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The papers in this virtual special issue of *Journal of Human Evolution* developed out of an international symposium organized by Mina Weinstein-Evron and Yossi Zaidner at the University of Haifa in November, 2017. The original title for the meeting was “The Lower to Middle Paleolithic Boundary: A view from the Near East.” A total of 27 presentations covered topics ranging from dating to hominin taxonomy, with a strong emphasis on the archaeological evidence. The papers presented showcased original data as well as broad reviews. Given the title of the symposium there was an obvious geographic bias toward the Near East, although multiple contributions presented results from Europe, diverse regions of Africa, the Caucasus, and East Asia. The workshop was funded by the Wenner-Gren Foundation, Israel Science Foundation, and the Dan David Foundation. The symposium was hosted by the Zinman Institute of Archaeology at the University of Haifa. The 13 contributions to this special issue represent a subset of the papers presented at the original symposium. These focus mainly on evidence from

southwest Asia and Europe. Recently-excavated sites such as Misliya and Qesem Caves are strongly represented among the contributed papers, in part because of the regional focus of the symposium and in part because there is a great deal of active research on them.

The transition from Lower to Middle Paleolithic (or from Early to Middle Stone Age) occurred during the second part of the Middle Pleistocene¹, a period spanning roughly 500 ka to 125 ka, or MIS 14-5. This evolutionary event encompassed far more than a shift in prevailing systems for producing and shaping stone tools (i.e., from bifacial *façonnage* to Levallois *débitage*).

Behavioral and socio-cultural developments at this time had far-reaching consequences for subsequent cultural evolution. The organizers of and participants to this symposium and special issue are not the first to recognize the importance of cultural and biological developments during this period of time. In 1975, Glynn Isaac coined the term “Muddle in the Middle” to refer to the many behavioral and cultural developments between the Lower and Middle Paleolithic (Isaac, 1975), and this trope has been revived periodically in papers reviewing new data and new understandings of this intriguing interval (Gowlett, 2008; Malinsky-Buller, 2016). The landmark volume *After the Australopithecines* (Butzer and Isaac, 1975), as well as later conferences organized at the University of Haifa (Ronen, 1982; Ronen and Weinstein-Evron, 2000) assembled researchers from across the globe to look more deeply into environmental, biological, and cultural developments during the later Middle Pleistocene.

There are many reasons for the continuing interest in the later Middle Pleistocene. First, it follows a remarkable change in global regimes of climate variation, the so-called Early-Middle Pleistocene Transition, in which 41 ky climate cycles gave way to longer (100 ky), but more extreme and asymmetric cycles. Early Pleistocene climate fluctuations are usually attributed to Milanković cycle forcing. The cause for the shift to longer climate cycles, with gradual onset and abrupt termination of glacial periods, is less clear. Various studies attribute it to interactions between orbital forcing, fluctuations in CO₂, and atmospheric dust, and regolith removal (Clark et al., 2006). Regardless of why they happened, changes in periodicity and severity of climate cycles have in turn been cited as a source of important selective pressures on biotic communities as well as hominin behavior and cognition (Potts 1998; Bonnefille et al., 2004; Potts and Faith 2015).

The fossil hominins of the Middle Pleistocene are persistently interesting in large part because of their diversity and ambiguity. Many hominin fossil specimens from the earlier part of this time interval in Africa and western Eurasia have been assigned to *Homo heidelbergensis*, a taxon which seems to be most notable for its variability and shifting boundaries (Mounier et al., 2009; Wagner et al., 2010; Stringer, 2012; Buck and Stringer, 2014; Manzi, 2016; Roksandic et al., 2018). Later on other hominins appeared in different parts of the world. Currently, the earliest date for the taxon *Homo sapiens* is just before 300 ka (Richter et al., 2017), and *Homo sapiens* fossils from East Africa (Aubert et al., 2012), the Near East (Hershkovitz et al., 2018), and even southern Europe (Harvati et al., 2019) have been dated to around 200ka. Nonetheless, other forms of Middle Pleistocene *Homo* may have survived in the Near East until ca 120 ka (Hershkovitz et al., 2021; Zaidner et al., 2021). During this same period the northern hemisphere was populated by two sister taxa, Neanderthals and Denisovans (Lalueza-Fox and Gilbert, 2011; Rogers et al., 2017). African hominin diversity seems to have been high at this time as well, including closely related (Stringer, 2016; Mounier and Mirazón Lahr, 2019) as well as distantly related forms (Dirks et al., 2017).

Finally, as most of the papers in this volume illustrate, archaeological evidence points to important changes in behavior across the globe beginning during the Middle Pleistocene. The earliest evidence for hafting dates to around 500ka (Wilkins et al., 2012). The frequency and ubiquity of hafted tools expanded over the next few hundred thousand years (Villa and Lenoir, 2009; Barham, 2013; Kuhn, 2020), developments which have important implications for both the functional effectiveness of implements and their cognitive and labor demands (Wynn, 2009; Ambrose, 2010; Barham, 2013). As we discuss in greater detail below, Levallois technology and systematic blade production also trace their roots back to this interval. Starting around 400 ka, archaeological deposits in a number of regions across Eurasia document a notable increase in the frequency of evidence of fire (Roebroeks and Villa, 2011; Shimelmitz et al., 2014). Whether this represents the initial “domestication” of fire by hominins, or simply a step towards greater dependence on pyrotechnology, remains a topic of debate (e.g., Sandgathe et al., 2011). Nonetheless, it is apparent that fire was a more regular and probably more important part of hominin lives after this time. Assemblages of animal bones from the time period seem to reflect the emergence of a distinctly hominin pattern of predation, targeting prime-aged animals (Stiner, 2002; Stiner et al., 2011). This strategy, which gave hominins access to the largest and fattest

individuals in a prey population, implies a relatively high level of control over prey selection. The individual papers in this special issue document a range of other developments in foraging, technology and raw material management (Barsky et al., 2019; Agam and Zupancich, 2020; Shimelmitz et al., 2020, 2021) and even use of space within sites (Yeshurun et al., 2020).

Although the papers assembled in this special issue cover a broad set of topics, regions and sites, several general themes emerge from them.

As several papers illustrate quite clearly, key components of later Middle and Upper Paleolithic technologies, especially Levallois and blade production *sensu lato*, have their origins in the Middle Pleistocene. It is becoming broadly acknowledged that similar behaviors developed independently in different parts of the world out of a similar Acheulean/Lower Paleolithic substrate (Hérisson and Soriano, 2020; Moncel et al., 2020). Of the regions covered in this volume, the Levant is different in that Levallois seems to be intrusive (Zaidner and Weinstein-Evron, 2016, 2020; Meignen and Bar-Yosef, 2020).

The technological developments did not end with Levallois and blade production. These two modes of blank production embody, in different ways, the principle of “predetermination” of blank form, which is thought to require relatively advanced cognitive abilities, well-developed “executive function” and long-term working memory in particular (Wynn & Coolidge, 2009, 2011). But to a certain extent we focus on these phenomena because they were formerly used to define particular chronostratigraphic units, the Middle Paleolithic or Middle Stone Age (or Mode 3) in the case of Levallois, and the Upper Paleolithic/Late Stone Age (Mode 4) for prismatic blades. In fact, many parts of Africa as well as Eurasia witnessed a marked *generalized* diversification of methods for producing both small and large stone tools during the Middle Pleistocene. In some respects, this appears to be a period of considerable experimentation with lithic debitage, an “adaptive radiation” in methods of *débitage* (Chazan, 2016). It began as early as 500 ka in eastern and southern Africa, somewhat later in Eurasia. A range of methods either appeared (e.g., Quina/Yabrudian production (Bourguignon, 1996; Turq, 2000)) or were elaborated (e.g., discoid) around this time, including some which may not have persisted or diffused widely (e.g., Carmignani et al. 2017, de Lomberra-Hermida et al, 2020). In some areas, bifacial shaping technology, which appeared first in the Middle Acheulean, continued to be used alongside these new methods of flake production. Moreover, the diverse blank forms and

finished tools are seemingly adapted to different functions and patterns of use and renewal (Agam and Zupancich, 2020). Systematic secondary re-use of flake and bifacial tools - described as ramification or recycling - also emerged as a regular strategy for extending the useful lives of artifacts diverse range of assemblages (Hérisson and Soriano, 2020; de Lomberra-Hermida et al., 2020).

The increasing diversity and complexity of behavior with respect to stone tools is echoed in other facets of behavior. Use wear evidence attests to a range of applications for stone tools, including processing hides and plant material both before (Agam and Zupancich, 2020) and after (Vardi et al., 2018; Groman-Yaroslavski et al., 2021) the transition from LP to MP. These non-subsistence activities point to a range of technologies involving perishable raw materials which are largely invisible to us except for traces left on stone tools. Hide working and clothing manufacture have the *potential* to be particularly elaborate and complex, although we have little idea about what the finished products looked like. Still, evidence for scraping hides at different stages (wet, dry) does at least indicate that hominins took special measures to increase the workability (and wearability) of skins. Blasco and colleagues (2020) point to a widespread but little understood phenomenon observed at Qesem Cave and many Middle Pleistocene sites in Eurasia, the exploitation of birds. Some birds were probably eaten, but non-nutritional uses may also be indicated. Wider ranges of manufacture activities and exploration of new resources can be seen as parts of the broader trend towards exploration and experimentation in the technological and economic realms during the later Middle Pleistocene, perhaps best expressed in the variety of use-wear and other microscopic evidence on stone tools (Lemorini et al. 2006; Hardy and Moncel 2011; Agam and Zupanich 2020; Groman-Yaroslavski et al, 2016, 2021).

Another important general observation coming from this set of papers concerns the diverse trajectories of behavioral change across Africa and Eurasia between 500 ka and 125 ka. The records from many parts of Europe and sub-Saharan Africa show a high degree of continuity between Lower and Middle Paleolithic or Early and Middle Stone Age, and it can be difficult to draw a clear boundary between them. The patterns of behavioral evolution in Europe and Africa match up well with current understandings of the evolution of hominin populations. In Africa, the smooth transition from ESA to MSA fits comfortably with a local origin of *Homo sapiens*, while in Europe, the gradual emergence of the Middle Paleolithic parallels the local evolution of

Neanderthals. At the same time, the papers by Barsky et al., Moncel et al., Hérissou & Soriano, and de Lomberra-Hermida et al. demonstrate that even within a relatively small area (France and northern Spain), there is a distinctly mosaic pattern during this period.

The Levant seems to tell a very different story. Here, abrupt changes in the nature of lithic technology and other forms of behavior, marked by the appearance of the laminar Early Levantine Mousterian, occurred sometime around 250 ka. As Meignen & Bar-Yosef and Zaidner & Weinstein-Evron argue, the sudden appearance of the distinctive early Mousterian technologies may signal the initial appearance of African *Homo sapiens* in the region. However, both sets of authors also point out that it is easier to make the case for an African connection for the hominins than for the lithic technology. The uncertain links with Africa could simply be due to limited data from intervening areas (northeast Africa) or rapid behavioral change in dispersing populations of *Homo sapiens*. Fine-grained analyses of the details of lithic technology in likely ancestral African and descendent Levantine assemblages (following Tostevin, 2013, for example) could help resolve this question in the future. What seems clear, however, is their (Weissbrod & Weinstein-Evron 2020a,b) and probably also other Levantine *Homo* groups' (HersHKovitz et al. 2021; Zaidner et al. 2021) appreciable adaptability to highly variable climates.

Although it is not a central topic of the papers in this collection, the early appearance of *Homo sapiens* in the Levant signaled by the Misliya hominin specimen (HersHKovitz et al. 2018) also highlights a seeming anomaly later in time. It has long been believed, based on the abundant human fossils from Skhul and Qafzeh, that the “middle” (Tabun C type) Levantine Mousterian was produced by *Homo sapiens*. Arguably, the greatest discontinuity in the Levantine Mousterian sequence is between the early and “middle” phases, when strongly laminar Levallois and non-Levallois technologies were supplanted by more generalized centripetal Levallois variants (Zaidner et al. 2021). Before the Misliya hominin specimen, it was possible to imagine that this shift also represented the appearance of a new hominin population. It could still mark a dispersal event or population turnover, but now it would be the replacement of one group of *H. sapiens* (and possibly a second population [HersHKovitz et al. 2021]) by another *H. sapiens* population. Alternatively, the changes in technology could represent an autochthonous behavioral development.

The contributions to this volume should also remind us to remain critical of continuing reliance on broadly-defined chrono-typological units such as Lower Paleolithic or Middle Stone Age, and the habit of focusing on transitions between them. Certainly, these concepts are still useful as short-hand references for time, space and sets of associated archaeological features. It might be more accurate to refer to the Middle Paleolithic as “a set of archaeological occurrences characterized by stone artifact assemblages produced mostly though not exclusively through application of a variety of flake production and tool shaping procedures, made by Neanderthals, *Homo sapiens*, Denisovans, and/or other taxa, distributed across Eurasia and dating to between roughly 300 ka and 40 ka,” but nobody actually wants to write or say that, repeatedly. At the same time, the growing corpus of research demonstrates that these broad definitions subsume a great deal of important variability in behavior, ecology, and hominin biology. Consequently, as we have seen, the nature of transitions varies regionally. There are a great many interesting questions to be asked and answered. But they are not the same questions everywhere. In Europe and sub-Saharan Africa, the behavioral transitions are expressed as gradual shifts in economy and technology, and beg questions about the nature of external and internal pressures on indigenous hominins. In the Levant, and possibly in areas such as Arabia and south Asia, the transition may be expressed as more abrupt changes in material culture. In these areas, it forces us to be cognizant and critical of the long-established habit of equating the “sudden” appearance of novel forms of material culture with a change in populations (e.g., compare Foley and Lahr, 1997; Mirazón Lahr and Foley, 1998; White and Ashton, 2003; Fontana et al., 2013; Moncel et al., 2020, on Levallois technology). It also highlights the broader methodological challenge of determining which similarities in behavior and material culture reflect shared ancestry (homology), and which were the products of convergent evolution (homoplasy) (O’Brien et al., 2018; Groucutt, 2020). Moreover, even if one can demonstrate that new populations brought new ways of making stone tools, that only tells part of the story. It should further encourage us to investigate the causes for the appearance and demographic success of the allochthonous populations as well as the cultural dynamics arising from interactions between local and intrusive groups (both Neanderthals and *H. sapiens*).

Finally, it is important to be attentive to how terminologies can influence our thinking. Scholars originally created broad classifications and definitions such as Lower and Middle Paleolithic to summarize known variation, but the definitions do more than just that. They focus our attention

on particular intervals and facts, specifically differences across periods and transitions between them. An example relevant to many papers in this volume illustrates this. Most of the contributors to this volume classify Yabrudian, Amudian and Acheulo-Yabrudian assemblages in the Levant as late Lower Paleolithic. From this perspective there is an abrupt LP-MP transition marked by the appearance of new, more complex forms of blank production as well as hafted points around 250 ka. To be clear, that is an empirically verifiable event, and one deserving explanation. Yet, other researchers (summarized in Shimelmitz and Kuhn, 2018) have argued that the Yabrudian and Amudian could be defined as early Middle Paleolithic rather than late Lower Paleolithic (e.g., Jelinek 1982: 68; LeTensorer 2005). Doing so would effectively create a different transition, highlighting the relationship between the Acheulo-Yabrudian and the late Acheulean. With respect to lithic technology, this perspective would highlight questions about the origins of new sets of procedures such as blade production and Quina method, and about the loss of more classically “predetermined” methods for producing blanks for Large Cutting Tools (Goren-Inbar et al., 2008; Herzlinger et al., 2017). It also would focus our attention on changes in site selection, especially the increasing preference for natural shelters. Of course, we can still study these phenomena, but somehow they appear less salient simply because they do not coincide with a recognized transition between cultural phases or stages. One can see how the same principle would apply in other cases, for example to the industry of unit D at Caune de l’Arago analyzed here by Barsky and colleagues. To be clear, we are not advocating classifying the Acheulo-Yabrudian as Middle Paleolithic. The point is that we need to be attentive to the way the definitions we use direct our thinking about the empirical phenomena they describe.

Notes

¹ The International Union of Geological Sciences officially renamed the Middle Pleistocene the Chibanian in early 2020. However, to be consistent with the papers in the Special Issue we use the older term, Middle Pleistocene, in this introductory section.

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