complexes differ in important ways from the latest Middle Paleolithic. Indeed, by 20,000–18,000 BP,¹ the height of the Last Glacial Maximum, many fundamental and unique features of modern human behavior—from the use of material culture as a medium of symbolic communication to the development of complex and costly technologies—are expressed on a global scale. The evolutionary roots of these behavioral characteristics may be much deeper, and, in a handful of places, they seem to be expressed precociously in time horizons considerably more ancient than the Last Glacial Maximum (McBrearty and Brooks 2000). Yet there is no consensus on where and when modern human behavior first appeared. More important, there is no consensus on what processes led to its emergence (Clark 1999).

The concept of the early Upper Paleolithic as a period distinct from both the late Middle Paleolithic and late Upper Paleolithic is intimately tied to these questions. The degree to which researchers emphasize the differences between the late Middle Paleolithic, early Upper Paleolithic, and late Upper Paleolithic is in part a function of where they work, but it is also connected with their views about the relationship between human behavioral and biological change. Much effort has been expended on characterizing the earlier of these transitions, between the late Middle and earliest Upper Paleolithic, in part because the earliest appearance of the Upper Paleolithic has long been associated with the origin and spread of anatomically modern humans. Supporters of models positing an abrupt replacement of indige-

A 22

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1. Throughout the volume, all ages are reported in radiocarbon years before present (BP) or thousands of radiocarbon years before present (ka) unless otherwise noted.

nous archaic hominins (e.g., Neanderthals) by anatomically modern humans coming out of sub-Saharan Africa would like to see an abrupt archaeological break in the late Pleistocene archaeological sequence, perhaps coinciding with the appearance of the first Upper Paleolithic cultural complexes around 45,000 BP (e.g., Klein 1999; Mellars 1996, 1999). Supporters of models positing regional continuity in late Pleistocene cultural and biological evolution would like to see, in contrast, profound changes occurring only after anatomically modern humans evolved and became established across the globe, the behavioral transitions coinciding perhaps with the appearance of the late Upper Paleolithic around 20,000 BP (e.g., Strauss 1997). Neither of these expectations is particularly realistic.

The differences of interpretation stem in part from an insistence that behavioral evolution occurred in tandem with biological evolution. On the contrary, we see no necessary theoretical link between the transition from the Middle to the Upper Paleolithic and the biological origins of anatomically modern humans or, for that matter, the demise of archaic hominins. Nonhuman biological systems offer a wide range of examples where very complex behavioral transitions occurred repeatedly among unrelated taxa (see Camazine et al. 2001; Maynard Smith and Szathmáry 1995). Eusociality, for example, has evolved among sponge-dwelling shrimp (*Synalpheus* sp.) (Duffy et al. 2000), naked mole-rats (*Heterocephalus glaber*) (Sherman et al. 1991), termites (*Macrotermes* sp.) (Camazine et al. 2001) and bees and ants (Hymenoptera) (Wilson 1971)—within the last order at least a dozen times independently. Closer to home, the repeated independent origin of various complex stone core and tool technologies (Bar-Yosef and Kuhn 1999; Brantingham and Kuhn 2001), big- and small-game hunting (Stiner 2001, 2002), complex hunter-gatherer adaptations (Arnold 2001) and urbanism (Smith 2003) similarly do not diagnose biological transitions, and few anthropologists would argue that they do. What these examples illustrate is that, although phylogeny might be a good predictor of the probability that a particular behavioral feature might evolve, the opposite is not necessarily true: the presence of a specific behavior or behavioral system is not necessarily an accurate predictor of biological phylogeny. To wit, there is no more theoretical justification for saying that the Middle Paleolithic unequivocally diagnoses archaic hominins than there is for linking the Upper Paleolithic to the origins of anatomically modern humans.

Why continue to treat as problematic the relationship between the Middle and Upper Paleolithic if there is no necessary relationship between the evolution of "modern behavior" and the origin of modern humans? And why pay attention to the early Upper Paleolithic? We believe that it is precisely because of the potential for decoupling behavioral and biological evolution that the Middle-Upper Paleolithic transition is interesting. Indeed, the behavioral changes recognized within the early Upper Paleolithic sig-

nify a much more complex evolutionary process than is often imagined. Absent an assumed link between—or direct fossil evidence associating—individual hominin morphotypes and specific cultural complexes, anthropologists are forced to reevaluate their models for explaining the fundamental nature of behavioral change.

MODELING BEHAVIORAL TRANSITIONS

Use of the term "transition" to describe the emergence of the earliest Upper Paleolithic implies a jumping of significant evolutionary hurdles. There is little to dispute that imposing chemical, biological, and behavioral hurdles were jumped in the origins of self-replicating molecules, eukaryotic cells, and multicellular organisms (Maynard Smith and Szathmáry 1995; Michod 1999). These major evolutionary transitions were both difficult to achieve and astonishingly precise because of the hurdles that stood in their way. It is not immediately clear, in contrast, what evolutionary hurdles were jumped during the Middle-Upper Paleolithic transition. Although we agree that many of the features comprising the Upper Paleolithic are astonishing, this is no guarantee that the Middle-Upper Paleolithic transition was in some way evolutionarily difficult. The unprecedented development of the Upper Paleolithic are no less impressive than the independent development of formalized systems of writing, mathematical notation, and logic among later cultures, but they need not have been enormously more difficult.

We believe that the most appropriate questions to ask at this juncture are: How "accessible" was the Upper Paleolithic, given what we know about Middle Paleolithic adaptations? Were Upper Paleolithic adaptations easily derived from many different starting points within the Middle Paleolithic, or only from a few discrete Middle Paleolithic variants? Was the Middle-Upper Paleolithic transition highly improbable, involving radical, unpredictable changes in the way that behavioral adaptations were organized? Or was the transition highly probable, involving small, predictable changes to existing adaptations?

The difficulty of an evolutionary transition is relatively straightforward to establish for genetic systems (Barbel et al. 2001), and sometimes also for phenotypic systems (McGhee 1999). In such cases, metrics exist that provide reasonable measures of the distance between alternative states of the system. The distance between any two variants within a genotypic space, for example, is easily measured by the number of single base-pair mutations that it would take to transform one variant into the other. Thus, for a genetic string of length $N = 1$, the genotypic space consists of four alternative states (i.e., A, T, C, G) and it takes at most only one mutational step to get from any one variant to another. Assuming that mutation occurs at random—that there are no selective advantages to having any one genotype—it is clear that

all areas of this very simple genotypic space are equally accessible from any starting point. For a genetic string of length $N > 1$, it becomes more difficult to access certain parts of the genotypic space: for a string of length $N = 2$ and a given starting point (e.g. AA), there will be exactly six genetic variants that are accessible through one mutational step (e.g. AT, TA, AC, CA, AG, GA), but an additional nine variants that are accessible only through two mutations (e.g. TT, TC, TG, . . . , GG). In the absence of selective pressures, we would classify transitions to any of the states two mutational steps away as fundamentally more difficult to access. Accordingly, the difficulty of a transition between any two genetic strings is measured by the distance in mutational steps between states.

Phenotypic spaces describing theoretically possible morphologies or behavioral organizations are often more difficult to map. There are straightforward mathematical models describing the range of theoretically possible univariate shell forms (Raup 1966; McChee 1999), branching morphologies of trees (McChee 1999), hominin cranial morphologies (Ponce de León and Zollikofer 2001), and even some stone core and tool technologies (Dibble 1995; Brantingham and Kuhn 2001). Although it is possible to measure distances within these phenotypic spaces, an assessment of the difficulty of transition between alternative phenotypic states is necessarily dependent upon our understanding of the biological and/or behavioral mechanisms generating these alternative states. For example, a mathematical model describing the morphological distance between the shell shapes of two gastropod species must reference the growth and development of the respective species before it can be established whether one morphological alternative is easy or difficult to access from the other (McChee 1999): a dramatic change in shell morphology in one direction might prove to be easy to engineer developmentally, whereas a seemingly minor morphological change in another direction might be exceedingly difficult to accomplish. As will become apparent, moreover, transitions that are easily accomplished in one direction are not necessarily easy in reverse.

Arguably, the mechanisms generating different Paleolithic behavioral adaptations are not well known compared with either genetic or ontogenetic systems. As a consequence, even if we possessed all the necessary tools for measuring distances between alternative Paleolithic behavioral adaptations—something we are already prone to do informally and implicitly—it would be overly optimistic to assume that these measurements could immediately be used to evaluate how accessible the Upper Paleolithic was from the Middle Paleolithic. Although a realistic quantitative approach to this question is still a distant goal, it is possible to develop simple topological models that are conceptually useful for considering the difficulty of the Middle–Upper Paleolithic transition (see Bärbel et al. 2001). Our intention here in outlining the models is to provide a general but effective theoretical structure

that readers may use in evaluating the origins of the Upper Paleolithic in the various geographic regions treated in this volume.

In much the same way that we would build a genotypic space for a genetic string of a certain length, assume that we could quantify all of the theoretically possible combinations of behaviors comprising Middle and Upper Paleolithic adaptations, respectively. Such combinatorial models might describe, for example, the possible foraging, mobility, and mating strategies and forms of social organization that could co-occur in a coherent Middle or Upper Paleolithic adaptation. Assume also that we understood the mechanisms by which a behavioral feature in one adaptation is modified or replaced, yielding an alternative adaptation; for example, through innovation, drift, or acculturation. Within each modeled Paleolithic phenotypic space, one could measure the distances between alternatively configured adaptations and compute how many steps it would take to transform one into the other. For example, we could conceivably identify within Upper Paleolithic phenotypic space the positions of adaptations from the Dordogne and the Levant, evaluate the distance between them, and, given a mechanism of behavioral change, establish how difficult it would reach one from the other. Of interest here is whether transitions between phenotypic spaces comprising the Middle Paleolithic and those comprising the Upper Paleolithic were inherently difficult or easy.

Figure 1.1 presents a number of possible topological relationships underlying the Middle–Upper Paleolithic transition. The light and dark gray boxes represent hypothetical phenotypic spaces for the Middle Paleolithic and Upper Paleolithic, respectively. The size of a given box captures conceptually the size of the phenotypic space, roughly the number of distinct behavioral combinations that could comprise a coherent adaptation. The distance between any two points within a space is proportional to number of steps that it would take to transform one adaptation into the other. Note that larger phenotypic spaces can accommodate much greater distances between any two adaptive configurations while still being classified as Middle or Upper Paleolithic. In this way, larger spaces imply greater phenotypic variability.

Leaving open the question of the potential fitness differences of alternative adaptations within a single phenotypic space, transitions between the Middle and Upper Paleolithic are assumed to entail distinct changes in fitness. Indeed, a common—albeit tacit—assumption is that Upper Paleolithic adaptations arising from modification of one or more Middle Paleolithic configurations have greater fitness, although it is difficult to demonstrate conclusively that this is the case. Figure 1.1 conveys these assumed fitness differences by mapping the Middle and Upper Paleolithic as separate phenotypic spaces and thus by requiring a transition between spaces.

The length of the edge shared between two phenotypic spaces in each of the graphic models represents the proportion of one adaptive space that is

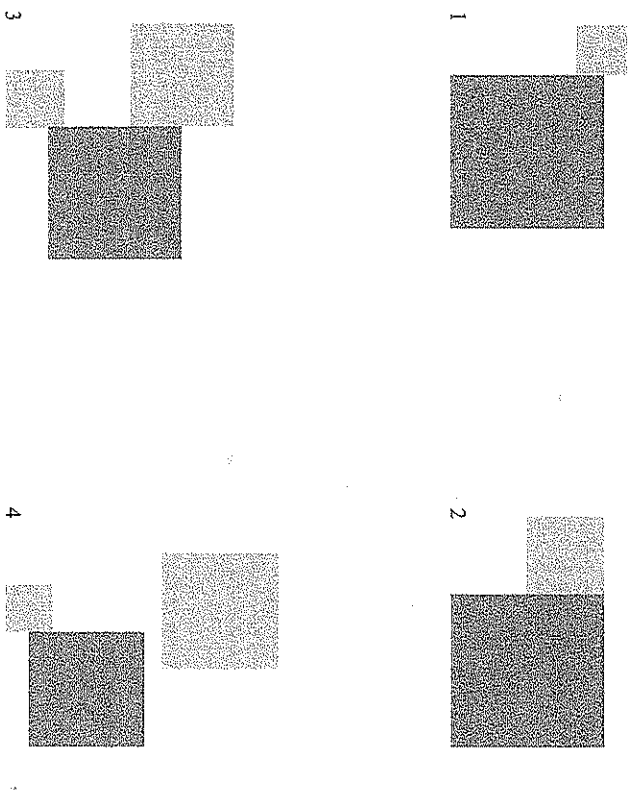


Figure 1.1. Alternative topological models for the Middle-Upper Paleolithic transition. Light gray boxes represent phenotypic spaces for the Middle Paleolithic, and dark gray boxes represent those for the Upper Paleolithic.

directly accessible from the other (see Barbel et al. 2001). If two phenotypic spaces are the same size and share an entire edge, then both spaces are of comparable combinatorial diversity and each adaptive configurations in one space is directly accessible through minor transformations of one or more adaptive configurations in the other space, and vice versa. At the other extreme, if two phenotypic spaces differ in size and share no edge, then the combinatorial diversity of one adaptive system is greater, and, more importantly, there are no transformations that lead between the two phenotypic spaces.

Panels 1 and 2 in figure 1.1 represent alternative topological models in which well-bounded Middle Paleolithic adaptations give rise to well-bounded Upper Paleolithic adaptations, with some probability that the reverse transition (i.e., “back reaction”) will also occur. In panel 1, the phenotypic space representing the Middle Paleolithic is substantially smaller than that for the Upper Paleolithic, indicating a lower degree of phenotypic diversity in the Middle Paleolithic. The absolute length of the edge shared

between the two phenotypic spaces is the same, but is larger as a proportion of the Middle Paleolithic space ($p = 0.5$) compared with the Upper Paleolithic ($p = 0.2$). This hypothetical relationship suggests that it is easier to exit the Middle Paleolithic through relatively minor modifications of existing adaptations. In other words, transitions in the direction of the Upper Paleolithic are much more easily achieved than transitions in the opposite direction. Numerically, we could suppose that approximately 50% of the adaptive configurations in the Middle Paleolithic are readily transformed into Upper Paleolithic configurations, whereas only 20% of the Upper Paleolithic configurations are easily transformed into characteristic Middle Paleolithic configurations. Symmetrically, of course, the other 50% of the modifications to Middle Paleolithic adaptations lead to alternative Middle Paleolithic adaptations, and the remaining 80% of the modifications to Upper Paleolithic adaptations lead to alternative Upper Paleolithic adaptations. Panel 2 represents a variant of the first postulated relationship, but in this case the Middle Paleolithic phenotypic space shares an entire edge with the Upper Paleolithic space. Hypothetically, then, all Middle Paleolithic adaptive configurations could lead to the Upper Paleolithic through simple transformations. However, a much smaller proportion of the Upper Paleolithic phenotypic space is easily transformed back into Middle Paleolithic adaptive configurations.

Panels 3 and 4 represent more complex topological relationships. Panel 3 illustrates a situation where the Middle Paleolithic is composed of two distinct phenotypic spaces representing nonoverlapping combinations of behaviors. One could interpret the two spaces as separate adaptive peaks (i.e., alternative equilibria) with similar—hence the Middle Paleolithic classifications—but not necessarily identical fitnesses. Generally speaking, there are no feasible transformations of adaptive configurations in one Middle Paleolithic space that lead *directly* to the other. The separate Middle Paleolithic spaces are, however, connected to a single Upper Paleolithic phenotypic space. This relationship implies that the two nonoverlapping Middle Paleolithic spaces could converge on a common set of Upper Paleolithic adaptations and, admitting the possibility, could also access one another through the Upper Paleolithic. In other words, one distinctive set of Middle Paleolithic adaptations could transition to an alternative, nonoverlapping set of Middle Paleolithic adaptations by first assuming an Upper Paleolithic configuration.

Finally, panel 4 illustrates a situation where one Middle Paleolithic phenotypic space is isolated from both an alternative set of Middle Paleolithic adaptive configurations and Upper Paleolithic configurations. In this case, there are no feasible transformations of the isolated set that lead to the Upper Paleolithic. Rather, the Upper Paleolithic arises from a relatively small and unique set of Middle Paleolithic adaptations.

How do these simple topological models map to current perspectives in the study of modern human origins and the Middle-Upper Paleolithic transition? There is no necessary or implied link between these topological models of behavioral transitions and the dynamics of hominin populations, although it may be tempting to interpret them in such terms. This said, the topologies represented by panels 1–3 are all broadly consistent with multi-regional models of human behavioral evolution. Panels 1 and 2 are similar in suggesting that there are single phenotypic spaces, differentiated on the basis of fitness, for both the Middle and Upper Paleolithic. The topology represented in panel 2 corresponds to an extreme multi-regional formulation in which all Middle Paleolithic variants lead easily into the Upper Paleolithic. Panel 1 is consistent with a less extreme interpretation in which a large proportion of local Middle Paleolithic variants lead easily to the Upper Paleolithic, whereas other local variants require more difficult (but not impossible) transformations to achieve the same result. Panel 3 is consistent with more complex multi-regional models, ones that further underscore the decoupling of biological and behavioral evolution: variants of the Middle Paleolithic, perhaps geographically defined, are themselves nonoverlapping and possibly of very different fitness levels, but converge on a common set of Upper Paleolithic adaptations. This convergence would be impossible if the two phenotypic spaces classified as Middle Paleolithic diagnosed reproductively isolated archaic hominin populations, and the Upper Paleolithic diagnosed reproductively isolated anatomically modern humans. Interestingly, all three models imply the possibility of devolution from Upper to Middle Paleolithic patterns, a possibility seldom discussed.

Panel 4 is the only general topological form illustrated here that leads to interpretations of the origin of Upper Paleolithic strictly consistent with a model of complete biological replacement. In this case, a phenotypically restricted Middle Paleolithic gives rise to the Upper Paleolithic allowing for no contributions from Middle Paleolithic variants. This fourth alternative would correspond with a strict "Out of Africa" scenario, in which anatomically and behaviorally modern humans originated in sub-Saharan Africa and spread throughout the world with little or no genetic or cultural input from other contemporary hominin populations.

The above models are not meant to provide an exhaustive set of all the theoretically possible relationships between the Middle and Upper Paleolithic. Rather, these simple examples are intended to provide a conceptual structure for the reader to begin considering the diversity of adaptations within the Middle and Upper Paleolithic and, in particular, what the early Upper Paleolithic tells us about how these phenotypic spaces were connected. The models are also intended to highlight the significant theoretical gaps in our understanding of the Middle-Upper Paleolithic and the position of the early Upper Paleolithic in the origins of modern human behavior. In particular,

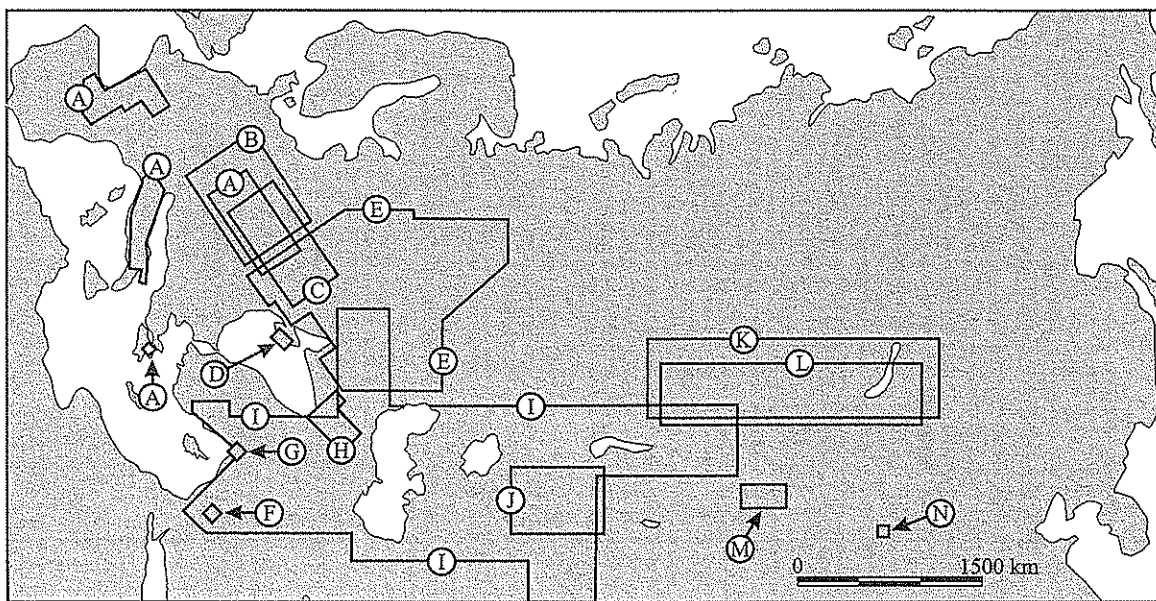


Figure 1.2. Map showing various areas and/or regions discussed in this book by chapter number. Key: A, chapter 2; B, chapter 3; C, chapter 4; D, chapter 5; E, chapter 6; F, chapter 7; G, chapter 8; H, chapter 9; I, chapter 10; J, chapter 11; K, chapter 12; L, chapter 13; M, chapter 14; N, chapter 15.

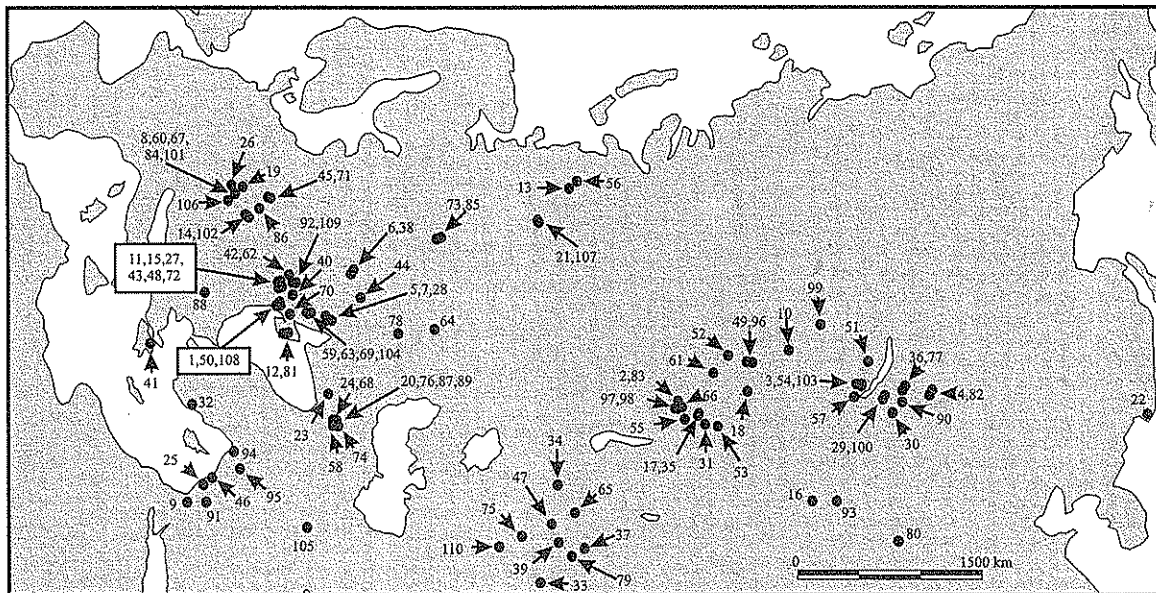


Figure 1.3. Map showing sites discussed in this book. Key: 1, Anetovka 13; 2, Anuy; 3, Arembovskii; 4, Arta 2; 5, Belokuzminovka; 6, Betovo; 7, Biryuchia Balka; 8, Bohunice; 9, Boker Tachtit; 10, Brazhnoye; 11, Brynzeny 1; 12, Buran-Kaya III; 13, Byzovaya; 14, Čertova Pec; 15, Chervony Kamen; 16, Chikhen Agui; 17, Denisova; 18, Dvuglazka Cave; 19, Dzierzyslaw; 20, Dzudzuana; 21, Garchi 1; 22, Geographical Society Cave; 23, Gubski Rockshelter; 24, Gvardjilas Klde; 25, Hayonim Cave; 26, Hradsko; 27, Ivanychi; 28, Kalitvenka; 29, Kamenka; 30, Kandabaevo; 31, Kara Bom; 32, Karain B; 33, Kara Kamar; 34, Karasu; 35, Kara Tenesh; 36, Khotyk 3; 37, Khonako 3; 38, Khotylevo 2; 39, Khudji; 40, Klimautsy 1; 41, Klisoura Cave; 42, Korman 4; 43, Korpatch; 44, Kostenki; 45, Kraków-Zwierzyniec; 46, Ksar Akil; 47, Kulbulak; 48, Koulichivka; 49, Kurtak 4; 50, Leski; 51, Makarovo 4; 52, Malaia Syia; 53, Maloialomanskaia; 54, Malta; 55, Malyi Yaloman; 56, Mamontovaya Kurya; 57, Mamony 2; 58, Mgvimevi; 59, Mira; 60, Mohelno; 61, Mokhovo 2; 62, Molodova 5; 63, Nenasytets; 64, Nepryakhino; 65, Obi Rakhmat; 66, Okladnikov Cave; 67, Ondratice; 68, Ortvale Klde; 69, Osokorovka; 70, Peremoga 1; 71, Piekaty II; 72, Ripiceni-Izvor; 73, Rusanikha; 74, Sagvardjile; 75, Samarkandskaya; 76, Samerzkhle Klde; 77, Sapun; 78, Shlyakh; 79, Shugnou; 80, Shuidonggou; 81, Siuren; 82, Sokhatino; 83, Strashnaya Cave; 84, Stránská skála; 85, Sungir; 86, Szeleta Cave; 87, Taro Klde; 88, Temnata Cave; 89, Togon Klde; 90, Tolbaga; 91, Tor Sadaf; 92, Tochilnitsa; 93, Tsagaan Agui; 94, Úçağlızı Cave; 95, Umm el Tlel; 96, Ust Izbul; 97, Ust Kanskaia; 98, Ust Karakol; 99, Ust Kova; 100, Varvarina Gora; 101, Vedrovice; 102, Vlčkovce; 103, Voennyi Hospital; 104, Vorona; 105, Warwasi; 106, Willendorf; 107, Zaozerie; 108, Zeleny Khutor; 109, Zhornov; 110, Zirabulak.

we believe that we have a poor grasp of the mechanisms that drive behavioral change. The models presented above clearly take their inspiration from theoretical approaches to biological evolution. In these theoretical models, adaptive organizations are graded in terms of fitness, and both selection and drift are primary mechanisms driving organizational changes and, ultimately, evolutionary transitions. Although fitness may yet be a primary currency in human behavioral evolution, and both selection and drift primary mechanisms of change, the models presented here are not restricted to these theoretical positions. Reasonable arguments could be made for innovation, acculturation, or other social and ideational mechanisms as the primary mechanisms underlying behavioral change. Regardless of one's theoretical choices in this domain, the above models demand that we evaluate the nature of the Middle-Upper Paleolithic transition in terms of its difficulty.

THE EARLY UPPER PALAEOLITHIC BEYOND WESTERN EUROPE

The models presented in the previous section provide a framework for examining and evaluating evolutionary transitions in general. Another set of questions concerns where—geographically and chronologically—we should look to evaluate the Middle-Upper Paleolithic transition. Until 30 years ago, the accounts of the Middle-Upper Paleolithic transition found in European and American texts focused almost exclusively on southwestern Europe, especially southern France and northern Spain, and secondarily on the Levant. The resulting models of the Middle-Upper Paleolithic transition were relatively uncomplicated.

Such a myopic view was not simply a matter of chauvinism, however. In all fairness, these were the only parts of the world that the majority of European and American researchers knew much of anything about. Continued exploration of the archaeological record outside the traditional Paleolithic heartland, combined with the easing of restrictions on international travel and communication resulting from the collapse of the Soviet Union in 1991, has changed the situation radically. Teams of researchers from Western Europe and the United States are now able to excavate sites in Russia, Central Asia, Eastern Europe, and other areas formerly off limits to them. More important, scholars from these regions can now attend conferences and contribute to publications in Western countries, bringing with them the fruits of decades of dedicated research that many of their Western colleagues knew little or nothing about. Suddenly, for the Paleolithic specialist, the world is a much bigger and more complicated place.

This explosion of new information is welcome. Curiously, however, the recent increase in available data has had only limited influence on the accounts of modern human origins found in textbooks, synthetic papers,

and popular articles. If anything, a consensus on where and when modern human behavior first appeared and the evolutionary processes that led to its emergence seems farther away. For too many scholars, the story devolves sooner or later to southwestern Europe and the now-familiar story of the Mousterian, Aurignacian, and Châtelperronian. A primary motive for assembling this volume, therefore, is to make available to anglophone scholars the most recent results on the beginnings of the Upper Paleolithic from areas outside Western Europe. The geographic coverage is not absolutely even, but we have tried to include those parts of Eurasia where there is active research on the early Upper Paleolithic (figures 1.2 and 1.3).

Although the chapters in this volume do not provide a complete consensus on the geographic nature, timing, and processes underlying the origins of modern human behavior, we believe that collectively, they put us in a much better position to assess the general topology of the Middle-Upper Paleolithic transition, or perhaps more accurately stated, the Middle-Upper Paleolithic transitions. We hope the reader will draw on the general theoretical models presented earlier in this chapter to organize their interpretations of the Middle-Upper Paleolithic transitions as seen in different regions: What is the range of early Upper Paleolithic phenotypic space? Is this a single, well-integrated phenotypic space, or is there reason to believe that there many independently organized spaces? What does the early Upper Paleolithic tell us about the region of contact between Middle and Upper Paleolithic cultural and behavioral adaptations? What does this region of contact (or lack thereof) tell us about the difficulty of the transition between phenotypic spaces? Do some lines of evidence (e.g., lithic technology) suggest relative ease of transition, whereas others (e.g., symbolic behavior) imply radical and difficult transformations? Many of the chapter authors postulate historical or phylogenetic relationships between local Middle and Upper Paleolithic cultures, irrespective of differences or similarities in adaptations. The relationship between evolutionary potential and phylogenetic history in the various regions is an issue of considerable interest. We return to these questions in the concluding chapter.